Scripting Reference Manual

for

BrainVoyager QX 2.1 - 2.8

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Chapter 1

Introduction

Welcome to the BrainVoyager Scripting Reference Manual![1] This reference manual can be used for scripting in BrainVoyager QX 2.8, but most commands can also be used in 2.6, 2.4 and 2.3, some even in BrainVoyager QX 2.2, and some in BrainVoyager QX 2.1. This manual contains the BrainVoyager functions (Application Programmer's Interface (API), see Chapter 3), some introduction to the JavaScript language (Chapter 6) and a short section on writing scripts in BrainVoyager with a user interface (see Chapter 5). A very nice new feature is the Script Debugger, which will be discussed in section 2.5.
When starting with scripting, in BrainVoyager or in general, please also check out our Getting Started with Scripting in BrainVoyager Guide. This can be found in the "GettingStartedGuides" folder of the BrainVoyager directory or online at the BrainVoyager support site.
Latest update: 30-06-2013

1.1 Location of script files

Scripts (*.js) for BrainVoyager QX 2.1 and higher can be stored in the folder `(My) Documents/BVQXExtensions/Scripts/`, so that they will be present in the BrainVoyager "Scripts" menu. An option to specify a custom scripts folder has been added in v2.4.1. Users can switch between standard and custom folder in "Settings" dialog.

[1] This used to be called the 'Scripting Guide' but the new names 'Getting Started Guide for scripting' and 'Scripting Reference Manual' are hopefully more clear.

1.2 History

1.2.1 Scripting in BrainVoyager

BrainVoyager QX 2.8

There are a lot of new functions for surface processing in this version, for example for inhomogeneity correction, transformation of anatomical data to AC-PC and Talairach space, morphing meshes, running single-study GLMs and cortex-based alignment. See sections 3.11 (transformations and normalisation) and 3.12 (surface functions) of the API for more information. Also, there are now mesh and mesh scene objects, which can be obtained via the anatomical object (see example scripts).

v2.8.2 Two new functions and a property, concerning correction of slice timing and mean intensity adjustment, have been introduced.

BrainVoyager QX 2.6

The property `UseBoundingBoxForVTCCreation` is now default set to false, so one only needs to mention the property in a script (set to 'true') in case one wishes to use this numerical bounding box creation.

BrainVoyager QX 2.4.1

It is now possible to perform *temporal high-pass filtering (drift removal) using the GLM approach* using Fourier or discrete cosine transform (DCT) basis functions. In previous versions, only the FFT-based high-pass filtering was available. The new commands are "TemporalHighPassFilterGLMFourier()" and "TemporalHighPassFilterGLMDCT()" with one parameter that specifies the number of cycles (pairs of two basis functions) used to build an appropriate design matrix. The installed script "HighPassFilterUsingGLM.js" shows how to use the new commands. Other new scripting commands allow to interrogate information about the running BrainVoyager version including the build number and whether the program is running in 32 or 64 bit mode. The installed script "VersionScript.js" shows how these commands can be used.
Scripts are installed in a standard location within the user's "Documents" folder ("BVQXExtensions/Scripts"). For some scenarios, it would be beneficial if scripts could be accessed from a custom folder as default, i.e. when written scripts are made available to members of a research group in a shared network folder. For such scenarios it is now possible to change the default scripts folder in the "Scripts" tab of the "Global Preferences" dialog.
There are two new possibilities for manipulating VTCs. The first is that the manual specification of bounding boxes is enabled. This works for any target reference space. Use the property 'UseBoundingBoxForVTCCreation' in combination with TargetVTCBoundingBoxXStart (or Y, or Z) and TargetVTCBoundingBoxXEnd (or Y, or Z).
It is now possible to save the VTC after a protocol has been linked, using the command SaveVTC().

BrainVoyager QX 2.3

BrainVoyager QX can now be used in combination with AppleScript on Mac OS X. For more information, see the 'BVQXAppleScripting.pdf' guide.
For Qt Script there are the following additions. When creating VMR projects, the internally created V16 data set is now stored to disk. When saving the VMR data with a new name ("save as" command used usually after VMR creation), both files will be renamed as long as they have the default "untitled.vmr/.v16" file name.
The new command "CorrectSliceTimingWithSliceOrder" allows to run slice scan correction with a custom slice order (see "Preprocessing.js" script). The "getCurrentDirectory()" function is now a property, i.e. you can use "BrainVoyagerQX.CurrentDirectory" to read and set its value.
There are also new properties pointing to common locations:
The "PathToData" property points as default to the "BVQXData" folder in the user's "(My)Documents" folder and the "PathToSampleData" points as default to the "BVQXSampleData" folder.
Please note that the `FileNameOfPreprocessedFMR` now provides the filename and the path, not just the filename.

BrainVoyager QX 2.2

There are now reading and writing (File I/O) possibilities. Also, the COM (component object model) functionality has been implemented, which means that communication between COM-enabled applications on Windows is possible, for example scripting BrainVoyager from Matlab.
New BrainVoyager script functions are available for preprocessing VTC files, creation of MTC from VTC and create function handles.

BrainVoyager QX 2.1

The language is now fully ECMA-script compliant, which means it is basically JavaScript. Most of the language features are the same; the graphical user interface (GUI) widgets can be made using external user interface files (*.ui)(see section 5).
The parameter `dataType` has been added for creating VTC and VDW files. Two properties for changing the confound in SDM files have been added.

BrainVoyager QX 2.0

No changes.

BrainVoyager QX 1.10

In BrainVoyager QX 1.10.4, it is also possible to create VDW files via scripting.
In BrainVoyager QX 1.10.3, the types of interpolation that can be selected have been extended. For more information, please consult the Interpolation in motion correction page.

BrainVoyager QX 1.9

This version is updated for BrainVoyager QX 1.9. Two important new changes in BrainVoyager QX 1.9 are the DTI analysis functionality and scripting via the component object model (COM)(this works on Windows platforms). Concerning COM, a separate guide appeared called ScriptingBrainVoyagerQXfromMatlab.pdf. For a short introduction, please see the topic Using BrainVoyager via COM.
Also, there are 5 new scripting functions:
RenameDicomFilesInDirectory(), BrowseFile(), BrowseDirectory(), CreateProjectDMR() and CreateProjectMosaicDMR().

For details on creating diffusion weighted projects (DMR), see the topic Creating DMR projects.

For the function to rename DICOM files and the use of BrowseDirectory(), please see the new rename DICOM files page.

The new BrainVoyager QX Getting Scripted Guide can be consulted for a step-by-step approach into scripting.

In 1.9.10, the number of interpolation options has increased for slice scan time correction* and VTC creation. For details, see the BrainVoyager QX 1.9.10 Release Notes.
Changes in the programming language itself concern, for example, the `undefined` which is in BrainVoyager QX 1.9 an object (so no double quotes are needed). Also, the arguments for the getOpenFileName(s) functions have changed. The language specification for Qt Script 1.2.2 by Trolltech can be found also in this guide.

1.2.2 Documentation history

v1.6

Added information about new slice scan time correction and mean intensity adjustment functions and paragraph 2.5.1 about setting breakpoints during debugging. Also, paid some more attention to the BrainVoyagerQX object functions BrowseFile() and BrowseDirectory().

v1.5

Added new VMR functions and mesh scene object functions to documentation.

v1.4

Added mesh object functions.

v1.3

Added descriptions of String functions (section 6.2.2).

v1.2

Corrected description of `SliceScanTimeCorrection()`.

v1.1

03-04-2013 Corrected the property `CorrectForSerialCorrelations`: value is integer so that both AR(1) and AR(2) can be applied.

v1.0

08-06-2012 Added a section on design matrix properties (in particular, setting confounds and constant predictors) and brief information about setting bounding boxes for VTCs and saving VTCs.

v0.9

08-03-2012 Added short section about the script object, added the new functions from BrainVoyager QX 2.4.1 to the API documentation.

v0.8

07-02-2012 Added a section about using Qt Objects in BrainVoyager scripting (section 6.3) and added some information to the File I/O chapter (Chapter 4). Improved layout and markup of the document.

v0.7

21-11-2011 Added the GUI scripts example, moved the "Switching from BrainVoyager QX 2.0 to 2.1 scripting" to the Appendix.

1.3 Switching from scripting in BrainVoyager QX 2.0 to 2.1 or higher

How to use Qt Script and what are the differences with respect to QSA?
- To start, call the scripting dialog clicking on "Scripts" → "Scripting..." menu.
- Files are stored as ".js" (JavaScript) text files allowing to use also external editors (by simple double-clicking).
- Instead of "Application.BrainVoyagerQX", you only need "BrainVoyagerQX" global symbol to get access to the BVQX API, please have a look at the example scripts.
- There (at present) no support for "projects", i.e. only one file is evaluated (this might change).
- The script editor has syntax highlighting. Furthermore the QScript debugger is integrated, which allows for easy hunting of bugs.
- On Windows, COM support is available from version 2.2.
- QScript is much faster than QSA, so some "plugin" processing will be possible without requiring C++ code.
- Scripts with a graphical user interface (GUI) have to be started from within the script editor.
- Script GUIs are saved in user interface (*.ui) files that can be created with the free Qt Designer software.
See also appendix A.

Chapter 2

The BrainVoyager Script Editor

2.1 General properties of the BrainVoyager Script Editor

In the BrainVoyager Script Editor it is possible to perform all scripting operations, namely creating a script, debugging a script en running a script.

2.1.1 The user interface

The Script Editor will be displayed in 3/4 window. To see the script editor buttons “Load”, “Save”, “Save As”, “Close”, “Debug” and “Run” on Mac OS X, press the green circle in the left upper corner of the window. The line numbers of the script are provided on the left side of the screen. The currently selected line in the script will be colored light yellow.

2.2 Creating scripts

A script can be created in the BrainVoyager QX script editor (see figure 2.2). The script editor can be opened via the “Scripting...” menu option in BrainVoyager QX (see figure 2.1).

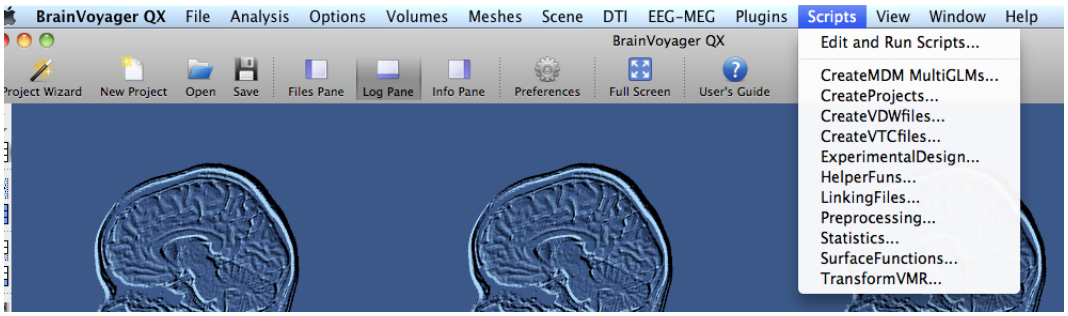


Figure 2.1: Open the Scripting Editor

2.3 Running scripts

There are two ways to run a script. If the script has no user interface, the script can be run directly from the BrainVoyager "Scripts" menu (see the Example scripts being listed in the "Scripts" menu of figure 2.1), provided that the scripts are present in the folder `Documents/BVQXExtensions/Scripts/`. It is also possible to run the script by clicking the "Run" button in the BrainVoyager QX Script Editor. Scripts that come with a user interface, so that it has a dialog(s) which is defined in an accompanying *.ui file, can be started by clicking the "Run" button in the BrainVoyager QX Script Editor.
For running a script, load the script if it is not opened yet via the button "Load" in the lower left corner of the Scripting Editor. Then, click "Run" in the lower right corner of the Scripting Editor window. All command lines that are not embedded within a `function ... { }` block will be executed (of course these lines can invoke the functions).

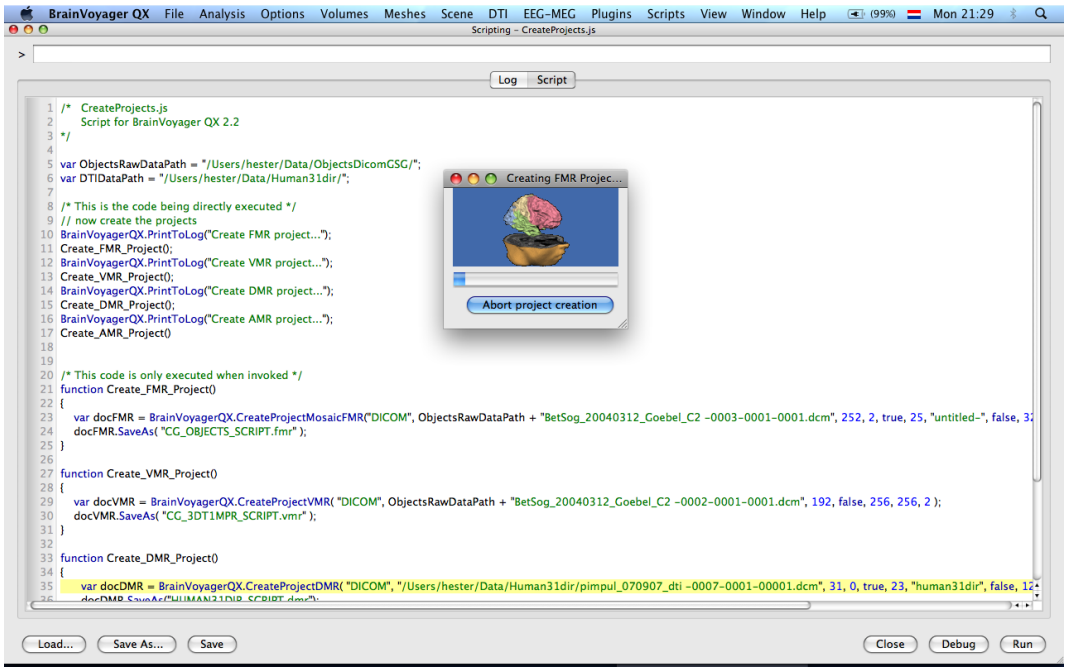


Figure 2.2: Running a script

The script will run; effects may be visible via BrainVoyager dialogs (see figure 2.2) or messages printed to the BrainVoyager QX Log tab (see figure 2.3).

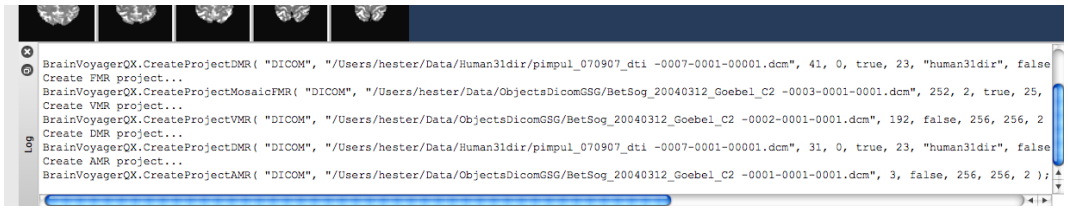


Figure 2.3: Messages printed to the BrainVoyager QX Log tab while running a script

2.4 Using the interpreter

In the BrainVoyager QX Script Editor, also a direct interpreter is available. Type the command to be evaluated in the command line field, which is depicted in figure 2.4, then press "Enter".

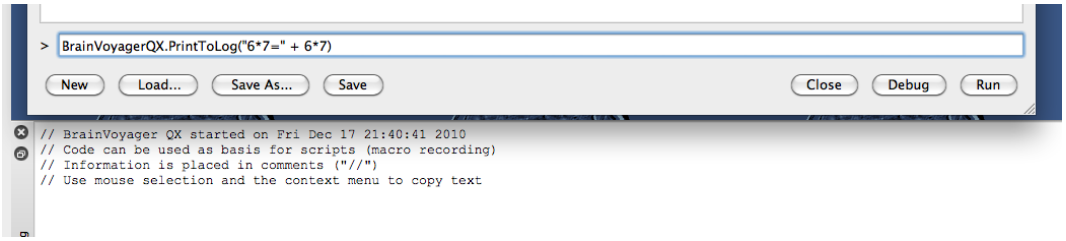


Figure 2.4: Commands typed in this field will be evaluated directly

The command and the output of the command will be visible in the command history window directly above the command line (see figure 2.5). If the command does not produce output, the command history window will print `undefined`, otherwise the output is placed under the command in the history window.

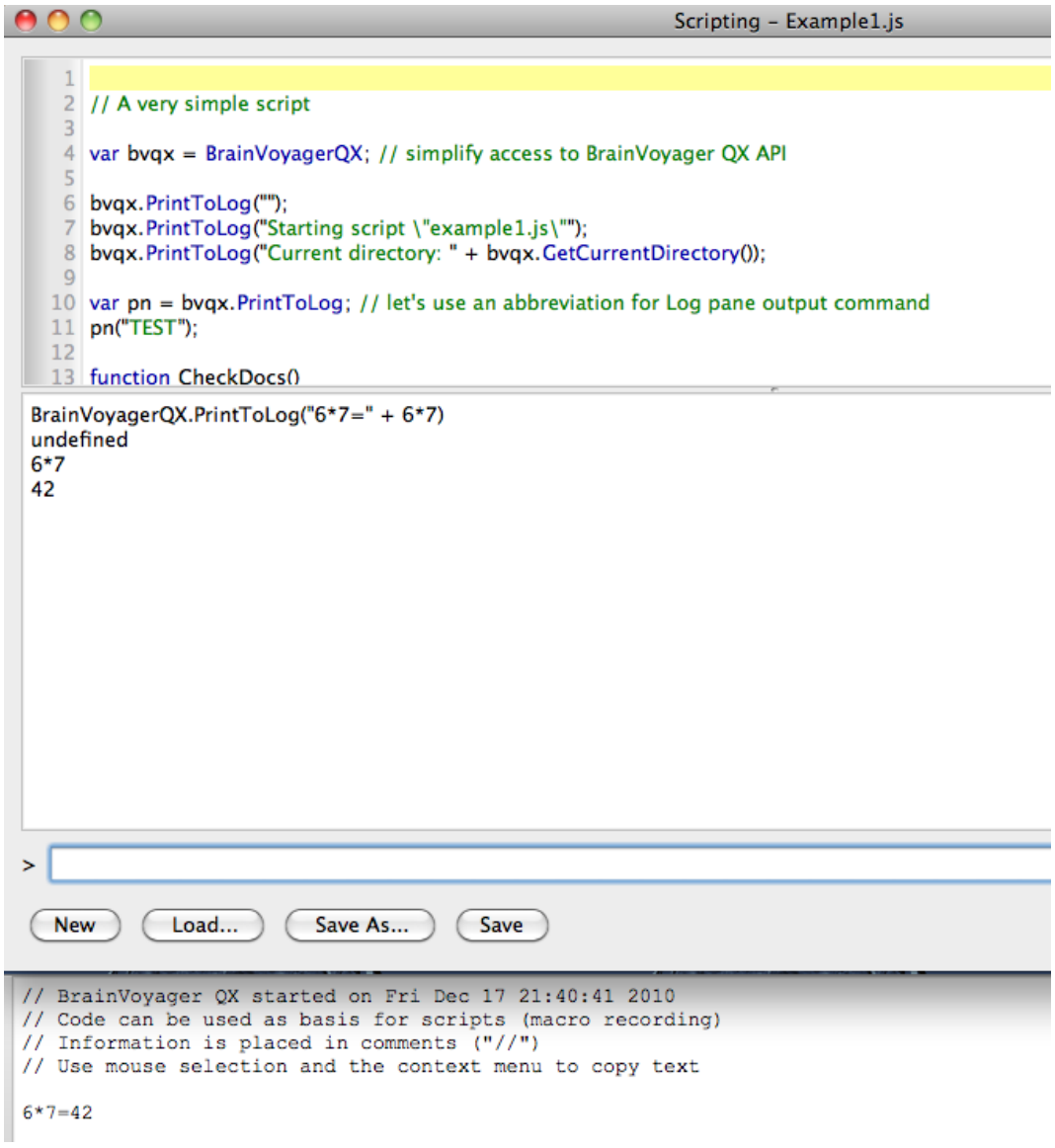


Figure 2.5: Commands typed in the command line are printed in the command history window

2.5 Debugging

When an error cannot be found, it can be useful to try the debugging functionality. Click the "Debug" button and the window as depicted in figure 2.6 will appear. This will locate the error. If the script does not contain bugs after pressing 'Run' (green arrow) in the Debugger, the Debugger will disappear after running the script and the Script Editor will be shown again.

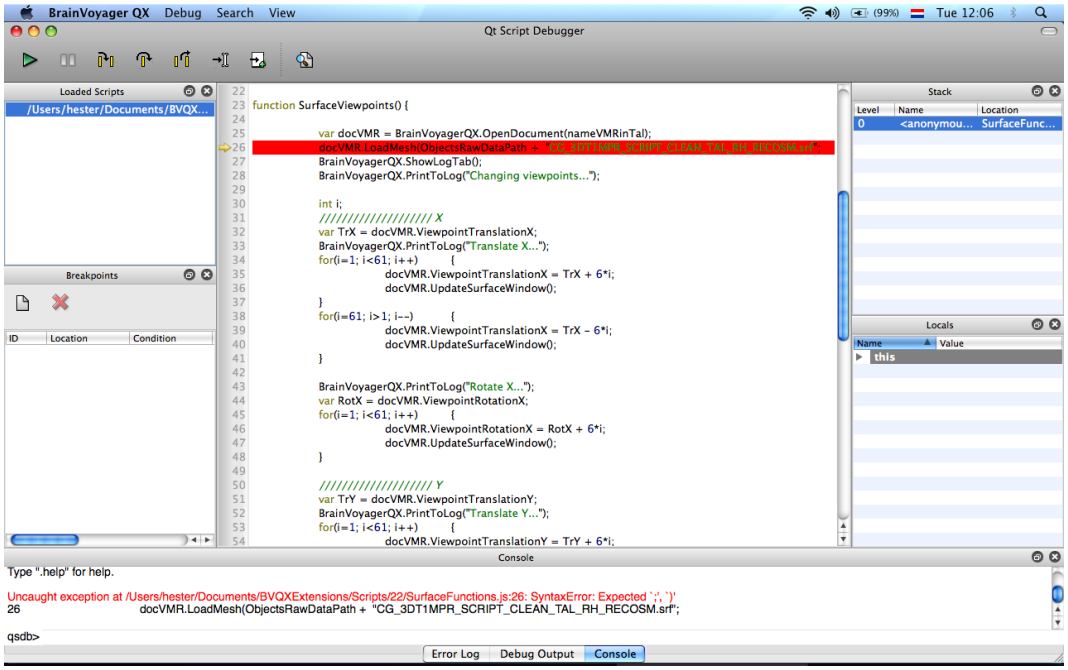


Figure 2.6: Debugging in the Scripting Editor

2.5.1 Setting breakpoints

A breakpoint can also be used go stepwise through the script while it is running, in order to inspect the values of the variables in scope. Click left of the line to set a breakpoint (a round, red dot); click again to remove the breakpoint. A list of all breakpoints with line numbers can be found on the left hand side of the Debugger dialog. When the script runs until the breakpoint, all values that have been assigned to variables in scope, will be visible under 'Scope' on the right hand side of the Debugger dialog.

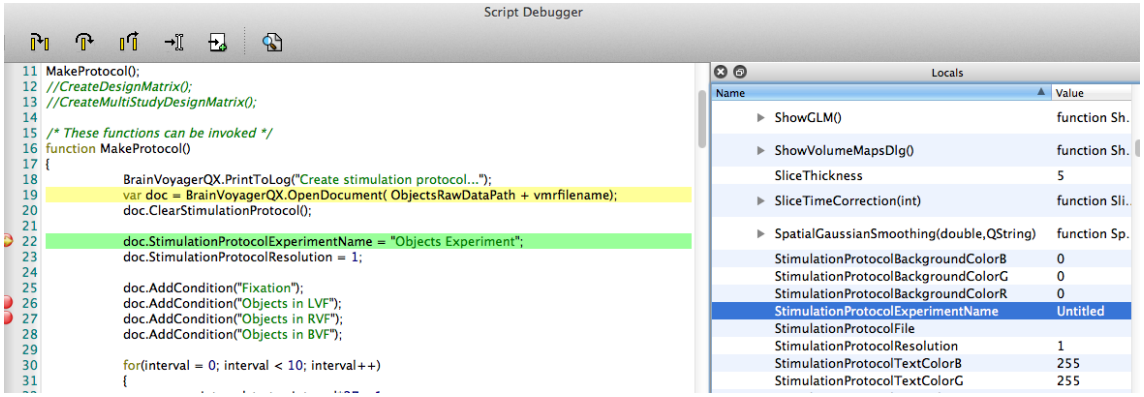


Figure 2.7: Using run to cursor

In figure 2.8, we see for example that the project property `StimulationProtocolExperimentName` has now been filled (starting with 'Objects Exp ...'); in figure 2.7 we see that this was still 'Untitled'.

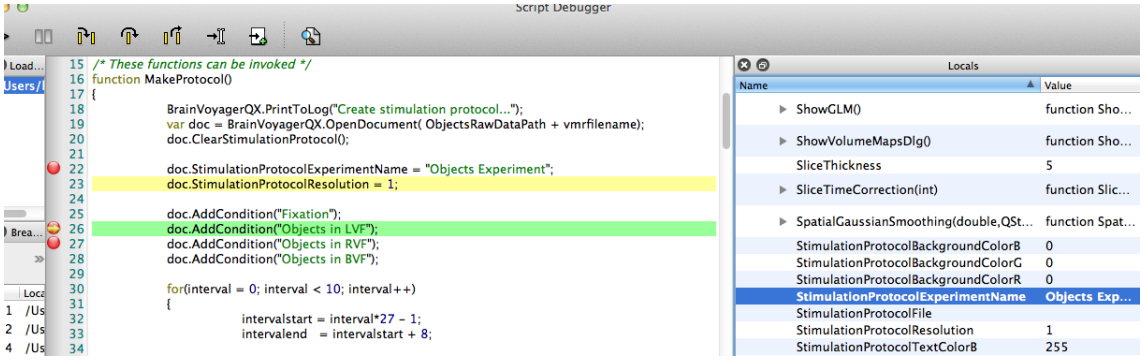


Figure 2.8: Setting breakpoints

Using the button 'Step into' (figure 2.9), the Debugger will run the script line by line.

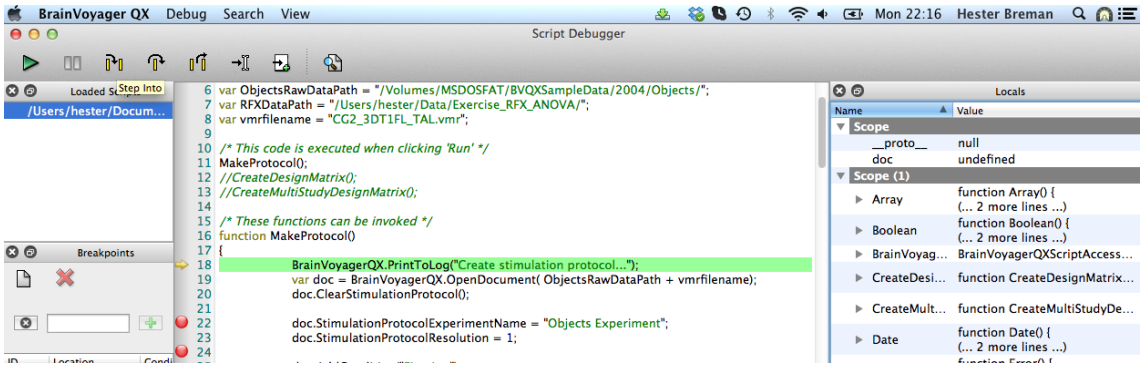


Figure 2.9: The 'Step into' button runs the script line by line (upper left hand side of figure). Note that the doc (VMR) object is still 'undefined' at line 18 (upper right hand side).

The yellow arrow will indicate at which line the Debugger is. In the Scope section, we will see which values have been assigned to our object `doc` (see figure 2.10).

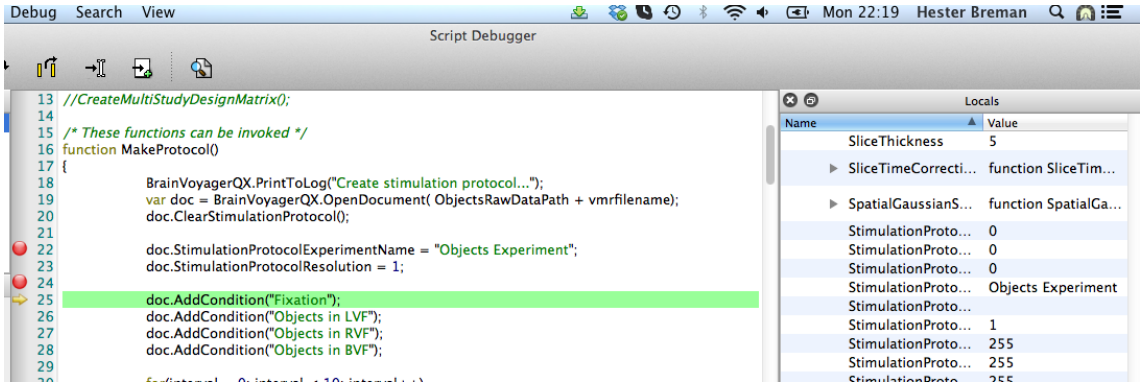


Figure 2.10: Now the Debugger has run the script until line 25, the doc object now has values assigned; these can be inspected under Locals: Scope on the right hand side.

Chapter 3

BrainVoyager Scripting Commands (API)

3.1 Introduction

In this chapter is documented which BrainVoyager scripting methods are available.

