Universität Hamburg
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MIN-Faculty
Department Informatics
Scene Analysis and Visualisation (SAV)

Interactive Functional Medical Image Analysis

A Demo using Functional Languages and VIGRA

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Agenda

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

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1. Introduction
   - Medical image analysis
   - Interactive work-flow
2. Fitting VigRacket for Medical Image Processing
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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.

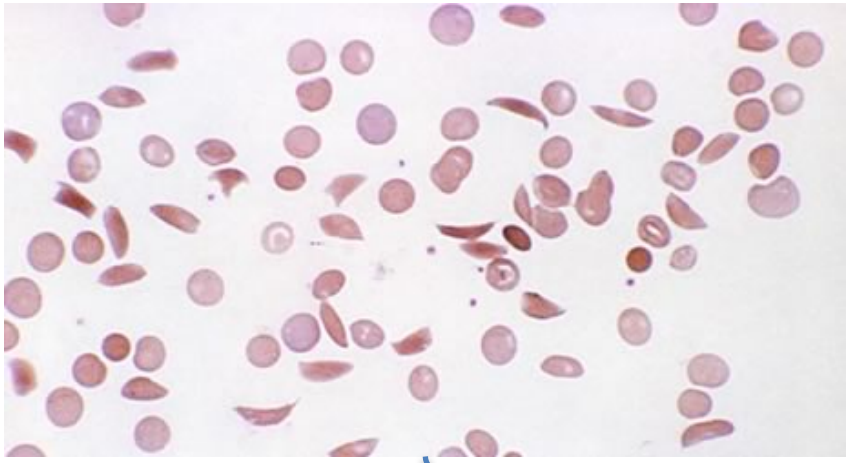
Agenda

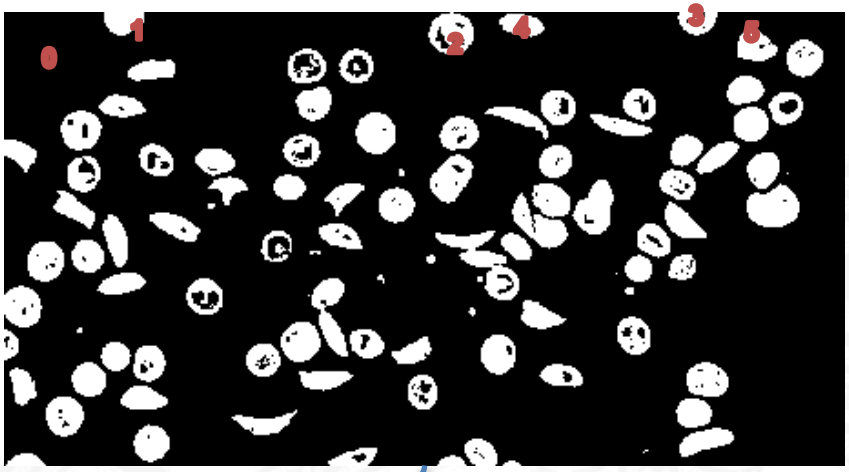
1. Introduction
2. Fitting VigRacket for Medical Image Analysis
   - Segmentation and Labelling
   - From Labels to Region Features
3. Demonstration
4. Conclusions

