Threaded Paws: A Serious Game for Learning the Pitfalls of Concurrent Programming

Luisa Rojas Garcia • **Jeremy S. Bradbury** • **Michael A. Miljanovic**
Faculty of Science • **University of Ontario Institute of Technology** • **Oshawa, Ontario, Canada**
{luisa.rojasgarcia, jeremy.bradbury, michael.miljanovic}@uoit.ca

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].

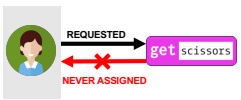
Research Goal:
Develop a serious game that allows students to learn how to identify and fix concurrency pitfalls.

2. Gameplay

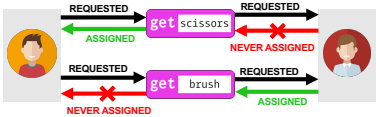
- In **Threaded Paws** [3], the learner assumes the role of manager at a dog grooming salon, where they need to coordinate the workers to attend to all incoming customers before the day ends.
- Within the game, each worker can concurrently perform tasks (e.g. grooming, washing) as well as acquire resources (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.

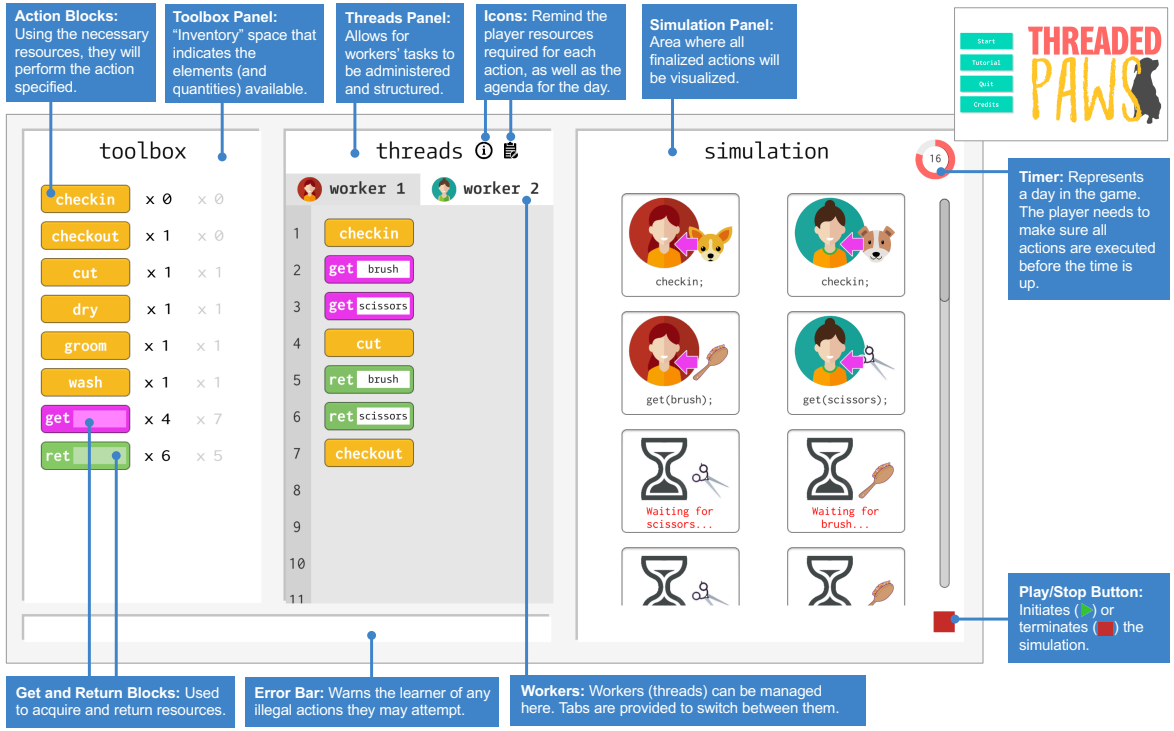


Starvation



Deadlock

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/

CASCON 2017 Technology Expo • Markham, Ontario, Canada • November 2017

Funding provided by: NSERC CRSNG