3.1.1 Invoking BrainVoyager scripting functions from other programs

On Windows, the BrainVoyager scripting functions can also be invoked from COM-enabled programs like Matlab. To use this, open the 'command prompt', go to the BrainVoyager QX directory via the DOS command `cd ..` (change directory). When in the BrainVoyager QX directory, type

```
BrainVoyagerQX.exe -regserver.
```

This declares the COM-facilities of BrainVoyager to the rest of Windows.
Then, for example in Matlab, start BrainVoyager by typing:
`bvqx = actxserver('BrainVoyagerQX.BrainVoyagerQXScriptAccess.1')`. Now the BrainVoyager script functions can be used just like they are described below. Details can be found in the "Scripting BrainVoyager QX from Matlab" guide.
The Component Object Model (COM) has been developed by Microsoft. Most applications from Microsoft are COM-enabled. Therefore, another possibility is to use the Windows Scripting Host to execute the BrainVoyager script functions. The script should be saved as a Visual Basic Script (*.vbs) in that case. An example is shown below. To run this script on Windows, one just needs to double-click the *.vbs file.
On Mac, AppleScript can be used. For a nice AppleScript guide (by Bert Altenburg), see
http://files.macscripter.net/sourcebook/AS4ASb2.pdf.

3.1.2 Example script

In this example is shown how to invoke BrainVoyager script functions from other COM-enabled programs.

```
Dim BrainVoyagerQX
Set BrainVoyagerQX = CreateObject("BrainVoyagerQX.BrainVoyagerQXScriptAccess")

'BrainVoyagerQX.TimeOutMessageBox "Welcome to COM scripting", 3

BrainVoyagerQX.PrintToLog "Hello from VBS script!"

'MeshFile = BrainVoyagerQX.BrowseFile("Select Mesh File", "*.srf")
'BrainVoyagerQX.PrintToLog MeshFile

Set docVMR = BrainVoyagerQX.OpenDocument("C:\Users\rainer\Data\CG2_3DT1FL_SINC4_TAL.vmr")
BrainVoyagerQX.TimeOutMessageBox "VMR document loaded!", 3

'Set docVMR = BrainVoyagerQX.CreateProjectVMR "DICOM",
"C:\Users\rainer\Data\BetSog_20040312_Goebel_C2 -0002-0001-0001.dcm", 192, false, 256, 256, 2
'docVMR.SaveAs "CG_3DT1MPR_SCRIPT.vmr"
docVMR.Close
```

3.2 List of all methods

RenameDicomFilesInDirectory()
PrintToLog()
ShowLogTab()
MoveWindow()
OpenDocument()
BrowseFile()
BrowseDirectory()
CreateProjectFMR()
LinkAMR()
CreateProjectMosaicFMR()
CreateProjectFMRSlicesTimeLooping()
CreateProjectDMR()
CreateProjectMosaicDMR()
CreateProjectVMR()
LinkStimulationProtocol()
LinkVTC()
CreateProjectAMR()
Close()
CorrectSliceTiming()
CorrectSliceTimingWithSliceOrder()
CorrectSliceTimingUsingTimeTable()
CorrectMotion()
CorrectMotionEx()
CorrectMotionTargetVolumeInOtherRun()
CorrectMotionTargetVolumeInOtherRunEx()
TemporalHighPassFilterGLMFourier()
TemporalHighPassFilterGLMDCT()
TemporalHighPassFilter()
LinearTrendRemoval()
TemporalGaussianSmoothing()
SpatialGaussianSmoothing()
AdjustMeanIntensity()
SpatialGaussianSmoothing()
LinearTrendRemoval()
TemporalHighPassFilter()
TemporalGaussianSmoothing()
AutoTransformToIsoVoxel()
AutoTransformToSAG()
SetVoxelIntensity(x, y, z, intensity)
GetVoxelIntensity(x, y, z)
CorrectIntensityInhomogeneities()
AutoACPCAndTALTransformation()
CreateVTCInVMRSpace()
CreateVTCInACPCSpace()
CreateVTCInTALSpace()
CreateVDWInVMRSpace()
CreateVDWinACPCSpace()
CreateVDWInTALSpace()
SaveVTC()
ClearStimulationProtocol()
LinkStimulationProtocol()
AddCondition()
SetConditionColor()
AddInterval()
SaveStimulationProtocol()
ClearDesignMatrix()

SetPredictorValues()
SetPredictorValuesFromCondition()
ApplyHemodynamicResponseFunctionToPredictor()
ScalePredictorValues()
SaveSingleStudyGLMDesignMatrix()
ClearMultiStudyGLMDefinition()
AddStudyAndDesignMatrix()
SaveMultiStudyGLMDefinitionFile()
LoadSingleStudyGLMDesignMatrix()
LoadMultiStudyGLMDefinitionFile()
ComputeSingleStudyGLM()
ComputeMultiStudyGLM()
ComputeRFXGLM()
LoadGLM()
ShowGLM()
SaveGLM()
ClearContrasts()
SetCurrentContrast()
SetCurrentContrastAtIndex()
AddContrast()
SetContrastValue()
SetContrastString()
SetContrastValueAtIndex()
LoadMesh()
AddMesh()
SaveMesh()
UpdateSurfaceWindow()
SaveSnapshotOfSurfaceWindow()
LinkMTC()
CreateMTCFromVTC()
mesh.MeshScene.UpdateSurfaceWindow()
mesh.SaveAs()
mesh.CalculateCurvature()
mesh.CalculateCurvatureCBA()
mesh.SmoothMesh()
mesh.SmoothRecoMesh()
mesh.SmoothCurrentMap()
mesh.InflateMeshToSphere()
mesh.InflateMesh()
mesh.CorrectInflatedSphereMesh()
mesh.CreateMultiScaleCurvatureMap()
mesh.SpatialSmoothing()
mesh.LinearTrendRemoval()
mesh.TemporalHighPassFilterFFT()
mesh.TemporalGaussianSmoothing()
mesh.CreateMTCFromVTC()
mesh.LinkMTC()
mesh.SaveMTC()
mesh.LinkMTC()
mesh.ClearDesignMatrix()
mesh.LoadSingleStudyGLMDesignMatrix()
mesh.ComputeSingleStudyGLM()
mesh.ShowGLM()
mesh.SaveGLM()
mesh.CreateSphericalCoordinatesMapFromSMP()

MapSphereMeshFromStandardSphere()
SetStandardSphereToFoldedMesh()

CreateStandardSphereMesh()
ClearGroupCBACurvatureFiles()
AddCurvatureFileForGroupCBA()
RunRigidCBA()
RunCBA()
CreateAverageCurvatureGroupMap()
CreateAverageFoldedGroupMesh()

3.3 BrainVoyager QX-specific classes

A BrainVoyager document in the scripting module is an FMR, VMR, DMR, AMR project. To retrieve a pointer to a BrainVoyager document object, use the property `ActiveDocument`:
`var doc = BrainVoyagerQX.ActiveDocument;`
when the project is currently open in BrainVoyager. If it needs to be opened first, provide the document name and use the function `OpenDocument()`:
`var doc = BrainVoyagerQX.OpenDocument(docname);.`

3.4 Functions of the BrainVoyagerQX object

3.4.1 List of methods

RenameDicomFilesInDirectory()
PrintToLog()
ShowLogTab()
MoveWindow()
BrowseFile()
BrowseDirectory()
OpenDocument()
Also the `CreateProject()` functions below (see section 3.5) are functions of the BrainVoyagerQX object. All other functions in BrainVoyager's API are functions of the Document object (AMR/FMR/DMR/VMR projects).

BrainVoyagerQX properties

x: Get or set the position on the x-axis of the BrainVoyager window.
y: Get or set the position on the x-axis of the BrainVoyager window.
ActiveDocument: The currently opened document (a BrainVoyager AMR/FMR/DMR/VMR project).
CurrentDirectory: You can use "BrainVoyagerQX.CurrentDirectory" to read and set its value (changed from function to property in QX 2.3).
PathToData: This property points as default to the "BVQXData" folder in the user's "(My)Documents" folder (added in QX 2.3).
PathToSampleData: This property points as default to the "BVQXSampleData" folder (added in QX 2.3).
VersionMajor: Get version number of BrainVoyager QX. *VersionMinor:* Get subversion number of BrainVoyager QX. *BuildNumber:* Get build number of BrainVoyager QX. *Is64Bits:* If BrainVoyager QX version is 64 bits, value is true; otherwise the version is 32 bits.

3.4.2 Detailed description of methods

RenameDicomFilesInDirectory()

RenameDicomFilesInDirectory()
Description: Rename all DICOM files in the current directory.
Parameter 1: Name of directory.

PrintToLog()

PrintToLog()
Description: Print text to the BrainVoyager QX Log tab.
Parameter 1: Text to print.

ShowLogTab()

ShowLogTab()
Description: Show the BrainVoyager QX Log tab.

MoveWindow()

MoveWindow()
Description: Move the BrainVoyager QX window to a new position on the screen.
Parameter 1: New position on x-axis.
Parameter 2: New position on y-axis.

BrowseFile()

See BrowseFile() in File I/O.

BrowseDirectory()

See BrowseDirectory() in File I/O.

OpenDocument()

OpenDocument()
Description: Open a BrainVoyager project.
Parameter 1: Name of the FMR/AMR/VMR/DMR project to open.
Returns: The project.

3.5 Create projects

3.5.1 List of Methods

CreateProjectFMR()
LinkAMR()
CreateProjectMosaicFMR()
CreateProjectFMRSlicesTimeLooping()
CreateProjectDMR()
CreateProjectMosaicDMR()
CreateProjectVMR()
LinkStimulationProtocol()
LinkVTC()
CreateProjectAMR()
Close()

3.5.2 Create FMR project

CreateProjectFMR()

CreateProjectFMR() *Function:* CreateProjectFMR(FileType, FirstFileName, NrOfVolumes, nrOfVolumesToSkip, createAMR, nrOfSlices, prefixSTCs, swapBytes, resX, resY, nrBytes, savingDir).
Description: FMR projects consist of a set of functional data in the original "slice space".
Member of class: BrainVoyagerQX.
Parameter 1: FileType (string): file type of original data. One of `"DICOM"`, `"SIEMENS"`, `"GE_I"` (no parameters for +20 logic like in GUI),`"GE_MR"`, `"PHILIPS_REC"` or `"ANALYZE"`.
Parameter 2: FirstFileName: name of the first "raw" data file.
Parameter 3: NrOfVolumes: number of volumes for this project.
Parameter 4: nrOfVolumesToSkip: number of volumes that should be skipped at the beginning, so number of volumes in FMR project will be (NrOfVolumes - nrOfVolumesToSkip).
Parameter 5: createAMR: boolean (true or false): create AMR from first EPI volume or not.
Parameter 6: nrOfSlices: number of slices per volume.
Parameter 7: prefixSTCs: name for the stc file.
Parameter 8: swapBytes: swap bytes (true or false).
Parameter 9: resX - dimension of image along x-axis
Parameter 10: resY - dimension of image along y-axis
Parameter 11: nrBytes - number of bytes per pixel, usually 2.
Parameter 12: savingDir - directory for saving the FMR project.
Returns: Document

CreateProjectMosaicFMR()

CreateProjectMosaicFMR() *Description:* FMR projects consist of a set of functional data in the original "slice space". The "Mosaic" version of FMR creation is necessary when reading Siemens files from scanning sequences which store several slices within a single image. The format of such "mosaic-images" is not a stack of slices (i.e. as in ANALYZE files), therefore special treatment is required.
Member of class: BrainVoyagerQX.
Parameter 1: FileType (string): file type of original data. One of `"DICOM"`, `"SIEMENS"`, `"GE_I"` (no parameters for +20 logic like in GUI),`"GE_MR"`, `"PHILIPS_REC"` or `"ANALYZE"`.
Parameter 2: FirstFileName
Parameter 3: NrOfVolumes
Parameter 4: nrOfVolumesToSkip
Parameter 5: createAMR
Parameter 6: nrOfSlices
Parameter 7: prefixSTCs
Parameter 8: swapBytes
Parameter 9: mosaicResX - mosaic size: dimension of images in volume along x-axis
Parameter 10: mosaicResY - mosaic size: dimension of images in volume along x-axis
Parameter 11: nrBytes
Parameter 12: savingDir
Parameter 13: volsInImg - number of volumes per file

Parameter 14: resX - dimension of image along x-axis
Parameter 15: resY - dimension of image along y-axis
Returns: Document
Example:

```
 var docFMR = BrainVoyagerQX.CreateProjectMosaicFMR("DICOM",
ObjectsRawDataPath + "BetSog_20040312_Goebel_C2 -0003-0001-0001.dcm", 252, 2, true,
 25, "untitled-", false, 320, 320, 2, ObjectsRawDataPath, 1, 64, 64 );
```

CreateProjectFMRSlicesTimeLooping()

CreateProjectFMRSlicesTimeLooping() *Function:* CreateProjectFMRSlicesTimeLooping(FileType, FirstFileName, NrOfVolumes, nrOfVolumesToSkip, createAMR, nrOfSlices, prefixSTCs, swapBytes, resX, resY, nrBytes, savingDir)
Description: See CreateProjectFMR(). The current function is similar to using the "Slices x time" checkbox via the BrainVoyager Create Project dialog. *Member of class:* BrainVoyagerQX.
Parameter 1: FileType (string): file type of original data. One of `"DICOM"`, `"SIEMENS"`, `"GE_I"` (no parameters for +20 logic like in GUI),`"GE_MR"`, `"PHILIPS_REC"` or `"ANALYZE"`.
Parameter 2: FirstFileName: name of the first "raw" data file.
Parameter 3: NrOfVolumes: number of volumes for this project.
Parameter 4: nrOfVolumesToSkip: number of volumes that should be skipped at the beginning, so number of volumes in FMR project will be (NrOfVolumes - nrOfVolumesToSkip).
Parameter 5: createAMR: boolean (true or false): create AMR from first EPI volume or not.
Parameter 6: nrOfSlices: number of slices per volume.
Parameter 7: prefixSTCs: name for the stc file.
Parameter 8: swapBytes: swap bytes (true or false).
Parameter 9: resX - dimension of image along x-axis
Parameter 10: resY - dimension of image along y-axis
Parameter 11: nrBytes - number of bytes per pixel, usually 2.
Parameter 12: savingDir - directory for saving the FMR project.
Returns: Document

LinkAMR()

LinkAMR() *Description:* Link the provided AMR to the currently opened FMR.
Parameter 1: Name of the AMR file.

FMR project properties

TR: Repetition time in milliseconds. For example '2000'.
InterSliceTime: Time in milliseconds between acquisition of two adjacent slices. Example value: 80;
TimeResolutionVerified: Property to assert that the time resolution is correction. Values either true or false (boolean).
PixelSizeOfSliceDimX: Size of a pixel in millimeters in x-dimension. Example value: 3.5.
PixelSizeOfSliceDimY: Size of a pixel in millimeters in y-dimension. Example value: 3.5.
SliceThickness: Thickness of a slice in millimeters. For example '3'.
GapThickness: Space between slices, measured in millimeters. Example value: 0.99. *VoxelResolutionVerified:* Property ensuring that the voxel resolution of the FMR project has been set properly. Value is either true or false (boolean). *HasSliceTimeTable:* Indicates whether the data contain a time table for multiband data (MB-EPI). Use with CorrectSliceTimingUsingTimeTable().

3.5.3 Create DMR projects

CreateProjectDMR()

CreateProjectDMR()
Parameter 1: Filetype (string): file type of original data. One of `"DICOM"`, `"PHILIPS_REC"` or `"ANALYZE"`.
Parameter 2: firstFile (string): the filename and path of the first file of the data.
Parameter 3: Number of directions (integer): the number of directions (=volumes).
Parameter 4: Number of directions to skip (integer): the number of directions (=volumes) to skip.
Parameter 5: Create AMR (boolean): should an AMR project be created: true or false. This is for visualization purposes.
Parameter 6: nrOfSlices (integer): the number of slices in a volume.
Parameter 7: Prefix (string): Name for DWI file.
Parameter 8: isLittleEndian (boolean): Is 'true' when the byte order is little endian; otherwise 'false'.
Parameter 9: nrOfBytes (integer): Number of bytes for each pixel. 1 byte is 8 bits. Example value: 2.
Parameter 10: xSize (integer): Size of image along x-axis. Example value: 128.
Parameter 11: ySize (integer): Size of image along y-axis. Example value: 128.
Parameter 12: Number of bytes per pixel (integer): Precision of intensity value. Usually 2 byte (16 bits).
Parameter 13: Saving directory (string): Name of path where DMR project should be saved.
Returns: Document

CreateProjectMosaicDMR()

Function: CreateProjectMosaicDMR()
Member of class: BrainVoyagerQX.
Parameter 1: FileType (string): file type of original data. One of `"DICOM"`, `"SIEMENS"`, `"GE_I"` (no parameters for +20 logic like in GUI),`"GE_MR"`, `"PHILIPS_REC"` or `"ANALYZE"`.
Parameter 2: FirstFileName
Parameter 3: NrOfDirections (number of volumes)
Parameter 4: nrOfVolumesToSkip
Parameter 5: createAMR
Parameter 6: nrOfSlices
Parameter 7: prefixSTCs
Parameter 8: swapBytes
Parameter 9: mosaicResX - mosaic size: dimension of images in volume along x-axis
Parameter 10: mosaicResY - mosaic size: dimension of images in volume along x-axis
Parameter 11: nrBytes
Parameter 12: savingDir
Parameter 13: volsInImg - number of volumes per file
Parameter 14: resX - dimension of image along x-axis
Parameter 15: resY - dimension of image along y-axis
Returns: Document

3.5.4 Create VMR projects

CreateProjectVMR()

Function: CreateProjectVMR()
Creates an anatomical project in 8-bit (.vmr) and 16-bit (*.v16). Parameter 1:* Filetype (string): file type of original data. One of `"DICOM"`, `"SIEMENS"`, `"GE_I"` (no parameters for +20 logic like in GUI),`"GE_MR"`, `"PHILIPS_REC"` or `"ANALYZE"`.
Parameter 2: firstFile (string): the filename and path of the first file of the data.
Parameter 3: nrOfSlices (integer): the number of slices in a volume.
Parameter 4: isLittleEndian (boolean): Is 'true' when the byte order is little endian; otherwise 'false'.
Parameter 5: xSize (integer): Size of image along x-axis. Example value: 256.
Parameter 6: ySize (integer): Size of image along y-axis. Example value: 256.
Parameter 7: nrOfBytes (integer): Number of bytes for each pixel. 1 byte is 8 bits. Most often used value: 2 bytes.
Returns: Document

LinkStimulationProtocol()

Function: LinkStimulationProtocol()
Description: Valid only if the document is a) of type FMR or b) of type VMR and if a VTC file has been linked. In the latter case, the specified stimulation protocol is linked to the VTC file. To establish a permanent link, save the FMR project or the VTC file.
Parameter 1: Name of the stimulation protocol file.

LinkVTC()

Function: LinkVTC()
Description: Link the provided VTC file to the currently opened VMR.
Parameter 1: Name of the normalized functional data file (*.vtc).

List of VMR properties

VMRVoxelResolutionX: Size of a pixel along x-dimension.
VMRVoxelResolutionY: Size of a pixel along y-dimension.
VMRVoxelResolutionZ: Size of a pixel along z-dimension.
ExtendedTALSpaceForVTCCreation: Necessary to set explicitly before creating a VTC in any space. When this property is true, it will create a VTC where the Talairach bounding box includes the cerebellum.
FileNameOfCurrentVTC Retrieve file name of attached functional (VTC) file.
UseBoundingBoxForVTCCreation: True if one would like to create a bounding box of a different size than the default, using the offset into the VMR. Set this property to true of false before starting to create any VTC. (Since 2.6: this property is default set to false, so it does not need to be set before creation of any VTC.)
TargetVTCBoundingBoxXStart: Start of the bounding box in VMR on x-axis.
TargetVTCBoundingBoxYStart: Start of the bounding box in VMR on y-axis.
TargetVTCBoundingBoxZStart: Start of the bounding box in VMR on z-axis.
TargetVTCBoundingBoxXEnd: End of the bounding box in VMR on x-axis.
TargetVTCBoundingBoxYEnd: End of the bounding box in VMR on y-axis.
TargetVTCBoundingBoxZEnd: End of the bounding box in VMR on z-axis.
CurrentMeshScene: Create and obtain mesh scene object. See CurrentMeshScene in surface section.
MeshScene: Obtain mesh scene object. See MeshScene in surface section.

3.5.5 Create AMR projects

CreateProjectAMR()

CreateProjectAMR() *Function:* CreateProjectAMR()
Description: Creates an AMR project file. AMR projects consist of a set of two-dimensional anatomical scans used to overlay statistical maps in the original "slice space". If successful, an AMR document is returned. Use this object to access document methods. The name of the first file must contain the full path information. You may want to check proper reading of your data using the New Project Wizard or Create Project dialog before using this command in your scripts. *Parameter 1:* Filetype (string): file type of original data. One of `"DICOM"`, `"SIEMENS"`, `"GE_I"` (no parameters for +20 logic like in GUI),`"GE_MR"`, `"PHILIPS_REC"` or `"ANALYZE"`.
Parameter 2: firstFile (string): the filename and path of the first file of the data.
Parameter 3: nrOfSlices (integer): the number of slices in a volume.
Parameter 4: isLittleEndian (boolean): Is 'true' when the byte order is little endian; otherwise 'false'. Is usually 'true'.
Parameter 5: xSize (integer): Size of image along x-axis. Example value: 256.
Parameter 6: ySize (integer): Size of image along y-axis. Example value: 256.
Parameter 7: nrOfBytes (integer): Number of bytes for each pixel. 1 byte is 8 bits. Example value: 2.
Returns: Document

3.5.6 For all projects

Close()

Description: Close the current FMR/VMR/AMR/DMR project.

3.5.7 Example scripts

```
/*  CreateProjects.js
Script for BrainVoyager QX 2.1
*/

var ObjectsRawDataPath = "/Users/hester/Data/ObjectsDicomGSG/";
var DTIDataPath = "/Users/hester/Data/Human31dir/";

/* This is the code being directly executed */
// now create the projects
BrainVoyagerQX.PrintToLog("Create FMR project...");
Create_FMR_Project();
BrainVoyagerQX.PrintToLog("Create VMR project...");
Create_VMR_Project();
BrainVoyagerQX.PrintToLog("Create DMR project...");
Create_DMR_Project();
BrainVoyagerQX.PrintToLog("Create AMR project...");
Create_AMR_Project()


/* This code is only executed when invoked */
function Create_FMR_Project()
{
    var docFMR = BrainVoyagerQX.CreateProjectMosaicFMR("DICOM", ObjectsRawDataPath +
     "BetSog_20040312_Goebel_C2 -0003-0001-0001.dcm",
     252, 2, true, 25, "untitled-", false, 320, 320, 2, ObjectsRawDataPath, 1, 64, 64 );
    docFMR.SaveAs( "CG_OBJECTS_SCRIPT.fmr" );
}

function Create_VMR_Project()
{
    var docVMR = BrainVoyagerQX.CreateProjectVMR( "DICOM", ObjectsRawDataPath +
     "BetSog_20040312_Goebel_C2 -0002-0001-0001.dcm",
     192, false, 256, 256, 2 );
    docVMR.SaveAs( "CG_3DT1MPR_SCRIPT.vmr" );
}

function Create_DMR_Project()
{
var docDMR = BrainVoyagerQX.CreateProjectDMR( "DICOM",
"/Users/hester/Data/Human31dir/pimpul_070907_dti -0007-0001-00001.dcm",
31, 0, true, 23, "human31dir", false, 128, 128, 2, "/Users/hester/Data/Human31dir" );
docDMR.SaveAs("HUMAN31DIR_SCRIPT.dmr");
}

function Create_AMR_Project()
{
    var docAMR = BrainVoyagerQX.CreateProjectAMR( "DICOM",
     ObjectsRawDataPath + "BetSog_20040312_Goebel_C2 -0001-0001-0001.dcm",
     3, false, 256, 256, 2 );
    docAMR.SaveAs("CG_SLICELOCALIZER_SCRIPT.amr");
}
```

3.6 BVQX Project functions: Preprocessing of functional data (FMR)

3.6.1 List of methods

CorrectSliceTiming()
CorrectSliceTimingWithSliceOrder()
CorrectSliceTimingUsingTimeTable()
CorrectMotion()
CorrectMotionEx()
CorrectMotionTargetVolumeInOtherRun()
CorrectMotionTargetVolumeInOtherRunEx()
TemporalHighPassFilterGLMFourier()
TemporalHighPassFilterGLMDCT()
TemporalHighPassFilter()
LinearTrendRemoval()
TemporalGaussianSmoothing()
SpatialGaussianSmoothing()
AdjustMeanIntensity()

3.6.2 Detailed description of methods

CorrectSliceTiming()

CorrectSliceTiming()
Function: CorrectSliceTiming()
Description: Most EPI sequences measure the slices of a functional volume in succession but one often would like to treat the data of one volume as if it were acquired at the same time, particularly in the context of event-related studies. Using linear interpolation, the present method resamples the time series for the different slices in such a way that the resulting slice time courses can be treated as if they were obtained simultaneously. Valid only if document is of type FMR. Slice time correction can only be done in FMR projects because these projects contain the time series data separated with respect to the individually measured slices (STC files); this information is lost in VTC files after spatial transformation. Slices typically are scanned ascending (i.e., slice 1, slice 2, slice 3 ...) or interleaved (i.e., slice 1, slice 3, slice 5 .. slice 2, slice 4, slice 6 ...). While the TR value should be easily obtained from the scanner protocol or from a file header, the inter slice time might be more difficult to get. If scanning ran continously, i..e. if there is no pause between scanning the last slice of volume N and the first slice of volume N+1, then you can simply divide the TR value by the number of slices per volume to get the inter slice time. If scanning ran not continously, you must either get the information about the duration of acquiring all slices or the duration of the pause between volumes. An alternative possibility (used by our group) is to read slice trigger pulses from the scanner measuring the time point when each slice is scanned; by subtracting, for example the time point of slice 1 from the time point of slice 2 results in the inter slice time. The resulting corrected data is automatically saved to disk. The names for the new FMR project and the new STC prefix is determined as in the GUI version, i.e., if the FMR project "cg_objects.fmr" is used, the resulting new file on disk will be "cg_objects_SCCAI.fmr". In addition, a set of new STC file, actuallly containing the time series data, is stored to disk.
Parameter 1: Scan order: 0: Ascending, 1: Ascending-interleaved, 2: Ascending-interleaved 2 (Siemens only), 10: Descending, 11: Descending-interleaved, 12: Descending-interleaved 2.
Parameter 2: Interpolation method: 0: trilinear, 1: cubic spline, 2: windowed SINC. For ascending interleaved slice order, this results in the following filenames: trilinear: `*_SCLAI.fmr`; cubic spline: `*_SCCAI.fmr`, windowed SINC: `*_SCSAI.fmr`.

CorrectSliceTimingWithSliceOrder()

Function CorrectSliceTimingWithSliceOrder():
Description: In case default options for the scan order parameter do not apply, you can also use a free slice order (as a string param) to specify slice time correction (new in BVQX 2.3).
Parameter 1: Scan order with slice numbers specified in a text string.
Parameter 2: Interpolation method: 0: trilinear, 1: cubic spline, 2: windowed SINC. For ascending interleaved slice order, this results in the following filenames: trilinear: `*_SCLAI.fmr`; cubic spline: `*_SCCAI.fmr`, windowed SINC: `*_SCSAI.fmr`.
Example: The following string specifies the same order as the "ascending interleaved" option using cubic spline interpolation:

```
FMR.CorrectSliceTimingWithSliceOrder("1 14 2 15 3 16 4 17 5 18 6 19 7 20 8 21 9 22 10 23 11 24 12 25 13", 1);
```

CorrectSliceTimingUsingTimeTable()

Function CorrectSliceTimingUsingTimeTable():
Description: The slice-scan time correction for multi-band sequences that acquire 2 or more slices in a single shot. For Siemens Mosaic data files, slice timing information is now directly extracted from the DICOM header; since this information (time of acquistion for each slice with respect to the begin of a volume) can be used to correct slice timing differences for all 2D EPI sequences (e.g. with ascending, descending, interleaved slice order with or without multi-band with or without extra (silent) gaps between TRs), a new "slice time table" option is now used as default if the respective data is available. In order to be available for preprocessing, the extracted slice timing data (one value per slice) is permanently stored in created .FMR files. The availability of time table can be interrogated using the `'HasSliceTimeTable'` property)(function and property new in BVQX 2.8.2).
Parameter 1: Interpolation method (1 = cubic spline).
Example: The following example applies slice scan time correction using cubic spline interpolation, for

multi-band and single-band data:

```
if (docFMR.HasSliceTimeTable)
docFMR.CorrectSliceTimingUsingTimeTable(1); // 1: cubic spline interpolation
else
docFMR.CorrectSliceTiming(2, 1); // 2: ascending interleaved 2, 1: cubic spline interpolation
```

CorrectMotion()

Function CorrectMotion():
Function: CorrectMotion()
Description: Detects and corrects rigid-body motion within an FMR file. The target volume provided by the user serves as the reference to which all other volumes are aligned. This version uses the default settings as shown in the GUI version (FMR Data Preprocessing): trilinear interpolation to perform the rigid-body translation/rotation, a reduced data set (every second voxel in each dimension = one eighth of a full volume = 12.5%), a maximum of 100 iterations to fit a volume to the reference, creation of pre- and post movie files and a standard log file. The new file name is based on the name of the FMR file prior to starting the filter and adds an abbreviation describing the preprocessing performed. If, for example, the name of the FMR file was "cg_objects_SCCAI.fmr", the new name will be "cg_objects_SCCAI_3DMC.fmr". The added infix "_3DMC" describes that motion correction (MC) has been performed in 3D (3DMC), i.e. fitting 3 translation and 3 rotation parameters. All 3D preprocessing steps add such descriptive naming abbreviations which makes it easy to get the information about the sequence of steps which has been performed to produce a particular FMR file.
Parameter 1: Target volume.
Returns: True or false (boolean).
Discussion: The applied method for this function is trilinear detection and sinc interpolation.

