

Open-source software

Carlos Castillo Passi

What is open-source software

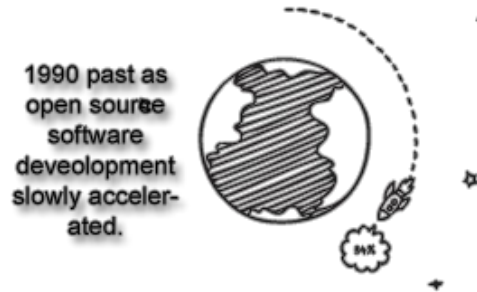
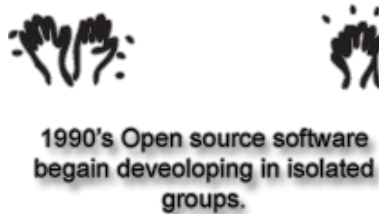
- Open-source software is distributed with its **source code**, making it **available** for use, **modification**, and **distribution** with its original rights.



open source
initiative®

History of open-source software

Timeline of Open Source Software



Today Linux, Mozilla and Android are most popular open source



Richard Stallman

- GNU project
- GNU General Public License



collective/example.p4p5 is licensed under the

GNU General Public License v2.0

The GNU GPL is the most widely used free software license and has a strong copyleft requirement. When distributing derived works, the source code of the work must be made available under the same license. There are multiple variants of the GNU GPL, each with different requirements.

Permissions

- ✓ Commercial use
- ✓ Modification
- ✓ Distribution
- ✓ Private use

Limitations

- ✗ Liability
- ✗ Warranty

Conditions


- ① License and copyright notice
- ① State changes
- ① Disclose source
- ① Same license

Replication crisis

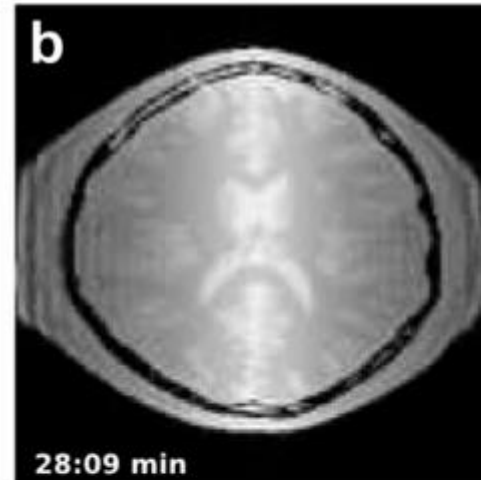
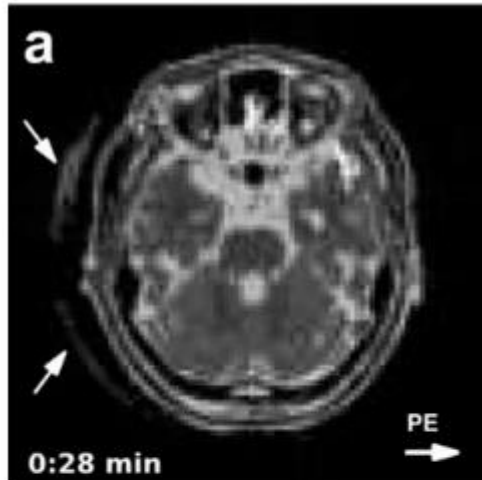
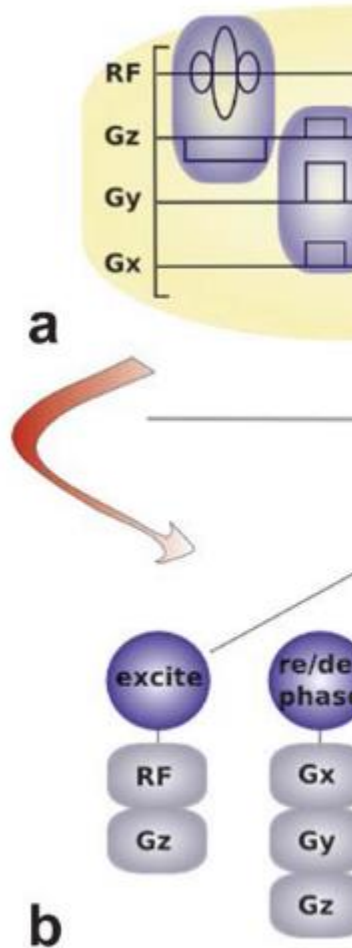
		Data	
		Same	Different
Analysis	Same	Reproducible	Replicable
	Different	Robust	Generalisable

