A Pypelined Approach to Neuroimaging Data Analysis

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RAPIDART
Why neuroimaging pipelines?

Why in Python?
Why another batch scripting system?

Architecture

Data Interoperability

Neuroimaging Pypelines | RAPIDART

Region-of-interest Analysis of Parcellated Imaging Data
Reducing inter-subject anatomical variability

ARtifact detection Tools
Quality assurance

MATLAB-based
SPM-focused

Neuroimaging Pypelines	Data formats

SPM	FSL	FreeSurfer
nii (3D/4D)	nii.gz/nii (4D)	mgz
img/hdr (analyze)		nii
MAT (matlab)	C++	
		C++
MATLAB		

Problem 1. Data formats

Neuroimaging Pypelines

Wishlist

- Motion Correction
- Coregistration
- Normalization
- Smoothing
- Model Specification
- Model Estimation
- Statistical Inference

Neuroimaging Pypelines

Wishlist

Motion Correction

Coregistration

Normalization

Smoothing

Model Specification

Model Estimation

Statistical Inference

Optimized processing

Motion Correction
FSL

Coregistration
SPM

Normalization
ANTS

Smoothing
FreeSurfer

Model Specification
NIPY

Model Estimation
FMRISTAT

Neuroimaging Pypelines

Wishlist

Optimized processing

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Optimized processing

- Motion Correction FSL
- Coregistration SPM
- Normalization ANTS
- Smoothing FreeSurfer
- Model Specification NIPY
- Model Estimation FMRISTAT

Compare algorithms

- Motion Correction
- Coregistration
- Normalization
  - Smoothing SPM
    - Model Specification
    - Model Estimation
  - Smoothing FreeSurfer
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Custom Software

- Preprocessing
- Model Specification
- Model Estimation
- Statistical Inference

Neuroimaging Pypelines | Python

- High-level language
- Well formed programming language
- Cross-platform
- Free
- Extensive community, commercial support and use
- Strong numerical and robust scientific computing packages (numpy, scipy)
- Integrates well with other software (PyR2)
- Interactive-command line
- Automatic doc generation

Image courtesy
Dr. Arno Klein

Neuroimaging Pypelines | Replication

- Interoperability!
- Extensible framework based on a high-level language
- Integrates different neuroimaging software (FSL, SPM, etc.,.)
- Lightweight
- Provides embarrassing and finer levels of parallelism
- Minimizes data redundancy
- Supports evaluation of the impact of different parameters

Target three levels of users:
- those who like to drag and drop
- those who like to type config files
- those who like to code

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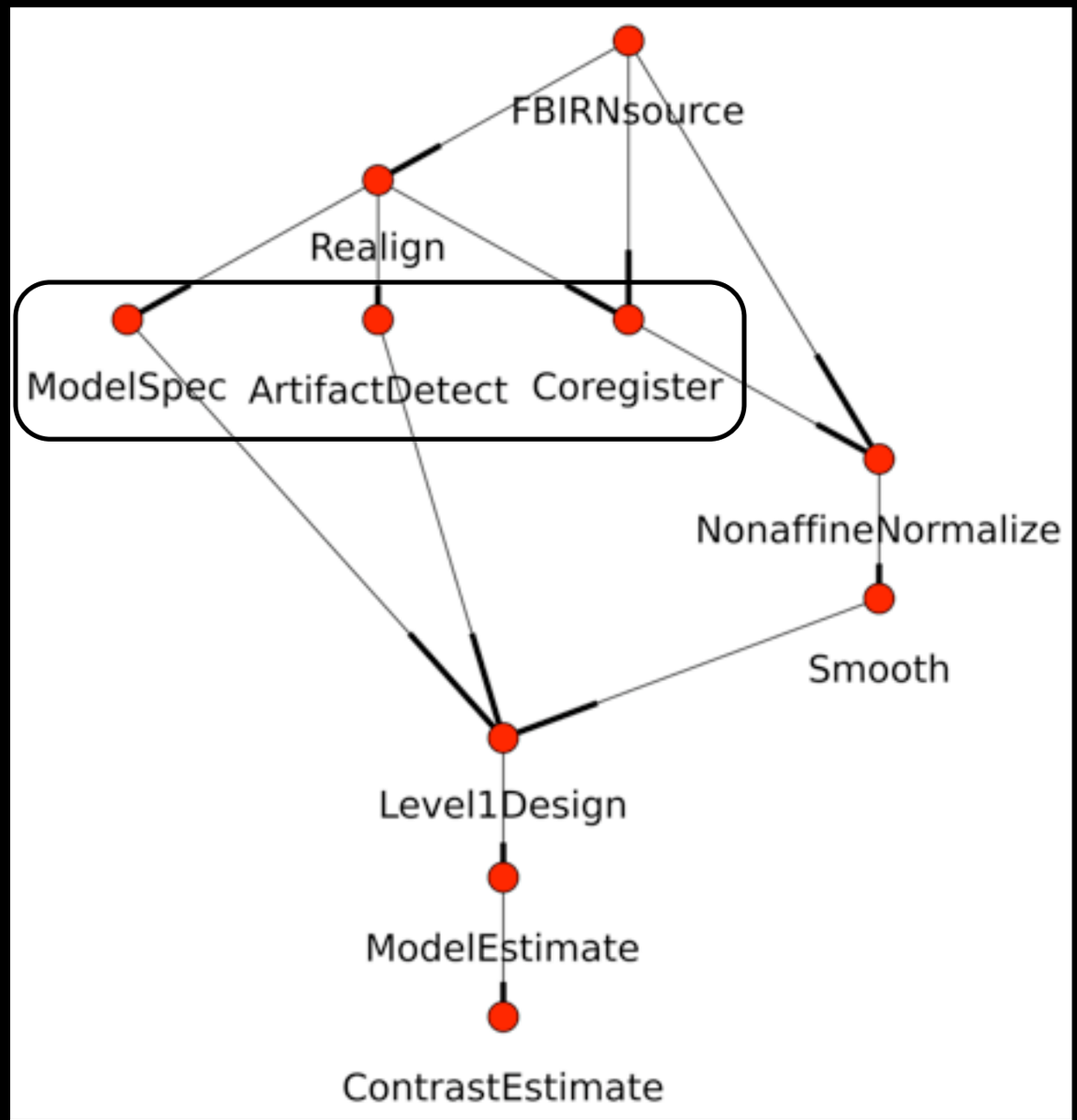
Neuroimaging Pypelines

Architecture

- Processing pipeline represented as a directed acyclic graph (DAG)
- Leverages graph algorithms for scheduling
- Each process defines its own inputs and outputs
- Provides wrappers/interfaces to call external software (SPM, FSL)
- Can iterate pipeline-segment over parameterizations of modules
- Separates data specification and code execution



- Generalized framework for neuroimaging analysis
- Integrates several neuroimaging software
- Python-based (easy to learn, easy to use) – really
- Pedagogical (you should know your parameters)
- Engages the community
- Go to Matthew Brett's talk tomorrow

Problem 1. Data Formats

Dicom, Nifti, Analyze, MATLAB, Gifti, MGZ, VTK

Problem 2. Metadata

What metadata should be carried along with the data?

What is essential?

Problem 3. Ontology

What is our vocabulary?

How are all the relations stored?