CorrectMotionEx()

CorrectMotionEx()
Function: CorrectMotion()
Description: Detects and corrects rigid-body motion within an FMR file. The target volume provided by the user serves as the reference to which all other volumes are aligned. In this version, the default settings (described in CorrectMotion()) can be modified.
The new file name is based on the name of the FMR file prior to starting the filter and adds a suing describing the preprocessing performed. If, for example, the name of the FMR file was "cg_objects_SCCAI.fmr", the new name will be "cg_objects_SCCAI_3DMC.fmr". The added infix "_3DMC" describes that motion correction (MC) has been performed in 3D (3DMC), i.e. fitting 3 translation and 3 rotation parameters. All 3D preprocessing steps add such descriptive naming abbreviations which makes it easy to get the information about the sequence of steps which has been performed to produce a particular FMR file.
Parameter 1: Target volume: number of the volume to which other volumes should be aligned.
Parameter 2: Interpolation method: 0 and 1: trilinear detection and trilinear interpolation, 2: trilinear detection and sinc interpolation or 3: sinc detection of motion and sinc interpolation.
Parameter 3: Use full data set: true if yes, false if one would like to use the reduced dataset (default in GUI).
Parameter 4: Maximum number of iterations: defines for how many iterations the parameters should be fitted. Value in GUI is default '100'.
Parameter 5: Generate movies: true if yes, false if no. Creates an *.avi movie on Windows and *.mov on Mac OS X.
Parameter 6: Generate extended log file: true if one would like the motion estimation parameters in a text file, false otherwise.
Returns: True or false (boolean).

CorrectMotionTargetVolumeInOtherRun()

CorrectMotionTargetVolumeInOtherRun()
Function: CorrectMotionTargetVolumeInOtherRun()
Description: Detects and corrects rigid-body motion within several runs. This intra-session alignment

method makes it possible to align all volumes of all runs in a session to the same targetvolume. This version uses the default settings as shown in the GUI version (FMR Data Preprocessing): trilinear interpolation to perform the rigid-body translation/rotation, a reduced data set (every second voxel in each dimension = one eighth of a full volume = 12.5%), a maximum of 100 iterations to fit a volume to the reference, creation of pre- and post movie files and a standard and extended log file. The new file name is based on the name of the FMR file prior to starting the filter and adds a suing describing the preprocessing performed. If, for example, the name of the FMR file was "cg_objects_SCCAI.fmr", the new name will be "cg_objects_SCCAI_3DMC.fmr". The added infix "_3DMC" describes that motion correction (MC) has been performed in 3D (3DMC), i.e. fitting 3 translation and 3 rotation parameters. All 3D preprocessing steps add such descriptive abbreviations to the name which makes it easy to get the information about the sequence of steps which has been performed to produce a particular FMR file. The intra-session alignment is integrated in the 3D motion correction step by specifying to which target volume and target run the data should be aligned. The target run should be the one, which is closest in time to the recorded 3D data set to minimize the effect of motion across scans. If a session, for example, started with a 3D data set followed by three runs, run 1, run 2 and run 3, 3D motion correction in the first run would proceed as in the CorrectMotion() method by selecting a target volume i.e. volume 1 (default). For run 2, the same target volume in run 1 is specified aligning th data of run 2 directly with run 1. The same is specified for run 3, i.e. the data are directly aligned to the target volume in run 1. This procedure ensures that all volumes in all runs are aligned to the very same target volume. Note that the described strategy works only if all runs have been recorded with the same nominal slice positions. If slice positions have been changed across runs, intra-session alignment can be achieved by using coregistration.
Parameter 1: Target FMR name: The name of the FMR project to which the current project should be aligned.
Parameter 2: Target volume number: The number of the volume within that run to which the project should be aligned.

CorrectMotionTargetVolumeInOtherRunEx()

CorrectMotionTargetVolumeInOtherRunEx()
Function: CorrectMotionTargetVolumeInOtherRunEx()
Description: Perform combined intra-session alignment and motion correction.
Parameter 1: Target FMR name: name of the run to which the current FMR project should be aligned.
Parameter 2: Target volume: number of the volume to which other volumes should be aligned.
Parameter 3: Interpolation method: 0 and 1: trilinear detection and trilinear interpolation, 2: trilinear detection and sinc interpolation or 3: sinc detection of motion and sinc interpolation.
Parameter 4: Use full data set: true if yes, false if one would like to use the reduced dataset (default in GUI).
Parameter 5: Maximum number of iterations: defines for how many iterations the parameters should be fitted. Value in GUI is default '100'.
Parameter 6: Generate movies: true if yes, false if no. This feature has been disabled for some time.
Parameter 7: Generate extended log file: true if one would like the motion estimation parameters in a text file, false otherwise.
Returns: True or false (boolean).

TemporalHighPassFilterGLMFourier()

Function: TemporalHighPassFilterGLMFourier()
Parameter 1: A parameter that specifies the number of cycles (pairs of two basis functions) used to build an appropriate design matrix.

TemporalHighPassFilterGLMDCT()

Function: TemporalHighPassFilterGLMDCT()*Parameter 1:* A parameter that specifies the number of cycles (pairs of two basis functions) used to build an appropriate design matrix.

TemporalHighPassFilter()

TemporalHighPassFilter()
Description: Apply a high-pass filter to the functional data ('classical approach', FFT).
Parameter 1: Cut-off value.
Parameter 2: Units: `"cycles"` or `"Hz"` (string).
Note: Includes linear trend removal.

LinearTrendRemoval()

LinearTrendRemoval()
Description: Apply a linear high-pass filter to the functional data.
Note: Is not necessary when using `TemporalHighPassFilter()`.

TemporalGaussianSmoothing()

Description: Since temporal gaussian smoothing blurs timing information across neighboring data points, it is not recommended as default. Temporal smoothing improves, however, the signal-to-noise ratio by removing high frequency fluctuations. The width of the kernel can now be specified in seconds. Note that the specification in seconds is only correct if the TR value has been specified correctly. Example value for kernel width: "2.8" seconds. If you want to specify the width of the kernel in units of data points (TR's), set the data points parameter instead of the secs parameter.
Parameter 1: Width of kernel.
Parameter 2: Units: `"s"` or `"TR"` (string).

SpatialGaussianSmoothing()

SpatialGaussianSmoothing() *Description:* Apply a spatial low-pass filter to the functional data.
Parameter 1: Width of kernel (FWHM).
Parameter 2: Units: `"mm"` or `"px"` (string).

AdjustMeanIntensity()

AdjustMeanIntensity() *Description:* Volume-based adjustment of mean intensity (MIA). During operation, the program plots two curves, one showing the measured mean intensity of volumes over time and the other showing the mean level of each volume after correction (a straight line). Furthermore, a zero-mean predictor of the global fluctuations is automatically stored to disk allowing to add it as a confound predictor in the design matrix. If the MIA preprocessed FMR is used for further processing (e.g., VTC creation), adding of the MIA confound predictor is not necessary. If one wants to perform the correction as part of the GLM, however, one should use the non-MIA FMR for further processing adding the MIA confound predictor to the design matrix.
Example: The following example applies mean intensity adjustment to a FMR project:

```
docFMR.AdjustMeanIntensity();
```

3.6.3 Example script

Please note that the document (project) property `FileNameOfPreprocessdFMR` returns just the name of the preprocessed FMR before BrainVoyager QX 2.3, and the name including the path from BrainVoyager QX 2.3 onwards.

```
var ObjectsRawDataPath = "/Users/hester/Data/ObjectsDicomGSG/";
var MocoISAPath = "/Users/hester/Data/testdata/moco_isa/";

/* This code will be executed when clicking 'Run' */
Preprocess_FMR();
//MotionCorrectionISA();
//var fmrname = MocoISAPath  + "FFA_localizer_2/series0003_SCLAI2.fmr";
//MotionCorrection(fmrname, 1);

/* These functions can be invoked */
function Preprocess_FMR()
{
    var ret = BrainVoyagerQX.TimeOutMessageBox("This script function will run standard FMR " +
    " preprocessing steps. \n\nYou can cancel this script by pressing the 'ESCAPE' key.", 8);
    if( !ret ) return;

    // Create a new FMR or open a previously created one.  Here we open the "CG_OBJECTS_SCRIPT.fmr" file
    var docFMR = BrainVoyagerQX.OpenDocument(ObjectsRawDataPath  + "CG_OBJECTS_SCRIPT.fmr");

    // Set spatial and temporal parameters relevant for preprocessing
    // You can skip this, if you have checked that these values are set when reading the data
    // To check whether these values have been set already (i.e. from header), use the
    // "VoxelResolutionVerified" and "TimeResolutionVerified" properties
    //
    if( !docFMR.TimeResolutionVerified )
    {
docFMR.TR = 2000;
docFMR.InterSliceTime = 80;
docFMR.TimeResolutionVerified = true;
    }
    if( !docFMR.VoxelResolutionVerified )
    {
docFMR.PixelSizeOfSliceDimX = 3.5;
docFMR.PixelSizeOfSliceDimY = 3.5;
docFMR.SliceThickness = 3;
docFMR.GapThickness = 0.99;
docFMR.VoxelResolutionVerified = true;
    }

    // We also link the PRT file, if available
    // (if no path is specified, the program looks in folder of dcoument)
    docFMR.LinkStimulationProtocol( "CG_OBJECTS.prt" );

    // We save the new settings into the FMR file
    docFMR.Save();

    //
    // Preprocessing step 1: Slice time correction
    ret = BrainVoyagerQX.TimeOutMessageBox("Preprocessing step 1: Slice time correction.\n\n" +
    " To skip this step, press the 'ESCAPE' key.", 5);
    if(ret)
    {
docFMR.CorrectSliceTiming( 1, 0 ); // First param: Scan order 0  -> Ascending,  1  -> Asc-Interleaved,
//  2  -> Asc-Int2,   10 -> Descending,  11 -> Desc-Int,  12 -> Desc-Int2
  // Second param: Interpolation method: 0 -> trilinear, 1 -> cubic spline, 2 -> sinc

  ResultFileName = docFMR.FileNameOfPreprocessdFMR;
  docFMR.Close();          // close input FMR
  docFMR = BrainVoyagerQX.OpenDocument( ResultFileName );
 }

 // Preprocessing step 2: 3D motion correction
 ret = BrainVoyagerQX.TimeOutMessageBox("Preprocessing step 2: 3D motion correction.\n\n" +
 " To skip this step, press the 'ESCAPE' key.", 5);
 if(ret)
 {
  docFMR.CorrectMotion(1); // 1 is target volume. For more parameters, use CorrectMotionEx()
  ResultFileName = docFMR.FileNameOfPreprocessdFMR;  // the current doc (input FMR) knows
  // the name of the automatically saved output FMR
  docFMR.Close();            // close input FMR
  docFMR = BrainVoyagerQX.OpenDocument( ResultFileName ); // Open motion corrected file (output FMR)
  // and assign to our doc variable
 }

 // Preprocessing step 3: Spatial Gaussian Smoothing
 // (not recommended for individual analysis with a 64x64 matrix)
 ret = BrainVoyagerQX.TimeOutMessageBox("Preprocessing step 3: Spatial gaussian smoothing.\n\n" +
 "To skip this step, press the 'ESCAPE' key.", 5);
 if(ret)  {
   docFMR.SpatialGaussianSmoothing( 4, "mm" );    // FWHM value and unit
```

```
   ResultFileName = docFMR.FileNameOfPreprocessdFMR;
   docFMR.Close();          // close input FMR
   docFMR = BrainVoyagerQX.OpenDocument( ResultFileName );
 }

 // Preprocessing step 4: Temporal High Pass Filter, includes Linear Trend Removal
 ret = BrainVoyagerQX.TimeOutMessageBox("Preprocessing step 4: Temporal high-pass filter.\n\n" +
 " To skip this step, press the 'ESCAPE' key.", 5);
 if(ret) {
   docFMR.TemporalHighPassFilter( 3, "cycles" );
   ResultFileName = docFMR.FileNameOfPreprocessdFMR;
   docFMR.Close();           // close input FMR
   docFMR = BrainVoyagerQX.OpenDocument( ResultFileName );
 }

 // Preprocessing step 5: Temporal Gaussian Smoothing  (not recommended for event-related data)
 ret = BrainVoyagerQX.TimeOutMessageBox("Preprocessing step 5: Temporal gaussian smoothing.\n\n" +
 "To skip this step, press the 'ESCAPE' key.", 5);
 if (ret) {
  docFMR.TemporalGaussianSmoothing( 10, "s" );
  ResultFileName = docFMR.FileNameOfPreprocessdFMR;
  docFMR.Close();           // close input FMR
  docFMR = BrainVoyagerQX.OpenDocument( ResultFileName );
 }

 // docFMR.Close() // you may want to close the final document, i..e to preprocess another run
}

function MotionCorrectionISA()
{

var docFMR = BrainVoyagerQX.OpenDocument(MocoISAPath  + "FFA_localizer_2/series0003_SCLAI2.fmr");
// docFMR.CorrectMotionTargetVolumeInOtherRun(MocoISAPath + "FFA_localizer_1/series0002_SCCAI2_3DMCT.fmr", 1);
docFMR.CorrectMotionTargetVolumeInOtherRunEx(MocoISAPath + "FFA_localizer_1/series0002_SCCAI2_3DMCT.fmr",
1, 1, 1, 100, 0, 1 );
}

function MotionCorrection(fmrname, targetvolume)
{
var docFMR = BrainVoyagerQX.OpenDocument(fmrname);
  docFMR.CorrectMotion(targetvolume);

  // for intra-session motion correction use this command (with approprate file name):
     // docFMR.CorrectMotionTargetVolumeInOtherRun("run1.fmr", 1);

 var ResultFileName = docFMR.FileNameOfPreprocessdFMR;
  docFMR.Close();
docFMR = BrainVoyagerQX.OpenDocument( ResultFileName );
}
```

3.6.4 Example script 'HighPassFilterUsingGLM.js'

Example script for high-pass temporal filtering using GLM-Fourier basis set of a FMR project (single run).

```
// Example script for high-pass temporal filtering using GLM-Fourier basis set of a FMR project (single run).
// Feel free to adapt this script to your needs
//
//  Created by Rainer Goebel February 2012

// you can now use and set the properties "PathToData" and "PathToSampleData" (
var ObjectsRawDataPath = BrainVoyagerQX.PathToSampleData +  "ObjectsDicomGSG/";

// These functions can be invoked

function HighpassFilterWithGLM()
{
// Create a new FMR or open a previously created one.  Here we open the "CG_OBJECTS_SCRIPT.fmr" file created previously via s
var docFMR = BrainVoyagerQX.OpenDocument(ObjectsRawDataPath  + "CG_OBJECTS_SCRIPT.fmr");
if(docFMR == undefined)
return;

docFMR.TemporalHighPassFilterGLMFourier( 2 );
// you can also use GLM with Discrete Cosine Transform (DCT) basis functions: docFMR.TemporalHighPassFilterGLMDCT( 2 );
ResultFileName = docFMR.FileNameOfPreprocessdFMR;
docFMR.Close();           // docFMR.Remove();  // close or remove input FMR
docFMR = BrainVoyagerQX.OpenDocument( ResultFileName );
}

HighpassFilterWithGLM();
```

3.7 BVQX Project functions: Preprocessing of functional data (VTC)

3.7.1 List of methods

SpatialGaussianSmoothing()
LinearTrendRemoval()
TemporalHighPassFilter()
TemporalGaussianSmoothing()

3.7.2 Detailed description of methods

SpatialGaussianSmoothing()

Function: SpatialGaussianSmoothing()
Description: Spatial low-pass filter for VTC file; removes spatial high-frequency elements in VTC file, like sharp edges.
Parameter 1: FWHM value (number)
Parameter 2: FWHM unit: “mm” or “vx”

LinearTrendRemoval()

Function: LinearTrendRemoval()
Description: Removes temporal linear trends in VTC file.

TemporalHighPassFilter()

Function: TemporalHighPassFilter()
Description: Removes low-frequency noise in VTC file, for example physiological noise.
Parameter 1: High-pass filter value
Parameter 2: High-pass filter unit: “cycles” or “Hz”

TemporalGaussianSmoothing()

Function: TemporalGaussianSmoothing()
Description: Removes high-frequency noise in VTC file, like sharp peaks in the timecourse.
Parameter 1: FWHM value (number)
Parameter 2: FWHM unit: “d” or “dps” (data points) or “s” or “secs” (seconds)

3.7.3 Example script

```
// This simple script shows how VTC files linked to a VMR document can be preprocessed
// This is especially helpful if VTCs are created with no (or modest, i.e. 4mm) spatial smoothing
// but when spatial smoothing (e.g. with FWHM of 8-10mm) is desired for group studies.
// In this case one could smooth the original FMR and create a second VTC file. It is, however,
// much more efficient to smooth the VTC file directly with an appropriate kernel as shown here
// While spatial smoothing is probably the most useful scenario of VTC smoothing, the
// code below shows how to call all available preprocessing options.
//
// To prepare this script, load a VMR and link a VTC - or add the appropriate script commands

var docVMR = BrainVoyagerQX.ActiveDocument;

BrainVoyagerQX.PrintToLog("Current VTC file: " + docVMR.FileNameOfCurrentVTC);  // show name of current VTC

// now smooth VTC with a large kernel of 10 mm:
//
docVMR.SpatialGaussianSmoothing( 10, "mm" );    // FWHM value and unit ("mm" or "vx")

BrainVoyagerQX.PrintToLog("Name of spatially smoothed VTC file: " + docVMR.FileNameOfCurrentVTC);

// now we could do a linear trend removal (see code in comments)
// since high-pass temporal filter (see below) includes LTR, we skip this here
//docVMR.LinearTrendRemoval();    // FWHM value and unit ("mm" or "vx")
//BrainVoyagerQX.PrintToLog("Name of VTC file without linear trends: " + docVMR.FileNameOfCurrentVTC);

// now perform temporal high-pass filter
//
docVMR.TemporalHighPassFilter(3, "cycles");    // HP value and unit ("cycles" or "Hz")
BrainVoyagerQX.PrintToLog("Name of VTC file without linear trends: " + docVMR.FileNameOfCurrentVTC);

// now perform Gaussian temporal smoothing
//
docVMR.TemporalGaussianSmoothing(3, "dps");
 // FWHM value and unit ("d" or "dps" (data points) or "s" or "secs" (seconds))
BrainVoyagerQX.MessageBox("Name of temporally smoothed VTC file: " + docVMR.FileNameOfCurrentVTC);

// Note that all intermediate VTC files are kept on disk. In order to remove no longer needed files, use
// the file access script routines (see "UsingCustomFiles.js" script)
```

3.8 BVQX Project (mesh) functions: Preprocessing of functional data (MTC)

3.8.1 List of methods

SpatialSmoothing()
LinearTrendRemoval()
TemporalHighPassFilterFFT()
TemporalGaussianSmoothing()

3.8.2 Detailed description of methods

SpatialSmoothing()

Function: SpatialSmoothing()
Description: Spatial low-pass filter for MTC file; removes spatial high-frequency elements in MTC file, like sharp edges.
Parameter 1: FWHM value (number)

LinearTrendRemoval()

LinearTrendRemoval()
Description: Apply a linear high-pass filter to the functional data.

TemporalHighPassFilterFFT()

TemporalHighPassFilterFFT()
Description: Apply a high-pass filter to the functional data ('classical approach', FFT).
Parameter 1: Cut-off value.

TemporalGaussianSmoothing()

TemporalGaussianSmoothing()
Description: Since temporal gaussian smoothing blurs timing information across neighboring data points, it is not recommended as default. Temporal smoothing improves, however, the signal-to-noise ratio by removing high frequency fluctuations. The width of the kernel can now be specified in seconds. Note that the specification in seconds is only correct if the TR value has been specified correctly. Example value for kernel width: "2.8" seconds. If you want to specify the width of the kernel in units of data points (TR's), set the data points parameter instead of the secs parameter.
Parameter 1: Width of kernel.
Parameter 2: Units: `"Seconds"` or

3.8.3 Example script “MeshMTCPreprocessing.js”

```
//
// Example script showing how to apply preprocessing with the new "mesh" object
// Feel free to adapt this script to your needs
//
//  Created by Rainer Goebel, May 2013
//

var ObjectsRawDataPath = BrainVoyagerQX.PathToSampleData + "ObjectsDicomGSG/";

// when calling this fn, we assume a VMR and the desired mesh have been loaded already (see also other "Mesh..." scripts)
//
function PreprocessMTC()
{
var ok;

docVMR = BrainVoyagerQX.ActiveDocument;
if(docVMR == undefined) return;

var mesh = docVMR.CurrentMesh;
if(mesh == undefined) return;

ok = mesh.LinkMTC(ObjectsRawDataPath + "CG_Objects_Float_SCCAI_3DMCT_THPGLMF2c_TAL_NGF_LH.mtc" ); if(!ok) return;

mesh.SpatialSmoothing(3);
mesh.LinearTrendRemoval();
mesh.TemporalHighPassFilterFFT(3);
mesh.TemporalGaussianSmoothing(5, "Seconds");

var PreprocessedMTCFileName = mesh.FileNameOfPreprocessdMTC;
BrainVoyagerQX.PrintToLog("Preprocessed .MTC: " + PreprocessedMTCFileName);
mesh.SaveMTC(PreprocessedMTCFileName);
}

PreprocessMTC();
```

3.9 BVQX Project functions: Experimental design

3.9.1 List of Methods for stimulation protocols

ClearStimulationProtocol()
LinkStimulationProtocol()
AddCondition()
SetConditionColor()
AddInterval()
SaveStimulationProtocol()
SaveVTC()

3.9.2 List of Properties for stimulation protocols

StimulationProtocolFile: String
StimulationProtocolExperimentName: String
StimulationProtocolResolution: Number
StimulationProtocolBackgroundColorR: Number
StimulationProtocolBackgroundColorG: Number
StimulationProtocolBackgroundColorB: Number
StimulationProtocolTimeCourseColorR: Number
StimulationProtocolTimeCourseColorG: Number
StimulationProtocolTimeCourseColorB: Number
StimulationProtocolTextColorR: Number
StimulationProtocolTextColorG: Number
StimulationProtocolTextColorB: Number
StimulationProtocolTimeCourseThickness: Number

3.9.3 Detailed description of methods

ClearStimulationProtocol()

ClearStimulationProtocol() *Function:* ClearStimulationProtocol()
Description: Function to start a new stimulation protocol.

LinkStimulationProtocol()

LinkStimulationProtocol() *Function:* LinkStimulationProtocol()
Description: Link the stimulation protocol with the provided name to the currently opened VMR file.
Parameter 1: Name protocol: name of the stimulation protocol (*.prt).

AddCondition()

AddCondition() *Function:* Add a condition for the current stimulation protocol.
Parameter 1: Name for the condition (string).

SetConditionColor()

SetConditionColor() *Function:* SetConditionColor()
Description: To discriminate the different conditions, different colors can be used. The colors in BrainVoyager are specified as a combination of red, green and blue components, in this order. To lowest value for each component is 0 and the highest value is 255. When one of the components is set to 255 and the other two to 0, a primary color is obtained. When each of the components red, green and blue is set to 0, the result will be black in absence of all colors. Example colors are displayed in figure 3.1.
Parameter 1: Name of condition (string)
Parameter 2: Red color component (0-255)
Parameter 3: Green color component (0-255)
Parameter 4: Blue color component (0-255)

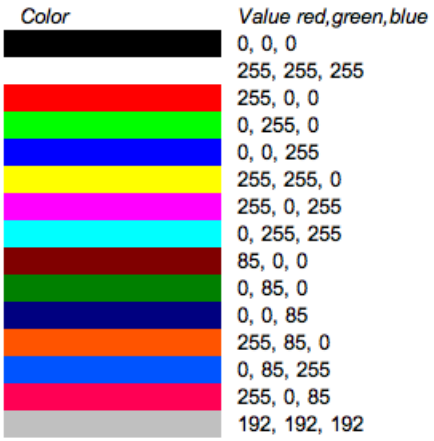


Figure 3.1: Example colors for protocol conditions

AddInterval()

AddInterval()
Description: Add an interval for a condition.
Example: `fmr.AddInterval(``Images in RVF", 1, 2);.`
Parameter 1: Name of condition (string)
Parameter 2: Start of interval in milliseconds or volumes
Parameter 3: End of interval in milliseconds or volumes

SaveStimulationProtocol()

SaveStimulationProtocol() *Description:* Save the newly created stimulation protocol with the provided name.
Parameter 1: Name for the protocol file.

SaveVTC()

SaveVTC() *Description:* Save the VTC, which will also save the name of the stimulation protocol in a VTC. New in BVQX 2.4.1.
Parameter 1: Name for current VTC. When using an empty string (””), the current VTC file name will be used.

3.9.4 Example scripts

Creating a stimulation protocol

To use the code, select the text below and save with the JavaScript extension ".js".

```
MakeProtocol(); // invoked function below

function MakeProtocol() {

var interval, intervalstart, intervalend;
BrainVoyagerQX.PrintToLog("Create stimulation protocol...");
var doc = BrainVoyagerQX.ActiveDocument;
// = BrainVoyagerQX.OpenDocument( ObjectsRawDataPath + "CG2_3DT1FL_SINC4_TAL.vmr" );
doc.ClearStimulationProtocol();
doc.StimulationProtocolExperimentName = "Objects Experiment";
doc.StimulationProtocolResolution = 1;
doc.AddCondition("Fixation");
doc.AddCondition("Objects in LVF");
doc.AddCondition("Objects in RVF");
doc.AddCondition("Objects in BVF");
for (interval = 0; interval < 10; interval++) {
intervalstart = interval*27 -1;
intervalend = intervalstart + 8;
if (interval == 0) {
intervalstart = 1; intervalend = 7;
}
doc.AddInterval("Fixation", intervalstart, intervalend);
}
for (interval = 0; interval < 3; interval++) {
intervalstart = 35+interval*81;
intervalend = intervalstart + 17;
doc.AddInterval("Objects in LVF", intervalstart, intervalend);
}
for (interval = 0; interval < 3; interval++) {
intervalstart = 8+interval*81;
intervalend = intervalstart + 17;
doc.AddInterval("Objects in RVF", intervalstart, intervalend);
}
for (interval = 0; interval < 3; interval++) {
intervalstart = 62+interval*81;
intervalend = intervalstart + 17;
doc.AddInterval("Objects in BVF", intervalstart, intervalend);
}
doc.SetConditionColor("Fixation", 100, 100, 100);
doc.SetConditionColor("Objects in LVF", 255, 0, 0);
doc.SetConditionColor("Objects in RVF", 0, 255, 0);
doc.SetConditionColor("Objects in BVF", 0, 0, 255);
doc.StimulationProtocolBackgroundColorR = 0;
doc.StimulationProtocolBackgroundColorG = 0;
doc.StimulationProtocolBackgroundColorB = 0;
doc.StimulationProtocolTimeCourseColorR = 255;
doc.StimulationProtocolTimeCourseColorG = 255;
doc.StimulationProtocolTimeCourseColorB = 255;
doc.StimulationProtocolTimeCourseThickness = 4;
doc.SaveStimulationProtocol("CG_OBJECTS_FROMSCRIPT.prt"); //Users/hester/Data/bvqxdata/
doc.Save(); // to save link to protocol permanently
}
```

Save VTC (including protocol name)

```
var docVMR = BrainVoyagerQX.ActiveDocument;

BrainVoyagerQX.PrintToLog("Current VTC file: " + docVMR.FileNameOfCurrentVTC);  // show name of current VTC

docVMR.LinkStimulationProtocol( "CG_Objects.prt" );
docVMR.SaveVTC("test_script.vtc"); // when using an empty string (""), the current VTC file name will be used
```

3.9.5 List of Methods for design matrices

ClearDesignMatrix()
SetPredictorValues()
SetPredictorValuesFromCondition()
ApplyHemodynamicResponseFunctionToPredictor()
ScalePredictorValues()
SaveSingleStudyGLMDesignMatrix()
ClearMultiStudyGLMDefinition()

AddStudyAndDesignMatrix()
SaveMultiStudyGLMDefinitionFile()

3.9.6 List of Properties for design matrices

FirstConfoundPredictorOfSDM: Integer. Provides possibility to indicate when, after columns of predictors of interest, the confound predictor columns start.
SDMContainsConstantPredictor: Boolean: true or false.

3.9.7 Detailed description of methods

ClearDesignMatrix()

ClearDesignMatrix()
Description: Removes any current design matrices.

SetPredictorValues()

SetPredictorValues()
Description: Specify the predictor value from a certain time point to the specified end time point in a specific condition.
Parameter 1: Name of condition (string)
Parameter 2: Timepoint from (integer)
Parameter 3: Timepoint to (integer)
Parameter 4: Value for the predictor

SetPredictorValuesFromCondition()

SetPredictorValuesFromCondition()
Description: Set the predictor values for the provided condition using the information from the stimulation protocol.
Parameter 1: Name of predictor in design matrix (string)
Parameter 2: Name of condition in stimulation protocol (string)
Parameter 3: Maximum value for predictor. Default: '1.0'

ApplyHemodynamicResponseFunctionToPredictor()

ApplyHemodynamicResponseFunctionToPredictor()*Description:* Apply the hemodynamic response function (HRF) to the provided predictor (Boynton). To use the 2-gamma HRF, BrainVoyager QX plugins can be used (see the 'Design Matrix Access Functions' topic in the 'Plugins' chapter of the BrainVoyager QX User's Guide).
Parameter 1: Name of the condition that should be convolved with the HRF.

ScalePredictorValues()

ScalePredictorValues() *Description:* Scale the values of the provided predictor.
Parameter 1: Name of the condition that should be scaled.
Parameter 2: Maximum value for scale, for example 1.0.
Parameter 3: Boolean (true or false).

SaveSingleStudyGLMDesignMatrix()

SaveSingleStudyGLMDesignMatrix()
Description: Save the single study design matrix as *.rtc or *.sdm file. *Parameter 1:* Name for the design matrix file.

ClearMultiStudyGLMDefinition()

ClearMultiStudyGLMDefinition() *Description:* Remove any present *.mdm file.

AddStudyAndDesignMatrix()

AddStudyAndDesignMatrix() *Description:* Add a combination of functional data (*.vtc) and design matrix (*.sdm).
Parameter 1: Name of the functional run (*.vtc)
Parameter 2: Name of the design matrix (*.sdm)

SaveMultiStudyGLMDefinitionFile()

SaveMultiStudyGLMDefinitionFile() *Description:* Save the newly created multi-study design matrix (*.mdm).
Parameter 1: Name for the multi-study design matrix file.

