# Developing Computational Methods to Measure and Track Learners' Spatial Reasoning in an Open-Ended Simulation

Aditi Mallavarapu
University of Illinois at Chicago
amalla5@uic.edu

Leilah Lyons
University of Illinois at Chicago
llyons@uic.edu

Tia Shelley
University of Illinois at Chicago
tshell2@uic.edu

Brian Slattery
University of Illinois at Chicago
bslatt2@uic.edu

Moira Zellner
University of Illinois at Chicago
mzellner@uic.edu

Emily Minor
University of Illinois at Chicago
eminor@uic.edu

## ABSTRACT

Interactive learning environments can provide learners with opportunities to explore rich, real-world problem spaces, but the nature of these problem spaces can make assessing learner progress difficult. Such assessment can be useful for providing formative and summative feedback to the learners, to educators, and to the designers of the environments. This work adds to a growing body of research that is applying EDM techniques to more open-ended problem spaces.

The open-ended problem space under study here is an environmental science simulation. Learners were confronted with the real-world challenge of effectively placing green infrastructure in an urban neighborhood to reduce surface flooding. Learners could try out different spatial arrangements of green infrastructure and use the simulation to test each solution's impact on flooding. The learners' solutions and the solutions' performances were logged during a controlled experiment with different user interface designs for the simulation. As with many open-problem spaces, analyzing this data was difficult due to the large state space, many good solutions, and many alternate paths to those good solutions.

This work proposes a procedure for reducing the state space of solutions defined by spatial patterns while maintaining their critical spatial properties. Spatial reasoning problems are a problem class not yet examined by EDM, so this work sets the stage for further research in this area. This work also details a procedure for discovering effective spatial strategies and solution paths, and demonstrates how this information can be used to give formative feedback to the designers of the interactive learning environment.