Software Verification Through Gamification
Chun Chan, Caroline Sih, Dan Mu, Priyal Suneja
Advisors: Sorin Lerner, William Griswold, Massimiliano Menarini

Background
Software verification is a bullet proof method to ensure that a piece of software has no bugs. The gamification approach to software verification includes building a game that helps verify software through user play. It is more reliable and cheaper than automation, but requires more people. Bounov et al. developed INVgame, where players inexperienced in software verification can identify loop invariants by entering solutions to the levels. The main drawbacks of INVgame included low user ratings on enjoyment, UI design, and accessibility.

Evaluation and Results
We evaluated our game by comparing it to the single player game. Our participant pool included 8 undergraduate students from 3 different majors.
• The average rating for the single player game was a 3.25/5 while the average rating for the multiplayer version was 3.75/5.

What is a Loop Invariant?
A loop invariant is some condition that is true for every iteration of the loop.

Example: i + j == 5 (strong) and j >= 0 (weak)

The game aims to verify loops present in software by getting users to generate loop invariants like these given variable values.

Motivation and Our Work
Our work is motivated by the lack of users for INVgame.

The main improvements to the game have been switching the platform from Facebook to a mobile game and introducing a multiplayer mode. We anticipate that the competitive element will increase the number of invariants generated by users. We used Unity 2D and C# to develop this application.

Future Plans
We have currently evaluated the effect of multiplayer on the quantity of invariants entered by the players. The next step would be to study the effect on the quality of invariants generated.

Acknowledgements
We’d like to thank our research advisors Massimiliano Menarini, William G. Griswold, and Sorin Lerner for their constant guidance and support. We’d also like to thank the Early Research Scholars’ Program, Christine Alvarado, and Vignesh Gokul for providing us with this opportunity. This material is based on Inventing Loop Invariants Through Gamification by Dimitar Bounov. This work was funded by National Science Foundation Grant #1423517.