3.9.8 Some elaboration on design matrix properties

The scriptable design matrix properties display the behavior specified below; some situations that can arise are described far below.
SDMContainsConstantPredictor is by default false (situation 1). To create a constant predictor, not only the property 'SDMContainsConstantPredictor' needs to be set to true, also the predictor needs to be added and given a value (situation 2).
If any confound is defined and the variable 'FirstConfoundPredictorOfSDM' is set, BrainVoyager will assume that this is the constant (situation 3) and set the field 'FirstConfoundPredictor' in the *.sdm file to 1. So this would mean that it would not be possible to define any other confound without also defining a constant. Any constant predictor should be manually defined in the script, and the SDMContainsConstantPredictor should then be set to 'true' (situation 4).
FirstConfoundPredictor should be set after the predictor is actually defined, otherwise it will be set to 1 in the *.sdm file (situation 5).
Possible situations concerning the specification of confound predictors including constants in BrainVoyager via scripting:

1. If nothing is specified, the 'SDMContainsConstantPredictor' will be false. The field 'IncludesConstant' will then be 0, there will be no column with a constant, and the field FirstConfoundPredictor in the *.sdm file will point at the first column after the predictors of interest (which will not be present).

2. If the field 'SDMContainsConstantPredictor' is set to true in the script, but no actual constant predictor is provided, the 'IncludesConstant' will still be 0 and there will be no column with a constant.

3. If a confound predictor is manually specified, the FirstConfoundPredictorOfSDM is manually set to that column in the script, but the variable SDMContainsConstantPredictor is not set in the script, BrainVoyager will assume that this first confound predictor is the constant, and the field IncludesConstant in the *.sdm file will be set to 1 by BrainVoyager.

4. If neither the variable 'SDMContainsConstantPredictor' nor the variable 'FirstConfoundPredictorOfSDM' is set, the field 'FirstConfoundPredictor' in the *.sdm file will automatically point to the column after the last predictor, even if this last predictor is a manually specified constant.

5. If the variable 'FirstConfoundPredictorOfSDM' is set to a column - say column 4- before any predictors are specified, the field 'FirstConfoundPredictor' in the *.sdm file will point to column 1, even if later in the script three predictors of interest and one confound predictor would be specified.

3.9.9 Example scripts

To use the code, select the text below and save with the JavaScript extension ".js".

```
/* Declarations */
var ObjectsRawDataPath = "/Users/hester/Data/ObjectsDicomGSG/";
var RFXDataPath = "/Users/hester/Data/Exercise_RFX_ANOVA/";

/* This code is executed when clicking 'Run' */
CreateDesignMatrix();
CreateMultiStudyDesignMatrix();

function CreateDesignMatrix()
{
BrainVoyagerQX.PrintToLog("Create single subject design matrix...");
var doc = BrainVoyagerQX.OpenDocument(ObjectsRawDataPath + "CG2_3DT1FL_SINC4_TAL.vmr" );
doc.LinkVTC(ObjectsRawDataPath + "CG_OBJECTS_SCRIPT_TAL.vtc");
doc.LinkStimulationProtocol(ObjectsRawDataPath + "CG_OBJECTS_FROMSCRIPT.prt");
doc.ClearDesignMatrix();

doc.AddPredictor("LVF");
doc.SetPredictorValuesFromCondition("LVF", "Objects in LVF", 1.0);
doc.ApplyHemodynamicResponseFunctionToPredictor("LVF");

doc.AddPredictor("RVF");
doc.SetPredictorValuesFromCondition("RVF", "Objects in RVF", 1.0);
doc.ApplyHemodynamicResponseFunctionToPredictor("RVF");

doc.AddPredictor("BVF");
doc.SetPredictorValuesFromCondition("BVF", "Objects in BVF", 1.0);
doc.ApplyHemodynamicResponseFunctionToPredictor("BVF");

// You can also set any value at any time point (interval),
// here we define a linear trend predictor
doc.AddPredictor("Linear Trend");
for(i = 1; i<= doc.NrOfVolumes; i++)
{
value = 0.1*i;
doc.SetPredictorValues("Linear Trend", i, i, value);
}
doc.ScalePredictorValues("Linear Trend", 1.0, false);

doc.SaveSingleStudyGLMDesignMatrix("CG_OBJECTS_FROMSCRIPT.rtc");
doc.SaveSingleStudyGLMDesignMatrix("CG_OBJECTS_FROMSCRIPT.sdm");
}

function CreateMultiStudyDesignMatrix()
{
var doc = BrainVoyagerQX.OpenDocument(RFXDataPath + "Average_Tal.vmr");
doc.ClearMultiStudyGLMDefinition();
var subjName;
var nrOfSubjects = 17;
for (i=0; i<nrOfSubjects; i++) {
// create vtc name with subject
subjName = RFXDataPath + "Sub" + (i+1) + "_run1_SCSAI2_3DMCTS_LTR_THPFFT3c_TAL.vtc";
// now use subject name and always same protocol
doc.AddStudyAndDesignMatrix(subjName, RFXDataPath + "run1_SCSAI2_3DMCTS_LTR_THPFFT3c_TAL.sdm");
}
doc.SaveMultiStudyGLMDefinitionFile(RFXDataPath + "MultiStudy_FROMSCRIPT.mdm");

}
```

3.10 BVQX Project functions: Statistics

3.10.1 List of Methods

LoadSingleStudyGLMDesignMatrix()
LoadMultiStudyGLMDefinitionFile()
ComputeSingleStudyGLM()
ComputeMultiStudyGLM()
ComputeRFXGLM()
LoadGLM()
ShowGLM()
SaveGLM()
ClearContrasts()
SetCurrentContrast()
SetCurrentContrastAtIndex()
AddContrast()
SetContrastValue()
SetContrastString()
SetContrastValueAtIndex()

3.10.2 List of Properties

CorrectForSerialCorrelations: Integer. If set to "1", AR(1) is used, if set to "2", AR(2) is used.
SeparationOfSubjectPredictors: Boolean (true or false). Create one beta value for condition in each subject (concatenated runs).
SeparationOfStudyPredictors: Boolean (true or false). Create one beta value for condition in each run.
ZTransformStudies: Boolean (true or false). Use z-transform for data.
PSCTransformStudies: Boolean (true or false). Use percent-signal-change (PSC) transformation for data.
ZTransformStudiesBaselineOnly: Boolean (true or false).

3.10.3 Detailed description of methods

Computing the general linear model (GLM)

LoadSingleStudyGLMDesignMatrix()

LoadSingleStudyGLMDesignMatrix() *Description:* Load a design matrix file (*.rtc, *.sdm).
Parameter 1: Name of the design matrix file (string).

LoadMultiStudyGLMDefinitionFile()

LoadMultiStudyGLMDefinitionFile() *Description:* Load a design matrix file (*.rtc, *.sdm).
Parameter 1: Name of the design matrix file (string).

ComputeSingleStudyGLM()

ComputeSingleStudyGLM() *Description:* Compute a fixed-effects general linear model for a single run.

ComputeMultiStudyGLM()

ComputeMultiStudyGLM()
Description: Compute a fixed-effects general linear model for a group of studies.

ComputeRFXGLM()

ComputeRFXGLM()
Description: Compute a random-effects general linear model.

LoadGLM()

LoadGLM()
Description: Load a general linear model file (*.glm) from harddisk.
Parameter 1: Name of the *.glm file.

ShowGLM()

ShowGLM()
Description: Show the GLM that just has been computed.

SaveGLM()

SaveGLM()
Description: Save the GLM that just has been computed.
Parameter 1: Name for the GLM (with *.glm extension).

Setting contrasts

ClearContrasts()

ClearContrasts()
Description: Remove any current contrasts.

SetCurrentContrast()

SetCurrentContrast()
Description: The effect of this function is to set the internal "contrast pointer" to one of the existing contrasts. To have an effect, the command has to be followed by "setContrastValue()" which set the value of the respective vector element of that contrast that is chosen by the "SetCurrentContrast" command.

SetCurrentContrastAtIndex()

SetCurrentContrastAtIndex()
Description: The effect of this function is to set the internal "contrast pointer" to one of the existing contrasts. To have an effect, the command has to be followed by "setContrastValueAtIndex()" which set the value of the respective vector element of that contrast that is chosen by the "SetCurrentContrastAtIndex" command.

AddContrast()

AddContrast()
Description: Add a contrast.
Parameter 1: Name for the contrast, for example `"LVF > RVF"`.

SetContrastValue()

SetContrastValue()
Description: Set a contrast value for a condition.
Parameter 1: Name of the condition.
Parameter 2: Value (integer), for example $+1$ or -1.

SetContrastString()

SetContrastString() *Description:* Set the contrast by entering a sequence of parameters (one number for each condition) in a string. Only works if `AddContrast()` has been invoked first. *Parameter 1:* parameters in string, for example: "1 -1 0 0"

SetContrastValueAtIndex()

SetContrastValueAtIndex() *Description:* Set the contrast by entering a parameter for one condition. Only works if `AddContrast()` has been invoked first. *Parameter 1:* Index of predictor, starts counting at 1.
Parameter 2: Value for predictor, for example -1.

3.10.4 Example script

To use the code, select the text below and save with the JavaScript extension ".js"; then, load in the Script Editor and click"Run". Or copy-paste the text directly in the Script Editor.

```
/*  Statistics.js
Script for BrainVoyager QX 2.2
*/
/* Declarations */
var ObjectsRawDataPath = "/Users/hester/Data/ObjectsDicomGSG/";
var RFXDataPath = "/Users/hester/Data/Exercise_RFX_ANOVA/";

/* This code is executed when clicking the 'Run' button */
try {

RunSingleSubjectGLM(); // invoke function below
OverlayContrasts();
RunMultiSubjectGLM();
RunRandomEffectsGLM();

} catch (error) {
BrainVoyagerQX.PrintToLog("Error: " + error);
}

/* These functions can be invoked */
function RunSingleSubjectGLM()
{
try {
var ObjectsRawDataPath = "/Users/hester/Data/ObjectsDicomGSG/";
var doc = BrainVoyagerQX.OpenDocument(ObjectsRawDataPath + "CG_3DT1MPR_SCRIPT_CLEAN_TAL.vmr");
doc.LinkVTC(ObjectsRawDataPath + "CG_OBJECTS_SCRIPT_TAL.vtc");
doc.ClearDesignMatrix();
  doc.LoadSingleStudyGLMDesignMatrix(ObjectsRawDataPath + "CG_OBJECTS_FROMSCRIPT.sdm");
doc.LinkStimulationProtocol(ObjectsRawDataPath + "CG_OBJECTS_FROMSCRIPT.prt");
doc.CorrectForSerialCorrelations = true;
doc.ComputeSingleStudyGLM();
doc.ShowGLM();
doc.SaveGLM(ObjectsRawDataPath + "CG_OBJECTS_FROMSCRIPT.glm");
} catch (error) {
BrainVoyagerQX.PrintToLog(error);
}
}

function RunMultiSubjectGLM()
{
var doc = BrainVoyagerQX.OpenDocument(RFXDataPath + "Average_Tal.vmr");
doc.CorrectForSerialCorrelations = false;
doc.SeparationOfSubjectPredictors = true;
doc.ZTransformStudies = true;
doc.LoadMultiStudyGLMDefinitionFile(RFXDataPath + "MultiStudy_FROMSCRIPT.mdm");
doc.ComputeMultiStudyGLM();
doc.ShowGLM();
doc.SaveGLM(RFXDataPath + "MultiStudy_FROMSCRIPT.glm");
}

function RunRandomEffectsGLM()
{
var doc = BrainVoyagerQX.OpenDocument(RFXDataPath + "Average_Tal.vmr");
doc.LoadMultiStudyGLMDefinitionFile(RFXDataPath + "MultiStudy_FROMSCRIPT.mdm");
doc.PSCTransformStudies = true;
doc.ComputeRFXGLM();
doc.SaveGLM(RFXDataPath + "RFXGLM_FROMSCRIPT.glm");
}

function OverlayContrasts()
{
var doc = BrainVoyagerQX.OpenDocument(ObjectsRawDataPath + "CG_3DT1MPR_SCRIPT_CLEAN_TAL.vmr");
doc.LoadGLM("CG_OBJECTS_FROMSCRIPT.glm");
doc.ClearContrasts();
doc.AddContrast("LVF > RVF");
doc.SetContrastValue("LVF", +1);
doc.SetContrastValue("RVF", -1);
//alternatively: doc.SetContrastString("1 -1 0 0");
// or ("Index" starts with 1)
//doc.SetContrastValueAtIndex(1, +1);
//doc.SetContrastValueAtIndex(2, -1);

doc.ShowGLM();
}
```

3.11 BVQX Project functions: Transformations and Normalization

3.11.1 List of methods

AutoTransformToIsoVoxel()
AutoTransformToSAG()
SetVoxelIntensity(x, y, z, intensity)
GetVoxelIntensity(x, y, z)
CorrectIntensityInhomogeneities()
AutoACPCAndTALTransformation()
CreateVTCInVMRSpace()
CreateVTCInACPCSpace()
CreateVTCInTALSpace()
CreateVDWInVMRSpace()
CreateVDWinACPCSpace()
CreateVDWInTALSpace()

3.11.2 Detailed description of methods

Transforming VMR files

AutoTransformToIsoVoxel()

AutoTransformToIsoVoxel() *Description:* Transforms a non-isovoxel VMR file to isovoxel (same voxel sizes in x-dimension, y-dimension and z-dimension, in this case 1x1x1mm). The result is saved to disk with the new name.
Parameter 1: Interpolation method (integer): 1 - trilinear, 2 - cubic spline (recommended), 3 - sinc
Parameter 2: New VMR name (string): name for transformed VMR.
Returns: boolean: success.

AutoTransformToSAG()

Function: AutoTransformToSAG()
Description: Transforms an isovoxel VMR file to sagittal orientation. The result is saved to disk with the new name. *Note:* does not work if the voxel sizes of the VMR are not equal, therefore isovoxelation might need to be applied on beforehand.
Parameter 1: newname (string): name for transformed VMR.
Returns: boolean

SetVoxelIntensity(x, y, z, intensity)

Function: SetVoxelIntensity(x, y, z, intensity)
Description: Give the voxel at position (x,y,z) a new intensity value. This values between 0 and 225 are gray scale; the values between 225 and 255 are color values (see figure 3.2).
Parameter 1: x: position of voxel on x-axis.
Parameter 2: y: position of voxel on y-axis.
Parameter 3: z: position of voxel on z-axis.
Parameter 4: intensity: new intensity value.

GetVoxelIntensity(x, y, z)

GetVoxelIntensity(x, y, z)
Description: Obtain the intensity value at position (x,y,z).
Returns: Intensity value: integer between 0 and 255.

CorrectIntensityInhomogeneities()

CorrectIntensityInhomogeneities()
Description: Perform non-uniformity correction with default parameters. This will save a corrected, brain-peeled anatomical image with `*_IIHC` in the name to disk.

AutoACPCAndTALTransformation()

AutoACPCAndTALTransformation()
Description: Transform the VMR object to AC-PC (`*_aACPC.vmr`) and Talairach space. The resulting files ((`*_aACPC.vmr`, `*_TAL.vmr`, `*_aACPC.tal`) will be saved to disk. The input *.vmr needs to be $1 \times 1 \times 1mm$ (if necessary, AutoTransformToIsoVoxel() can be applied first).

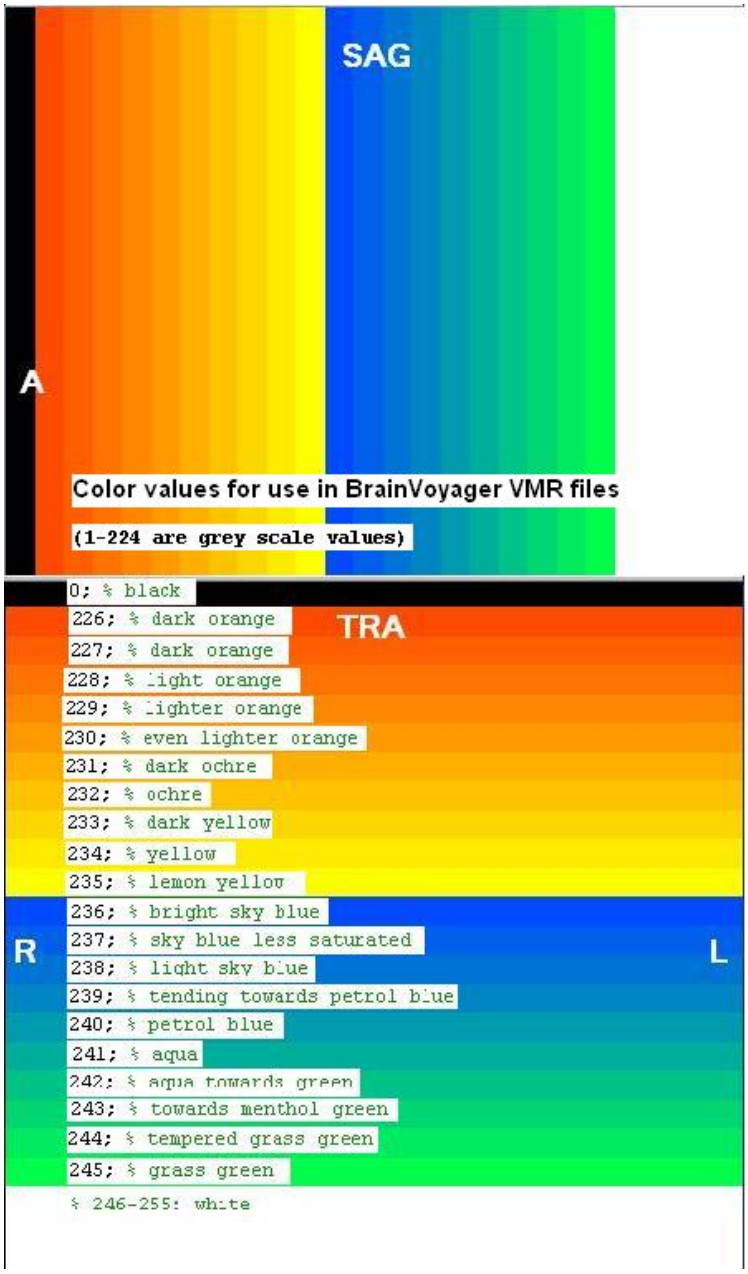


Figure 3.2: Intensity values for an anatomical file (*.vmr)

CreateVTCInVMRSpace()

CreateVTCInVMRSpace() *Function:* CreateVTCInVMRSpace()
Description: Transforms the time course data of an FMR project into a defined 3D space, in this case native space. The result of this transformation is a VTC file. Please note that the VMR properties 'UseBoundingBoxForVTCCreation' and 'ExtendedTALSpaceForVTCCreation' should be set to true or false (this applies to all spaces) before starting to create a VTC. (Since 2.6: the 'UseBoundingBoxForVTCCreation' property is default set to false, so it does not need to be set before creation of any VTC.)
Parameter 1: Name FMR: Name of the functional data file (*.fmr) which should be transformed to the space of the VMR.
Parameter 2: Name IA file: Name of the initial alignment transformation file (`*_IA.trf`).
Parameter 3: Name FA file: Name of the fine alignment transformation file (`*_FA.trf`).
Parameter 4: Name VTC: Name for the new VTC file.
Parameter 5: Datatype: Create the VTC in integer 2-byte format: 1 or in float format: 2.
Parameter 6: Resolution: Target resolution, either '1' (1x1x1mm), '2' or '3'.
Parameter 7: Interpolation: '0' for nearest neighbor interpolation, '1' for trilinear interpolation, '2' for sinc interpolation.
Parameter 8: Threshold: intensity threshold for bounding box (is not relevant for Talairach space, but should be provided). Default value: '100'.
Returns: True (success) or false.

CreateVTCInACPCSpace()

CreateVTCInACPCSpace() *Function:* CreateVTCInACPCSpace()
Description: Create a volume-time-course (VTC) file in AC-PC space. Please note that the VMR properties 'UseBoundingBoxForVTCCreation' and 'ExtendedTALSpaceForVTCCreation' should be set to true or false (this applies to all spaces) before starting to create a VTC. (Since 2.6: the 'UseBoundingBoxForVTCCreation' property is default set to false, so it does not need to be set before creation of any VTC.)
Parameter 1: Name FMR: Name of the functional data file (*.fmr) which should be transformed to AC-PC space.
Parameter 2: Name IA file: Name of the initial alignment transformation file (`*_IA.trf`).
Parameter 3: Name FA file: Name of the fine alignment transformation file (`*_FA.trf`).
Parameter 4: Name ACPC file: Name of the transformation file of the VMR to AC-PC space (`*_ACPC.trf`).
Parameter 5: Name VTC: Name for the new VTC file.
Parameter 6: Datatype: Create the VTC in integer 2-byte format: 1 or in float format: 2.
Parameter 7: Resolution: Target resolution, either '1' (1x1x1mm), '2' or '3'.
Parameter 8: Interpolation: '0' for nearest neighbor interpolation, '1' for trilinear interpolation, '2' for sinc interpolation.
Parameter 9: Threshold: intensity threshold for bounding box (is not relevant for Talairach space, but should be provided). Default value: '100'.
Returns: True (success) or false.

CreateVTCInTALSpace()

CreateVTCInTALSpace() *Function:* CreateVTCInTALSpace()
Description: Valid only if the opened document is of type VMR. FMR projects contain functional data in the originally recorded slices without any knowledge about where these slices are located with respect to a 3D reference frame, i.e. Talairach space. Transforming the functional data in Talairach space allows to analyze data from the same subject across different scanner sessions as well as to analyze data coming from different subjects. The resulting 4D VTC file consists of a series of 3D volumes aligned in stereotactic space. The file is saved to disk under the name for the new VTC file. The first parameter, the name of the FMR, specifies the FMR project whose functional data should be transformed in 3D space (the functional data actually resides in STC files which are referenced by the FMR project). The spatial transformation into Talairach space is controlled by three files which must exist prior to calling this method. The initial and fine alignment files are responsible to align the stack of 2D slices at the correct position of a 3D VMR data set which is typically recorded in the same session as the functional data. If

the functional data has been registered with a 3D VMR data set, the further alignment information can be obtained from anatomical transformations. The 3D data set to which the functional data has been aligned can be rotated into the AC-PC plane (see the BrainVoyager QX User's Guide). A transformation file (*.trf) is produced which transforms the source 3D data set into the AC-PC plane. Since the functional data should undergo exactly the same transformation, you must enter the obtained file as the name of the ACPC file for the present method. The AC-PC plane space is not Talairach space. The final step is to apply a non-linear scaling operation to bring the data in stereotactic space. This is done for the 3D VMR data set in AC-PC space and results in a TAL file. In order to apply the same transformatio to the functional data, enter the obtained file as the name of the TAL file.
Please note that the VMR properties 'UseBoundingBoxForVTCCreation' and 'ExtendedTALSpaceForVTC-Creation' should be set to true or false (this applies to all spaces) before starting to create a VTC. (Since BrainVoyager QX 2.6: 'UseBoundingBoxForVTCCreation' is default set to false, so does not need to be set before each VTC any more.) *Parameter 1:* Name FMR: Name of the functional data file (*.fmr) which should be transformed to Talairach space.
Parameter 2: Name IA file: Name of the initial alignment transformation file (`*_IA.trf`).
Parameter 3: Name FA file: Name of the fine alignment transformation file (`*_FA.trf`).
Parameter 4: Name ACPC file: Name of the transformation file of the VMR to AC-PC space (`*_ACPC.trf`).
Parameter 5: Name TAL file: Name of the file containing 12 landmarks used to transform the VMR to Talairach space (`*.tal`).
Parameter 6: Name VTC: Name for the new VTC file.
Parameter 7: Datatype: Create the VTC in integer 2-byte format: 1 or in float format: 2.
Parameter 8: Resolution: Target resolution, either '1' (1x1x1mm), '2' or '3'.
Parameter 8: Interpolation: '0' for nearest neighbor interpolation, '1' for trilinear interpolation, '2' for sinc interpolation.
Parameter 9: Threshold: intensity threshold for bounding box (is not relevant for Talairach space, but should be provided). Default value: '100'.
Returns: True (success) or false.
Note: Before using this function, please set explicitly the parameter
`ExtendedTALSpaceForVTCCreation`, for example:
`docVMR.ExtendedTALSpaceForVTCCreation = false;`. This is necessary to prevent an arbitrary size of the Talairach bounding box, with or without cerebellum.

3.11.3 Example script to create a VMR and transform to Talairach space

This is the example script "CreateVMRAndAutoTAL.js".

```
var ObjectsRawDataPath = BrainVoyagerQX.PathToSampleData + "ObjectsDicomGSG/";

function CreateVMR()
{
      var docVMR = BrainVoyagerQX.CreateProjectVMR( "DICOM", ObjectsRawDataPath + "RawData/BetSog_20040312_Goebel_C2 -0002-00
      docVMR.SaveAs( ObjectsRawDataPath + "CG_3DT1MPR_SCRIPT.vmr" );
}

function IIHC()
{
var ok;
var docVMR = BrainVoyagerQX.ActiveDocument;
docVMR.CorrectIntensityInhomogeneities();
}

function AutoACPCAndTAL()
{
var ok;
var docVMR = BrainVoyagerQX.ActiveDocument;
docVMR.AutoACPCAndTALTransformation();
}

CreateVMR();
IIHC();
AutoACPCAndTAL();
```

3.11.4 Example script to create VTC files

```
/*  CreateVTCfiles.qs
Script to create VTC files
By Rainer Goebel 2005
Modified for QX 2.1 by Hester Breman 2009
Modified for QX 2.4 by Rainer Goebel 2012
*/

/* This information is used in the functions */
var ObjectsRawDataPath = BrainVoyagerQX.PathToSampleData + "ObjectsDicomGSG/";
var DTIDataPath = BrainVoyagerQX.PathToSampleData + "Human31dir/";
var today = new Date();
var nameFMR = ObjectsRawDataPath + "CG_OBJECTS_SCRIPT_SCCAI_3DMCTS_SD3DSS4.00mm_THPGLMF2c.fmr";
var nameVMRinNative = ObjectsRawDataPath +"CG_3DT1MPR_SCRIPT_IIHC.vmr";
var nameVMRinACPC = ObjectsRawDataPath + "CG_3DT1MPR_SCRIPT_IIHC_aACPC.vmr";
var nameVMRinTAL = ObjectsRawDataPath + "CG_3DT1MPR_SCRIPT_IIHC_aTAL.vmr";
var nameIAfile = ObjectsRawDataPath +
"CG_OBJECTS_SCRIPT_SCCAI_3DMCTS_SD3DSS4.00mm_THPGLMF2c-TO-CG_3DT1MPR_SCRIPT_IIHC_IA.trf";
var nameFAfile = ObjectsRawDataPath +
"CG_OBJECTS_SCRIPT_SCCAI_3DMCTS_SD3DSS4.00mm_THPGLMF2c-TO-CG_3DT1MPR_SCRIPT_IIHC_FA.trf";
var nameACPCfile = ObjectsRawDataPath + "CG_3DT1MPR_SCRIPT_IIHC_aACPC.trf";
var nameTALfile = ObjectsRawDataPath + "CG_3DT1MPR_SCRIPT_IIHC_aACPC.tal";
var nameVTCinNative= ObjectsRawDataPath + "CG_OBJECTS_SCRIPT_NATIVE.vtc";
var nameVTCinACPC = ObjectsRawDataPath + "CG_OBJECTS_SCRIPT_ACPC.vtc";
var nameVTCinTAL= ObjectsRawDataPath + "CG_OBJECTS_SCRIPT_TAL.vtc";
var dataType = 2; // 1: int16, 2: float32
var resolution = 2; // one of 1, 2 or 3 mm^2
var interpolation = 1;
var threshold = 100;
var extendedBoundingBox = false;

/*  This code is executed when clicking 'Run'
If an error occurs, it is printed to the BrainVoyager QX Log tab
*/
BrainVoyagerQX.ShowLogTab();
BrainVoyagerQX.PrintToLog("Start creating VTCs...");
try {
//CreateVMRinNativeSpace();
//CreateVMRinAcpcSpace();
CreateVMRinTalairachSpace(extendedBoundingBox); // make a VTC in Talairach space with extended bounding box = false
//extendedBoundingBox = true;
//var nameVTCinTAL= ObjectsRawDataPath + "CG_OBJECTS_SCRIPT_TAL_ext.vtc"; // rename to preserve other file (if any)
//CreateVMRinTalairachSpace(extendedBoundingBox); // make a VTC in Talairach space with extended bounding box (in z-dir)
} catch (e) {
BrainVoyagerQX.PrintToLog("Error: " + e);
}

/* These functions are invoked from the section above */
function CreateVMRinNativeSpace()
{
var docVMR = BrainVoyagerQX.OpenDocument(nameVMRinNative);
docVMR.ExtendedTALSpaceForVTCCreation = false; // this is true or false
docVMR.UseBoundingBoxForVTCCreation = false; // do not use bounding box
```

```
var success = docVMR.CreateVTCInVMRSpace(nameFMR, nameIAfile, nameFAfile, nameVTCinNative,
dataType, resolution, interpolation, threshold);
docVMR.Close();
}

function CreateVMRinAcpcSpace()
{
var docVMR = BrainVoyagerQX.OpenDocument(nameVMRinNative);
docVMR.ExtendedTALSpaceForVTCCreation = false; // this is true or false
docVMR.UseBoundingBoxForVTCCreation = false; // do not use bounding box
var success = docVMR.CreateVTCInACPCSpace(nameFMR, nameIAfile, nameFAfile,
nameACPCfile, nameVTCinACPC, dataType, resolution, interpolation, threshold);
docVMR.Close();
}

function CreateVMRinTalairachSpace(useExtendedBoundingBox)
{
var docVMR = BrainVoyagerQX.OpenDocument(nameVMRinNative);
docVMR.ExtendedTALSpaceForVTCCreation = useExtendedBoundingBox; // this is true or false

// new in v2.4.1: specify bounding box for target VTC (works for any target reference space)
docVMR.UseBoundingBoxForVTCCreation = true; // use bounding box
// use properties to read and set bounding box values (here we create VTC only in lower posterior part of brain):
docVMR.TargetVTCBoundingBoxZStart = 110; // values will be adjusted to fit on multiple of resolution
docVMR.TargetVTCBoundingBoxZEnd  = 150; // values not changed (here X/Y) use default (TAL) bounding box values
docVMR.TargetVTCBoundingBoxYStart = 128;

var success = docVMR.CreateVTCInTALSpace(nameFMR, nameIAfile, nameFAfile, nameACPCfile, nameTALfile, nameVTCinTAL,
dataType, resolution, interpolation, threshold);

docVMR.Close();

var docVMRTAL = BrainVoyagerQX.OpenDocument(nameVMRinTAL);
docVMRTAL.LinkVTC(nameVTCinTAL);
}
```

3.11.5 Creating diffusion weighted (VDW) files

CreateVDWInVMRSpace()

CreateVDWInVMRSpace() *Description:* Create a normalized diffusion weighted (VDW) file in native space (directly from scanner).
Parameter 1: Name DMR: Name of the diffusion-weighted data file (*.dmr) which should be transformed.
Parameter 2: Name IA file: Name of the initial alignment transformation file (`*_IA.trf`).
Parameter 3: Name FA file: Name of the fine alignment transformation file (`*_FA.trf`).
Parameter 4: Name VDW: Name for the new VDW file.
Parameter 5: Datatype: Create the VDW in integer 2-byte format: 1 or in float format: 2.
Parameter 6: Resolution: Target resolution, either '1' (1x1x1mm), '2' or '3'.
Parameter 7: Interpolation: '0' for nearest neighbor interpolation, '1' for trilinear interpolation, '2' for sinc interpolation.
Parameter 8: Threshold: intensity threshold for bounding box. Default value: '100'.
Returns: True (success) or false.

