Interactive Functional Medical Image Analysis

A Demo using Functional Languages and VIGRA

Dr. Benjamin Seppke, Prof. Dr. Leonie Dreschler-Fischer
Agenda

1. Introduction
2. Fitting VigRacket for Medical Image Analysis
3. Demonstration
4. Conclusions
Agenda

1. Introduction
   - Medical image analysis
   - Interactive work-flow

2. Fitting VigRacket for Medical Image Processing

3. Demonstration

4. Conclusions
Medical Image Analysis

• Imaging in medical context often 3D, here we refer to 2D images only
• Images may come from:
  – 3D-Scanners (like CT, MRT) as slices
  – (Fluorescent) microscopy etc.
• Main applications take place on object level
  – Measure (e.g. size of objects)
  – Classify (e.g. normal vs. strange cells)
• Step from image to object level alone is non-trivial!
Interactive Workflow

• Experts prefer interactive workflows
• Use or define heuristics:
  – Try different approaches,
  – Eventually find the best fitting one for their application.
• Start with building blocks!
• Aim of the interactive procedure:
  – Get better insights in algorithms and
  – get better results while modelling the solution!
• At the end: Solution/product.
Agenda

1. Introduction
2. Fitting VigRacket for Medical Image Analysis
   – Segmentation and Labelling
   – From Labels to Region Features
3. Demonstration
4. Conclusions
Segmentation and Labelling

- Segmentation algorithms:
  - From image to regions (e.g. thresholding + pre-processing)

- Labelling of connected components:
# From Labels to Region Features

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Modelling in GUI-based Approaches
Agenda

1. Introduction
2. Fitting VigRacket for Medical Image Analysis
3. Demonstration
   – Preliminaries
   – Demo: Sickle Cell Anaemia
4. Conclusions
Preliminaries

• Racket 6.8  [http://racket-lang.org](http://racket-lang.org)
• VigRacket 1.5  [https://github.com/bseppke/vigracket](https://github.com/bseppke/vigracket)
  – For Linux and macOS:
    • VIGRA Computer Vision Library (v. 1.11.0 or newer)
    • FFTW lib
    • Image format libs of choice, e.g. libpng, libtiff...
  – Installation:
    • Run “install.rkt” – that’s all!
  – Tested under Windows, Linux (Ubuntu) and macOS!
Demo Time
Still time? New Preliminaries

- Any/SteelBank Common Lisp
- VigraCL (master) [https://github.com/bseppke/vigracl](https://github.com/bseppke/vigracl)
  - For Linux and macOS:
    - VIGRA Computer Vision Library (v. 1.11.0 or newer)
    - FFTW lib
    - Image format libs of choice, e.g. libpng, libtiff...
  - Installation:
    - Copy to any folder to work with
  - Tested under Windows and macOS with SBCL!
Demo Time
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Conclusions

• The History: 8 years of VigRacket (f.k.a. vigra-plt)
  – Improved Datatypates and interaction
  – Improved Functional Programming layer
  – Improved execution speed
  – Continuously expanding functionality
  – Improved documentation (scribble’d!)

• Currently:
  – VigRacket release 1.5
  – VigraCL (no current release, sorry – but master works) for CommonLisp integration (tested with SBCL)
Conclusions

• Now, powerful enough for interactive image and region analysis!
  – Independent of the application context
  – E.g. material research, general scene analysis tasks

• Understandable and usable by “newbies”
  – Students in our B.Sc. practice “Image Processing”
  – Even pupils visiting our lab for interactive “first contact” with the topic
  – Even if they do not know about functional programming so far.
Conclusions

- Functional vs. GUI-based approaches

Arrows may now represent either argument passing or function composition!

(image)

(curryr thresholdimage 230)

(curryr openingimage 1)

(curryr labelimage #t 0.0)

extractfeatures