# Scaling Up Collaborative Circuit Reconstruction with CATMAID

Andrew Champion FlyTEM Project HHMI Janelia Research Campus



Collaborative Annotation Toolkit for Massive Amounts of Image Data

- Collaborative sparse circuit reconstruction at large scale
- Analyses to quickly guide reconstruction based on biology



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#### 3D arbor visualization

- Morphological metrics
- Connectivity metrics, e.g., flow centrality



## 3D arbor visualization Morphology feature plots

• Detect common structure



# 3D arbor visualization Morphology feature plots

#### Connectivity graph

 Individual neurons, neuronal subarbors, and groups



# 3D arbor visualization Morphology feature plots Connectivity graph Connectivity partners

Detect strong common partners

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# 3D arbor visualization Morphology feature plots

### Connectivity graph

### Connectivity partners

#### Review system

- Independent tracking for each collaborator
- Collaboration review teams

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# API & Extensibility

 R interface by Gregory Jefferis @ Cambridge MRC

github.com/jefferis/rcatmaid

 Python and MATLAB consumers by Cardona lab

#### **New Capabilities**

- 60FPS image stack browsing (WebGL)
- Multi-stack support (e.g., EM/light) and multi-resolution reacquires
- Client GPU image filtering
- Orthogonal views
- PostGIS/spatial skeleton annotations

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G ′ D \_ F E

Z-section n+1





G D, F E

Z-section n+1









Links

Candidates





Links

Candidates





A B C D E F G

Bodies

Links

Candidates







### Single thread optimization



### Linear strong scaling



# Partition solution state

- Represented as
  - Prior solution state
  - Set of corrections
  - Delta of body graph member hashes
- Deterministically identified by
  - Hash of body hashes
  - Hash of correction DAG

# Advantages

- Efficient update of hierarchical graphs
- Efficient communication and update on clients
- "Append only" segmentation voxel data
- Allows diffs and 3-way merge, requirements for distributed reconstruction hosts
- < 1 min. to from correction to solution to updated client state in 500Mvx partition

# Acknowledgements

#### CATMAID

Albert Cardona Tom Kazimiers Stephan Saalfeld Mark Longhair (MySociety) Stephan Gerhard (INI) Frank Midgley

<u>Cardona Lab</u> Casey Schneider-Mizell Feng Li Maarten Zwart Ingrid Andrade

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### <u>Scientific Computing</u> Tom Dolafi Mark Bolstad Goran Ceric Rob Lines Don Lavu

#### github.com/catmaid/CATMAID

Adult Fly Brain Davi Bock **Rick Fetter** Harald Hess David Peale Jeff Jordan Tanya Tabacknik Khaled Khairy **Bill Karsh** Misha Kazhdan (JHU) Fric Trautman Fric Perlman Cam Robinson Zhihao Zheng Scott Lauritzen Corey Fisher John Price (Hudson Price) Omar Torrens (Coleman Tech.) Dan Milkie (Coleman Tech.)