CreateVDWInACPCSpace()

CreateVDWInACPCSpace() *Description:* Create a normalized diffusion weighted (VDW) file in AC-PC space.
Parameter 1: Name DMR: Name of the diffusion-weighted data file (*.dmr) which should be transformed to AC-PC space.
Parameter 2: Name IA file: Name of the initial alignment transformation file (`*_IA.trf`).
Parameter 3: Name FA file: Name of the fine alignment transformation file (`*_FA.trf`).
Parameter 4: Name ACPC file: Name of the transformation file of the VMR to AC-PC space (`*_ACPC.trf`).
Parameter 5: Name VDW: Name for the new VDW file.
Parameter 6: Datatype: Create the VDW in integer 2-byte format: 1 or in float format: 2.
Parameter 7: Resolution: Target resolution, either '1' (1x1x1mm), '2' or '3'.
Parameter 8: Interpolation: '0' for nearest neighbor interpolation, '1' for trilinear interpolation, '2' for sinc interpolation.
Parameter 9: Threshold: intensity threshold for bounding box. Default value: '100'.
Returns: True (success) or false.

CreateVDWInTALSpace()

CreateVDWInTALSpace() *Description:* Create a normalized diffusion weighted (VDW) file in Talairach space.
Parameter 1: Name DMR: Name of the diffusion-weighted data file (*.dmr) which should be transformed to Talairach space.
Parameter 2: Name IA file: Name of the initial alignment transformation file (`*_IA.trf`).
Parameter 3: Name FA file: Name of the fine alignment transformation file (`*_FA.trf`).
Parameter 4: Name ACPC file: Name of the transformation file of the VMR to AC-PC space (`*_ACPC.trf`).
Parameter 5: Name TAL file: Name of the file containing 12 landmarks used to transform the VMR to Talairach space (`*.tal`).
Parameter 6: Name VDW: Name for the new VDW file.
Parameter 7: Datatype: Create the VDW in integer 2-byte format: 1 or in float format: 2.
Parameter 8: Resolution: Target resolution, either '1' (1x1x1mm), '2' or '3'.
Parameter 9: Interpolation: '0' for nearest neighbor interpolation, '1' for trilinear interpolation, '2' for sinc interpolation.
Parameter 10: Threshold: intensity threshold for bounding box (is not relevant for Talairach space, but should be provided). Default value: '100'.
Returns: True (success) or false.

3.11.6 Example script to create VDW files

```
/*  CreateVDWfiles.js
Script to create VDW files (normalised diffusion weighted)
*/

/* This information is used in the functions */
var DTIDataPath  = "/Users/hester/Data/Human31dir/";
var today  = new Date();
var nameDMR  = DTIDataPath + "HUMAN31DIR_SCRIPT.dmr";
var nameVMRinNative  = DTIDataPath +"human.vmr";
var nameVMRinAcpc = DTIDataPath +"human_ACPC.vmr";
var nameVMRinTal  = DTIDataPath +"human_TAL.vmr";
var nameIAfile  = DTIDataPath + "HUMAN31DIR_SCRIPT-TO-human_IA.trf";
var nameFAfile  = DTIDataPath + "HUMAN31DIR_SCRIPT-TO-human_FA.trf";
var nameACPCfile  = DTIDataPath + "human_ACPC.trf";
var nameTALfile  = DTIDataPath + "human_ACPC.tal";
var nameVDWinNative = DTIDataPath + "HUMAN31DIR_SCRIPT_NATIVE.vdw";
var nameVDWinAcpc = DTIDataPath + "HUMAN31DIR_SCRIPT_ACPC.vdw";
var nameVDWinTal = DTIDataPath + "HUMAN31DIR_SCRIPT_TAL.vdw";
var dataType                = 2; // integer 2-byte format: 1 or in float format: 2.
var resolution  = 3; // one of 1, 2 or 3 mm^2
var interpolation  = 1;
var threshold  = 100;

/*  This code is executed when clicking 'Run'
If an error occurs, it is printed to the BrainVoyager QX Log tab
*/
BrainVoyagerQX.ShowLogTab();
BrainVoyagerQX.PrintToLog("Start creating VDWs...");
try {
//CreateVDWinNativeSpace();
//CreateVDWinAcpcSpace();
CreateVDWinTalSpace();
} catch (e) {
BrainVoyagerQX.PrintToLog("Error: " + e);
}

/* These functions are invoked from the section above */
function CreateVDWinNativeSpace() {

BrainVoyagerQX.TimeOutMessageBox("This function creates a VDW file in native space...", 5);
var vmr = BrainVoyagerQX.OpenDocument(nameVMRinNative);
BrainVoyagerQX.PrintToLog("Start creating VDW in native space...");
vmr.ExtendedTALSpaceForVTCCreation = false; // this is true or false
var success = vmr.CreateVDWInVMRSpace(nameDMR, nameIAfile, nameFAfile, nameVDWinNative,
dataType, resolution, interpolation, threshold);
if (success) {
BrainVoyagerQX.PrintToLog("Created VDW: " + nameVDWinNative);
} else {
BrainVoyagerQX.PrintToLog("VDW creation did not succeed.");
}
  vmr.Close();
}

function CreateVDWinAcpcSpace() {

BrainVoyagerQX.TimeOutMessageBox("This function creates a VDW file in AC-PC space...", 5);
var vmr = BrainVoyagerQX.OpenDocument(nameVMRinAcpc);
BrainVoyagerQX.PrintToLog("Start creating VDW in AC-PC space...");
vmr.ExtendedTALSpaceForVTCCreation = false; // this is true or false
var success = vmr.CreateVDWInACPCSpace(nameDMR, nameIAfile, nameFAfile, nameACPCfile,
nameVDWinAcpc, dataType, resolution, interpolation, threshold);
if (success) {
BrainVoyagerQX.PrintToLog("Created VDW: " + nameVDWinAcpc);
} else {
BrainVoyagerQX.PrintToLog("VDW creation did not succeed.");
}
  vmr.Close();
}

function CreateVDWinTalSpace() {

BrainVoyagerQX.TimeOutMessageBox("This function creates a VDW file in Talairach space...", 5);
var vmr = BrainVoyagerQX.OpenDocument(nameVMRinTal);
BrainVoyagerQX.PrintToLog("Start creating VDW in Talairach space...");
// vmr.ExtendedTALSpaceForVTCCreation = false; // this is true or false
var success = vmr.CreateVDWInTALSpace(nameDMR, nameIAfile, nameFAfile, nameACPCfile,
nameTALfile, nameVDWinTal, dataType, resolution, interpolation, threshold);
if (success) {
BrainVoyagerQX.PrintToLog("Created VDW: " + nameVDWinTal);
} else {
BrainVoyagerQX.PrintToLog("VDW creation did not succeed.");
}
  vmr.Close();
}
```

3.12 BVQX Project functions: Surface functions

3.12.1 List of Methods

These functions can be invoked using an anatomical volume (VMR):
LoadMesh()
AddMesh()
SaveMesh()
UpdateSurfaceWindow()
SaveSnapshotOfSurfaceWindow()
LinkMTC()
CreateMTCFromVTC()

The following functions can be invoking with the mesh object (SRF):
mesh.SaveAs()
mesh.CalculateCurvature()
mesh.CalculateCurvatureCBA()
mesh.SmoothMesh()
mesh.SmoothRecoMesh()
mesh.SmoothCurrentMap()
mesh.InflateMeshToSphere()
mesh.InflateMesh()
mesh.CorrectInflatedSphereMesh()
mesh.CreateMultiScaleCurvatureMap()
mesh.SpatialSmoothing()
mesh.LinearTrendRemoval()
mesh.TemporalHighPassFilterFFT()
mesh.TemporalGaussianSmoothing()
mesh.CreateMTCFromVTC()
mesh.LinkMTC()
mesh.SaveMTC()
mesh.LinkMTC()
mesh.ClearDesignMatrix()
mesh.LoadSingleStudyGLMDesignMatrix()
mesh.ComputeSingleStudyGLM()
mesh.ShowGLM()
mesh.SaveGLM()
mesh.CreateSphericalCoordinatesMapFromSMP()

The following functions can be invoking with the mesh scene object:
mesh.MeshScene.UpdateSurfaceWindow()
meshScene.LoadMesh()
MapSphereMeshFromStandardSphere()
SetStandardSphereToFoldedMesh()
CreateStandardSphereMesh()
ClearGroupCBACurvatureFiles()
AddCurvatureFileForGroupCBA()
RunRigidCBA()
RunCBA()
CreateAverageCurvatureGroupMap()
CreateAverageFoldedGroupMesh()

3.12.2 List of Properties

The properties can be used with an anatomical volume (VMR):
ViewpointTranslationX
ViewpointRotationX

ViewpointTranslationY
ViewpointRotationY
ViewpointTranslationZ
ViewpointRotationZ
CurrentMeshScene
MeshScene

The mesh (SRF) object has the following properties:
mesh.FileName
mesh.NrOfVertices
mesh.MorphingUpdateInterval
mesh.FileNameOfPreprocessdMTC
mesh.CorrectForSerialCorrelations

The mesh scene object has the following properties:
meshScene.CurrentMesh
meshScene.ViewpointPositionX
meshScene.ViewpointPositionY
meshScene.ViewpointPositionZ
meshScene.ViewpointRotationX
meshScene.ViewpointRotationY
meshScene.ViewpointRotationZ
meshScene.SphereResolutionCBA

3.12.3 Description of VMR object methods

LoadMesh()

LoadMesh() *Description:* Load a mesh into the current scene. This requires a *.vmr to be open. See also meshScene.LoadMesh().
Parameter 1: Name of the polygon mesh (*.srf).

AddMesh()

AddMesh() *Description:* Add a mesh to the current scene. This requires a *.vmr to be open.
Parameter 1: Name of the polygon mesh (*.srf).

SaveMesh()

SaveMesh() *Description:* Save the current mesh. This is a method of the *.vmr object. Please note that from BrainVoyager QX 2.8 one can use the mesh.SaveAs() function.
Parameter 1: Name for the polygon mesh (*.srf).

UpdateSurfaceWindow()

UpdateSurfaceWindow() *Description:* After changing the viewpoint settings or loading meshes, invoke this function to see the effect.

SaveSnapshotOfSurfaceWindow()

SaveSnapshotOfSurfaceWindow() *Description:* Save a snapshot of the current OpenGL window.
Parameter 1: Name for the snapshot.
Note: The file type of the snapshot is determined the filetype selected in BrainVoyager → Preferences.

LinkMTC()

Description: Link a mesh time series file to a surface file (*.srf). This is a function of the *.vmr object.
Parameter 1: Name of the mesh time course file including a path.

CreateMTCFromVTC()

CreateMTCFromVTC() *Description:* Create a mesh time series to be displayed on a surface file (*.srf). This is a function of the *.vmr object. First open a *.vmr and link a *.vtc.
Parameter 1: Sampling depth inside white matter, for example -1.0.
Parameter 2: Sampling depth inside gray matter, for example 3.
Parameter 3: New name for the mesh time course file, for example "mesh.mtc".

3.12.4 Description of Mesh object and MeshScene object methods

mesh.MeshScene.UpdateSurfaceWindow()

mesh.MeshScene.UpdateSurfaceWindow() *Description:* After any operation on a mesh, invoke this function to see the effect.

meshScene.LoadMesh()

meshScene.LoadMesh() *Description:* Load a mesh from the mesh scene object. The mesh scene object can be obtained from the VMR object. This requires BrainVoyager QX 2.8. For older versions, a mesh can also be loaded via a VMR (see LoadMesh()).

mesh.SaveAs()

mesh.SaveAs() *Description:* Save the current mesh. This is a method of the *.vmr object. To be used in BrainVoyager QX 2.8 or higher.
Parameter 1: Name for the polygon mesh (*.srf).

mesh.CalculateCurvatureCBA()

mesh.CalculateCurvatureCBA()
Description: Calculate the curvature of a mesh. The mesh object should refer to a smoothed mesh (`*_RECOSM.srf`) or preferably a simplified mesh (`* _D80k.srf`). While not strictly necessary, it is recommended to compute and overlay a curvature map on the folded cortex mesh, since it allows to identify sulci and gyri when the mesh is morphed to a sphere in the succeeding step.To be used in BrainVoyager QX 2.8 or higher.
Returns 1: A curvature map (`*_CURVATURE.smp`).

mesh.SmoothCurrentMap()

mesh.SmoothCurrentMap()
Description: Smooths the curvature map (`*_CURVATURE.smp`). To be used in BrainVoyager QX 2.8 or higher.
Parameter 1: Number of smoothing steps (for example 5).

mesh.InflateMeshToSphere()

mesh.InflateMeshToSphere()
Description: Inflates the simplified mesh (`*_D80k.srf`) to a sphere (`*_SPHERE.srf`). This will start an iterative morphing process that uses several forces with values that will be changed gradually over time. A *smoothing force* is used to remove the gyri and sulci from the mesh, while a *to-sphere force* attempts to push the mesh vertices outward towards points on a sphere. To be used in BrainVoyager QX 2.8 or higher. Apply `CorrectInflatedSphereMesh()` afterwards; then save the sphere using `mesh.SaveAs()` when the result is acceptable.
Parameter 1: Number of inflation steps (for example 800).

mesh.CorrectInflatedSphereMesh()

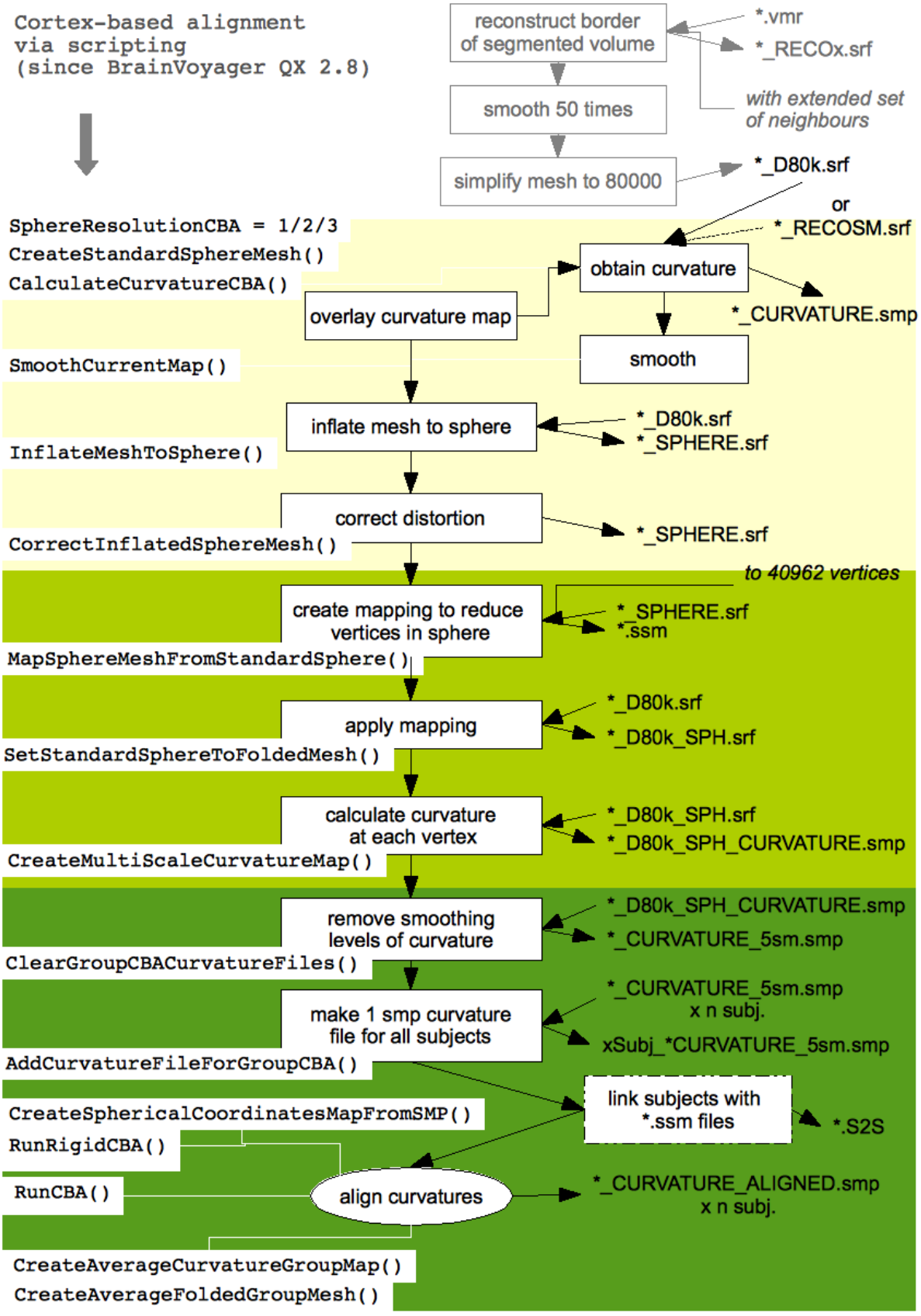
mesh.CorrectInflatedSphereMesh()
Description: The distortion correction process uses a "push-relax" approach on the spherical mesh (`*_SPHERE.srf`), to correct for some parts, which are expanded - especially mid-lateral and mid-medial parts - and other parts, which are squeezed - especially frontal and occipital regions. To be used in BrainVoyager QX 2.8 or higher.
Parameter 1: Number of correction steps (3000 should be sufficient).

MapSphereMeshFromStandardSphere()

MapSphereMeshFromStandardSphere()
Description: Function of `MeshScene` object. After the mesh has been inflated to a sphere (`*_SPHERE.srf`), this function can be used to calculate a mapping to a standard sphere with 40962 vertices to reduce the number of vertices. To be used in BrainVoyager QX 2.8 or higher.
Returns 1: A mapping between meshes file (*.ssm).

SetStandardSphereToFoldedMesh()

SetStandardSphereToFoldedMesh()
Description: Apply the mapping (*.ssm) obtained from mesh.MapSphereMeshFromStandardSphere(). This results in a standard "folded sphere" (`*_SPH.srf`). To be used in BrainVoyager QX 2.8 or higher.
Parameter 1: Name of folded mesh (`*_RECOSM.srf`). *Returns:* Name of "folded sphere" (`*_SPH.srf`).


Cortex-based alignment
via scripting
(since BrainVoyager QX 2.8)
reconstruct border of segmented volume
*.vmr
*_RECOx.srf
smooth 50 times
with extended set of neighbours
simplify mesh to 80000
*_D80k.srf
or
*_RECOSM.srf
SphereResolutionCBA = 1/2/3
CreateStandardSphereMesh()
CalculateCurvatureCBA()
obtain curvature
overlay curvature map
*_CURVATURE.smp
smooth
SmoothCurrentMap()
inflate mesh to sphere
*_D80k.srf
*_SPHERE.srf
InflateMeshToSphere()
correct distortion
*_SPHERE.srf
CorrectInflatedSphereMesh()
to 40962 vertices
create mapping to reduce vertices in sphere
*_SPHERE.srf
*.ssm
MapSphereMeshFromStandardSphere()
apply mapping
*_D80k.srf
*_D80k_SPH.srf
SetStandardSphereToFoldedMesh()
calculate curvature at each vertex
*_D80k_SPH.srf
*_D80k_SPH_CURVATURE.smp
CreateMultiScaleCurvatureMap()
remove smoothing levels of curvature
*_D80k_SPH_CURVATURE.smp
*_CURVATURE_5sm.smp
ClearGroupCBACurvatureFiles()
make 1 smp curvature file for all subjects
*_CURVATURE_5sm.smp
x n subj.
xSubj_*CURVATURE_5sm.smp
AddCurvatureFileForGroupCBA()
link subjects with *.ssm files
*.S2S
CreateSphericalCoordinatesMapFromSMP()
RunRigidCBA()
RunCBA()
align curvatures
*_CURVATURE_ALIGNED.smp
x n subj.
CreateAverageCurvatureGroupMap()
CreateAverageFoldedGroupMesh()

mesh.CreateMultiScaleCurvatureMap()

mesh.CreateMultiScaleCurvatureMap()
Description: Since the standard sphere is now folded as the original sphere, the curvature can be calculated directly at each vertex. This can be performed with the current function. Since the alignment procedure uses a coarse-to-fine approach, several different curvature maps will be calculated with various levels of smoothing. The resulting SMP file will contain four sub-maps with the smoothing levels that are provided, for example 2, 7, 20 and 40. To be used in BrainVoyager QX 2.8 or higher.
Parameter 1: Smoothing level 1 (should be most coarse, for example 0 or 2).
Parameter 2: Smoothing level 2 (can be quite coarse, for example 7).
Parameter 3: Smoothing level 3 (should be quite fine, for example 20).
Parameter 4: Smoothing level 4 (should be most fine, for example 40).
Returns: Name of curvature file (`*_CURVATURE.smp`).

CreateStandardSphereMesh()

CreateStandardSphereMesh()
Description: Create a standard sphere mesh via the mesh scene object. To be used in BrainVoyager QX 2.8 or higher.

ClearGroupCBACurvatureFiles()

ClearGroupCBACurvatureFiles()
Description: Remove any present information about curvature files via the mesh scene object. To be used in BrainVoyager QX 2.8 or higher.

AddCurvatureFileForGroupCBA()

AddCurvatureFileForGroupCBA()
Description: Inform BrainVoyager about the curvature files that are to be used in the cortex-based alignment. This function of the mesh scene object has to be invoked repeatedly until the files of all subjects are declared (see script example "MeshCBA.js"). In order to be consistent with the file names used during the CBA procedure, the same subject identifiers should be used for the subject mesh names and surface maps. The program uses the initial part of a map's name to identify a subject; this can be a number (e.g. "362"), text (e.g. "XY") or a combination of both (e.g. "S16"). To be used in BrainVoyager QX 2.8 or higher. Then, proceed to next step RunRigidCBA() or RunCBA().
Parameter 1: Name of curvature file (`*_SPH_CURVATURE.smp`).
Returns: Success or no success (boolean).

mesh.CreateSphericalCoordinatesMapFromSMP()

mesh.CreateSphericalCoordinatesMapFromSMP()
Description: Create a spherical target curvature file for RunRigidCBA(). From BrainVoyager QX 2.8.
Parameter 1: Name of target curvature file (`*_SPH_CURVATURE.smp`), any should be fine.
Returns: Name of spherical target curvature file (we get an empty string if it did not work).

RunRigidCBA()

RunRigidCBA()
Description: This is a function of the mesh scene object. After all files have been added via AddCurvatureFileForGroupCBA(), the surface maps of the subjects can be transformed into group-aligned space by this function. The resulting aligned surface maps are automatically saved to disk using the name of the original SMP with an added ``_ALIGNED'' string (`*_CURVATURE_ALIGNED_RIGIDONLY.smp`). The result of rigid alignment is automatically saved in a ".rga" file that will be used by subsequent CBA when using same input curvature SMP files. Then, proceed to next step RunCBA(). To be used in BrainVoyager QX 2.8 or higher.
Parameter 1: Name of target curvature file, which can be created via the function

mesh.CreateSphericalCoordinatesMapFromSMP().
Returns: Success or no success (boolean).

RunCBA()

RunCBA()
Description: This is a function of the mesh scene object. After all files have been added via AddCurvatureFileForGroupCBA(), the surface maps of the subjects can be transformed into group-aligned space by this function. The resulting aligned surface maps are automatically saved to disk using the name of the original SMP with an added ``_ALIGNED'' string (`*_CURVATURE_ALIGNED.smp`). To be used in BrainVoyager QX 2.8 or higher. *Returns:* Success or no success (boolean).

CreateAverageCurvatureGroupMap()

CreateAverageCurvatureGroupMap()
Description: This convenience function can only be called after RunCBA() (with internally stored set of .SRF, .SSM, .SMP file names): it creates a group curvature map indicating the quality of alignment; also, it saves a ".cal" file that can be used in the Cortex-Based Alignment dialog. To be used in BrainVoyager QX 2.8 or higher. *Returns:* Success or no success (boolean).

CreateAverageFoldedGroupMesh()

CreateAverageFoldedGroupMesh()
Description: This convenience function can only be called after RunCBA() (with internally stored set of .SRF, .SSM, .SMP file names): create folded group average cortex using created alignment (SSM) files. The function also saves a ".sal" file that can be used in the Cortex-Based Alignment dialog; the function only works if names of folded SPH meshes can be derived from curvature names by replacing trailing substring with `_RECOSM_SPH.srf`. To be used in BrainVoyager QX 2.8 or higher. *Returns:* Success or no success (boolean).

mesh.SmoothMesh()

mesh.SmoothMesh()
Description: This is the standard function for smoothing a mesh (`*_RECO.srf`). As a result, the mesh will shrink. For a function without shrinking, use mesh.SmoothRecoMesh(). To be used in BrainVoyager QX 2.8 or higher. (See example script "MeshMorphing.js".)
Parameter 1: Number of smoothing iterations (for example 30).
Parameter 2: Smoothing force (f.e. 0.07).

mesh.SmoothRecoMesh()

mesh.SmoothRecoMesh()
Description: Special "high-frequency" smoothing removing jags of reconstructed voxel borders without shrinking the mesh (`*_RECO.srf`). For the standard version of the function, see mesh.SmoothMesh(). To be used in BrainVoyager QX 2.8 or higher. (See example script "MeshMorphing.js".)
Parameter 1: Number of smoothing iterations (for example 50).
Parameter 2: Smoothing force (f.e. 0.07).

mesh.CalculateCurvature()

mesh.CalculateCurvature()
Description: After smoothing, calculate the curvature of the mesh via this function. (See example script "MeshMorphing.js".) To be used in BrainVoyager QX 2.8 or higher.

mesh.InflateMesh()

mesh.InflateMesh()
Description: Inflate the mesh (`*_RECO.srf`) after smoothing. To be used in BrainVoyager QX 2.8 or higher. (See example script "MeshMorphing.js".)
Parameter 1: Number of morphing iterations (for example 500).
Parameter 2: Smoothing force (for example 0.8).
Parameter 3: (" "). If " " used for 3rd param (area reference mesh), the current mesh at the moment the function is called is used to calculate the area of the reference mesh.

mesh.CreateMTCFromVTC()

mesh.CreateMTCFromVTC()
Description: Project the functional data (*.vtc) on the surface mesh (*.srf). It is assumed that a *.vmr with a linked *.vtc as well as a mesh is available (e.g. loaded). To be used in BrainVoyager QX 2.8 or higher. See script "MeshMTCFromVTC.js".
Parameter 1: Sampling VTC along mesh vertex normals (0 = at vertex) from (for example -1.0).
Parameter 2: Sampling VTC along mesh vertex normals (0 = at vertex) to (for example 2.0).
Parameter 3: Name for the new *.mtc.
Returns: Success or no success (boolean).

mesh.LinkMTC()

mesh.LinkMTC()
Description: Load a mesh time course file (*.mtc). To be used in BrainVoyager QX 2.8 or higher. See script "MeshMTCSingleStudyGLM.js".
Parameter 1: Name of *.mtc file.
Returns: Success or no success (boolean).

mesh.SaveMTC()

mesh.SaveMTC()
Description: Save the *.mtc after preprocessing. To be used in BrainVoyager QX 2.8 or higher. See script "MeshMTCPreprocessing.js". *Parameter 1:* Name for *.mtc file.

mesh.ClearDesignMatrix()

mesh.ClearDesignMatrix()
Description: Load a anatomical file (*.vmr), mesh (*.srf) and link functional data (*.mtc). Then it is time to remove any remaining design matrices via this function. To be used in BrainVoyager QX 2.8 or higher. See script "MeshMTCSingleStudyGLM.js".

mesh.LoadSingleStudyGLMDesignMatrix()

mesh.LoadSingleStudyGLMDesignMatrix()
Description: Function to load a single-subject or run design matrix (*.sdm). To be used in BrainVoyager QX 2.8 or higher.
Parameter 1: Name of design matrix file (*.sdm).
Returns: Success or no success (boolean).

mesh.ComputeSingleStudyGLM()

mesh.ComputeSingleStudyGLM()
Description: Load an anatomical file (*.vmr), a mesh (*.srf), obtain a mesh object, link functional data (*.mtc) and load a design matrix file (*.sdm), then this function can be used. To be used in BrainVoyager QX 2.8 or higher. See script "MeshMTCSingleStudyGLM.js".

mesh.ShowGLM()

mesh.ShowGLM()
Description: After running a single study GLM, make the results visible by using this function. To be used in BrainVoyager QX 2.8 or higher.

mesh.SaveGLM()

mesh.SaveGLM()
Description: Save the GLM that was calculated via `mesh.ComputeSingleStudyGLM()`. To be used in BrainVoyager QX 2.8 or higher. See script "MeshMTCSingleStudyGLM.js".
Parameter 1: Name for general linear model (*.glm) file.

3.12.5 Description of properties

CurrentMeshScene

CurrentMeshScene
Description: VMR property. Creates empty scene (surface view) if not available for the VMR object. Use: `var meshScene = docVMR.CurrentMeshScene;`. Since BrainVoyager 2.8.

