

Distributed deadline computing for real-time brain imaging analysis

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Introduction

Real-time fMRI enables online analyses, experiments, diagnoses, and neurofeedback-based treatment

Cloud computing allows users to rent arbitrary computing resources, providing modular, scalable, and maintainable infrastructure

How can cloud-computing infrastructure be used to expand the scope of real-time analyses?

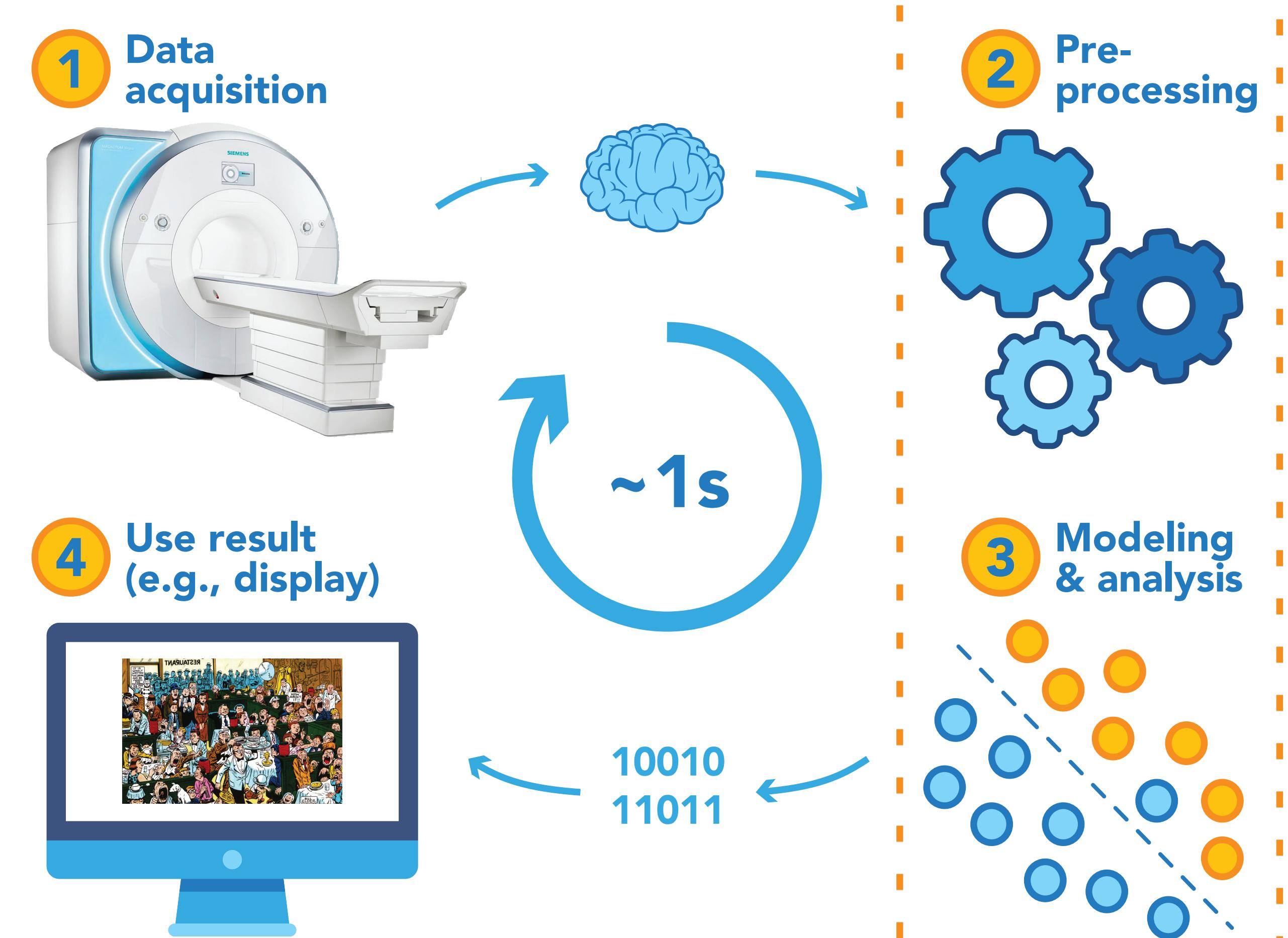
Analyze data online

Rapidly compute results

Update experiment based on results

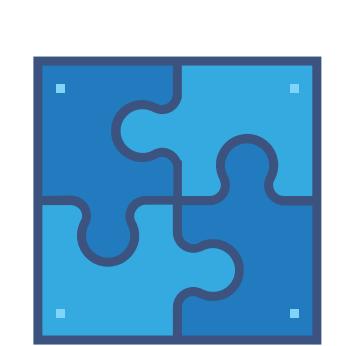
Can and has been done locally!

