

# What Software Libraries Can You Use to Extract and Visualize Datasets ?

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### Beyond Scripting: What's available out there ?

# Familiarize yourself with software options to select the library that is best suited for your project.

- Data extraction versus algorithm development.
- Should I invest in getting familiarized with a tool ?

This presentation introduces a few software libraries that you may (or may not) use in your research projects.



### **Options at a Glance**

- Vendor-provided scripts great for simple data-analytics type projects
  - RaySation, Varian ESAPI, Varian Velocity, Elekta IQScripts
    - Provide direct access to your clinical system database, algorithms
    - Perfect for customized interfaces to your clinical system
- Development Libraries
  - ITK, VTK, RTK, TubeTK
    - Offered as code that has to be compiled for your computer configuration
    - Learning curve to understand the algorithms
    - Flexibility in creating your own algorithm

Existing functionality in your clinical system ? Want to build your own algorithm ? Use scripts. Look at other libraries.



### **Scripts**

Or how to quickly customize your clinical system



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### **Sample Scripting: ESAPI**

### C# code to access objects in Varian's database

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### Any value that you see in Eclipse can be accessed directly from code.

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# **Sample Scripts (ESAPI)**

- Extracting patient statistics from database
- Checking if a plan meets constraints

 Automating treatment planning Structure

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Maximum Number of CT Slices in 3D Image	< 250	52	~	
DVH Structure Dose Coverage (%)	≥ 100%	≥ 100%	~	
DVH Structure Sample Coverage (%)	≥ 100%	≥ 100%	1	

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0.5 ± 0.05cm

Prostate Structure Checks

**Prostate Margin Checks** 

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0.5 ± 0.05cm 0.5 ± 0.05cm



Easily input department plan check standards and identify deviations in your patient's treatment plan with 38 different types of plan checks.



### **Data Extraction**

- Automated extraction of RTOG protocols, treatment logs, dose and contour data for research projects.
- Input : A list of patients and what to extract
- Output: An Excel file to interpret

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### Advantages\Disadvantages

- Access: Your code has direct access to the clinical data
- **Practical:** Easily integrates your with your clinical workflow.
- Automation of repetitive and tedious tasks best suited for scripting.

- Limited functionality: Only algorithms available in the clinical system can be used
- Mostly Clinical: Not a good tool for developing "your idea".





### **Data Access**

### Or how to access any data in the database



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### **Direct Database Access**



# Using C++ Builder to connect directly to the database. Other compilers can be used as well

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### **Database Access Without Code**

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### What Can Be Accessed ?



### **Beyond Scripting**

### Or libraries to for developing your algorithm



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# **Beyond Scripting**

- **Open source:** Set of library offered as code. You can modify it in any way your like.
- Don't invent the wheel: Set of standard building block performing common tasks that you can configure to your needs.
- Feel free to modify: You can change the code according to your project needs.



Here is the code. You have complete control.

### **Sample Library: ITK**



Welcome to the National Library of Medicine **Insight Segmentation and Registration Toolkit (ITK)**. ITK is an open-source, cross-platform system that provides developers with an extensive suite of software tools for image analysis. Developed through extreme programming methodologies, ITK employs leading-edge algorithms for registering and segmenting multidimensional data. The goals for ITK include:

- Supporting the Visible Human Project.
- Establishing a foundation for future research.
- Creating a repository of fundamental algorithms.
- Developing a platform for advanced product development.
- Support commercial application of the technology.
- Create conventions for future work.
- Grow a self-sustaining community of software users and developers.

#### ITK

ITK provides leading-edge segmentation and registration algorithms in two, three, and more dimensions; it is distributed as an open-source software package.



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NIDCD

### **Many Algorithms Available**



#### Best suited for :

- Larger research projects.
  - Need customization/changes over time.
  - Likely to implement new algorithm or approaches.

more at Open HUB

Commercial software development

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news
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#### More News >

12.16.2014 Kitware Announces a Virtual Surgery System to Help Surgeons Treat...

10.09.2014 Kitware Receives Award to Develop Retinal Image Management System...

#### There are thousands of algorithms implemented in ITK

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∏K ITK provides leading-edge se् registration algorithms in two it is distributed as an open-so	<ol> <li>Mostly written in C++</li> <li>Mature, well-establishe</li> <li>Very large, active devel</li> </ol>	ed codebase opment team
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	Insight Toolkit - Proj	ject Cost
	Include Markup And Code 👻	Avg. Salary \$ 55000 /year
	Codebase 1,702,264 Lines	Effort (est.) 487 Person Years
	Estimated Cost	\$26,785,280

Updated Jul 05, 2015

# **Scripting versus ITK**

### Scripts sample applications:

- I don't like the buttons in the commercial application
- My colleagues would need to print customized reports
- Would like to do some analysis with the clinical data

### • ITK sample applications:

- I want to develop a new segmentation algorithm for my images.
- Need a customized image registration for my images
- Want to develop an image reconstruction algorithm.
- Some insight into images



### A family of libraries



All these libraries use same concepts and are connected.