MeshScene

MeshScene
Description: VMR property. Obtain mesh scene object from the VMR object.
Use: `var meshScene = docVMR.MeshScene;`. Since BrainVoyager 2.8.

meshScene.CurrentMesh

meshScene.CurrentMesh
Description: meshScene property. Obtain mesh object from the mesh scene object.
Since BrainVoyager 2.8.

meshScene.ViewpointPositionX

meshScene.ViewpointPositionX
Description: Set the x-coordinate for the camera. Since BrainVoyager 2.8. For background information on viewing transformations, see section "Viewing transformations" in the OpenGL guide (an older version is available online at:
http://www.glprogramming.com/red/chapter03.htmlname2.

meshScene.ViewpointPositionY

meshScene.ViewpointPositionY
Description: Set the y-coordinate for the camera. Since BrainVoyager 2.8.

meshScene.ViewpointPositionZ

meshScene.ViewpointPositionZ
Description: Set the z-coordinate for the camera. Since BrainVoyager 2.8.

meshScene.ViewpointRotationX

meshScene.ViewpointRotationX
Description: Rotates the camera on the x-axis with provided number of degrees. Since BrainVoyager 2.8.

meshScene.ViewpointRotationY

meshScene.ViewpointRotationY
Description: Rotates the camera on the y-axis with provided number of degrees. Since BrainVoyager 2.8.

meshScene.ViewpointRotationZ

meshScene.ViewpointRotationZ
Description: Rotates the camera on the z-axis with provided number of degrees. Since BrainVoyager 2.8.

meshScene.SphereResolutionCBA

meshScene.SphereResolutionCBA
Get or set the resolution of the sphere for cortex-based alignment.
1: standard resolution (default)
2: low resolution
3: high resolution

mesh.FileName

mesh.FileName
Description: Obtain the name of the surface file (*.srf).

mesh.NrOfVertices

mesh.NrOfVertices
Description: Obtain the number of vertices of the surface file (*.srf).

mesh.MorphingUpdateInterval

mesh.MorphingUpdateInterval
Description: This sets or gives the number of steps after which the OpenGL window is updated during the morphing process. To be set before `InflateMeshToSphere()` and `CorrectInflatedSphereMesh()`. A default value is 50.

mesh.CorrectForSerialCorrelations

mesh.CorrectForSerialCorrelations
Description: This sets the level of correction for serial correlations in the noise. For AR(1), set to 1, for AR(2), use 2 (this is the better option).

3.12.6 Example script: visualization

To use the code, select the text below and save with the JavaScript extension ".js". Then, load in the Script Editor and click"Run".

```
/*  SurfaceFunctions.js
Script to visualize surface files
*/

/* This information is used in the functions */
var ObjectsRawDataPath = "/Users/hester/Data/ObjectsDicomGSG/";
var nameVMRinTal = ObjectsRawDataPath + "CG_3DT1MPR_SCRIPT_CLEAN_TAL.vmr";

/* This code will be executed when clicking 'Run' */
LoadVMRandSRF();
SurfaceViewpoints();

/* These functions can be invoked */
function LoadVMRandSRF()
{
var docVMR = BrainVoyagerQX.OpenDocument(nameVMRinTal);
docVMR.LoadMesh(ObjectsRawDataPath + "CG_3DT1MPR_SCRIPT_CLEAN_TAL_LH_RECOSM.srf");
docVMR.AddMesh(ObjectsRawDataPath + "CG_3DT1MPR_SCRIPT_CLEAN_TAL_RH_RECOSM.srf");
docVMR.Close();
}

function SurfaceViewpoints() {

var docVMR = BrainVoyagerQX.OpenDocument(nameVMRinTal);
docVMR.LoadMesh(ObjectsRawDataPath +  "CG_3DT1MPR_SCRIPT_CLEAN_TAL_RH_RECOSM.srf");
BrainVoyagerQX.ShowLogTab();
BrainVoyagerQX.PrintToLog("Changing viewpoints...");

var i;
////////////////////// X
var TrX = docVMR.ViewpointTranslationX;
BrainVoyagerQX.PrintToLog("Translate X...");
for(i=1; i<61; i++) {
docVMR.ViewpointTranslationX = TrX + 6*i;
docVMR.UpdateSurfaceWindow();
}
for(i=61; i>1; i--) {
docVMR.ViewpointTranslationX = TrX - 6*i;
docVMR.UpdateSurfaceWindow();
}

BrainVoyagerQX.PrintToLog("Rotate X...");
var RotX = docVMR.ViewpointRotationX;
for(i=1; i<61; i++) {
docVMR.ViewpointRotationX = RotX + 6*i;
docVMR.UpdateSurfaceWindow();
}

////////////////////// Y
var TrY = docVMR.ViewpointTranslationY;
BrainVoyagerQX.PrintToLog("Translate Y...");
for(i=1; i<61; i++) {
docVMR.ViewpointTranslationY = TrY + 6*i;
docVMR.UpdateSurfaceWindow();
}
BrainVoyagerQX.PrintToLog("Rotate Y...");
for(i=61; i>1; i--) {
docVMR.ViewpointTranslationY = TrY - 6*i;
docVMR.UpdateSurfaceWindow();
}
var RotY = docVMR.ViewpointRotationY;
for(i=1; i<61; i++) {
docVMR.ViewpointRotationY = RotY + 6*i;
docVMR.UpdateSurfaceWindow();
}

////////////////////// Z
var TrZ = docVMR.ViewpointTranslationZ;
BrainVoyagerQX.PrintToLog("Translate Z...");
for(i=1; i<61; i++) {
docVMR.ViewpointTranslationZ = TrZ + 6*i;
docVMR.UpdateSurfaceWindow();
}
for(i=61; i>1; i--) {
docVMR.ViewpointTranslationZ = TrZ - 6*i;
docVMR.UpdateSurfaceWindow();
}

BrainVoyagerQX.PrintToLog("Rotate Z...");
var RotZ = docVMR.ViewpointRotationZ;
```

```
for(i=1; i<61; i++) {
docVMR.ViewpointRotationZ = RotZ + 6*i;
docVMR.UpdateSurfaceWindow();
}

docVMR.SaveSnapshotOfSurfaceWindow(ObjectsRawDataPath + "Surface.png");
BrainVoyagerQX.PrintToLog("Finished.");
}
```

3.12.7 Example script: create MTC (via VMR)

To use the code, select the text below and save with the JavaScript extension ".js". Then, load in the Script Editor and click"Run". Please note that in BrainVoyager QX 2.8, one can use the mesh object to create an MTC (see functions below).

```
var path = "C:/Data/bvqxdata/CBA_RFX_June2009/subj_AA/";
var docVMR = BrainVoyagerQX.OpenDocument(path + "AA_TAL.vmr");
docVMR.LinkVTC(path + "AA_Localizer.vtc");
docVMR.LoadMesh(path + "AA_TAL_LH_RECOSM.srf");
docVMR.CreateMTCFromVTC(-1.0, 3.0, "test2.mtc" );
```

3.12.8 Example script: create MTC (via mesh object)

To use the code, select the text below and save with the JavaScript extension "MeshMTCFromVTC.js". Then, load in the Script Editor and click"Run". For use in QX 2.8 or higher.

```
//
// This script shows how MTC files can be created for a given mesh based on a VMR-VTC file
// it is assumed that a VMR with a linked VTC as well as a mesh is availalbe (e.g. loaded)
//
//  Created by Rainer Goebel, May 2013
//

function ProjectVTCDataOnMesh()
{
var ok;
var docVMR = BrainVoyagerQX.ActiveDocument;
if(docVMR == undefined) return;
var mesh = docVMR.CurrentMesh;
if(mesh == undefined) return;

ok = mesh.CreateMTCFromVTC(-1.0, 2.0, "MeshTimeCourseData.mtc" );
if(!ok)
BrainVoyagerQX.PrintToLog("Could not create MTC data from VTC data.");
}

ProjectVTCDataOnMesh();
```

3.12.9 Example script: Cortex-Based Alignment (via mesh scene object)

To use the code, select the text below and save as "MeshCBA.js". Then, load in the Script Editor and click"Run" or place in /Documents/BVQXExtensions/Scripts/, start BrainVoyager, and select the script from the Script Menu in order to run it. For use in QX 2.8 or higher.

```
//
// This script shows how to prepare and run (rigid) CBA including group mesh/curvature map visualization.
//
//  Created by Rainer Goebel, May 2013
//

function CreateSphereFromFoldedMesh()
{
var ok;
var docVMR = BrainVoyagerQX.ActiveDocument; if(docVMR == undefined) return;
// It is assumed that a folded "*_RECOSM.srf" mesh is availalbe (e.g. loaded)
var mesh = docVMR.CurrentMesh; if(mesh == undefined) return;

mesh.MorphingUpdateInterval = 50;
mesh.CalculateCurvatureCBA();
mesh.SmoothCurrentMap(5);
mesh.MeshScene.UpdateSurfaceWindow();
mesh.InflateMeshToSphere(800);
mesh.CorrectInflatedSphereMesh(3000);
var new_name = removeLastUnderscoreSegment(mesh.FileName) + "_SPHERE.srf";
mesh.SaveAs(new_name);
}

function MapSphereGetCurvature()
{
var ok;
var docVMR = BrainVoyagerQX.ActiveDocument; if(docVMR == undefined) return;
var meshScene = docVMR.MeshScene; if(meshScene == undefined) return;
var mesh = meshScene.CurrentMesh; if(mesh == undefined) return;

/* we assume created sphere mesh (see "CreateSphereFromFoldedMesh" above) is available as current mesh
(created or loaded) AND available on disk (since it is reloaded)*/
var sphere_mesh_name =  mesh.FileName;
/* we need name of folded original mesh below -
here we assume that name is same as SPHERE mesh but instead of "SPHERE" has "RECOSM" at end of name*/
var folded_mesh_name = removeLastUnderscoreSegment(sphere_mesh_name) + "_RECOSM.srf";

meshScene.SphereResolutionCBA = 1; // 1 -> standard resolution (default), 2 -> low resolution, 3 -> high resolution
var saved_ssm_file          = meshScene.MapSphereMeshFromStandardSphere();
var saved_foldedSPH_file = meshScene.SetStandardSphereToFoldedMesh(folded_mesh_name);
mesh = meshScene.CurrentMesh;
var saved_curvature_file  = mesh.CreateMultiScaleCurvatureMap(2, 7, 20, 40);
/* the obtained curvature file (automatically saved) is needed for CBA -
store in array, one for each subject (per hemisphere)*/
BrainVoyagerQX.PrintToLog("Curvature file: " + saved_curvature_file);
}

function RunRigidCBAStep()
{
var ok;
var docVMR = BrainVoyagerQX.ActiveDocument; if(docVMR == undefined) return;
var meshScene = docVMR.MeshScene; if(meshScene == undefined) return;
// the mesh for rigid alignment must be a sphere (SPH file)
// to ensure that we have a sphere mesh, we can create one
meshScene.CreateStandardSphereMesh();
var mesh = meshScene.CurrentMesh;

meshScene.ClearGroupCBACurvatureFiles();
var NSubjects = 5;
var CurvatureFile, TargetCurvatureFile;
for(i=0; i<NSubjects; i++) // loop over subjects (per hemisphere)
{
// for demonstration, we simply hard-code files here - better to use/prepare array
if(i == 0) CurvatureFile = BrainVoyagerQX.PathToSampleData + "CortexBasedAlignment/AA/AA_TAL_LH_RECOSM_SPH_CURVATURE.smp";
if(i == 1) CurvatureFile = BrainVoyagerQX.PathToSampleData + "CortexBasedAlignment/MR/MR_TAL_LH_RECOSM_SPH_CURVATURE.smp";
if(i == 2) CurvatureFile = BrainVoyagerQX.PathToSampleData + "CortexBasedAlignment/PD/PD_TAL_LH_RECOSM_SPH_CURVATURE.smp";
if(i == 3) CurvatureFile = BrainVoyagerQX.PathToSampleData + "CortexBasedAlignment/RM/RM_TAL_LH_RECOSM_SPH_CURVATURE.smp";
if(i == 4) CurvatureFile = BrainVoyagerQX.PathToSampleData + "CortexBasedAlignment/SG/SG_TAL_LH_RECOSM_SPH_CURVATURE.smp";

ok = meshScene.AddCurvatureFileForGroupCBA(CurvatureFile);
if(!ok) // provided file not found
return;

if(i == 0) TargetCurvatureFile = CurvatureFile; // we here use first case for rigid alignment target (any should be fine)
}
var SphericalTargetCurvatureFile = mesh.CreateSphericalCoordinatesMapFromSMP(TargetCurvatureFile);
if(SphericalTargetCurvatureFile == "") // we get empty string if it did not work
return;

ok = meshScene.RunRigidCBA(SphericalTargetCurvatureFile);
```

```
/* the result of rigid alignment is automatically saved in a ".rga" file
that will be used by subsequent CBA when using same input curvature SMP files*/
}

function RunFullCBA()
{
var ok;
var docVMR = BrainVoyagerQX.ActiveDocument; if(docVMR == undefined) return;
var meshScene = docVMR.MeshScene; if(meshScene == undefined) return; // creates surface window if not present

// if this is run after rigid-CBA, we would not strictly fill curvature SMP list again
meshScene.ClearGroupCBACurvatureFiles();
var NSubjects = 5;
var CurvatureFile;
for(i=0; i<NSubjects; i++) // loop over subjects (per hemisphere)
{
// for demonstration, we simply hard-code files here - better to use/prepare array
if(i == 0) CurvatureFile = BrainVoyagerQX.PathToSampleData + "CortexBasedAlignment/AA/AA_TAL_LH_RECOSM_SPH_CURVATURE.smp";
if(i == 1) CurvatureFile = BrainVoyagerQX.PathToSampleData + "CortexBasedAlignment/MR/MR_TAL_LH_RECOSM_SPH_CURVATURE.smp";
if(i == 2) CurvatureFile = BrainVoyagerQX.PathToSampleData + "CortexBasedAlignment/PD/PD_TAL_LH_RECOSM_SPH_CURVATURE.smp";
if(i == 3) CurvatureFile = BrainVoyagerQX.PathToSampleData + "CortexBasedAlignment/RM/RM_TAL_LH_RECOSM_SPH_CURVATURE.smp";
if(i == 4) CurvatureFile = BrainVoyagerQX.PathToSampleData + "CortexBasedAlignment/SG/SG_TAL_LH_RECOSM_SPH_CURVATURE.smp";

ok = meshScene.AddCurvatureFileForGroupCBA(CurvatureFile);
if(!ok) // provided file not found
return;
}
ok = meshScene.RunCBA(); if(!ok) return;

/* these convenience functions can only be called after CBA
(with internally stored set of .SRF, .SSM, .SMP file names):
 create group curvature map indicating quality of alignment,
 saves also ".cal" file that can be used in CBA dialog */
ok = meshScene.CreateAverageCurvatureGroupMap();
/* create folded group average cortex using created alignment (SSM) files,
saves also ".sal" file that can be used in CBA dialog;
the function only works if names of folded SPH meshes can be derived from
curvature names by replacing trailing substring with "_RECOSM_SPH.srf" */
ok = meshScene.CreateAverageFoldedGroupMesh();
}

//CreateSphereFromFoldedMesh();
//MapSphereGetCurvature();
//RunRigidCBAStep();
RunFullCBA();

// helpers
function removeLastUnderscoreSegment(filename) {
var lastsegmentlength = getlastsegmentlength(filename);
var name = "";
for (i=0; i<(filename.length-lastsegmentlength); i++) {
letter = filename[i];
name += letter;
}
return name;
}

function getlastsegmentlength(filename) {
var lastsegmentlength, letter, underscorepos;
for (i=filename.length; i>0; i--) {
letter = filename[i];
if (letter == "_") {
underscorepos = i;
break;
}
}
lastsegmentlength = filename.length - underscorepos;
return lastsegmentlength;
}
```

3.12.10 Example script: loading a mesh (via mesh scene object)

To use the code, select the text below and save as "MeshLoading.js". Then, load in the Script Editor and click"Run" or place in /Documents/BVQXExtensions/Scripts/, start BrainVoyager, and select the script from the Script Menu in order to run it. For use in QX 2.8 or higher.

```
//
//  Created by Rainer Goebel, May 2013
//

var ObjectsRawDataPath = BrainVoyagerQX.PathToSampleData + "ObjectsDicomGSG/";

function LoadMeshFromMeshScene()
{
```

```
var ok;
var docVMR = BrainVoyagerQX.ActiveDocument; if(docVMR == undefined) return;
var meshScene = docVMR.CurrentMeshScene; // creates empty scene (surface view) if not available for docVMR
if(meshScene == undefined) return;

ok = meshScene.LoadMesh(ObjectsRawDataPath + "CG_Head.srf"); if(!ok) return;
var mesh = meshScene.CurrentMesh;

var n_vertices = mesh.NrOfVertices;
BrainVoyagerQX.PrintToLog("No. of vertices of current mesh: " + n_vertices);

BrainVoyagerQX.PrintToLog("Viewpoint position, x: " + meshScene.ViewpointPositionX + " y: " +
meshScene.ViewpointPositionY + " z: " + meshScene.ViewpointPositionZ);
meshScene.ViewpointPositionX = -500;
meshScene.ViewpointRotationX = 0;
meshScene.ViewpointRotationY = 180;
meshScene.ViewpointRotationZ = 0;
for(var i=0; i<90; i++) {
meshScene.ViewpointPositionX += 2;
meshScene.ViewpointRotationZ -= 1;
meshScene.UpdateSurfaceWindow();
}
BrainVoyagerQX.PrintToLog("Viewpoint position, x: " + meshScene.ViewpointPositionX + " y: " +
meshScene.ViewpointPositionY + " z: " + meshScene.ViewpointPositionZ);
}

function LoadMeshFromVMRDoc()
{
var ok;
var docVMR = BrainVoyagerQX.ActiveDocument;
if(docVMR == undefined)
return;

ok = docVMR.LoadMesh(ObjectsRawDataPath + "CG_Head.srf"); if(!ok) return;
var mesh = docVMR.CurrentMesh;

var n_vertices = mesh.NrOfVertices;
BrainVoyagerQX.PrintToLog("No. of vertices of current mesh: " + n_vertices);
}

LoadMeshFromMeshScene();
//LoadMeshFromVMRDoc();
```

3.12.11 Example script: smoothing and inflating a mesh (via mesh object)

To use the code, select the text below and save as "MeshMorphing.js". Then, load in the Script Editor and click"Run" or place in /Documents/BVQXExtensions/Scripts/, start BrainVoyager, and select the script from the Script Menu in order to run it. For use in QX 2.8 or higher.

```
//
// This script shows how a mesh can be smoothed and inflated.
// It is assumed that a "*_RECO.srf" mesh is available (e.g. loaded)
//
//  Created by Rainer Goebel, May 2013
//

function MorphMesh()
{
var ok;
var docVMR = BrainVoyagerQX.ActiveDocument;
if(docVMR == undefined) return;
var mesh = docVMR.CurrentMesh;
if(mesh == undefined) return;

mesh.MorphingUpdateInterval = 25;
//mesh.SmoothMesh(30, 0.07); // standard smoothing - mesh will shrink
mesh.SmoothRecoMesh(50, 0.07); // special "high-frequency" smoothing
//removing jags of reconstructed voxel borders without shrinking mesh
mesh.CalculateCurvature();
mesh.SmoothCurrentMap(5);
mesh.MeshScene.UpdateSurfaceWindow();
var new_name = removeextension(mesh.FileName) + "SM.srf";
mesh.SaveAs(new_name);
mesh.InflateMesh(500, 0.8, ""); // if "" used for 3rd param (area reference mesh),
// the current mesh at the moment the fn is called is
// used to calculate ref mesh area
}

MorphMesh();

// helpers
function removeextension(filename) {
var extlength = getextensionlength(filename);
var name = "";
```

```
for (i=0; i<(filename.length-extlength); i++) {
letter = filename[i];
name += letter;
}
return name;
}

function getextensionlength(filename) {
var extensionlength, letter, dotpos;
for (i=filename.length; i>0; i--) {
letter = filename[i];
if (letter == ".") {
dotpos = i;
break;
}
}
extensionlength = filename.length - dotpos;
return extensionlength;
}
```

3.12.12 Example script: create MTC

To use the code, select the text below and save as "MeshMTCFromVTC.js". Then, load in the Script Editor and click"Run" or place in /Documents/BVQXExtensions/Scripts/, start BrainVoyager, and select the script from the Script Menu in order to run it. For use in QX 2.8 or higher.

```
//
// This script shows how MTC files can be created for a given mesh based on a VMR-VTC file
// it is assumed that a VMR with a linked VTC as well as a mesh is available (e.g. loaded)
//
//  Created by Rainer Goebel, May 2013
//

function ProjectVTCDataOnMesh()
{
var ok;
var docVMR = BrainVoyagerQX.ActiveDocument;
if(docVMR == undefined) return;
var mesh = docVMR.CurrentMesh;
if(mesh == undefined) return;

ok = mesh.CreateMTCFromVTC(-1.0, 2.0, "MeshTimeCourseData.mtc" );
if(!ok)
BrainVoyagerQX.PrintToLog("Could not create MTC data from VTC data.");
}

ProjectVTCDataOnMesh();
```

3.12.13 Example script: preprocessing an *.mtc file (via mesh object)

To use the code, select the text below and save as "MeshMTCPreprocessing.js". Then, load in the Script Editor and click"Run" or place in /Documents/BVQXExtensions/Scripts/, start BrainVoyager, and select the script from the Script Menu in order to run it. For use in QX 2.8 or higher.

```
//
// Example script showing how to run statistics with the new "mesh" object
// Feel free to adapt this script to your needs
//
//  Created by Rainer Goebel, May 2013
//

var ObjectsRawDataPath = BrainVoyagerQX.PathToSampleData + "ObjectsDicomGSG/";

// when calling this fn, we assume a VMR and the desired mesh have been loaded already (see also other "Mesh..." scripts)
//
function PreprocessMTC()
{
var ok;

docVMR = BrainVoyagerQX.ActiveDocument;
if(docVMR == undefined) return;

var mesh = docVMR.CurrentMesh;
if(mesh == undefined) return;

ok = mesh.LinkMTC(ObjectsRawDataPath +
"CG_Objects_Float_SCCAI_3DMCT_THPGLMF2c_TAL_NGF_LH.mtc" ); if(!ok) return;

mesh.SpatialSmoothing(3);
mesh.LinearTrendRemoval();
mesh.TemporalHighPassFilterFFT(3);
```

```
mesh.TemporalGaussianSmoothing(5, "Seconds");

var PreprocessedMTCFileName = mesh.FileNameOfPreprocessdMTC;
BrainVoyagerQX.PrintToLog("Preprocessed .MTC: " + PreprocessedMTCFileName);
mesh.SaveMTC(PreprocessedMTCFileName);
}

PreprocessMTC();
```

3.12.14 Example script: single study GLM on mesh data (via mesh object)

To use the code, select the text below and save as "MeshMTCSingleStudyGLM.js". Then, load in the Script Editor and click"Run" or place in /Documents/BVQXExtensions/Scripts/, start BrainVoyager, and select the script from the Script Menu in order to run it. For use in QX 2.8 or higher.

```
//
// Example script showing how to run statistics with the new "mesh" object
// Feel free to adapt this script to your needs
//
//  Created by Rainer Goebel, May 2013
//

var ObjectsRawDataPath = BrainVoyagerQX.PathToSampleData + "ObjectsDicomGSG/";

function RunMeshGLM()
{
var ok;

var docVMR = BrainVoyagerQX.OpenDocument(ObjectsRawDataPath + "CG2_3DT1FL_SINC4_TAL.vmr");
if(docVMR == undefined) return;

ok = docVMR.LoadMesh(ObjectsRawDataPath +
"CG2_3DT1FL_SINC4_TAL_BRAIN_0.5mmISO_DS1mm_WM_LH_RECOSM.srf"); if(!ok) return;

var mesh = docVMR.CurrentMesh;
if(mesh == undefined) return;
ok = mesh.LinkMTC(ObjectsRawDataPath +
"CG_Objects_Float_SCCAI_3DMCT_THPGLMF2c_TAL_NGF_LH.mtc" ); if(!ok) return;

mesh.ClearDesignMatrix();
ok = mesh.LoadSingleStudyGLMDesignMatrix(ObjectsRawDataPath +
"CG_OBJECTS_FROMSCRIPT.sdm"); if(!ok) return;

mesh.CorrectForSerialCorrelations = 2; // 1 -> AR(1), 2 -> AR(2)
mesh.ComputeSingleStudyGLM();
mesh.ShowGLM();
mesh.SaveGLM(ObjectsRawDataPath + "CG_OBJECTS_MeshGLM_FROMSCRIPT.glm");

//docVMR.Close();

//ok = docVMR.LinkStimulationProtocolToMeshMTC(ObjectsRawDataPath +
"CG_OBJECTS_FROMSCRIPT.prt"); if(!ok) return;
}

RunMeshGLM();
```

Chapter 4

File input and output (I/O)

4.1 Introduction

4.1.1 Using the BrainVoyager object

From BrainVoyager QX 1.9, the name of a file can be obtained using
`BrainVoyagerQX.BrowseFile(``Please select the file'', ``*.*'').`

BrowseFile()

BrowseFile() *Description:* Get the name of a file on the filesystem via a file dialog.
Parameter 1: Instruction for the type of file.
Parameter 2: Filter (string), either a wildcard for all file types ("*.*") or specific file type (for example "*.vmr")

BrowseDirectory()

BrowseDirectory() *Description:* Get the name of a directory on the filesystem via a dialog; the directory name will not contain a file separation character "/" at the end of the string (for example "/Disk/maindir/subdir").

4.1.2 Using Qt objects

In these versions of BrainVoyager QX, file access can be obtained via the `QFile` object. After the `QFile` object has been created, the file object should be opened by providing an open mode, which is read, write or append. The open mode can be specified using the `QIODevice` object. Then, the text can be read or written via the `QTextStream` object. After all reading or writing has been finished, the `QFile` object needs to be closed.
For the use of Qt Objects, see a short discussion in the section 6.3.

Class QDir

The class `QDir` can for example be used to obtain a list of files of a specific format in a certain directory, by using its command `entryList()`. An example to print the third element in the file array to the BrainVoyager QX Log tab has been specified below:

```
    var dir = new QDir("/Users/me/Data/someproject/subsection/");
var list = dir.entryList(["*.*"]);
BrainVoyagerQX.PrintToLog(list[2]);
```

The wildcard "*.*" can of course be replaced by some specific format like "*.dcm".
For other functions of `QDir`, please consult the online Qt documentation for QDir.

Class QFile

4.1.3 List of (some) methods

QFile()
open()
close()

QFile properties

4.1.4 Detailed description of methods

open()

open() *Description:* Open the file object so that it can be read or written.
Parameter: OpenMode flag (an enum of QIODevice, see example script in section 4.3.2).

close()

close() *Description:* Close the file object.

4.2 Class QIODevice

4.2.1 List of methods

(Some of) QIODevice properties

WriteOnly: use this object and property for opening a file in write-only mode.
ReadOnly: use this object and property for opening a file in read-only mode.
Append: use this object and property for writing to an existing file, while preserving the contents of the file.

4.2.2 Class QTextStream

List of (some) methods

readLine()
writeString()
writeInt()
writeDouble()

Detailed description of methods

QTextStream()

QTextStream() *Description:* Create a textstream object.

readLine()

readLine() *Description:* Reads a line.

writeString()

writeString() *Description:* Write a string.
Parameter: Some text in double quotes.

writeInt()

writeInt() *Description:* Write an integer.
Parameter: Integer.

writeDouble()

writeDouble() *Description:* Write a number.
Parameter: Floating point number.

4.3 Example scripts

4.3.1 Example scripts: get file name and directory name

```
getFile("*.vmr");
getDir();

function getFile(filter) {

var fileWithPathName = BrainVoyagerQX.BrowseFile("Please select the file", filter);
BrainVoyagerQX.PrintToLog("Filename: " + fileWithPathName);
}

function getDir(filter) {

var dirName = BrainVoyagerQX.BrowseDirectory("Please select the directory");
BrainVoyagerQX.PrintToLog("Directory name: " + dirName);
}
```

4.3.2 Example scripts: write a file I

```
// A really simple "script"

var f = new QFile("script_generated.txt");
f.open(new QIODevice.OpenMode(QIODevice.WriteOnly));
var ts = new QTextStream(f);

ts.writeString("This file was written by a script using qt_core extension.\n\n");
ts.writeString("This is a decimal value: ");
ts.writeDouble(3.4);
ts.writeString("\n\nThis seem to works fine!\n\n");

f.close();
```

4.3.3 Example script: write a file II

Writes a text file with the number of filenames on the first line, and the filenames on the following lines.

```
var projfilenames = new Array();
projfilenames.push("/Users/me/Data/testdata/subj1.fmr");
projfilenames.push("/Users/me/Data/testdata/subj2.fmr");
var filename = this.writeToTextFile(projfilenames);

function writeToTextFile(projfilenames) {

    var filecounter;
    // write the textfile to the path of the first file
    var name = this.getPath(projfilenames[0]) + "filenames.txt";

     BrainVoyagerQX.PrintToLog("Name of file: " + name);

    var filenamesfile = new QFile(name);
    filenamesfile.open(new QIODevice.OpenMode(QIODevice.WriteOnly));
    var textstr = new QTextStream(filenamesfile);
    textstr.writeDouble(projfilenames.length);
    textstr.writeString("\n");
    for (filecounter = 0; filecounter < projfilenames.length; filecounter++) {
        textstr.writeString(projfilenames[filecounter] + "\n");
    }
    filenamesfile.close();
    BrainVoyagerQX.PrintToLog("Wrote: " + name);
    return name;
}

function getPath(filename) {

var start = 0; // start searching from begin
var last = filename.lastIndexOf("/"); // search for last path separator
var path = filename.substring(start, (last+1)); // now return path without filename
return path;
}
```

4.3.4 Example script: read a file

This script reads a text file that consists of the number of files on the first line, and filenames on all following lines.

```
var filename = String("/Users/hester/Data/testdata/filenames.txt");
var projfls = this.readTextFile(filename);


function readTextFile(name) {

    var projfilenames = new Array();
    var filecounter;
    BrainVoyagerQX.PrintToLog("Reading: " + name);

    var filenamesfile = new QFile(name);
    filenamesfile.open(new QIODevice.OpenMode(QIODevice.ReadOnly));
    var textstr = new QTextStream(filenamesfile);
    var nroffiles = parseInt(textstr.readLine());
    for (filecounter = 0; filecounter < nroffiles; filecounter++) {
        var filename = textstr.readLine();
        BrainVoyagerQX.PrintToLog(filename);
        projfilenames.push(filename);
    }
     filenamesfile.close();
     return projfilenames;
}
```

4.3.5 Example: delete a file

This script deletes a file (for example *.fmr), and also extra files of a functional project if they exist (*.stc and *-.stc). (This can be used for BrainVoyager QX 2.1, where the BrainVoyager `Remove()` command does not work.) *Thanks to Dirk Heslenfeld*

```
Remove("/Users/me/Data/Experiment1.fmr");

function Remove(file)
{
  BrainVoyagerQX.PrintToLog("REMOVING: " + file);
  if (QFile.exists(file))
      QFile.remove(file);
  if (QFile.exists(file.substring(0, file.lastIndexOf(".")) + ".stc" ))
      QFile.remove(file.substring(0, file.lastIndexOf(".")) + ".stc" );
  if (QFile.exists(file.substring(0, file.lastIndexOf(".")) + "-.stc" ))
      QFile.remove(file.substring(0, file.lastIndexOf(".")) + "-.stc" );
}
```

Chapter 5

Creating scripts with dialogs

5.1 Introduction

It is possible to connect a graphical user interface (*.ui) to the script, i.e. making a "GUI Script". This makes it possible to re-use the script for another project or by another BrainVoyager user without having to change the underlying script, since the specific parameters are not hardcoded in the script, but provided via the graphical components of the dialog. The user interface is saved in an XML file that can be created by Qt Designer (is included when downloading the Qt Creator package from http://qt.nokia.com/.
A nice description how to create a user interface for the script can be found at:
http://www.brainvoyager.com/resources_for_users/bvblog/bvblog.html.
See also the "Plugin" chapter in the BrainVoyager User's Guide:
http://www.brainvoyager.com/bvqx/doc/UsersGuide/WebHelp/BrainVoyagerQXUsersGuide.htm
since this also explains the GUI scripts.
An example script is shown in the section below. For more script examples for BrainVoyager QX 2.1, 2.2 and 2.3, please see
http://support.brainvoyager.com/ → "Available Tools → "Available Scripts" → "Scripts for BrainVoyager QX 2.1 and higher".

