

Threaded Paws: 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 for skilled concurrent programmers.
 - The role of concurrency in computing is expected to broaden, not only within industry, but also in the classroom at the undergraduate level.
- Writing concurrent programs remains challenging due to its non-deterministic nature [1].
 - Some of the challenging pitfalls include starvation, deadlocks, and data races.
- Serious games as teaching tools have been shown to motivate and engage learners through a goal-oriented dynamic, while also offering continual and immediate feedback [2].

Research Goal:

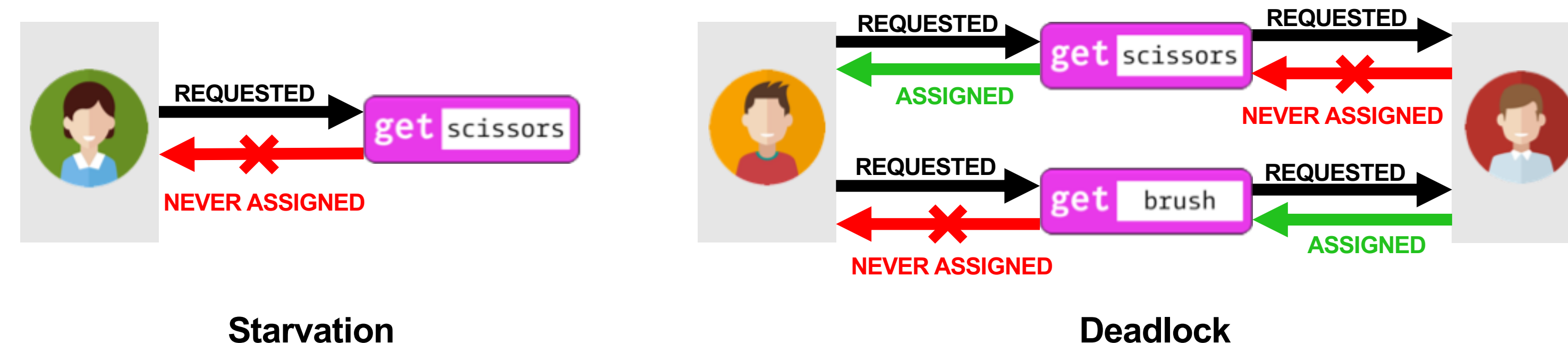
Develop a serious game that allows students to learn how to identify and fix concurrency pitfalls.

