COBALT: CLARITY-Optimized Brain AnaLysis Tools

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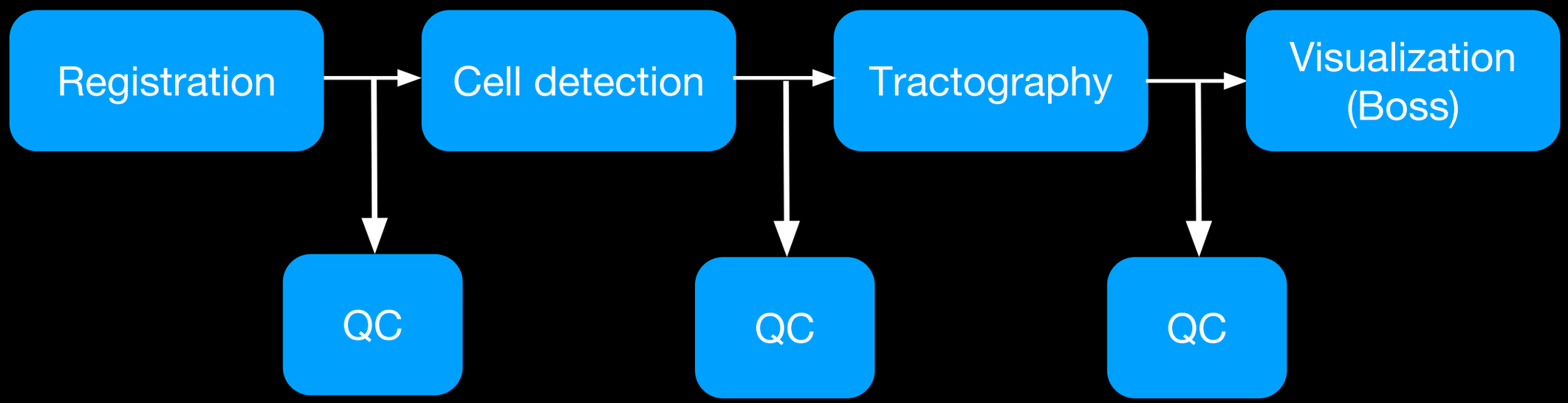
Pipeline overview



Mission

- To drive breakthrough neuroscience discoveries by enabling terabyte-scale, cleared brain tissue analysis through the use of a comprehensive and well-documented software package and web interface

Motivation

- Historically, microscopy stacks have been collected by physical sectioning of the brain followed by imaging requiring many days, sometimes weeks to complete

- Physical sectioning severs connections between different neurons of the brain, losing connectivity information

- Cleared brain tissue provides high-resolution access to the intact brain while reducing imaging time by orders of magnitude from ~weeks to ~hours through optical sectioning

Problem

- With the advent of novel technologies like CLARITY, neuroscientists are producing terabytes of optically-sectioned imaging data
- Not many robust tools exist to provide meaningful analyses of large volumes of such a novel data collection method

Causes

- Supporting analyses for data of this size requires efficient storage and visualization solutions
  - requires expertise to store and visualize large data
- Methods exist for analyzing imaging data but there aren’t many specific to this imaging modality
  - CLARITY was invented 4 years ago which is not enough time to develop and test computer vision methods for analysis

Current Best Practices

- ClearMap
  - iDISCO brain tissue pipeline that performs registration, cell detection, and voxel-/region-based statistical analyses
  - Not very user-friendly for neuroscientists. Too many parameters to tune
  - Not very generalizable to other tissue clearing methods

What’s missing

- What works
  - Some unsupervised cell detection algorithms (watershed, etc.)
- What doesn’t
  - No integrated pipeline that provides accurate results on CLARITY data
  - Most existing tools are not designed for terabyte-scale data
  - Clearmap is not very user-friendly or easy to tune parameters

Solution

- A one-click software pipeline for neuroscientists to obtain meaningful statistical results on their terabyte-scale data including:
  - Registration
  - Cell counting
  - Neurite tracing
  - Easy-to-use web interface
  - Comprehensive documentation with suggestions for optional optimal parameter tuning

Impact

- Neuroscientists
  - one-click pipeline to enable robust, reproducible neuroscience
  - easy-to-use software with comprehensive documentation