5.2 Writing GUI scripts

5.2.1 Capturing emitted signals

In graphical user interface (GUI) scripts, user input is collected from the signals emitted from the components on the dialog (*.ui), for example from buttons, radiobuttons, dropdownboxes etc. These graphical components are called 'widgets'. In the script (*.js) these signals can be caught and processed. For example, if the PushButton to start preprocessing has been clicked, invoke in the script a preprocessing function. A dialog can stay active for a long time, so a button could be clicked several times, if this is desirable. For capturing the emitted signals, the following properties can be used:

```
PushButton: clicked
RadioButton: toggled
CheckBox: stateChanged
LineEdit: editingFinished
TextEdit: textChanged (emit signal after each character)
```

In fact, these emitted signals are just notifications that the widget changed in state by action of the user, for example from unchecked to checked. The information itself can be collected via other properties of the widgets, which are described in section 5.2.2. The use of these signals has been illustrated in the extPrintDlg.js/ui script below.

5.2.2 Collecting information in the dialog

For obtaining the information in the widgets, the following properties of the respective widgets can be used:

```
Label: text
RadioButton: checked
CheckBox: checked
LineEdit: text
TextEdit: plainText
ComboBox: currentIndex, currentText (QX 2.2 and higher)
SpinBox: value
DoubleSpinBox: value
TimeEdit: time
DateEdit: date
```

Although it can be useful to capture the information when the signal has been emitted that the state of the widget has changed, it is not strictly necessary to do this directly after the user has entered some information. In the script below, for example, is all information collected via the function `collectInput()` when the user clicks the "Print" button. Say the LineEdit has the name "lePrint", then the text that the user has entered in the LineEdit can be access via `var text = lePrint.text;` if the LineEdit has been registered in the initDlg() function via FindChild() and otherwise via
`var textInLineEdit = this.<dialogname>.lePrint.text;` or, if the LineEdit is placed in a GroupBox:
`var textInLineEdit = this.<dialogname>.<groupboxname>.lePrint.text;`.

5.2.3 Functions for non-GUI scripts vs. functions in GUI scripts: the Script Object

In scripts (*.js) without a dialog, functions have the following form:

```
function <function name>( [arguments] ) {

<instructions>
}
```

while in a script with a dialog or graphical user interface (GUI) one can use the form above or the following form:

```
scriptObj.<function name> = function ( [arguments] ) {

<instructions>
}
```

In the latter case, the function is made a member function of the script object.

What does the script object do?

In scripts with a dialog or graphical user interface (GUI), a script object in the script (*.js) regulates the communication between the "script" and the user input via the GUI. The script object is initialised in the beginning of the script:

```
var scriptObj = new Object;
```

The following properties of the script object can be set:

dialogFileName: To provide the name of the dialog file (*.ui):
`scriptObj.dialogFileName = "ExampleGUIScript.ui";`

dialogAccessName: This name can be used when addressing widgets via the widget hierarchy:
`<this>.<dialog access name>.<widget name>.<emitted signal>.connect()`

scriptNameForUser: Name of script in BrainVoyager "Scripts" menu.
`scriptObj.scriptNameForUser = "GUIScriptTest";`

The following functions always need to be present in the GUI script:

initDlg: This function of the script object contains declarations of the widgets on the *.ui file, and connects signals emitted by the widgets to slots (functions in the script)

returnScriptObj: A function to return the script object (to the script engine in BrainVoyager)

For a basic example GUI script, see section 5.3.

5.2.4 An example script with different widgets

In the script below the behaviour of the different graphical components (widgets) and how to capture their information is demonstrated.

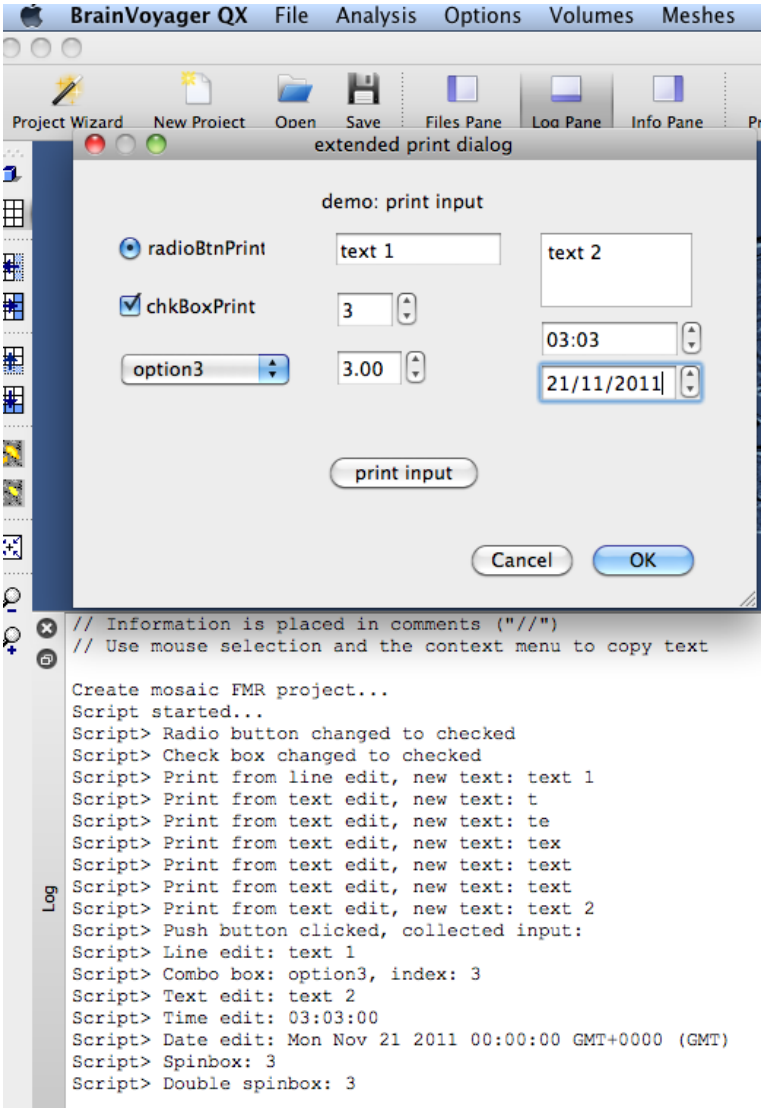


Figure 5.1: Dialog of the example script with different widgets

Behaviour of the script

Two different kinds of information capturing are shown.
At first, each widget *emits a signal* when it has been changed; this is received via the script and a notification is printed to the BrainVoyager Log tab.
Secondly, when the push button has been clicked, the *information* that the user has provided *in the widgets*, is collected and printed to the BrainVoyager Log tab.

Structure of the script

At the complete top and bottom of the script, matters using the script object (`scriptObj`) are defined. The script object is required for communication between BrainVoyager and the script and the script and the dialog.
Then, some custom functions are defined, with the names `collectInput()`,`printFromRadioButton()`, `printFromCheckBox()`,`printFromComboBox()`,`printFromLineEdit()` and `printFromTextEdit()`. In these functions, the information in a widget is collected and printed to the BrainVoyager QX Log tab.
Finally, in the standard `initDlg()` function, the emission of signals of each widgets is connected to each of these functions via the `connect()` function.

Usage of the script

The script can be used by saving the respective texts below in *.js and *.ui files in the /BVQXExtensions/Scripts/ directory, and start the BrainVoyager Script Editor. When the script is double clicked, its text will appear in the main screen of the Script Editor. Then the "Run" button can be pressed and the dialog of the script will appear (see figure 5.1).

5.2.5 The JavaScript

To use this script, save the following text with extension *.js in a text editor.

```
// extPrintDlg.js: Example GUI script for BrainVoyager QX 2.1
// This script bundle consists of extPrintDlg.js and extPrintDlg.ui,
place both in /Documents/BVQXExtensions/Scripts/ folder.
// Functionality: The script will print input from the widgets to the BrainVoyager QX log tab
if the button with label 'print input' and name 'btnPrint' is clicked.
// Some widgets will emit signals, and also print their input to the BrainVoyager QX log tab.
// Usage: In the BrainVoyager menu, select 'Scripts' > 'Edit and Run Scripts...' and
click 'Load...' to load this script, then 'Run'.
// HB, BI, 2010.

var scriptObj  = new Object;
scriptObj.scriptNameForUser  = "GUIScriptDemo";
scriptObj.dialogFileName  = "extPrintDlg.ui";
scriptObj.dialogAccessName  = "printDlg"; // the name 'printDlg' is used
// in the rest of the script to address the widgets
BrainVoyagerQX.PrintToLog("Script started...");

// in the initDlg() function below, this function is connected to btnPrint from extPrintDlg.ui
scriptObj.collectInput = function() {

BrainVoyagerQX.PrintToLog("Script> Push button clicked, collected input:");
     BrainVoyagerQX.PrintToLog("Script> Line edit: "  + this.printDlg.lnEditPrint.text);
BrainVoyagerQX.PrintToLog("Script> Combo box: "  + this.printDlg.cmBoxPrint.currentText +
", index: " + this.printDlg.cmBoxPrint.currentIndex);
BrainVoyagerQX.PrintToLog("Script> Text edit: "  + this.printDlg.txtEditPrint.plainText);
BrainVoyagerQX.PrintToLog("Script> Time edit: "  + this.printDlg.tmEditPrint.time);
BrainVoyagerQX.PrintToLog("Script> Date edit: "  + this.printDlg.dtEditPrint.date);
      BrainVoyagerQX.PrintToLog("Script> Spinbox: "  + this.printDlg.spnBoxPrint.value);
      BrainVoyagerQX.PrintToLog("Script> Double spinbox: "  + this.printDlg.dSpnBoxPrint.value);
}

scriptObj.printFromRadioButton = function() {
  if (this.printDlg.radioBtnPrint.checked) {
        BrainVoyagerQX.PrintToLog("Script> Radio button changed to checked");
    } else {
        BrainVoyagerQX.PrintToLog("Script> Radio button changed to unchecked");
    }
}

scriptObj.printFromCheckBox = function() {
    if (this.printDlg.chkBoxPrint.checked) {
        BrainVoyagerQX.PrintToLog("Script> Check box changed to checked");
    } else {
        BrainVoyagerQX.PrintToLog("Script> Check box changed to unchecked");
    }
```

```
}

scriptObj.printFromComboBox = function() {
    var currentItemIndex = this.printDlg.cmBoxPrint.currentIndex;
    var currentItemText = this.printDlg.cmBoxPrint.currentText;
    BrainVoyagerQX.PrintToLog("Script> Print from combobox, current index: " + currentItemIndex
     + ", current text: " + currentItemText);
}

scriptObj.printFromLineEdit = function() {
    var textInLineEdit = this.printDlg.lnEditPrint.text;
    BrainVoyagerQX.PrintToLog("Script> Print from line edit, new text: " + textInLineEdit);
}

scriptObj.printFromTextEdit = function() {
var newText =  this.printDlg.txtEditPrint.plainText;
BrainVoyagerQX.PrintToLog("Script> Print from text edit, new text: " + newText);
}

scriptObj.initDlg = function() {

    this.printDlg.windowTitle = "extended print dialog";

    // connect all the widgets to functions here
    this.printDlg.btnPrint.clicked.connect(this, this.collectInput); // this is the button from the extPrintDlg.ui
    this.printDlg.radioBtnPrint.toggled.connect(this, this.printFromRadioButton);
    this.printDlg.chkBoxPrint.stateChanged.connect(this, this.printFromCheckBox);
    this.printDlg.lnEditPrint.editingFinished.connect(this, this.printFromLineEdit);
    this.printDlg.txtEditPrint.textChanged.connect(this, this.printFromTextEdit);
     // the text edit emits a signal and thus prints after input of each character

}

returnScriptObj = function() {
return scriptObj;
}
returnScriptObj(); // should be after returnScriptOjb = function()
```

5.2.6 The user interface

To use the script, save also the text below with the name "extPrintDlg.ui" (because this is defined in the top of the JavaScript, see above) via a text editor. This text has been automatically generated when the user interface was built with Qt Designer.

```
<?xml version="1.0" encoding="UTF-8"?>
<ui version="4.0">
 <class>Dialog</class>
 <widget class="QDialog" name="Dialog">
  <property name="geometry">
   <rect>
    <x>0</x>
    <y>0</y>
    <width>468</width>
    <height>307</height>
   </rect>
  </property>
  <property name="windowTitle">
   <string>Dialog</string>
  </property>
  <widget class="QDialogButtonBox" name="buttonBox">
   <property name="geometry">
    <rect>
     <x>260</x>
     <y>260</y>
     <width>171</width>
     <height>32</height>
    </rect>
   </property>
   <property name="orientation">
    <enum>Qt::Horizontal</enum>
   </property>
   <property name="standardButtons">
    <set>QDialogButtonBox::Cancel|QDialogButtonBox::Ok</set>
   </property>
  </widget>
  <widget class="QPushButton" name="btnPrint">
   <property name="geometry">
    <rect>
     <x>170</x>
     <y>200</y>
     <width>113</width>
     <height>32</height>
```

```
  </rect>
 </property>
 <property name="text">
  <string>print input</string>
 </property>
</widget>
<widget class="QRadioButton" name="radioBtnPrint">
 <property name="geometry">
  <rect>
   <x>30</x>
   <y>50</y>
   <width>101</width>
   <height>20</height>
  </rect>
 </property>
 <property name="text">
  <string>radioBtnPrint</string>
 </property>
</widget>
<widget class="QCheckBox" name="chkBoxPrint">
 <property name="geometry">
  <rect>
   <x>30</x>
   <y>90</y>
   <width>121</width>
   <height>20</height>
  </rect>
 </property>
 <property name="text">
  <string>chkBoxPrint</string>
 </property>
</widget>
<widget class="QComboBox" name="cmBoxPrint">
 <property name="geometry">
  <rect>
   <x>30</x>
   <y>130</y>
   <width>121</width>
   <height>26</height>
  </rect>
 </property>
 <item>
  <property name="text">
   <string>select option</string>
  </property>
 </item>
 <item>
  <property name="text">
   <string>option1</string>
  </property>
 </item>
 <item>
  <property name="text">
   <string>option2</string>
  </property>
 </item>
 <item>
  <property name="text">
   <string>option3</string>
  </property>
 </item>
</widget>
<widget class="QLineEdit" name="lnEditPrint">
 <property name="geometry">
  <rect>
   <x>180</x>
   <y>50</y>
   <width>113</width>
   <height>22</height>
  </rect>
 </property>
</widget>
<widget class="QTextEdit" name="txtEditPrint">
 <property name="geometry">
  <rect>
   <x>320</x>
   <y>50</y>
   <width>104</width>
   <height>51</height>
  </rect>
 </property>
</widget>
<widget class="QTimeEdit" name="tmEditPrint">
 <property name="geometry">
  <rect>
   <x>320</x>
   <y>110</y>
```

```
      <width>111</width>
      <height>25</height>
     </rect>
    </property>
   </widget>
   <widget class="QDateEdit" name="dtEditPrint">
    <property name="geometry">
     <rect>
      <x>320</x>
      <y>140</y>
      <width>110</width>
      <height>25</height>
     </rect>
    </property>
   </widget>
   <widget class="QSpinBox" name="spnBoxPrint">
    <property name="geometry">
     <rect>
      <x>180</x>
      <y>90</y>
      <width>56</width>
      <height>25</height>
     </rect>
    </property>
   </widget>
   <widget class="QDoubleSpinBox" name="dSpnBoxPrint">
    <property name="geometry">
     <rect>
      <x>180</x>
      <y>130</y>
      <width>62</width>
      <height>25</height>
     </rect>
    </property>
   </widget>
   <widget class="QLabel" name="lblPrint">
    <property name="geometry">
     <rect>
      <x>170</x>
      <y>20</y>
      <width>121</width>
      <height>16</height>
     </rect>
    </property>
    <property name="text">
     <string>demo: print input</string>
    </property>
   </widget>
  </widget>
  <resources/>
  <connections>
   <connection>
    <sender>buttonBox</sender>
    <signal>accepted()</signal>
    <receiver>Dialog</receiver>
    <slot>accept()</slot>
    <hints>
     <hint type="sourcelabel">
      <x>248</x>
      <y>254</y>
     </hint>
     <hint type="destinationlabel">
      <x>157</x>
      <y>274</y>
     </hint>
    </hints>
   </connection>
   <connection>
    <sender>buttonBox</sender>
    <signal>rejected()</signal>
    <receiver>Dialog</receiver>
    <slot>reject()</slot>
    <hints>
     <hint type="sourcelabel">
      <x>316</x>
      <y>260</y>
     </hint>
     <hint type="destinationlabel">
      <x>286</x>
      <y>274</y>
     </hint>
    </hints>
   </connection>
  </connections>
</ui>
```

5.3 Procedure to create a GUI script

1. In Qt Creator, select to Create a Qt Designer Form (*.ui)(figure 5.2)
2. In the following dialog, select as type “Dialog” (not Main Window or Widget)
3. In the JavaScript (*.js) in the BrainVoyager script editor, create a script object
4. Set the name of the script object property that specifies the *.ui name
5. Set the name of the script object property that specifies an alias for the dialog
6. In the initDlg() function, connect each graphical component name to a function in the script

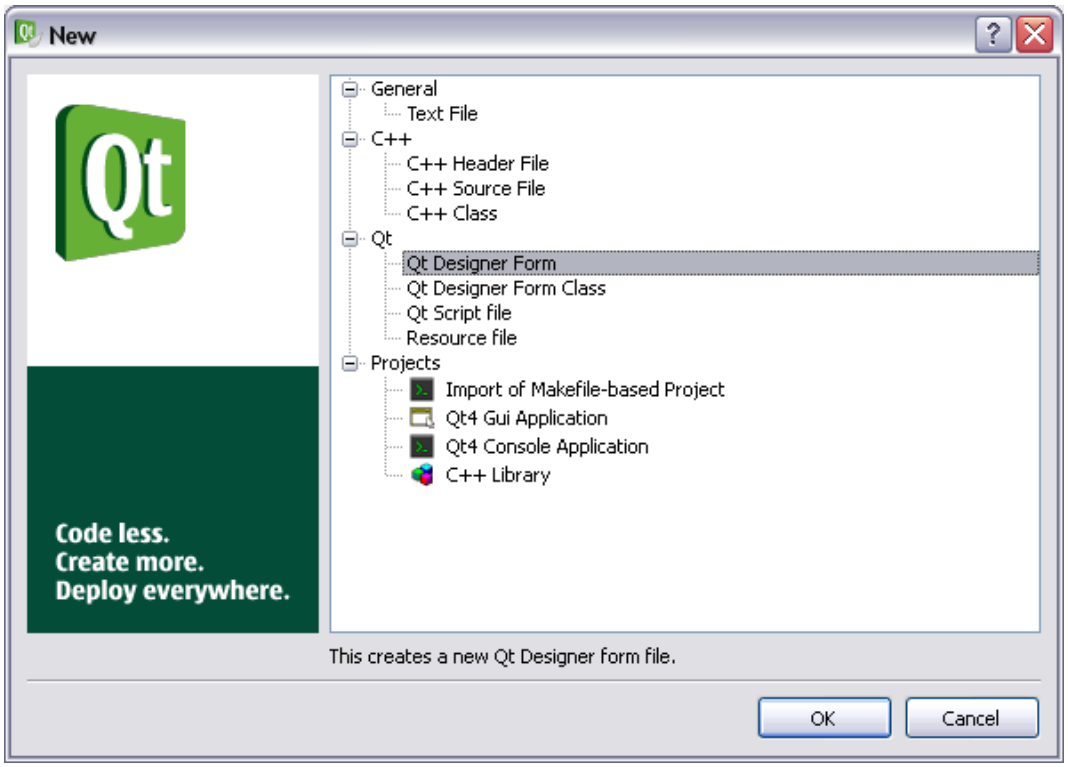


Figure 5.2: Select the Designer Form in Qt Creator

The script (*.js)

```
var scriptObj = new Object;
scriptObj.scriptNameForUser = "GUIScriptTest";
scriptObj.dialogFileName   = "ExampleGUIScript.ui";
scriptObj.dialogAccessName = "ScriptDialog";

scriptObj.initDlg = function() {
this.ScriptDialog.windowTitle = "Example GUI Script";
this.ScriptDialog.printToLogButton.clicked.connect(this, this.printTextToLog);
}

scriptObj.printTextToLog = function() {
BrainVoyagerQX.PrintToLog("Script> Dialog's Print to Log button clicked");
}

returnScriptObj = function() {
return scriptObj;
}
returnScriptObj();
```

5.3.1 The user interface (*.ui)

The user interface can be assembled in Qt Creator (see figure 5.3).

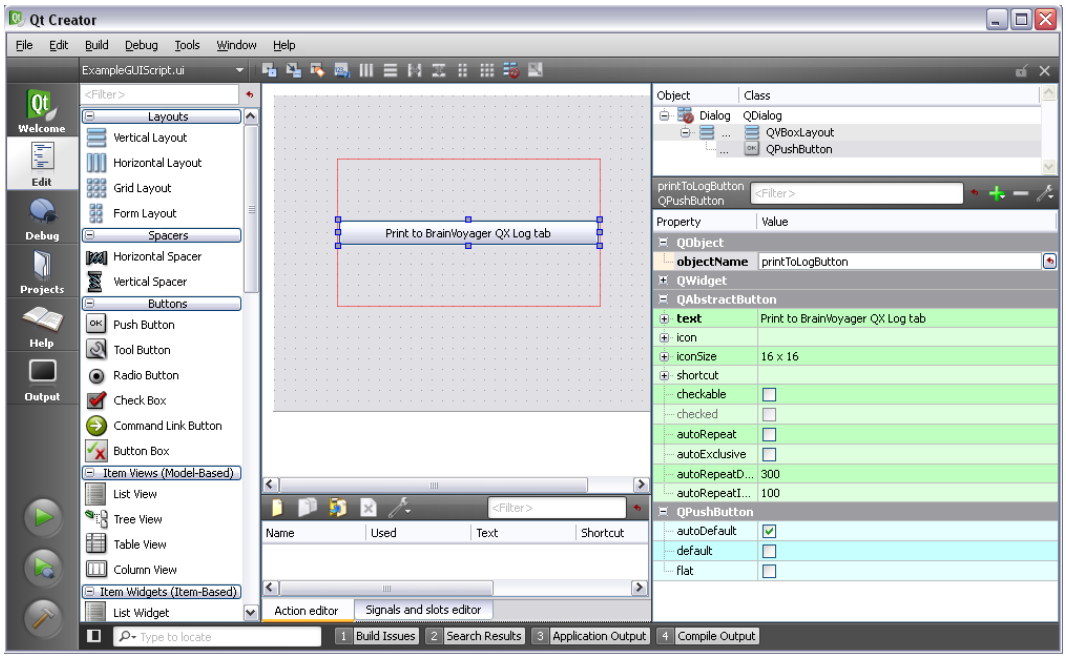


Figure 5.3: Creating the user interface in Qt Creator

When there are many widgets (graphical components), the function `BrainVoyagerQX.FindChild()` can help to address the widget in the script. This is useful when the widget is located in a groupbox on a tab, when it can be a lot of work to find its proper name to address from the script, because it could be:
`<this>.<dialogname>.<tabname>.<groupboxname>.<buttonname>`. For example, when there is a push button on the user interface (*.ui) with the name `btnGetFiles`, one could do the following:

1. Create a global variable `getFileButton`
2. In `initDlg()`, assign this simple name to the push button:
   `getFileButton = BrainVoyagerQX.FindChild("btnGetFiles");`
3. Use the variable `getFileButton` anywhere in the script.

5.3.2 Running a script with user interface

In the BrainVoyager main menu, select "Scripts" → "Edit and Run Scripts...". This will open the script editor. Then, load the script (*.js). When clicking the "Run" button, the dialog will pop up (see figure 5.4). Both script (*.js) and user interface (*.ui) should be placed in the directory `/Documents/BVQXExtensions/Scripts/`.

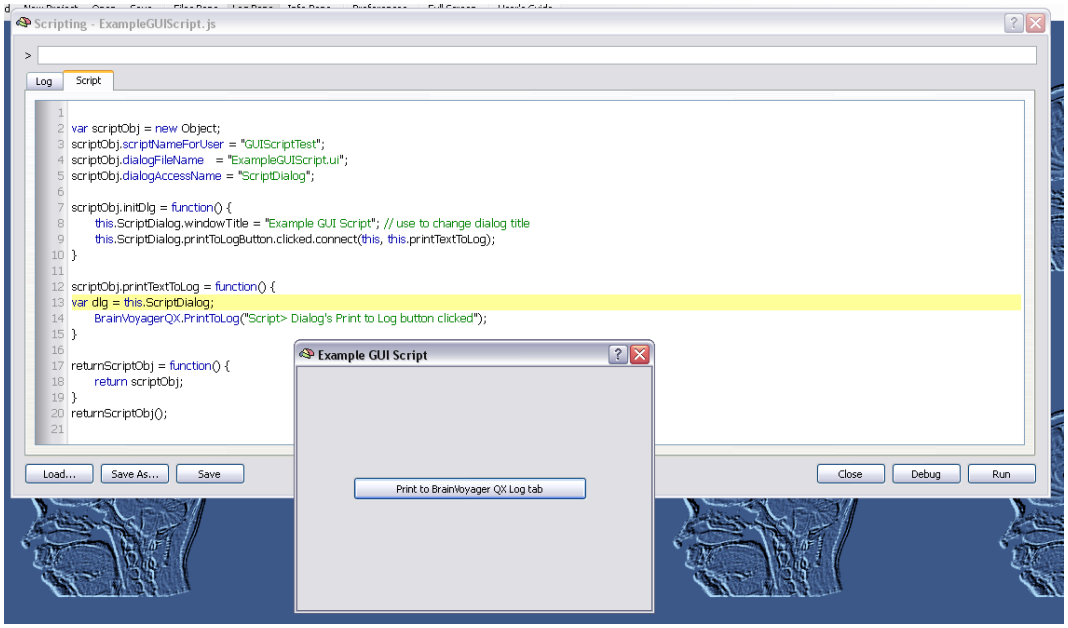


Figure 5.4: Using the user interface in BrainVoyager

5.3.3 Catching errors

If errors occur, it is good to be aware of them. They can be caught using the `try/catch` keywords:

```
  try {
...
(some critical code)
...
} catch (e) {
...
(some measure to take when an error occurs)
...
}
```

The idea is to put the critical code between the brackets of the `try`-block, and to place the measure that will be taken in case the critical code in the `try`-block fails, in the `catch`-block. The error `e` will be text, so one of the measures could be to print the error message to the BrainVoyager QX Log tab (see figure 5.5), so that the user can do something about the error. Another sensible measure would be of course to cancel any subsequent processes that are dependent of the critical code.