Real-time fMRI

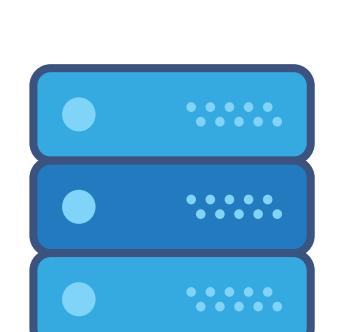


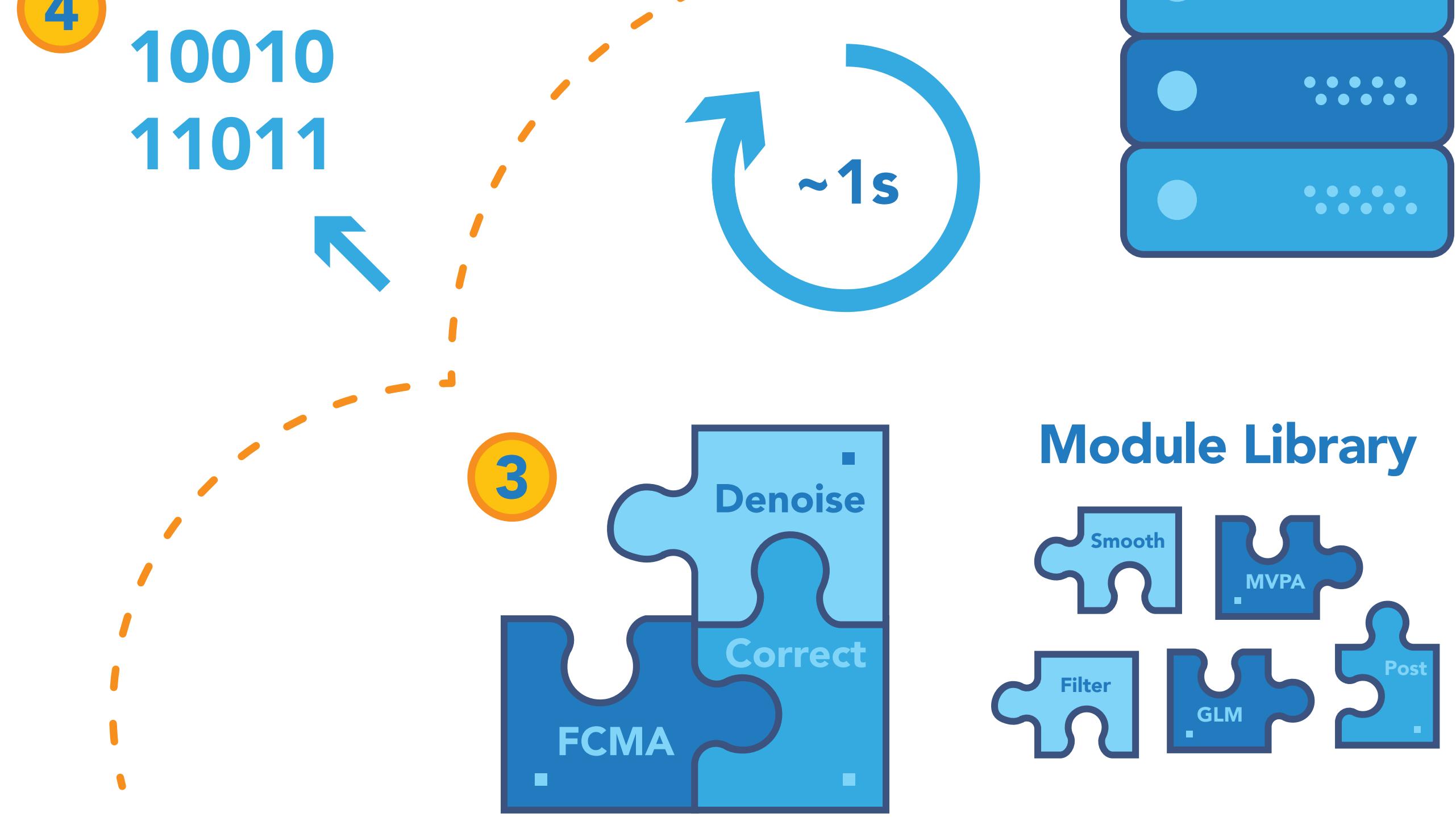
Cloud Computing

We move the pre-processing and modeling & analysis steps to the cloud to take advantage of:

 **Modular components**

 **Maintainable infrastructure**

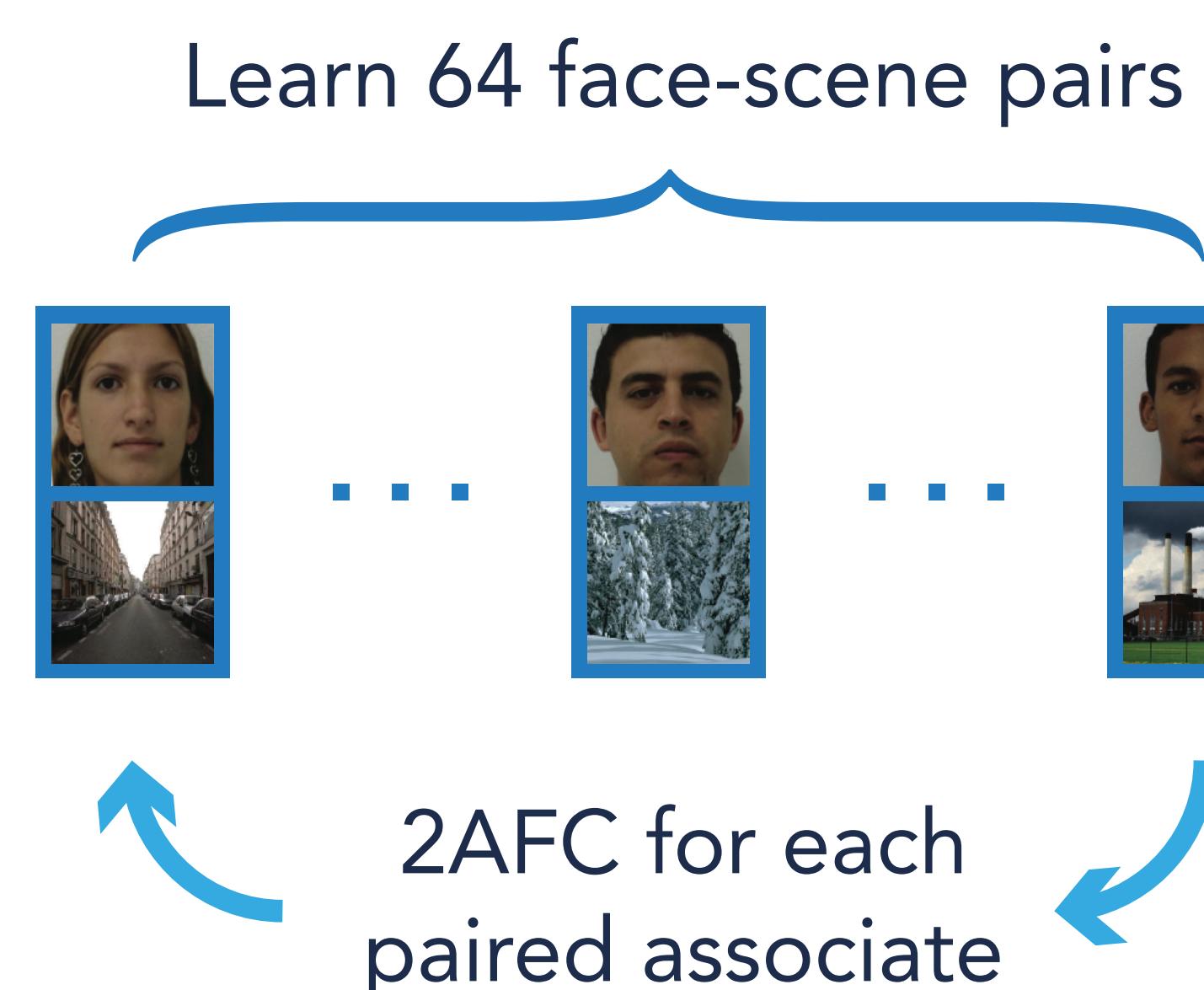
 **Scalable resources**