Python (1991)



The designer of
Python, [Guido van
Rossum](#), at [OSCON 2006](#) 

JEMRIS (2010)



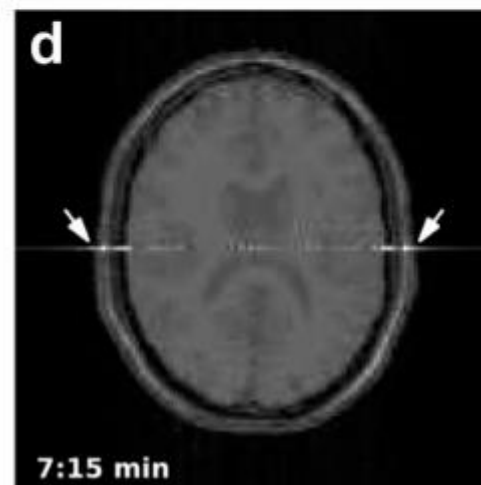
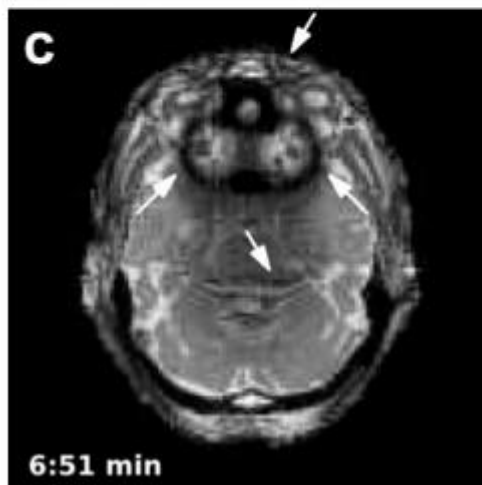
Object Interaction

"64"

le area in object Gx is
the observer list of the
variable in object EPI_loop.

= EPI_loop, counter

415*(-1)^a1"



talk in Runtime

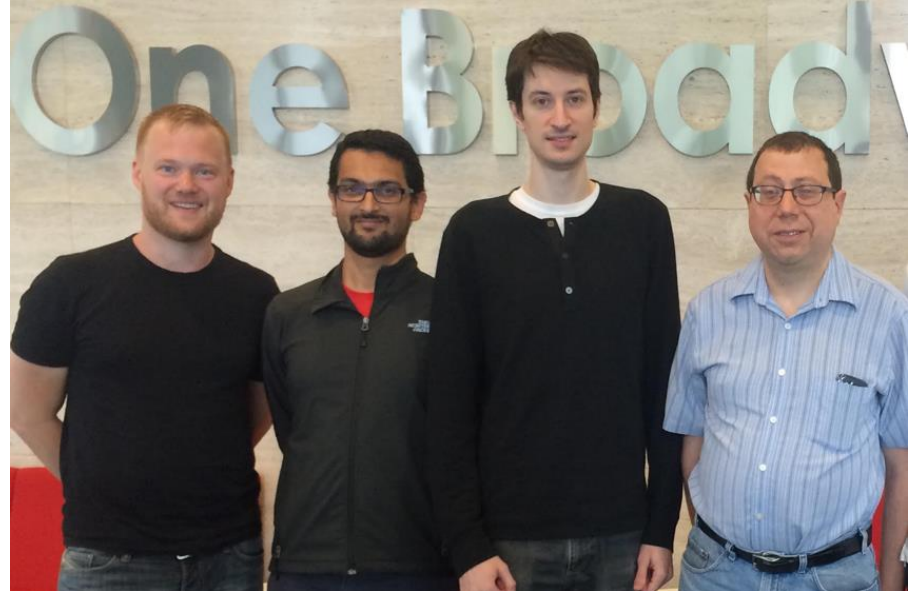
of an observed variable
automatic update of all
Here: (re-)evaluation of the
ed area formula.

