 Quantifying the Programming Process to Help Teach Incremental Development  
Ayaan M. Kazerouni  
Department of Computer Science, Virginia Tech

**TEACHING INCREMENTAL DEVELOPMENT TO EXPERIENCED PROGRAMMERS**

**HYPOTHESIS**  
- Good programming process is important for successful project outcomes  
- Continuous, adaptive feedback about the process can help developers adhere to good process

**PROBLEM**  
- Research on student programmers tends to be aimed at novices  
- Assessment practices tend to focus on post-hoc semantic and static checks

**GOAL**  
- A process for continuous assessment and self-correction while programming

---

**THE PROGRAMMING PROCESS AS CLICKSTREAM DATA**

**DEV-EVENT-TRACKER [1] – Observing a 30-hour programming process carried out at home.**

- We instrumented the Eclipse IDE to capture developer activity  
- Collects Edit, Launch, and Debug events, along with program snapshots using Git  
- Now produces approximately 6M events each semester

---

**QUANTIFYING INCREMENTAL DEVELOPMENT**

Reducing a large event-stream into actionable feedback. [2]

**Quantifying Procrastination**

*Early/Often Index: How many days before the deadline do you write code, on average?*

If $E$ is the vector of all edits on the project, then

$$\text{early/often}(E) = \frac{\sum_{e \in E} \text{size}(e) \times \text{daysToDeadline}(e)}{\sum_{e \in E} \text{size}(e)}$$

Positively related to project correctness ($p < 0.001$) and earlier completion times ($p < 0.001$).

**Quantifying Incremental Test Writing**

*Solution/Test Coevolution: How much test code do you write each time you sit down to code?*

If $SE$ and $TE$ are edits to solution code and test code:

$$\text{coevolution} = \text{Avg}(\frac{|TE|}{|SE| + |TE|})$$

Across all work sessions.  
Positively related to project correctness ($p = 0.007$).

The metrics described above could be applied in educational, industrial, and open-source contexts.

---

**REFERENCES AND ACKNOWLEDGMENT**


This work was funded in part by NSF grants DUE-1244334 and DUE-1625425.