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TRX: A community-oriented file format

BIDS-Connectivity: The case of Tractography

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BIDS-Connectivity: The case of Tractography

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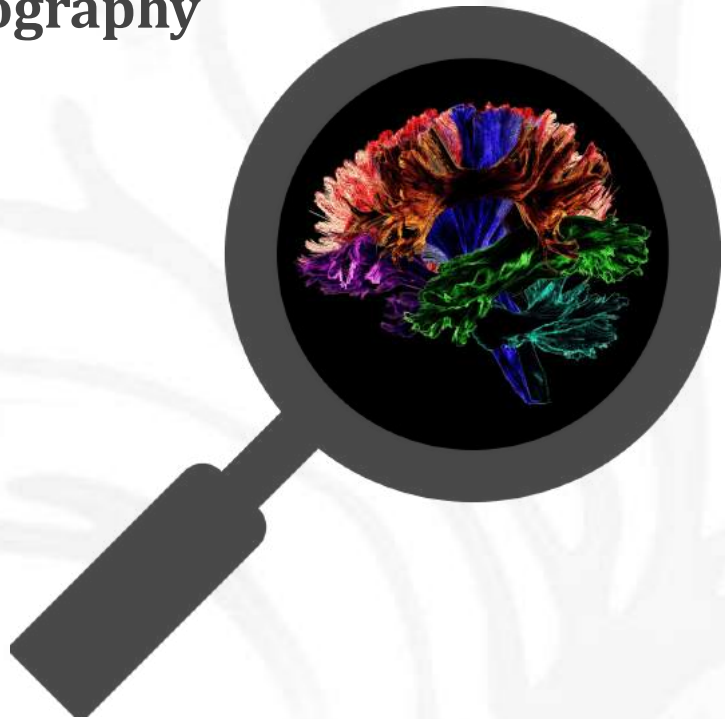
Slides, abstract and poster are linked on the page

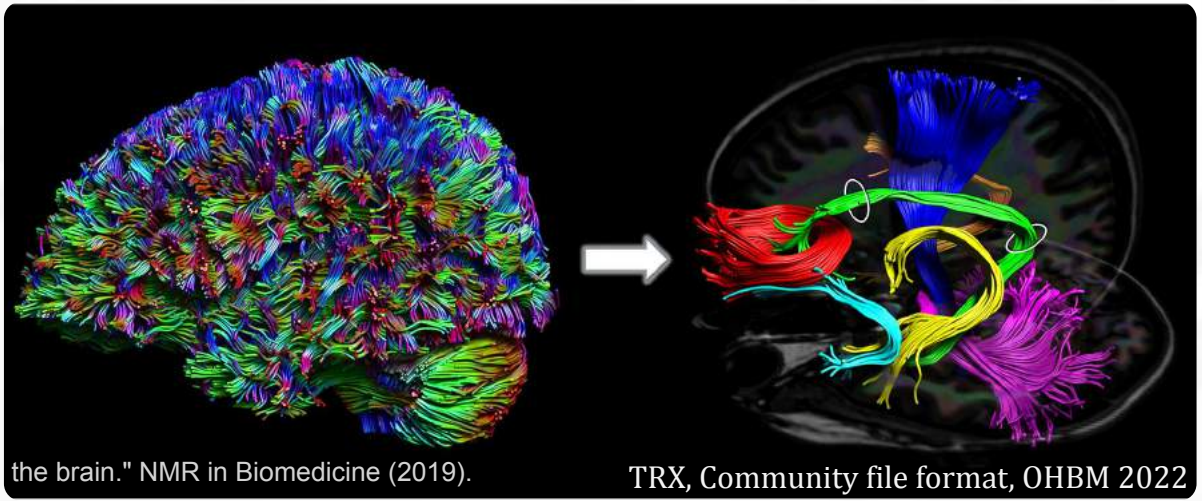
https://github.com/tee-ar-ex/trx



Background

What is tractography?