1415*(-1)^counter

Julia programming language (2012)



**Massachusetts
Institute of
Technology**

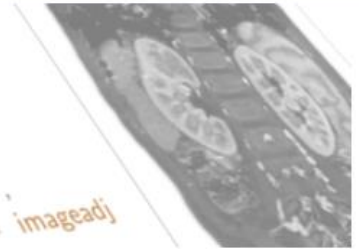


Stefan Karpinski, Viral B. Shah, Jeff Bezanson,
and Alan Edelman

BART (2014)

BART

```
void iter2_admm(iter_conf* conf,  
const struct operator_s* normaleq,  
unsigned int D,  
const struct operator_p_s* prox[D],  
const struct linop_s* ops[D],  
const float* biases[D],  
const struct operator_p_s* xupdate_op,  
float* imageadj)
```



BART: Computational Magnetic Resonance Imaging

Quick Links: [Home](#), [Download & Installation](#), [Tutorials](#), [Webinars](#), [List of Features](#), [References & Reproducibility](#)

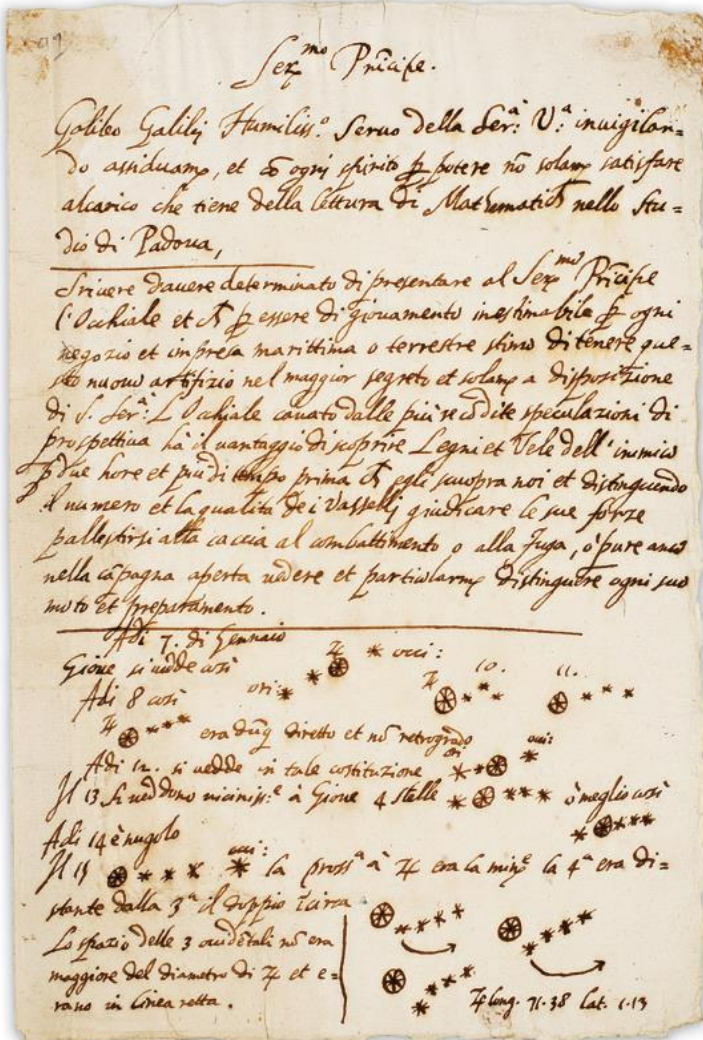
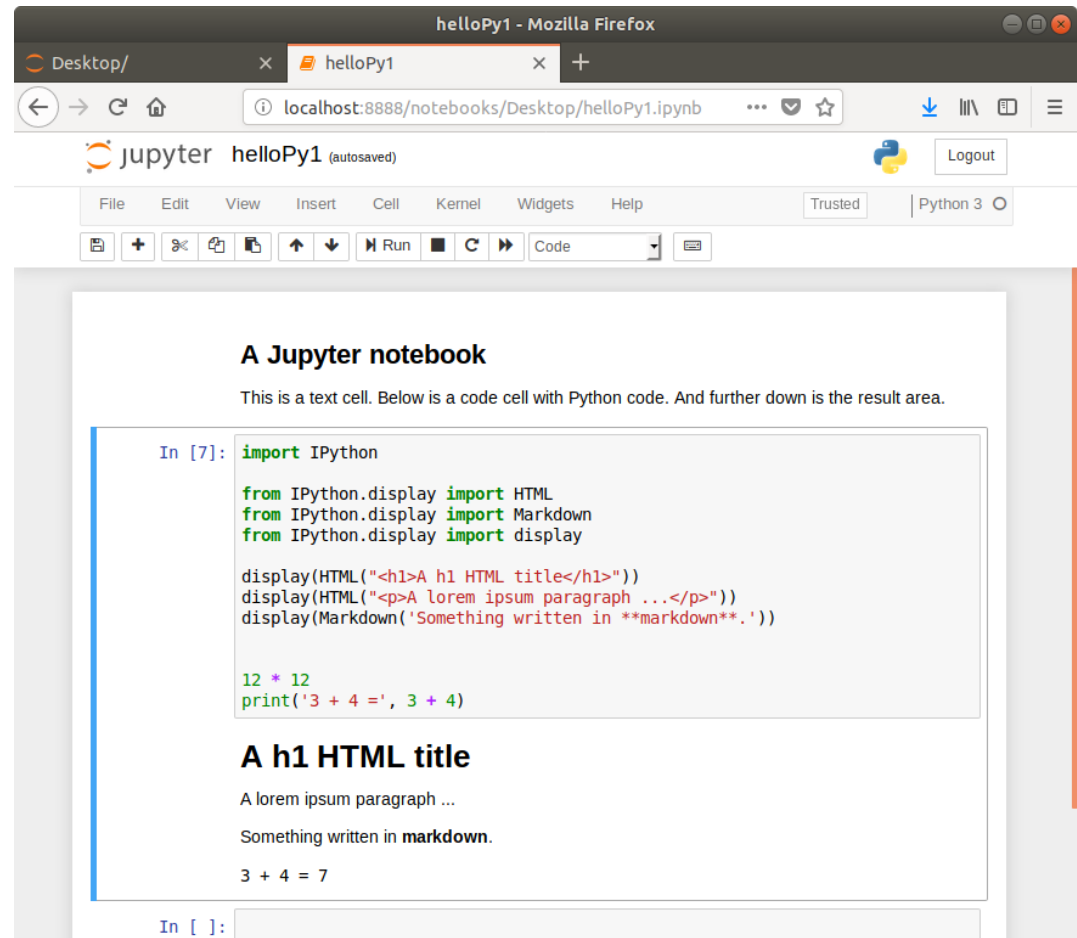