# Why I Like It ?

- ITK and VTK are like Legos
  - ITK designed as building blocks from which customized applications are created.









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#### Build your own toy from code snippets

### Prototyping





## Why the Lego Analogy ?



Libraries are a collection of "building blocks" that can be connected to **your** needs.





### **Example**

The itkFlipImageFilter image filter will flip an image along a user specified axis.







### Easy to change setting to experiment on your images



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# **Experimenting With Options**





### Example



# **Example Coding**

### From prototype to coding

```
int main (int argc, char *argv[])
{
    //define the image type
    typedef itk::Image< long, 3 > ImageType;
    //read an image
    typedef itk::ImageFileReader< ImageType > ReaderType;
    ReaderType::Pointer imageReader= ReaderType::New();
    imageReader->SetFileNames("c:\\myFile.dcm");
    //smoothing filter
    typedef itk::SmoothRecursiveGaussianFilter< ImageType, ImageType > SmoothFilter;
    SmoothFilter::Pointer smoothFilter = SmoothFilter::New();
    smoothFilter->SetInput( imageReader->GetOutput() );
    smoothFilter->Update();
    itkSmoothingRecursiveGaussianImageFilter
    itkSmoothingFilter
    itkSmoothingFilter
```

Once you prototyped your pipeline and settings, you can write corresponding code to build an application





### **Template Code**

It's easy to readapt to code to new situations

```
ITK Definition:
         template< class TPixel, unsigned int VImageDimension >
        Image< TPixel, VImageDimension >
       ]::Image()
           m Buffer = PixelContainer::New();
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       jint main (int argc, char *argv[])
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             typedef itk::Image< long</pre>
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                                                  SliceType;
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            typedef itk::Image< long,</pre>
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                                                  VolumeType;
                                                                       // a CT volume
            typedef itk::Image< long, 4 >
                                                  Scan4DType;
                                                                       // a 4D CT scan
             typedef itk::Image< float, 3 >
                                                  DoseType;
                                                                      // a dose volume
```



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### **Your Own Filter**

Deriving a filter from the ITK objects is simple:

Deriving a new inherited filter
<pre>template&lt; class TImage&gt; class MyOwnImageFilter:public ImageToImageFilter&lt; TImage, TImage &gt; {</pre>
public:
Implementing your own equation, $f(x) = x^{1.23456}$
<pre>inline TOutput operator()(const TInput &amp; A) const {</pre>

const double input = ( static cast< double >( A )) ;

const double output = pow(input, 1.23546);

return static cast< TOutput >( output );

}



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# **Catalog of ITK Features**



- Image IO
- Image processing
  - Canny Edge
  - Hough Transform (lines/ellipsoids)
  - Variable Conductance Diffusion
- Geometry IO/representation/processing (Spatial Objects)
- Statistics
- Registration/Segmentation
- Numerics (VXL)
- Optimizers
- Finite Element Simulation



### **Sample Project: Radiomics**

Simple voxel statistics: minimum, maximum, mean, standard deviation, variance.

**Image filters:** Canny, Laplacian, Sobel, derivative, Hessian, Sharpening, gradient magnitude, HMinima, HMaxima, HConvex, Hconcave.

Shape statistics: elongation, perimeter, radius, flatness, roundness, volume, etc.

First order textures: energy, entropy, inverse difference moment, inertia, cluster prominence, cluster shade.

**Second order textures:** short run emphasis, long run emphasis, grey level non- uniformity, run length non-uniformity, low gray level run emphasis, high gray level run emphasis, short run low grey level emphasis, short run high grey level emphasis, long run low grey level emphasis, long run high grey level emphasis.



Sample features extracted with ITK: (a) Original CT (Figure 1). (b) Gradient magnitude. (c) HConvex with a threshold of 500 HU (d) Homogeneity texture (e) Laplacian sharpening.

### **Where To Find Help**





### **Visualization Tool Kit**

Features · Resources ·

D



#### VTK – Algorithms to visualize the data

### **Paraview**



III ParaView

× 8 Google

× +

#### **Open-source application to visualize meshes**





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**Open-source application to visualize images** 







www.mevislab.de

www.itk.org



www.volview.org



www.itk.org



www.paraview.org



www.cmake.org



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