Task Design

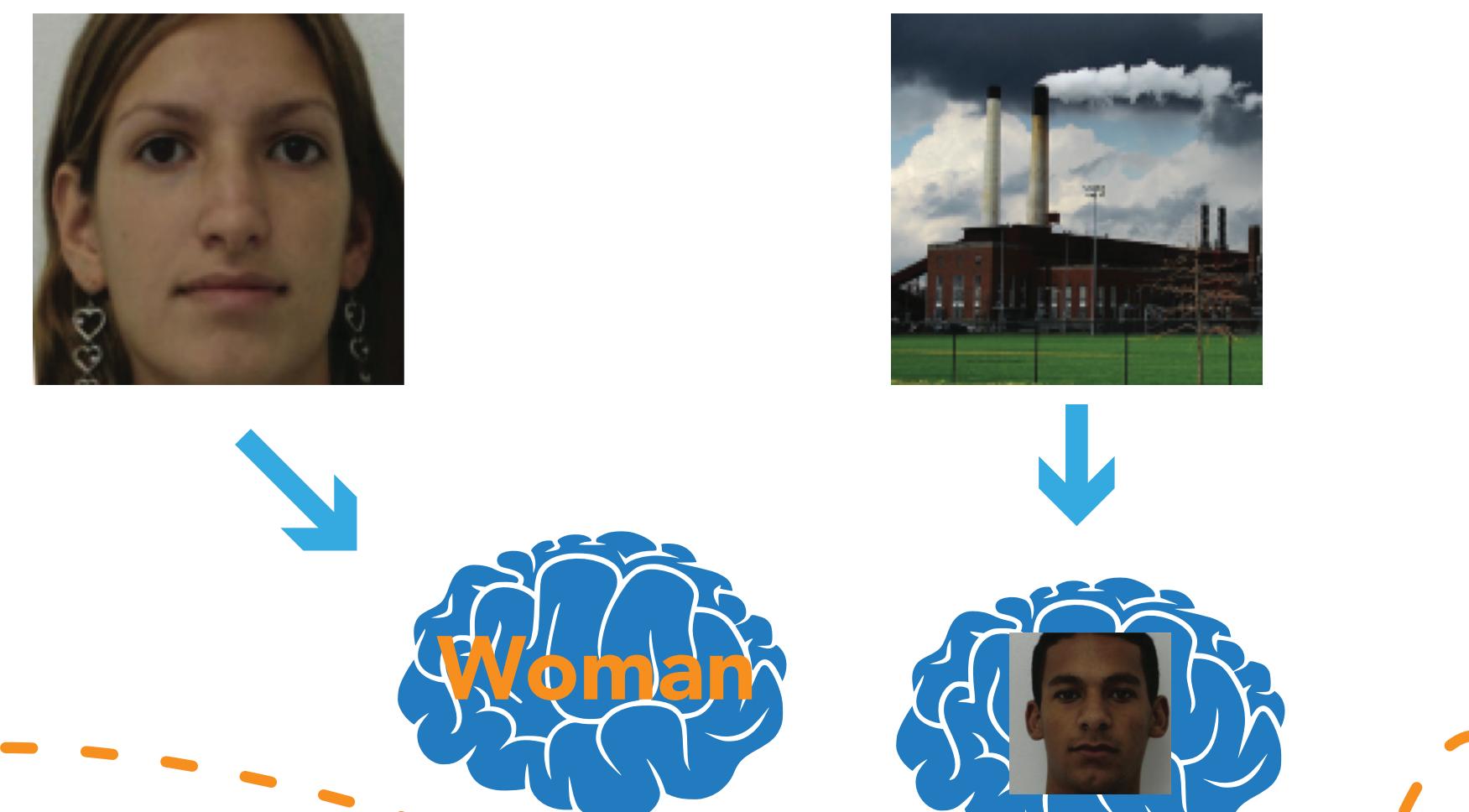
Offline (N=24): training a perceive / retrieve classifier