Segmentation and Labelling

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

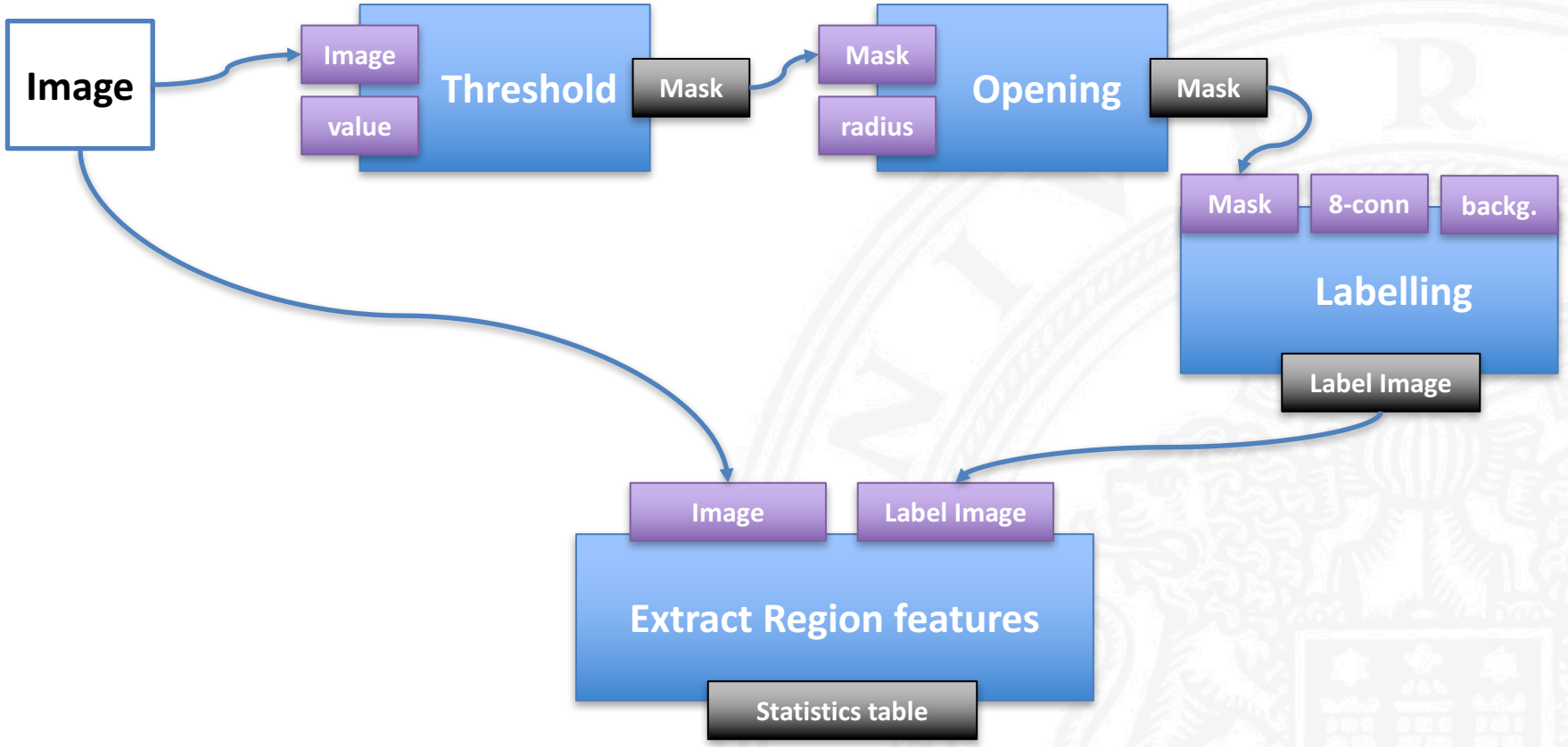
From Labels to Region Features





ID	size	left	upper	right	lower	…	min color	mean color	…
0	94177	0	0	461	248	…	(171.0 148.0 150.0)	(241.91 237.51 241.11)	…
1	229	55	0	76	12	…	(178.0 146.0 164.0)	(205.09 166.81 187.51)	…
2	200	371	0	391	12	…	(180.0 150.0 166.0)	(204.93 170.70 192.07)	…
3	361	233	1	257	22	…	(168.0 137.0 171.0)	(206.03 173.12 199.91)	…
4	226	272	1	295	12	…	(158.0 118.0 143.0)	(193.21 145.39 168.17)	…
5	277	403	9	424	26	…	(144.0 103.0 99.0)	(190.96 144.58 155.25)	…
…	…	…	…	…	…	…	…	…	…

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
- **VigRacket 1.5** 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**
  - 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 Datatypes 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