- 3D reconstruction of possible pathways interconnecting regions
- Millions of lines (*streamlines*) ⟶ Whole brain reconstruction (*tractogram*)
- Explicit representation: Each streamlines has 100s of 3D points
  - Easily Gigabytes
  - Compression algorithms
- Challenges in:
  - I/O Speed
  - RAM usage
  - Disk Usage



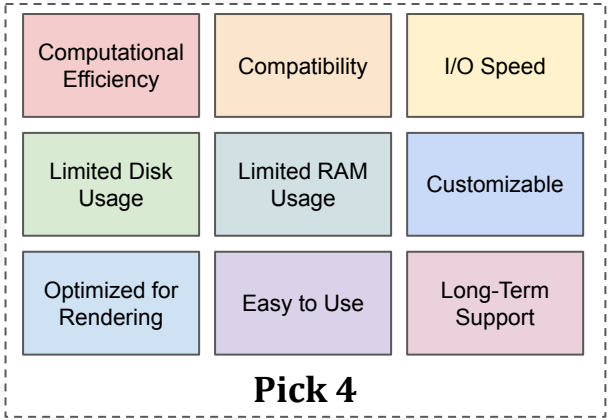
TRX, Community file format, OHBM 2022

Jeurissen, Ben, et al. "Diffusion MRI fiber tractography of the brain." NMR in Biomedicine (2019).

Challenges

Current situations

- Each file format has their pros and cons
- Each tool has its solution to computational challenges
- Each lab has its approach to workaround limitations
- Each project has its own technical requirements



Specialist

- Well-prepared for a few occurrences
- High success for a few scenarios, high failure for the rest

Generalist

- Semi-prepared for a wide variety of occurrences
- Moderate success for many scenarios, limited failure for many scenarios

Background

About BIDS (Brain Imaging Data Structure)

- Attempt to reach an agreement on data organization
- Facilitate data sharing and avoid waste of resources
- Each modality/field has its own specifications
  - (MRI, MEG, EEG, iEEG, behavioral, physiological, PET)

Connectivity information in BIDS

- **There is currently no specification for "connectivity"**
  - Functional or structural connectivity matrices
  - Lack of details on derivatives from fMRI and dMRI

Volumes	Surfaces	Metadata	Tabular	Tractograms
NIFTI	GIFTI	JSON	TSV	???

TRX, Community file format, OHBM 2022

Origin story

francopestilli commented on 30 Jul

It would be terrific to start a conversation about an agreed-upon data format for tractography
@arokem @Garyfallidis

Converged on desired attributes and features

- Uniformization across tools
- Allowing features needed by the field
- Conceptually simpler
- Less memory & hard drive hungry
- General robustness
- Load & save efficiency/speed
- Independence/standalone
- Extensibility

Computational Efficiency	Compatibility	I/O Speed
Limited Disk Usage	Limited RAM Usage	Customizable
Optimized for Rendering	Easy to Use	Long-Term Support

Pick "4"