A Form mental associations

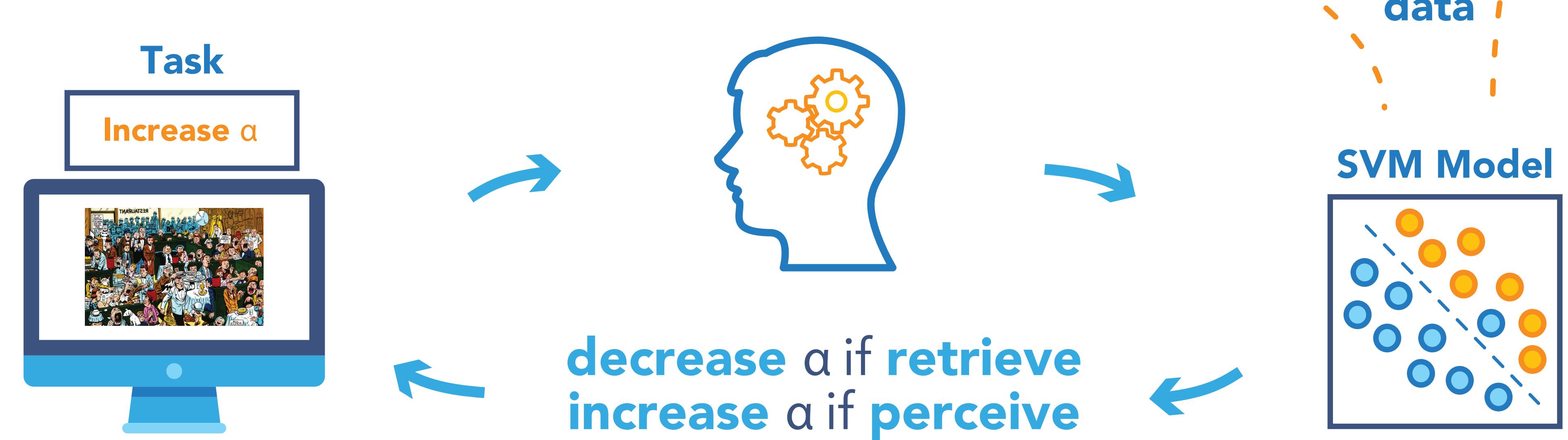


B fMRI task

Perceive: label the image
Retrieve: recall an image



Real-time (N=2): controlling the classifier

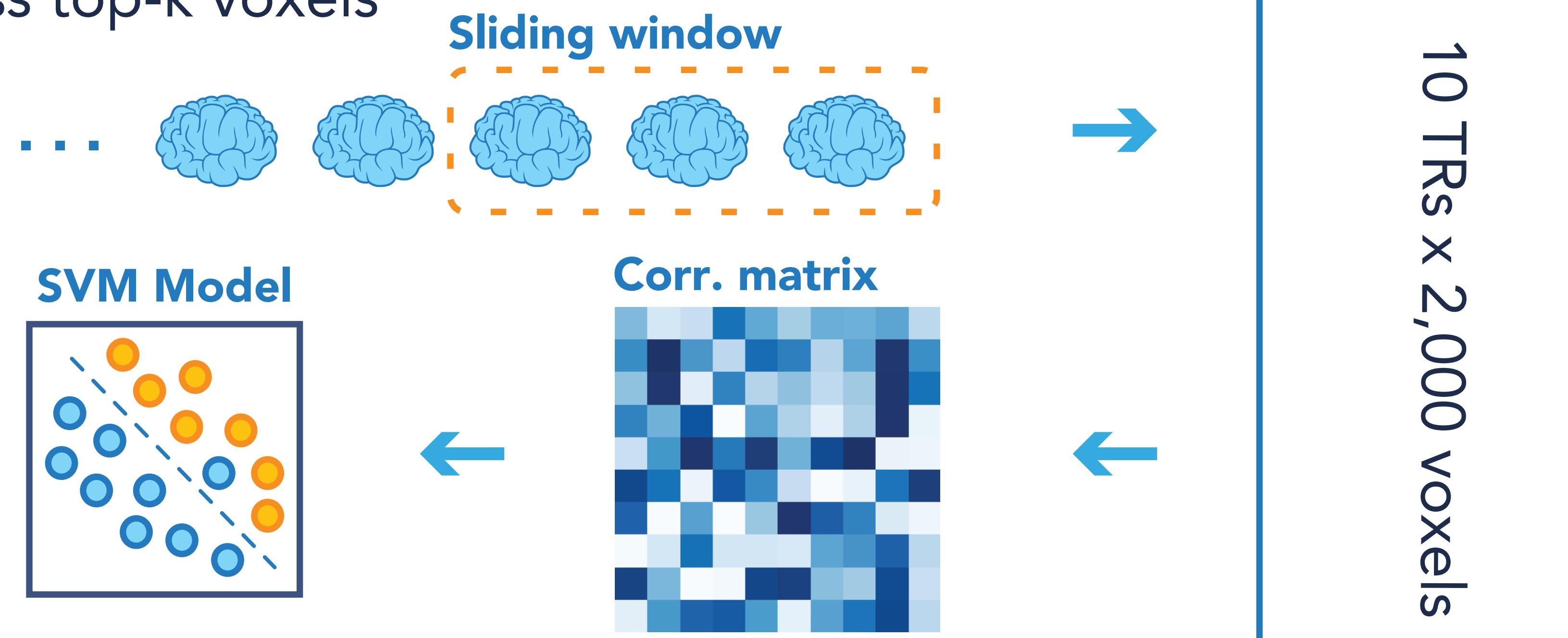


References

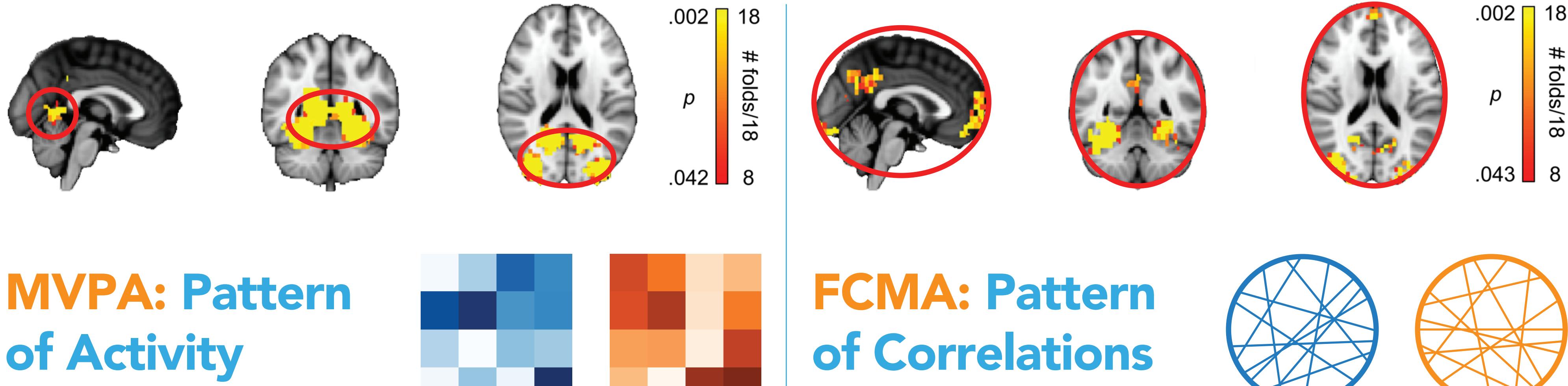
- Wang, Yida, et al. "Full correlation matrix analysis (FCMA): An unbiased method for task-related functional connectivity." *Journal of neuroscience methods* 251 (2015): 108-119.
 Wang, Yida, et al. "Real-time full correlation matrix analysis of fMRI data." *Big Data (Big Data), 2016 IEEE International Conference on*. IEEE, 2016.
 Sulzer, James, et al. "Real-time fMRI neurofeedback: progress and challenges." *NeuroImage* 76 (2013): 386-399.
 Hutchinson, J. Benjamin, Yida Wang, and Nicholas Turk-Browne. "Overlap and separation of remembered and perceived visual information in the human medial temporal lobe." *Journal of Vision* 16.12 (2016): 1429-1429.

Full Correlation Matrix Analysis (FCMA)

Computationally complex: correlation of time series activation data across top-k voxels