2. Gameplay

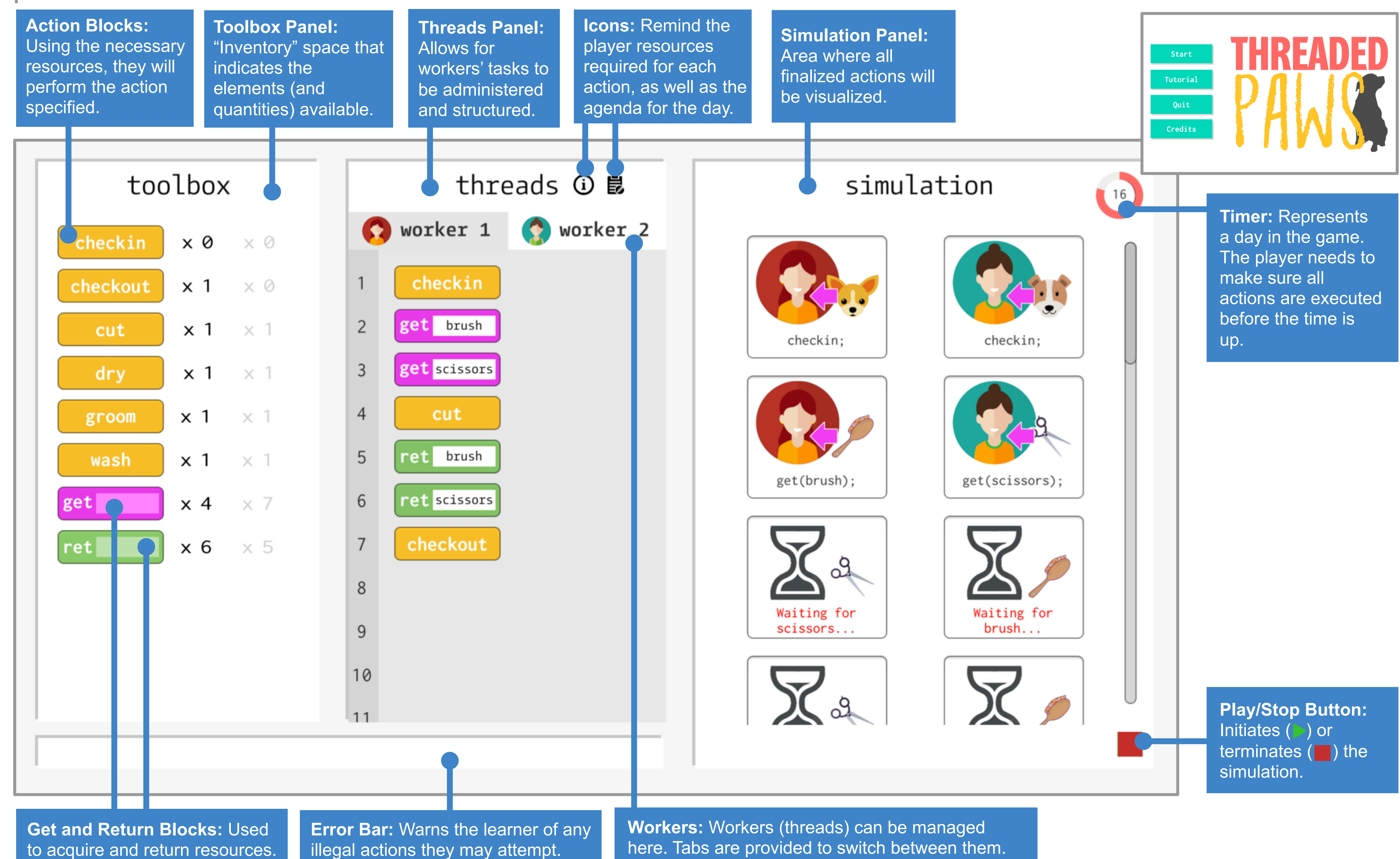
- In **Threaded Paws** [3], the learner assumes the role of manager at a dog grooming salon, where they need to coordinate the workers to attend to all incoming customers before the day ends.
- Within the game, each worker can concurrently perform tasks (e.g. grooming, washing) as well as acquire resources (e.g. brush, shampoo). Pitfalls can occur when the workers don't correctly coordinate.
- The player can initiate a simulation of a complete day at the dog grooming salon in order to check if all tasks have been completed successfully.

3. Level Breakdown

Level	Description
1	Introduces gameplay using a task involving one worker (sequential execution).
2	Introduces the starvation pitfall by providing a two-worker scenario that must be fixed.
3	Introduces the deadlock pitfall by providing a two-worker scenario that must be fixed.



4. Interface



5. Conclusions and Future Work

- Threaded Paws** is a serious game designed to facilitate the learning process with respect to concurrency. Each level aims to assist learners in understanding how to identify and fix a specific concurrency pitfall.
- Does **Threaded Paws** improve learning? In order to answer this question, we next plan to conduct a user study. It's important to know if there are any significant benefits in using Threaded Paws in comparison to more traditional methods.
- Additional future work includes:
 - Design new levels for additional concurrency pitfalls (e.g. data races).
 - Add a hint system to provide suggestions and reduce frustration.
 - Improve replayability through level data generation.

6. References

- [1] J. Yang, M. Cui, J. Wu, Y. Tang, and G. Hu, "Making parallel programs reliable with stable multithreading," *Communications of the ACM*, vol. 57, no. 3, pp. 58–69, 2014.
- [2] W. S. Yue and W. L. Wan, "The effectiveness of digital game for introductory programming concepts," *Proc. of ICITST 2015*, no. August, pp. 421–425, 2016.
- [3] Threaded Paws. website: <http://www.sqrlab.ca/software/threadedpaws/>