frheault

neurolabusc

Lestropie

jdtournier

arokem

Garyfallidis

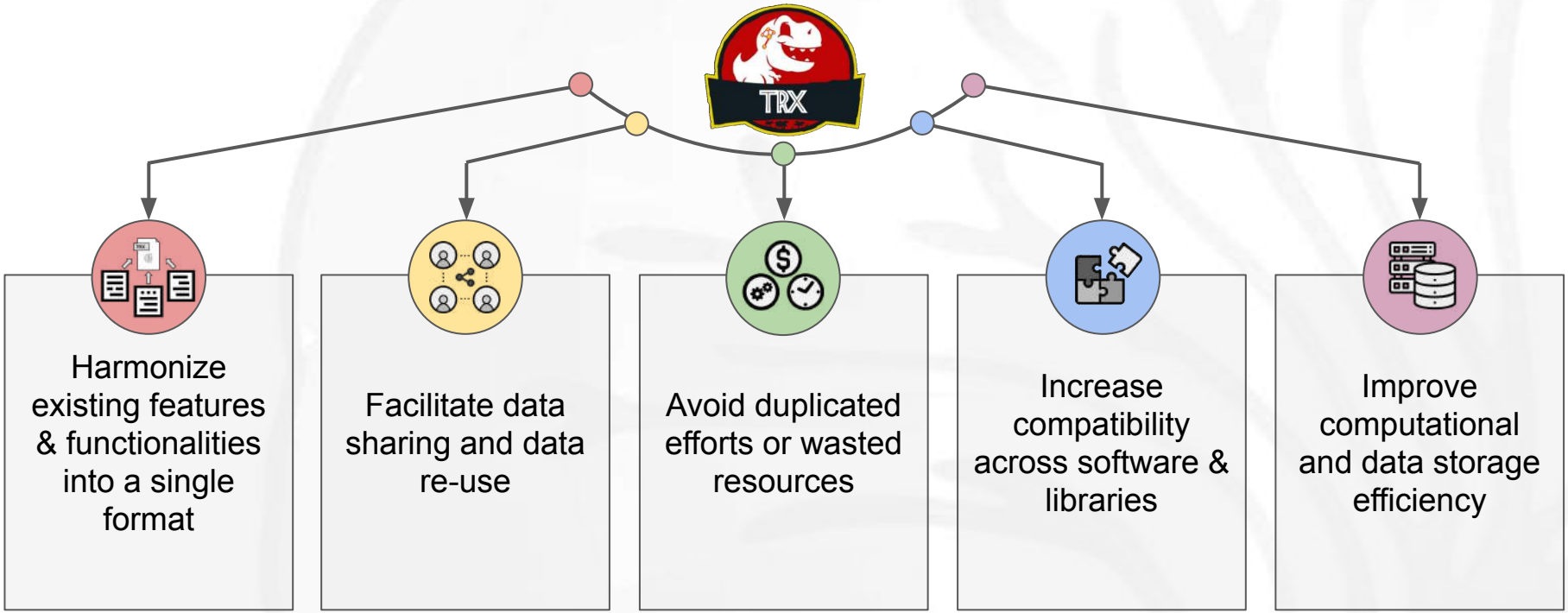
francopestilli

frankyeh

ValHayot

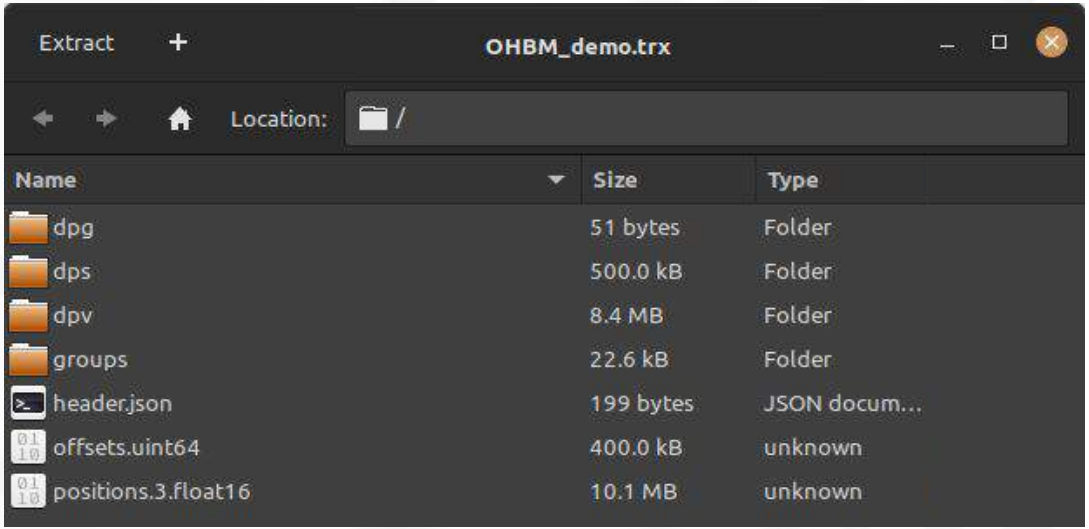
mdesco


Proposal: TRX



Proposal: TRX

OHBM_demo.trx
- header.json
- offsets.uint64
- positions.3.float16
- **dpv**
  - color_x.uint8
  - color_y.uint8
  - color_z.uint8
  - fa.float16
- **dps**
  - algo.uint8
  - clusters_QB.uint16
  - commit_colors.3.uint8
  - commit_weights.float32
- **groups**
  - AF_L.uint32
  - AF_R.uint32
  - CC.uint32
  - CST_L.uint32
  - CST_R.uint32
  - SLF_L.uint32
  - SLF_R.uint32
- **dpg**
  - AF_L
    - mean_fa.float16
    - shuffle_colors.3.uint8
    - volume.uint32
  - AF_R
    - mean_fa.float16
    - shuffle_colors.3.uint8
    - volume.uint32