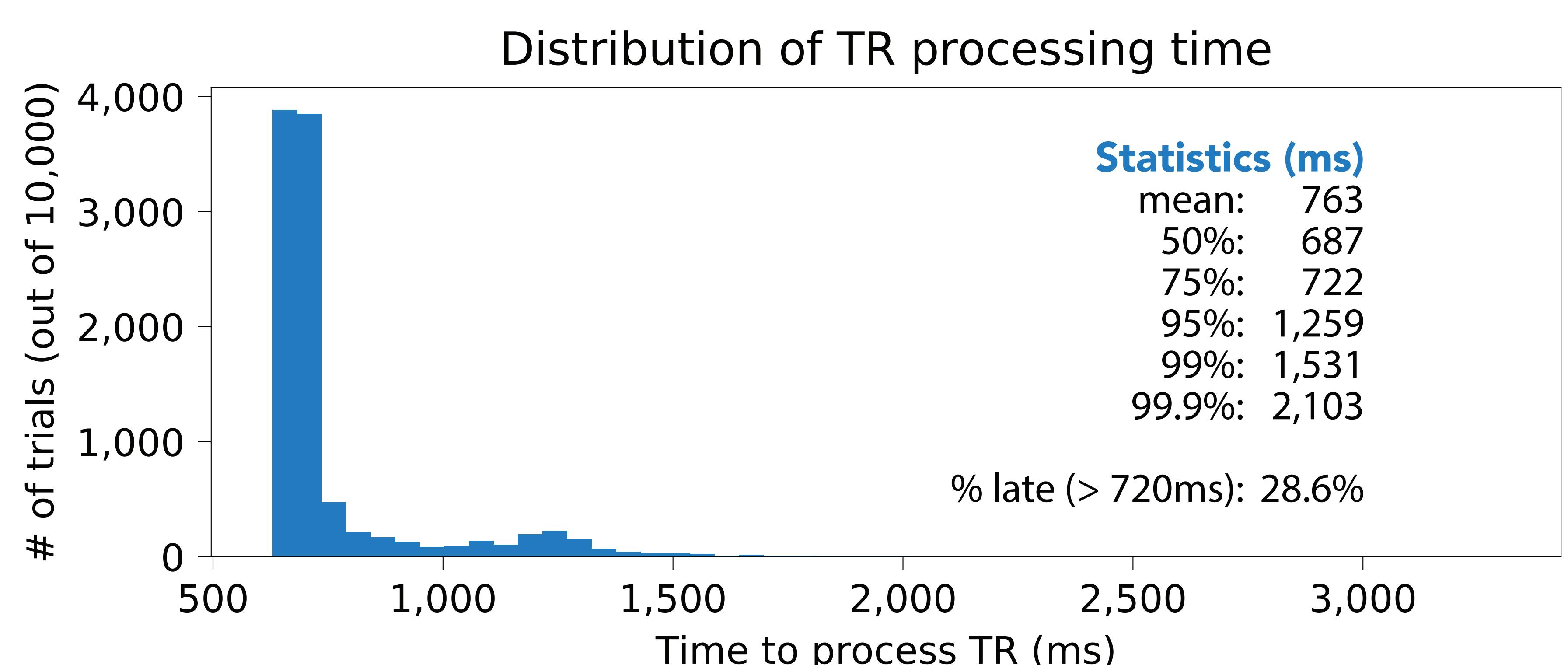


Whole-brain and spatially-distributed

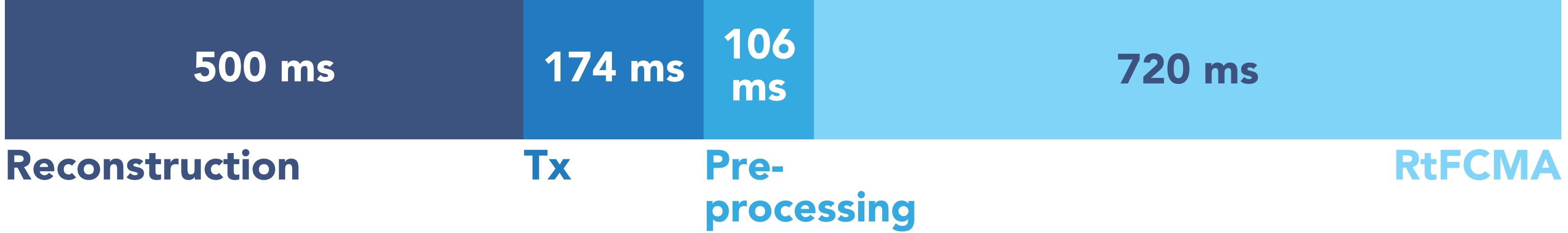


Results

1. Prototype cloud system for processing TRs in real time



Total Cloud: 1,500 ms (~\$40) vs. 56,240 ms locally

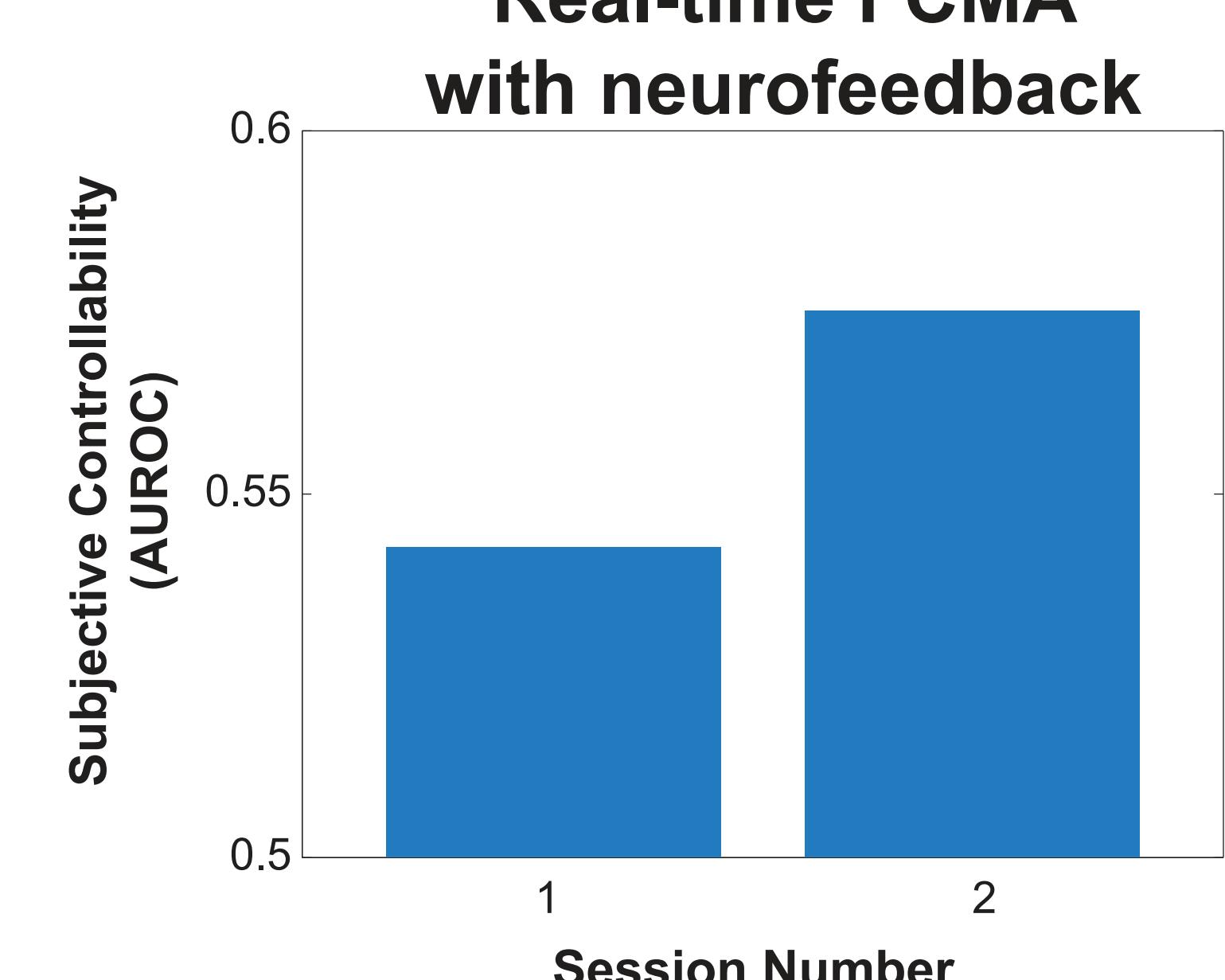


2. Generalize predictive capability across subjects

Whole-brain connectivity-based analysis shows initial promise

Possible that models trained on one group applicable to others

This analysis would be infeasible if run locally (~37x slower per TR)



Discussion

Cloud computing enables analyses such as FCMA for practitioners without access to hardware, software, or systems expertise

In addition to making new analyses tractable, may also accelerate existing work by running many analyses simultaneously

A collaboration among the authors' institutions is developing a service to provide cloud computing for practitioners. Please contact us if you're interested!

BrainIAK

Analysis performed using the BrainIAK Python package for high-performance neuroimaging analysis.
 For additional information, see brainiak.org/ohbm2018