Figure: Simulated MRI images.

The Berkeley Advanced Reconstruction Toolbox (BART) toolbox is a free and open-source image-reconstruction framework for **Computational Magnetic Resonance Imaging** developed by the research groups of [Martin Uecker](#) (Graz University of Technology), [Jon Tamir](#) (UT Austin), and [Michael Lustig](#) (UC Berkeley). It consists of a programming library and a toolbox of command-line programs. The

[Martin Uecker](#) (Graz University of Technology),
[Jon Tamir](#) (UT Austin), and
[Michael Lustig](#) (UC Berkeley)

Jupyter notebooks (2015)

helloPy1 - Mozilla Firefox

Desktop/ x helloPy1 x +

localhost:8888/notebooks/Desktop/helloPy1.ipynb

jupyter helloPy1 (autosaved) Logout

File Edit View Insert Cell Kernel Widgets Help Trusted Python 3

Code

A Jupyter notebook

This is a text cell. Below is a code cell with Python code. And further down is the result area.

```
In [7]: import IPython

from IPython.display import HTML
from IPython.display import Markdown
from IPython.display import display

display(HTML("<h1>A h1 HTML title</h1>"))
display(HTML("<p>A lorem ipsum paragraph ...</p>"))
display(Markdown('Something written in **markdown**.'))

12 * 12
print('3 + 4 = ', 3 + 4)
```

A h1 HTML title

A lorem ipsum paragraph ...

