Interactive Exploration of Developer Interaction Traces using a HMM

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Developer Interaction Traces

- Primarily collected from developer clicks and key presses in the IDE
  - Provide a perspective of development in the field
- BUT
  - Noisy
  - Large
  - Low-level
Typical Interaction Trace Analysis

• A time ordered stream of a single developer’s interactions and events
• Most analysis approaches extract low-level behaviors
Hidden Markov Models

- dual stochastic processes
- lower process represents the individual interactions, higher represents behaviors
Baum-Welch Learning from Interaction Data

- Uses maximum likelihood estimation to infer a HMM, given some sequential data

Diagram:
- DEBUG
  - StepIn — 0.5
  - StepOut — 0.5
- NAV
  - GoToDefinition — 0.25
  - OpenMethod — 0.75
- SEARCH
  - Find in Files — 1.0

Transition Probabilities:
- DEBUG to NAV: 0.25
- NAV to DEBUG: 0.75
- NAV to SEARCH: 0.75
- SEARCH to NAV: 0.25
- DEBUG to SEARCH: 0.75
- SEARCH to DEBUG: 1.0
Problem with Baum-W.

- StepIn — 0.2
- StepOut — 0.3
- GoToDefinition — 0.2
- Find in Files — 0.3

- In reality, most inferred models are not interpretable
Key Idea: B.Y.O. HMM

- There are many HMMs that fit the interaction data well
  - many similar local minima for the Baum-Welch algorithm to find
- Optimize understandability by building model \textit{interactively}, state by state
Interactive HMM Workflow

- Start with ALLDATA state
- View seq’s in dataset, poorly captured by model
- Add a state
- Check model quality

- Iteratively build up a quality, interpretable model, with appropriate number of states
HMM Workflow in Action

- Debugging in Visual Studio (200 developers at ABB Inc.)
Results on Debugging

- Code search and navigation lead to setting breakpoints, while opening files does not
Contributions

- A way to *interactively* build *interpretable* HMMs from developer interaction data
  - Focusing on high-level behaviors of interest
- Feedback via model quality measurement and sequences in data poorly captured by model
Thanks!

QUESTIONS?

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