Simple and **General**
Self-explanatory and **User-readable**
Easy-to-Support and **Extensible**

What has been done?

A lot of discussion!

- Architectures & dependencies
- Arrays' data types, dimensionalities & endianness
- Header, metadata & tags
- Nomenclature & terminology
- Compression standard (array vs streamlines)
- Tests & Benchmarking
- C++ standard & Python version

We propose **TRX** (pronounced T.R.X.) a tractography file format designed to facilitate dataset exchange, interoperability, and state-of-the-art analyses, acting as a community-driven replacement for **TCK** [1], **TRK** [2], **VTK**, **TT** [3], **TRAKO** [4], **qFIB** [5], **zFIB** [6], **NIML.TRACT** [10] and **DPY** [8].

View all 15 of 287

Add a reply

Data compression 7
#8 opened on 1 Dec 2020 by Lestropie

Invalid streamlines for software 7
#7 opened on 27 Nov 2020 by frheault

Online Meeting 8
#6 opened on 19 Nov 2020 by skoudoro

"Point" vs. "Vertex" 7
#5 opened on 16 Nov 2020 by Lestropie

Endianness 6
#4 opened on 15 Nov 2020 by Lestropie

Bitwise data / groups 2
#3 opened on 15 Nov 2020 by Lestropie

Reserved key for streamline seed point? 1
#2 opened on 15 Nov 2020 by Lestropie

Community file-format technological survey discussion 10
#1 opened on 13 Nov 2020 by frheault

18 Open ✓ 0 Closed Sort

Segmentation fault 2
#23 opened 5 days ago by neurolabusc

NPY file format for regular matrix data 2
#21 opened 21 days ago by Lestropie

Reference datasets 25
#20 opened 21 days ago by neurolabusc

Test coverage CI Python
#19 opened 26 days ago by arokem

Implications of compression algorithms 3
#17 opened on 14 Dec 2021 by DanNBullock

Benchmark against faster Python trk loader 14
#16 opened on 8 Dec 2021 by arokem

Some MRTrix desiderata for C++ implementation
#14 opened on 16 Nov 2021 by arokem

What is this for? 1
#12 opened on 12 Aug 2021 by arokem

Header: Choice of file format 3
#10 opened on 2 Dec 2020 by Lestropie

Extra header files for non-compulsory data 2
#9 opened on 2 Dec 2020 by Lestropie

What has been done?

Discussion about proposal

Proof-of-concept (Python)

Implementation in JS and C++

Scripts, utilities, testing and benchmarking

Candidate specification proposal

Incorporation to Nibabel (Python)

Proof-of-concept in MRtrix or MI-Brain (C++)

Unit tests and OS compatibility

OHBM 2022

OHBM 2023

Community review

Conversion scripts in various toolboxes

Final specifications

Inclusion in BIDS (2024)

Conclusion

Take-home messages:

- Difficulty in sharing data and incompatibility: Missing opportunities "*to do science*"
- Proposing a community-driven BIDS standard for connectivity
- Creating a next generation file format for general, wide-spread use
- Many contributors already involved, covering a range of tools and libraries

We need technical contributors

- Code review in C++ and Python
- Port to Nibabel/Dipy (Python)
- Implementation in Rust, Matlab, etc.
- Adding support for TRX in toolboxes (as alpha)

Visit poster #XXX for more details!

SCAN ME!

https://github.com/tee-ar-ex/trx

Thank you everyone!

NIH National Institute of Mental Health #MH126699

National Institute of Biomedical Imaging and Bioengineering #R01EB017230

TRX

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