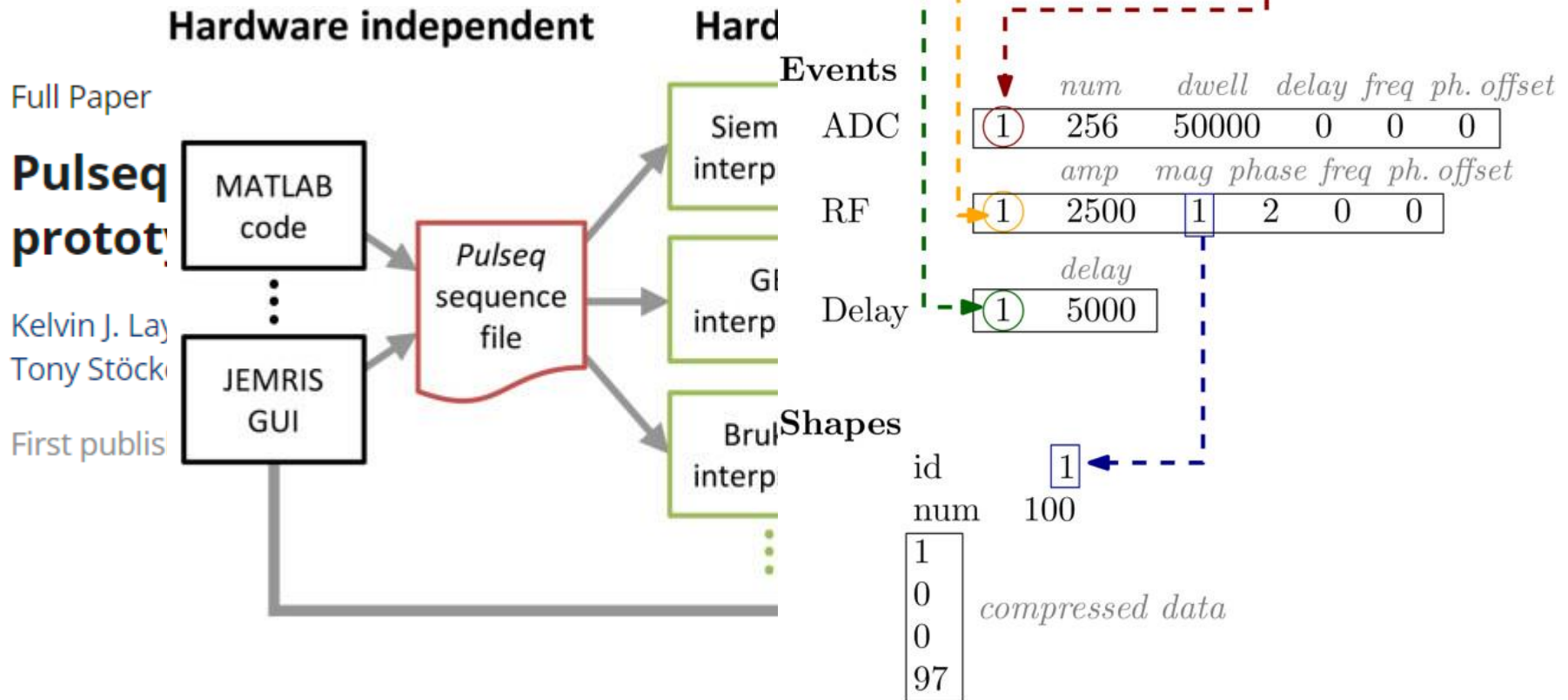
Something written in **markdown**.

3 + 4 = 7

In []:

Open-source standard

- ISMRMRD (2016)



Open-source standard

- ISMRMRD (2017)

ISMRRMRD Dataset

XML Header

Full Paper

ISMR
datas

Souheil J
David C.

First puk

```
<?xml version="1.0" encoding="UTF-8" standalone="no" ?>
<ismrmrHeader xmlns="http://www.ismrm.org/ISMRRD"
  xmlns: xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="http://www.ismrm.org/ISMRRD ismrmr.xsd">
```

```

encoding>
  <encodedSpace>
    <matrixSize>
      <x>512</x><y>256</y><z>1</z>
    </matrixSize>
    <fieldOfView_mm>
      <x>600</x><y>300</y><z>6</z>
    </fieldOfView_mm>
  </encodedSpace>
  <reconSpace>
    <matrixSize>
      <x>256</x><y>256</y><z>1</z>
    </matrixSize>
    <fieldOfView_mm>
      <x>300</x><y>300</y><z>6</z>
    </fieldOfView_mm>
  </reconSpace>
  <encodingLimits>
    <kSPACE_encoding_step_1>
      <minimum>0</minimum>
      <maximum>255</maximum>
      <center>128</center>
    </kSPACE_encoding_step_1>
    <repetition>
      <minimum>0</minimum>
      <maximum>1</maximum>
      <center>0</center>
    </repetition>
  </encodingLimits>
  <trajectory>cartesian</trajectory>
</encoding>

/ismrmrdHeader>

```

Raw Data

Data Header

Data Samples

[illegible]

raw

Authors ▾

MR-Hub (2019)



Categories:

All Categories (44) ▼

Many members of the [ISMRM](#) community develop customized software tools to solve problems in various



Sort by name

Sort by date added

Sort by date last updated

Sort by citations

DIPY

DIPY

Scientific computing software and community-driven medical imaging organization

Category: Multipurpose

Principal developers: Eleftherios Garyfallidis, Matthew Brett, Bagrat Amirbekian, Ariel Rokem, Stefan van der Walt, Maxime Descoteaux, Ian Nimmo-Smith and DIPY Contributors

Keywords: DTI, DKI, dMRI, diffusion MRI, neuroimaging, tractography, Diffusion Imaging

Date added to MR-Hub: 2020-01-27

Date software last updated: 2023-10-19

No. of citations: 868
(main associated paper on [Semantic Scholar](#))

