Analyzing imaging data
an open-source collaboration


11th World Conference on Neutron Radiography, Sydney, September 1-5, 2018
What happens after an imaging experiment?
1. **Empirical “Schöni Bildli”**
   - Observing and describing phenomena
   - Already the old Greeks did it

2. **Theoretical – analytical, many NI experiments**
   - Describing observations by model, abstraction/generalization
   - Newton

3. **Computational – Some NI**
   - Complex models, detailed problems \( \rightarrow \) Simulations

1. **Data exploration – Few NI**
   - Analysis by data management and statistics

**Science paradigms and neutron imaging**
Data processing can be a very labor- and computationally intense task.

- **Basic processing**: Minutes, hours
- **CT reconstruction**: Minutes, hours
- **Image processing**: Hours
- **Visualization**: Hours, days
- **Analysis**:
Data analysis is time-consuming!

+ evaluation
+ modeling
+ publication

Months of work from experiment to publication...

... if ever!!!
Analysis workflow

- Acquisition: Radiography
- Preprocessing: Normalization, Artifact removal, Corrections
- Improve quality: Denoising, Enhancement
- Analysis: Classification, Estimation, Shape analysis
- Transforms: Time series, Energy selective, CT, Diffraction, Grating interferometry
- Evaluation/Presentation: Parameter extraction, Visualization, Process modelling

Can be generalized
Needs creative interaction
Characterizing neutron imaging data

Data quality
• Limited number of observations
• Low SNR
• Less sharp than X-rays

long experiment times
weaker sources
detection principle

Data structure
• Single modality
• Temporal dependency
• Multi modality
• Multi energy
• Tensor valued

traditional transmission imaging
time series
combining images from different sources
material response, mixes
magnetism, strain, diffraction

Investigations often only involve few or even single samples → Generalization?
Data evaluation fitness of users

Users neutron imaging have very different background and experience

- Advanced
- Technical
- Non-technical
- Beginner

- High
- Data complexity
- Background
- Experience
- Low
Data evaluation fitness of users - Characterization

Serving people with different background and needs is a great challenge
Applications developed at PSI

MuhRec
• CT reconstruction tool
• Configurable processing chain

KipTool
• General processing tool 3D images
• Converter tools

NIQA tool
• Analysis of IAEA QA samples

nGI tool
• Reduction of phase stepping scans
New neutron sources with pulsed beam ... 
... Reveal new information about the sample \(\rightarrow\) New science (Many WCNR11 Contributions)

- Bragg edge analysis
- Diffraction imaging
- Modulation techniques

Challenges on the development
- Produce large data
- Adds new dimensions to the data
- Workflow flexibility

User interface
Guiding algorithms
Core
Modern software development

• Agile development
  – Iterative development
  – Collaboration

• Using repositories
  – New issues in repository branches
  – Maintain stable master through merge reviews

• Issue tracking (New features, Improvements, Fixing bugs)

• Frequent releases (2 x year)

• Automated testing and builds

• Online documentation
Some technical details about the development

Main coding language

In particular: C++11
- XCode (Mac)
- MSVC15 (Windows)
- g++ (Linux)

GUI Library

Version: 5.9 LTS
- Cross platform
- Qmake
- QTest

Planned binding

Python 3
- *Embedded scripting*
- *Call libs from python*
- *Tutorials*
- *Typical work flows*

Repository: GitHub
https://github.com/neutronimaging
- Development history
- Issue tracking
- Documentation (Wiki)

Build server: Jenkins
- Automated builds

Planned:
- *Nightly build installers*
- *Automatic unit testing*
Why open source?

• Its free ➔ Thus serves a wide community

• Insight in used methods ➔ Reproducibility and traceability

• Promotes interoperability and collaboration

• A requirement from funding agencies
Do you want to contribute?

There are different ways to contribute

**As user**
- Using and promoting open source analysis tools
- Give feedback (report issues, request new features)
- Promote interoperability between different sites

**As developer**
- Contribute to existing code base in ongoing projects
- Contribute with your own projects

**As stakeholder**
- Identify use cases
- Define requirements
- Monitoring
- Testing and verification
The analysis of imaging data should be ...

... done in a reproducible way.

... open source to promote collaboration.

... developed with modern techniques.

We welcome new partners to join.