Towards an Objective Measure of Developers' Cognitive Activities: Code, Biases, and Brains

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<Hello World/>

Motivation

What is going on in your brain when you are dealing with code?
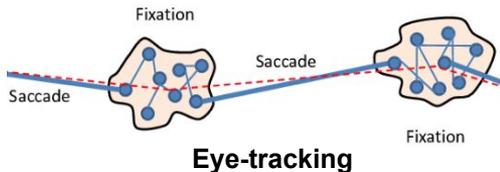**Is coding like doing math? Or processing natural languages?**

Can we answer these questions at all?

- **Systematically** - **Objectively** - **Rigorously**

fMRI   **fNIRS**   **Eye-tracking**

Code Writing vs. Prose Writing [ICSE'20]

Is being good at writing associated with being a good software developer? - *Unlikely!*

Brian was so fond of his dog that their brief _____ left him not just saddened, but in a state of sorrow.

```
int absoluteValue(int num1)
{
    /* YOUR CODE HERE */

    return absoluteValue;
}
```
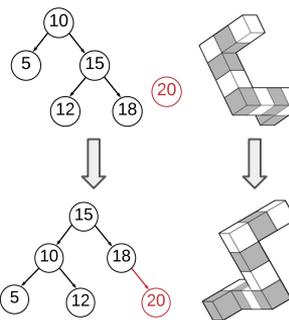
- fMRI and bespoke keyboard
- Fill in the Blank (FITB) tasks and Long Response (LR) tasks

Code writing: top-down control, memory, planning, spatial ability
Prose writing: language-related regions

-7.0   -3.1 3.5   5.8   Code LR > Prose LR

-5.1   -4.2 2.3   7.0   Code FITB > Prose FITB
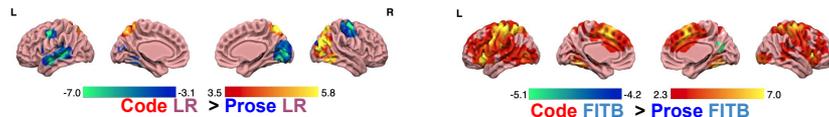
Data Structures vs. Spatial Ability [ICSE'19 🏅]

Do human brains represent data structures like 3D objects? - *Yes!*

- First time use both fMRI and fNIRS in SE
- List/array, tree operations vs. mental rotations

DS manipulations largely involve spatial ability. Human brains work even harder for more difficult DS tasks compared to mental rotations.
Humans' perceptions can be unreliable.

Biases in Code Review: Human vs. Machine [FSE'20]

Are there biases on gender and identities in code review? - *Yes!*

- *Deception*, fMRI and eye-tracking
- Controlled code quality
- Women, men, and machines (tools)

Universal biases exist in how humans treat code reviews as a function of the reviewers' gender and apparent author: neurologically, visually, behaviorally.

Eye-tracking: Fixation Time Distribution
Women Reviewers   Men Reviewers

	Author Pic	Code	PR Message	Indicator Image
Women	12.60%	57.30%	25.94%	3.59%
Men	8.60%	62.50%	12.50%	16.40%