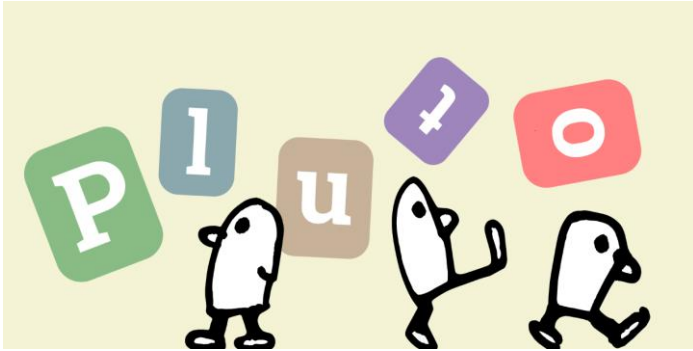
and data processing. The MR-Hub offers a platform with the rest of the community - hopefully making to solve their own problems more rapidly by building the ISMRM community to follow the spirit of behind their publications available to share.

[Study Group](#) of the ISMRM - and we encourage students to get involved. The GitHub repository for [ismrm/mrhub](#) - where you can also find instructions to the repository.

Open-sourced information related to open science and

to coincide with ISMRM 2019 in Montreal.

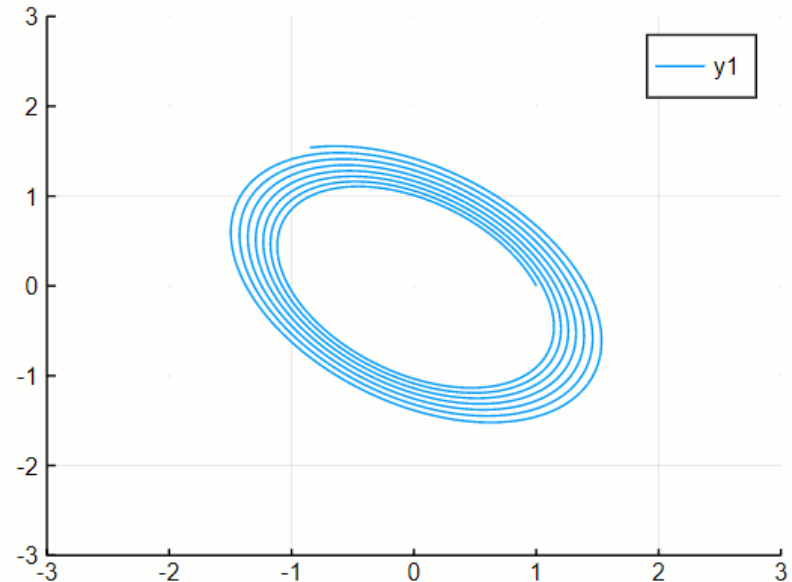
Pluto.jl (2020)



