ThreadedPaws: A Serious Game for Learning the Pitfalls of Concurrent Programming

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1. Motivation

- Developments in multi-core processors continue to increase the need skills in concurrent programming.
  - The role of concurrent computing is expected to broaden, not only within industry, but also in the classroom at the undergraduate level.
- Writing concurrent programs remains difficult due to it's non-deterministic nature.
- Using a serious game as a teaching tool provide the user with motivation to learn through a goal-oriented dynamic, allows for practice in an engaging manner, and offers continual, immediate feedback.

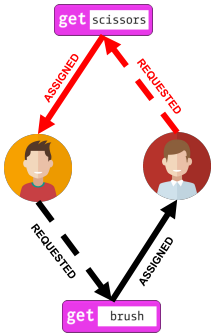
Research Goal:
Develop a game-based learning tool that teaches students to identify and fix concurrency pitfalls.

2. Gameplay

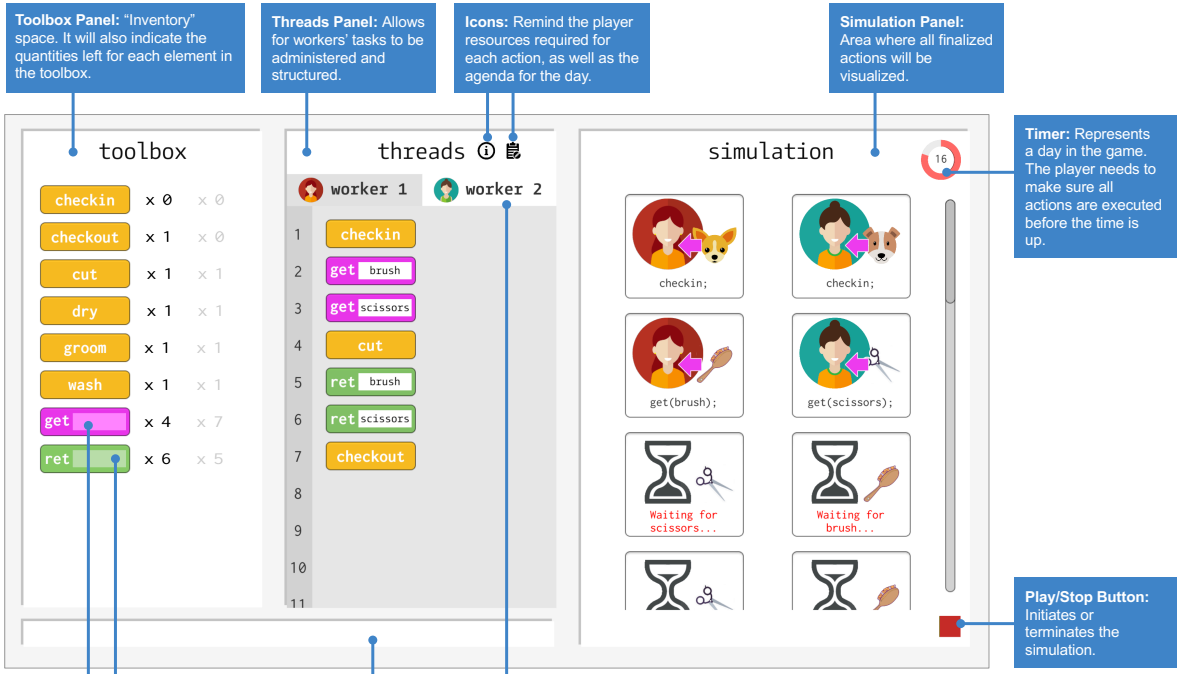
- The user plays the role of the manager of a dog grooming store, where they need to manage the workers they have available to attend all incoming customers before the day terminates.
- Using the elements available in the Toolbox Panel, the is to fulfill the requirements for the current customer(s) by dragging them to the corresponding worker to perform the action.
- When finished, the player must initiate the simulation, when the timer will start. To complete each level, all actions assigned to workers must be executed before the timer finishes. If completed successfully, they may move on to the next one. Otherwise, the user may attempt it again.

3. Level Breakdown

Level	Description
1	Introduction of game dynamics using sequential execution.
2	Given a **starvation** set up, provide a solution by using the `return` elements to release resources.
3	Given a **deadlocks** set up, provide a solution by changing the order of resource acquirement for each thread.



4. Interface



5. Conclusions and Future Work

- We created a game designed to facilitate the learning process in respect to concepts in concurrency. Throughout the levels proposed, **Threaded Paws** aims to assist students in understanding concurrency: its most basic theory and pitfalls, as well as how to approach and resolve them.
- Four (4) primary areas for future work were identified:
  - It may be helpful to provide additional feedback or suggestions to the user once they reach a set timed mark on said task.
  - Introduce data race conditions in a new level. Players could be challenged to design a structure that manages a queue of customers.
  - Level uniqueness by enabling each level to be generated at random.
  - User study. It's important to know if there are any real benefits for the user using the game as a learning tool as opposed to a more traditional method; if none, then it's equally as relevant to be aware of potential improvements.

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