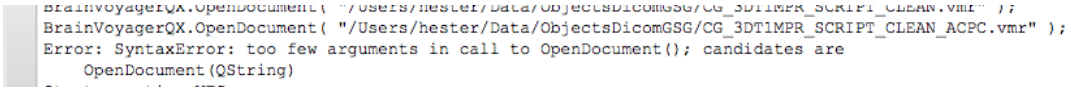


Figure 5.5: Print an error to the BrainVoyager QX Log tab

Chapter 6

JavaScript language reference

6.1 Introduction

This information about operators and objecta in the JavaScript language in this chapter was described by the WWW consortium; more information about the language can be found at

6.2 Keywords

6.2.1 Operators

Assignment operators

Assignment operators are used to assign values to JavaScript variables.
Given that `x=10` and `y=5`, the table below explains the assignment operators:

Table 6.1: Assignment operators

Operator	*Description*	*Same as*	*Result*
=	x=y		x=5
+=	x+=y	x=x+y	x=15
-=	x-=y	x=x-y	x=5
*=	x*=y	x=x*y	x=50
/=	x/=y	x=x/y	x=2
%=	x%=y	x=x%y	x=0

Arithmetic operators

Arithmetic operators are used to perform arithmetic between variables and/or values.
Given that y=5, the table below explains the arithmetic operators:

Comparison operators

Comparison operators are used in logical statements to determine equality or difference between variables or values.
Given that `x=5`, the table below explains the comparison operators:

Table 6.2: Arithmetic operators

Operator	*Description*	*Example*	*Result*
+	Addition	x=y+2	x=7
-	Subtraction	x=y-2 x=3	
*	Multiplication	x=y*2 x=10	
/	Division	x=y/2	x=2.5
%	Modulus (division remainder)	x=y%2	x=1
++	Increment	x=++y	x=6
–	Decrement	x=–y	x=4

Table 6.3: Comparison operators

Operator	*Description*	*Example*
==	is equal to	x==8 is false
===	is exactly equal to (value and type)	x===5 is true, x===“5” is false
! =	is not equal	x!=8 is true
>	is greater than	$x > 8$ is false
<	is less than	$x < 8$ is true
>=	is greater than or equal to	$x >= 8$ is false
<=	is less than or equal to	$x <= 8$ is true

Logical Operators

Logical operators are used to determine the logic between variables or values. The operators are `&&` (and), `II` (or), and `!` (not).

Conditional Operators

JavaScript also contains a conditional operator that assigns a value to a variable based on some condition.
Syntax

```
variablename=(condition)?value1:value2
```

Example

```
greeting=(visitor=="PRES")?"Dear President ":"Dear ";
```

If the variable visitor has the value of “PRES”, then the variable greeting will be assigned the value “Dear President ” else it will be assigned “Dear ”.

Bitwise

```
Xor (^), And (&), Or (|), Not (~), Bitwise left shift (<<)
Bitwise sign propagating right shift (>>)
Bitwise zero-operand right shift (>>>)
```

Special

```
?: (expression ? resultIfTrue : resultIfFalse)
, (evaluation of 1st and 2nd operand, returns 2nd)
function (var variable = function( optArgs ) { Statements } )
in (property in Object, returns boolean)
instanceof (object instanceof type, returns boolean)
new (var instance = new Type( optArgs )
this (this.property)
typeof (typeof item)
```

6.2.2 Data types

The following data types exist in JavaScript:

```
Array, Boolean, Date, Math, Number, String, RegExp
```

It is also possible to create own objects (see paragraph 6.2.3).

Array

Table 6.4: Array Object properties

Property	*Description*
constructor	Returns a reference to the array function that created the object
index	
input	
length	Sets or returns the number of elements in an array
prototype	Allows you to add properties and methods to the object

Table 6.5: Array Object methods

Method	*Description*
`concat()`	Joins two or more arrays and returns the result
`join()`	Puts all the elements of an array into a string.
...	The elements are separated by a specified delimiter
`pop()`	Removes and returns the last element of an array
`push()`	Adds one or more elements to the end of an array and returns the new length
`reverse()`	Reverses the order of the elements in an array
`shift()`	Removes and returns the first element of an array
`slice()`	Returns selected elements from an existing array
`sort()`	Sorts the elements of an array
`splice()`	Removes and adds new elements to an array
`toSource()`	Represents the source code of an object
`toString()`	Converts an array to a string and returns the result
`unshift()`	Adds one or more elements to the beginning of an array and returns the new length
`valueOf()`	Returns the primitive value of an Array object

Array Properties

Arrays have a single property, `length`, that holds the number of elements in the array.

Array Functions

The Array Functions documentation is available from the Qt Script documentation.

concat()

```
concat( array1, array2, optArray3, ... optArrayN )
```

```
    var x = new Array( "a", "b", "c" );
    var y = concat( a, [ "d", "e" ], [ 90, 100 ] );
    // y == [ "a", "b", "c", "d", "e", 90, 100 ]
```

Concatenates any number of arrays together in the order given, and returns a single array.

join()

```
join( optSeparator )
```

```
    var x = new Array( "a", "b", "c" );
    var y = x.join();          // y == "a,b,c"
    var z = x.join( " * " );   // y == "a * b * c"
```

Joins all the elements of an array together, separated by commas, or the specified optSeparator.

pop()

```
pop()

    var x = new Array( "a", "b", "c" );
    var y = x.pop(); // y == "c"  x == [ "a", "b" ]
```

Pops the top-most (right-most) element off the array and returns this element.
See also push(), shift() and unshift().

push()

```
push( element1, optElement2, ... optElementN )

    var x = new Array( "a", "b", "c" );
    x.push( 121 ); // x == [ "a", "b", "c", 121 ]
```

Pushes the given item(s) onto the top (right) end of the array.
See also push(), shift() and unshift().

reverse()

```
reverse()

    var x = new Array( "a", "b", "c", "d" );
    x.reverse(); // x == [ "d", "c", "b", "a" ]
```

Reverses the elements in the array.

shift()

```
shift()

    var x = new Array( "a", "b", "c" );
    var y = x.shift(); // y == "a"  x == [ "b", "c" ]
```

Shifts the bottom-most (left-most) element off the array and returns this element.
See also push(), shift() and unshift().

slice()

```
slice( startIndex, optEndIndex )

    var x = new Array( "a", "b", "c", "d" );
    var y = x.slice( 1, 3 ); // y == [ "b", "c" ]
    var z = x.slice( 2 );    // z == [ "c", "d" ]
```

Copies a slice of the array from the element with the given starting index, startIndex, to the element before the element with the given ending index, optEndIndex. If no ending index is given, all elements from the starting index onward are sliced.

sort()

```
sort( optComparisonFunction )
```

```
    var x = new Array( "d", "x", "a", "c" );
    x.sort(); // x == [ "a", "c", "d", "x" ]
```

Sorts the elements in the array using string comparison. For customized sorting, pass the sort() function a comparison function, optComparisonFunction, that has the following signature and behavior:

```
    function comparisonFunction( a, b ) // signature
```

The function must return an integer as follows:

```
-1 if a < b
0 if a == b
1 if a > b
```

Example:

```
    function numerically( a, b ) { return a < b ? -1 : a > b ? 1 : 0; }
    var x = new Array( 8, 90, 1, 4, 843, 221 );
    x.sort( numerically ); // x == [ 1, 4, 8, 90, 221, 843 ]
```

splice()

```
splice( startIndex, replacementCount, optElement1, ... optElementN )
```

```
    var x = new Array( "a", "b", "c", "d" );

    // 2nd argument 0, plus new elements   ==> insertion
    x.splice( 1, 0, "X", "Y" );
    // x == [ "a", "X", "Y", "b", "c", "d" ]

    // 2nd argument > 0, and no elements   ==> deletion
    x.splice( 2, 1 );
    // x == [ "a", "X", "b", "c", "d" ]

    // 2nd argument > 0, plus new elements ==> replacement
    x.splice( 3, 2, "Z" );
    // x == [ "a", "X", "b", "Z" ]
```

Splices elements into the array and out of the array. The first argument, startIndex, is the start index. The second argument, replacementCount, is the number of elements that are to be replaced. Make the second argument 0 if you are simply inserting elements. The remaining arguments are the elements to be inserted; there can be no elements if you are simply deleting a part of the array, i.e. if the second argument is > 0.

toString()

```
toString()
```

```
    var x = new Array( "a", "b", "c" );
    var y = x.toString();  // y == "a,b,c"
    var z = x.join();      // y == "a,b,c"
```

Joins all the elements of an array together, separated by commas. This function is used when the array is used in the context of a string concatenation or is used as a text value, e.g. for printing. Use join() if you want to use your own separator.

unshift()

```
unshift( expression, optExpression1, ... opExpressionN )

    var x = new Array( "a", "b", "c" );
    x.unshift( 121 ); // x == [ 121, "a", "b", "c" ]
```

Unshifts the given item(s) onto the bottom (left) end of the array. See also push(), shift() and unshift().

String

The functions that can be used for a string object are shown in the table below.

Table 6.6: String Object methods

Method	*Description*
`anchor("anchorName")`	
`big()`	
`blink()`	
`bold()`	
`charAt(index)`	Returns the character at the specified index
`charCodeAt([i])`	Returns the Unicode of the character at the specified index
`concat(string2)`	Joins two or more strings, and returns a copy of the joined strings
`fixed()`	
`fontcolor(#rrggbb)`	
`fontsize(1to7)`	
`fromCharCode(n1...)*`	Converts Unicode values to characters
`indexOf("str" [,i])`	Returns the position of the first found occurrence of a specified value in a string
`italics()`	
`lastIndexOf("str" [,i])`	Returns the position of the last found occurrence of a specified value in a string
`link(url)`	
`localeCompare()`	
`match(regexp)`	Searches for a match between a regular expression and a string, and returns the match
`replace(regexp,str)`	Searches for a match between a substring (or regular expression) and a string, and replaces the matched substrin
`search(regexp)`	Searches for a match between a regular expression and a string, and returns the position of the match
`slice(i,j)`	Extracts a part of a string and returns a new string
`small()`	
`split(char)`	Splits a string into an array of substrings
`strike()`	
`sub()`	
`substring(from, to)`	Return part of the string, starting with position “from”. “to” is optional.
`sup()`	
`toLocaleLowerCase()`	
`toLocaleUpperCase()`	
`toLowerCase()`	Converts a string to lowercase letters
`toString()`	
`toUpperCase()`	Converts a string to uppercase letters
`valueOf()`	Returns the primitive value of a String object

Math

The Math object allows you to perform mathematical tasks.
Syntax:

```
var pi_value=Math.PI;
var sqrt_value=Math.sqrt(16);
```

Note: Math is not a constructor. All properties and methods of Math can be called by using Math as an object without creating it.

Table 6.7: Math properties

Property	*Description*
`E`	Returns Euler's number (approx. 2.718)
`LN2`	Returns the natural logarithm of 2 (approx. 0.693)
`LN10`	Returns the natural logarithm of 10 (approx. 2.302)
`LOG2E`	Returns the base-2 logarithm of E (approx. 1.442)
`LOG10E`	Returns the base-10 logarithm of E (approx. 0.434)
`PI`	Returns PI (approx. 3.14159)
`SQRT1_2`	Returns the square root of 1/2 (approx. 0.707)
`SQRT2`	Returns the square root of 2 (approx. 1.414)

Table 6.8: Math methods

Method	*Description*
`abs(x)`	Returns the absolute value of a number
`acos(x)`	Returns the arccosine of a number
`asin(x)`	Returns the arcsine of a number
`atan(x)`	Returns the arctangent of x as a numeric value between -PI/2 and PI/2 radians
`atan2(y,x)`	Returns the angle theta of an (x,y) point as a numeric value between -PI and PI radians
`ceil(x)`	Returns the value of a number rounded upwards to the nearest integer
`cos(x)`	Returns the cosine of a number
`exp(x)`	Returns the value of E^x
`floor(x)`	Returns the value of a number rounded downwards to the nearest integer
`log(x)`	Returns the natural logarithm (base E) of a number
`max(x,y)`	Returns the number with the highest value of x and y
`min(x,y)`	Returns the number with the lowest value of x and y
`pow(x,y)`	Returns the value of x to the power of y
`random()`	Returns a random number between 0 and 1
`round(x)`	Rounds a number to the nearest integer
`sin(x)`	Returns the sine of a number
`sqrt(x)`	Returns the square root of a number
`tan(x)`	Returns the tangent of an angle
`toSource()`	Represents the source code of an object
`valueOf()`	Returns the primitive value of a Math object

RegExp

A regular expression is an object that describes a pattern of characters.
Regular expressions are used to perform powerful pattern-matching and "search-and-replace" functions on text. Syntax:
`var txt=new RegExp(pattern,modifiers);`
or more simply:
`var txt=/pattern/modifiers;`

`pattern` specifies the pattern of an expression
`modifiers` specify if a search should be global, case-sensitive, etc.

Table 6.9: RegExp modifiers

Modifier	*Description*
i	Perform case-insensitive matching
g	Perform a global match (find all matches rather than stopping after the first match)
m	Perform multiline matching

Table 6.11: RegExp metacharacters

Metacharacter	*Description*
`.`	Find a single character, except newline or line terminator
`\w`	Find a word character
`\W`	Find a non-word character
`\d`	Find a digit
`\D`	Find a non-digit character
`\s`	Find a whitespace character
`\S`	Find a non-whitespace character
`\b`	Find a match at the beginning/end of a word
`\B`	Find a match not at the beginning/end of a word
`\0`	Find a NUL character
`\n`	Find a new line character
`\f`	Find a form feed character
`\r`	Find a carriage return character
`\t`	Find a tab character
`\v`	Find a vertical tab character
`\xxx`	Find the character specified by an octal number xxx
`\xdd`	Find the character specified by a hexadecimal number dd
`\uxxxx`	Find the Unicode character specified by a hexadecimal number xxxx

6.2.3 Creating objects

There are two ways for creating objects: via *direct instantiation* and via a *constructor*.

Table 6.12: RegExp quantifiers

Quantifier	*Description*
`n+`	Matches any string that contains at least one n
`n*`	Matches any string that contains zero or more occurrences of n
`n?`	Matches any string that contains zero or one occurrences of n
`n{X}`	Matches any string that contains a sequence of X n's
`n{X,Y}`	Matches any string that contains a sequence of X or Y n's
`n{X,}`	Matches any string that contains a sequence of at least X n's
`n$`	Matches any string with n at the end of it
`^n`	Matches any string with n at the beginning of it
`?=n`	Matches any string that is followed by a specific string n
`?!n`	Matches any string that is not followed by a specific string n

Table 6.13: RegExp object properties

Property	*Description*
`global`	Specifies if the `g` modifier is set
`ignoreCase`	Specifies if the `i` modifier is set
`lastIndex`	The index at which to start the next match
`multiline`	Specifies if the `m` modifier is set
`source`	The text of the RegExp pattern

1. Create a direct instance of an object

The following code creates an new instance of an object, and adds four properties to it:

```
personObj=new Object();
personObj.firstname="John";
personObj.lastname="Doe";
personObj.age=50;
personObj.eyecolor="blue";
```

alternative syntax (using object literals):

```
personObj={firstname:"John",lastname:"Doe",age:50,eyecolor:"blue"};
```

Adding a method to the personObj is also simple. The following code adds a method called `eat()` to the `personObj`:

```
personObj.eat=eat;
```

2. Create an object constructor

Create a function that construct objects:

```
function person(firstname,lastname,age,eyecolor)
{
this.firstname=firstname;
this.lastname=lastname;
this.age=age;
this.eyecolor=eyecolor;
}
```

Table 6.14: RegExp methods

Method	*Description*
`compile()`	Compiles a regular expression
`exec()`	Tests for a match in a string. Returns a result array
`test()`	Tests for a match in a string. Returns true or false

Inside the function you need to assign things to this.propertyName. The reason for all the ”this” stuff is that you’re going to have more than one person at a time (which person you’re dealing with must be clear). That’s what ”this” is: the instance of the object at hand.
Once you have the object constructor, you can create new instances of the object, like this:

```
var myFather=new person("John","Doe",50,"blue");
var myMother=new person("Sally","Rally",48,"green");
```

You can also add some methods to the person object. This is also done inside the function:

```
function person(firstname,lastname,age,eyecolor)
{
this.firstname=firstname;
this.lastname=lastname;
this.age=age;
this.eyecolor=eyecolor;

this.newlastname=newlastname;
}
```

In short, independent functions can be declared function

```
nameOfFunction(<possible arguments>) {
...
}
```

while a function of an object uses the syntax

```
<objectName>.nameOfFunction = function(<possible arguments>) {
...
}
```

The use of member functions in BrainVoyager scripting can be found in the scripts (*.js) that operate with the user interface (*.ui) for scripts: functions of the script object are declared using

```
scriptOjb.<nameOfFunction> = function() { ... }
```

for example in the `scriptObj.initDlg()` function:

```
scriptObj.initDlg = function() {

    this.exampleDlg.windowTitle = "example dialog";

(etc)
}
```

6.2.4 Declarations

```
var, const, class, this, function
```

6.2.5 Control statements

```
break, case, catch, continue, default, do, else, for, if, finally, label,
return, switch, throw, try, while, with
```

6.2.6 Error handling

```
try...catch
```

6.2.7 Comments

For single line: `\\`
Multi-line comments: `\* ... *\`

6.2.8 Date and time

```
Date, getDay(), getFullYear(), getHours(), getMilliseconds(),
getMinutes(), getMonth(), getSeconds(), getTime(),
getTimeZoneOffset()
Universal Coordinated Time (=Greenwich Mean Time, GMT)
getUTCDate(), getUTCDay(), getUTCFullYear(),
getUTCHours(), getUTCMilliseconds(), getUTCMinutes(),
getUTCMonth(), getUTCSeconds(), getUTC()
Set functions
setDate(), setFullYear(), setHours(), setMilliseconds(), setMinutes(),
setMonth(), setSeconds(), setTime(), setUTCDate(), setUTCFullYear(),
setUTCHours(), setUTCMilliseconds(), setUTCMinutes(),
setUTCMonth(), setUTCSeconds(), setUTCTime()
parse(), toString(), toLocaleString(), toUTCString
```

6.3 Using Qt Objects

It is also possible to use Qt Objects via scripting. All available objects can be found in the 'Locals' window of the debugger (see figure 6.1). When clicking on the objects, its functions will be revealed (at some point). Via these Qt objects some functions can be retrieved that are not directly available via BrainVoyager's scripting functions or JavaScript.
For example, the script below, which actually just seems to work on Windows, uses the function `grabWindow()` of the Qt object `QPixMap` to make a screenshot of the BrainVoyager volume window. More documentation will be available in later versions of this document. For now, we provide a link to the Qt API: http://doc.qt.nokia.com/4.8-snapshot/classes.html.

```
 var test = QPixmap.grabWindow(true,0,0,500, 500);
test.save('test.png');
```

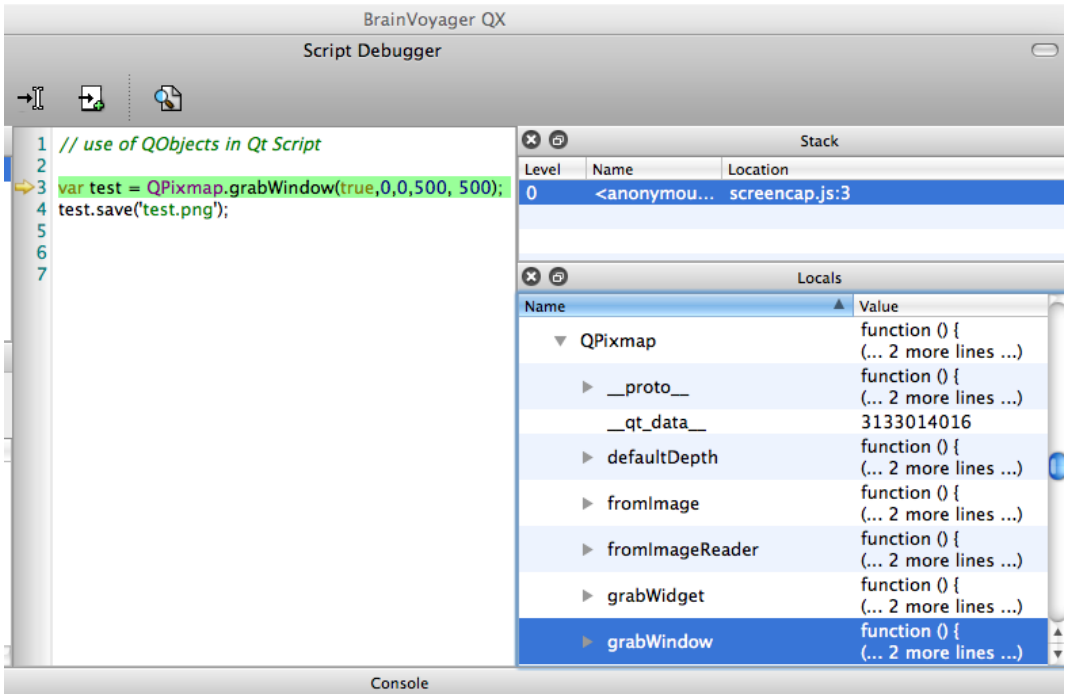


Figure 6.1: List of available Qt Objects in Locals window of BrainVoyager Script Debugger

With thanks to Holger Hecht and Dirk Heslenfeld

Appendix A

Switching from BrainVoyager QX 2.0 to 2.1 scripting

The scripting module in BrainVoyager QX 2.1 uses the new script module from Qt. The previous language was called QSA. The script language in BrainVoyager QX 2.1 in called Qt Script. The differences between the languages - as described by Nokia (see `http://qt.nokia.com`) - can be found in this chapter.

A.1 The Scripting Language

The scripting language used in QSA, from here on referred to as QSA, was derived from ECMAScript 3.0 and 4.0 and is a hybrid of these standards. Most of the run-time logic, such as classes and scoping rules, is based on the ECMAScript 4.0 proposal, while the library implementation is based on the ECMAScript 3.0 standard. Qt Script on the other hand is solely based on the ECMAScript 3.0 standard. Though the languages look identical at first glance, there are a few differences that we'll cover in the sections below.

A.1.1 Classes vs. Objects and Properties

QSA implements classes and inheritance much in a familiar way to users of other object oriented languages, like C++ and Java. However, the ECMAScript 3.0 standard defines that everything is an object, and objects can have named properties. For instance to create an point object with the properties x and y one would write the following Qt Script code:

```
point = new Object();
point.x = 12;
point.y = 35;
```

The object point in this case is constructed as a plain object and we assign two properties, x and y, to it with the values 12 and 35. The point object is assigned to the "Global Object" as the named property point. The global object can be considered the global namespace of the script engine. Similarly, global functions are named properties of the global object; for example:

```
function manhattanLength(point) {
    return point.x + point.y;
}
```

An equivalent construction that illustrates that the function is a property of the global object is the following assignment:

```
manhattanLength = function(point) {
   return point.x + point.y;
```

```
}
```

Since functions are objects, they can be assigned to objects as properties, becoming member functions:

```
point.manhattanLength = function() {
    return this.x + this.y;
}
```

print(point.manhattanLength()); // prints 47 In the code above, we see the first subtle difference between QSA and Qt Script. In QSA one would write the point class like this:

```
class Point() {
    var x;
    var y;
    function manhattanLength() { return x + y; }
}
```

where in the manhattanLength() function we access x and y directly because, when the function is called, the this object is implicitly part of the current scope, as in C++. In Qt Script, however, this is not the case, and we need to explicitly access the x and y values via this.
All the code above runs with QSA except the assignment of a function to point.manhattanLength, which we repeat here for clarity:

```
point.manhattanLength = function() {
    return this.x + this.y;
}
print(point.manhattanLength()); // prints 47
```

This is because, in QSA, the value of this is decided based on the location of the declaration of the function it is used in. In the code above, the function is assigned to an object, but it is declared in the global scope, hence there will be no valid this value. In Qt Script, the value of this is decided at run-time, hence you could have assigned the manhattanLength() function to any object that had x and y values.

A.1.2 Constructors

In the code above, we use a rather awkward method for constructing the objects, by first instantiating them, then manually assigning properties to them. In QSA, the proper way to solve this is to implement a constructor in the class:

```
class Car {
    var regNumber;
    function Car(regnr) {
        regNumber = regnr;
    }
}
var car = new Car("ABC 123");
```

The equivalent in Qt Script is to create a constructor function:

```
function Car(regnr) {
    this.regNumber = regnr;
}
var car = new Car("ABC 123");
```

As we can see, the constructor is just a normal function. What is special with is how we call it, namely prefixed with the new keyword. This will create a new object and call the Car() function with the newly created object as the this pointer. So, in a sense, it is equivalent to:

```
var car = new Object();
car.constructor = function(regnr) { ... }
car.constructor();
```

This is similar to the `manhattenLength()` example above. Again, the main difference between QSA and Qt Script is that one has to explicitly use the keyword this to access the members and that instead of declaring the variable, regNumber, we just extend the this object with the property.

A.1.3 Member Functions and Prototypes

As we saw above, one way of creating member functions of a Qt Script object is to assign the member function to the object as a property and use the this object inside the functions. So, if we add a toString function to the Car class

```
class Car {
    var regNumber;
    function Car(regnr) {
        regNumber = regnr;
    }
    function toString() {
        return regNumber;
    }
}
```

one could write this in Qt Script as:

```
function Car(regnr) {
    this.regNumber = regnr;
    this.toString = function() { return this.regNumber; }
}
```

In QSA, the member functions were part of the class declaration, and were therefore shared between all instances of a given class. In Qt Script, each instance has a instance member for each function. This means that more memory is used when multiple instances are used. Qt Script uses prototypes to remedy this.
The basic prototype-based inheritance mechanism works as follows. Each Qt Script object has an internal link to another object, its prototype. When a property is looked up in an object, and the object itself does not have the property, the interpreter searches for the property in the prototype object instead; if the prototype has the property then that property is returned. If the prototype object does not have the property, the interpreter searches for the property in the prototype of the prototype object, and so on. This chain of objects constitutes a prototype chain. The chain of prototype objects is followed until the property is found or the end of the chain is reached.
To make the toString() function part of the prototype, we write code like this:

```
function Car(regnr) {
    this.regNumber = regnr;
}
Car.prototype.toString = function() { return this.regNumber; }
```

Here, we made the toString() function part of the prototype so that, when we call car.toString() it will be resolved via the internal prototype object of the car object. Note, however, that the this object is still the original object that the function was called on, namely car.

A.1.4 Inheritance

Now that we've seen how to use prototypes to create a "class" members in Qt Script, let's see how we can use prototypes to create polymorphism. In QSA you would write

```
class GasolineCar extends Car {
    function GasolineCar(regnr) {
        Car(regnr);
    }
    function toString() {
        return "GasolineCar(" + regNumber + ")";
    }
}
```

With Qt Script, we acheive the same effect by creating a prototype chain. The default prototype of an object is a plain Object without any special members, but it is possible to replace this object with another prototype object.

```
function GasolineCar(regnr) {
    Car(regnr);
}
GasolineCar.prototype = new Car();
GasolineCar.prototype.toString = function() {
    return "GasolineCar(" + this.regNumber + ")";
}
```

In the code above, we have a constructor, GasolineCar, which calls the "base class" implementation of the constructor to initialize the this object with the property regNumber, based on the values passed in the constructor. The interesting line in this case is the line after the constructor where we change the default prototype for GasolineCar to be an instance of type Car. This means that all members available in a Car object are now available in all GasolineCar objects. In the last line, we replace the toString() function in the prototype with our own, thus overriding the toString() for all instances of GasolineCar.

A.1.5 Static Members

QSA allowed users to declare static members in classes, and these could be accessed both through instances of the class and through the class itself. For example, the following variable is accessed through the Car class:

```
class Car {
    static var globalCount = 0;
}
print(Car.globalCount);
```

The equivalent in Qt Script is to assign variables that should appear as static members as properties of the constructor function. For example:

```
Car.globalCount = 0;
print(Car.globalCount);
```

Note that in QSA, static member variables were also accessible in instances of the given class. In Qt Script, with the approach illustrated above, the variable is a member of the constructor object only, and thus only accessible through Car.globalCount.

A.2 The Built-in Functions and Library

The built-in functions in QSA are based on those defined in the ECMAScript 3.0 standard, the same standard used for Qt Script, but QSA adds some extensions to this, specifically for the String and RegExp types. QSA also lacked some functions from the standard, most notably the Date type. Below we list all the differences. All changes made to Qt Script are to increase compliance with ECMAScript 3.0.
QSA Function and notes about Equivalent Qt Script Functions `eval()` The eval function in QSA opened a new scope for code being executed in the eval function, so locally declared variables were not accessible outside. In Qt Script, the `eval()` function shares the current scope, making locally declared variables accessible outside the `eval()` call.
`debug()` This function is not available in Qt Script. Use print() instead.
`connect()` QSA had closures, meaning that a member function reference implicitly contained its this object. Qt Script does not support this. See the Qt Script documentation for details on using the connect function.
`String.arg()` This function is not available in Qt Script. Use replace() or concat() instead.
`String.argDec()` This function is not available in Qt Script. Use replace() or concat() instead.
`String.argInt()` This function is not available in Qt Script. Use replace() or concat() instead.
`String.argStr()` This function is not available in Qt Script. Use replace() or concat() instead.
`String.endsWith()` This function is not available in Qt Script. Use lastIndexOf() instead.
`String.find()` This function is not available in Qt Script. Use indexOf() instead.
`String.findRev()` This function is not available in Qt Script. Use lastIndexOf() and length instead.
`String.isEmpty()` This function is not available in Qt Script. Use length == 0 instead.
`String.left()` This function is not available in Qt Script. Use substring() instead.
`String.lower()` This function is not available in Qt Script. Use toLowerCase() instead.
`String.mid()` This function is not available in Qt Script. Use substring() instead.
`String.right()` This function is not available in Qt Script. Use substring() instead.
`String.searchRev()` This function is not available in Qt Script. Use search() / match() instead.
`String.startsWith()` This function is not available in Qt Script. Use indexOf() == 0 instead.
`String.upper()` This function is not available in Qt Script. Use toUpperCase() instead.
`RegExp.valid` This property is not available in Qt Script because it is not required; a SyntaxError exception is thrown for bad RegExp objects.
`RegExp.empty` This property is not available in Qt Script. Use toString().length == 0 instead.
`RegExp.matchedLength` This property is not available in Qt Script. RegExp.exec() returns an array whose size is the matched length.
`RegExp.capturedTexts` This property is not available in Qt Script. RegExp.exec() returns an array of captured texts.
`RegExp.search()` This function is not available in Qt Script. Use RegExp.exec() instead.
`RegExp.searchRev()` This function is not available in Qt Script. Use RegExp.exec() or String.search()/match() instead.
`RegExp.exactMatch()` This function is not available in Qt Script. Use RegExp.exec() instead.
`RegExp.pos()` This function is not available in Qt Script. Use String.match() instead.
`RegExp.cap()` This function is not available in Qt Script. RegExp.exec() returns an array of captured texts.
QSA also defined some internal Qt API which is not present in Qt Script. The types provided by QSA which are not provided by Qt Script are:

```
Rect
Point
Size
Color
Palette
ColorGroup
Font
Pixmap
ByteArray
```