**Massachusetts
Institute of
Technology**

```
2×2 Array{Float64,2}:  
-0.4 -1.0  
 1.0  0.41
```

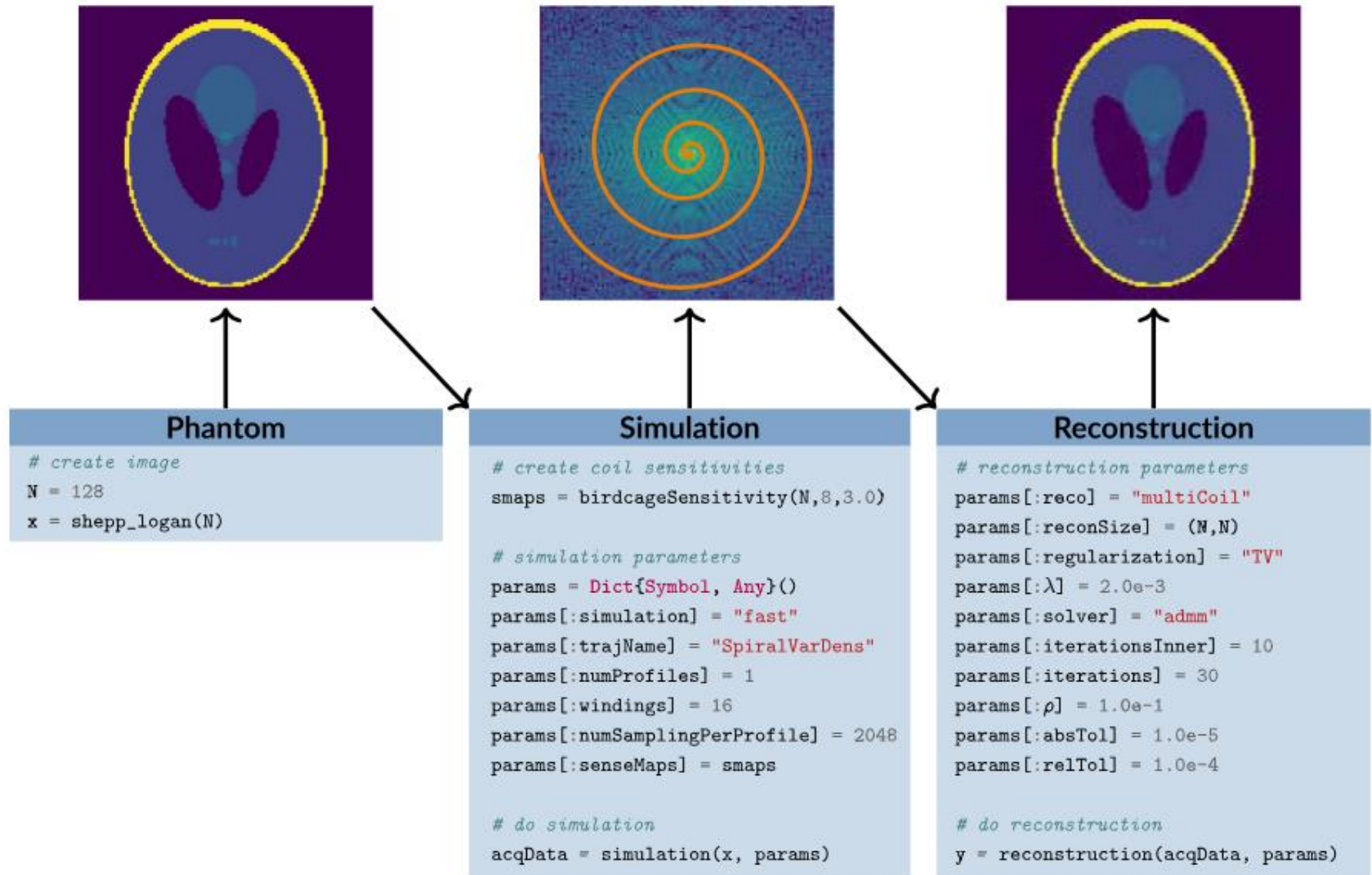
```
· A = [ -0.4 -1  
·       1  0.41]
```



```
· let  
·   x, y = integrate_ODE(A, 50.0)  
·   plot(x, y, xlims=(-3,3), ylims=(-3,3), size=  
·         (400,300))  
· end
```

Each notebook also contains the package versions used

MRIReco.jl (2021)



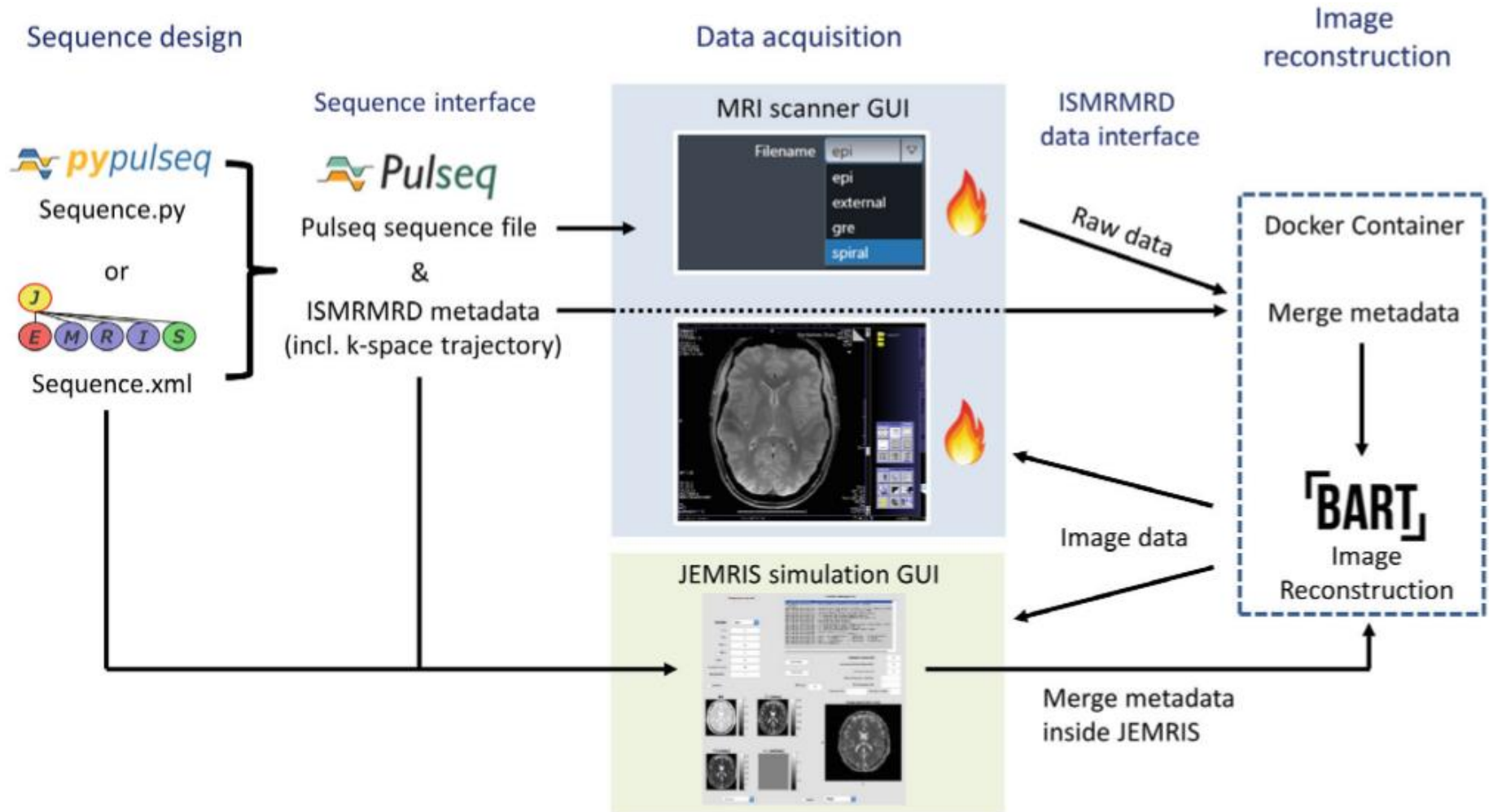
ISMIRM REPRODUCIBLE RESEARCH (2021)

ISMIRM

Reproducible
Research

STUDY GROUP

Open-source MRI pipeline (2022)



KomaMRI.jl (2023)



(A) Column 1D

Nspins = 200

(B) 2-spheres with
chemical shift

Nspins = 7825

(C) Brain with
susceptibility

Nspins = 25841

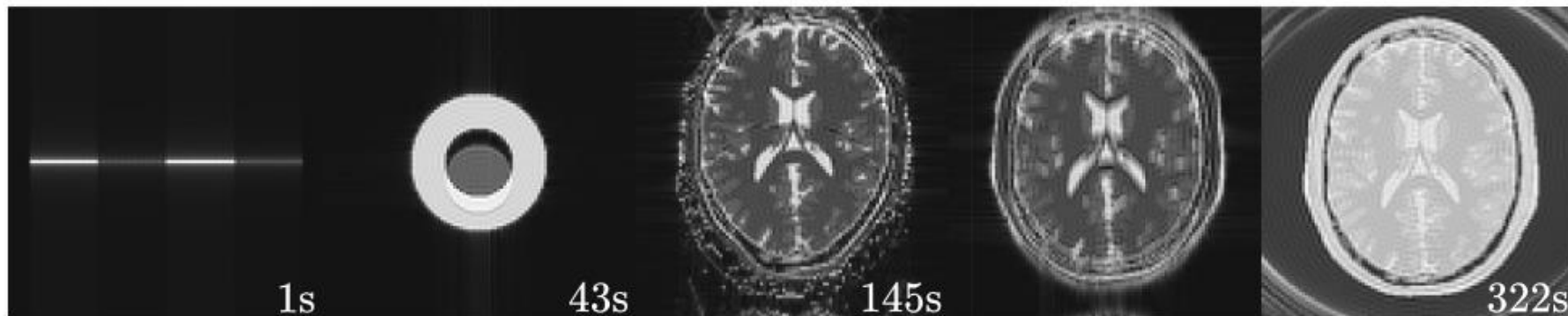
(D) Motion

Nspins = 25841

(E) Spiral acquisition

Nspins = 25841

JEMRIS v2.9



Koma v0.7



MAD = 0.074 %

MAD = 0.016 %

MAD = 0.072 %

MAD = 0.011 %

MAD = 0.092 %

Your Contribution (202X)

- Be a part of the MRI open-source software history!