

# GAME-CHANGING

## Fast Dynamic Updates in a Flexible Navigation Mesh

### LEVEL 1: OUTLINE

Games and simulations often use a **navigation mesh** to steer AI-driven characters through a virtual environment.

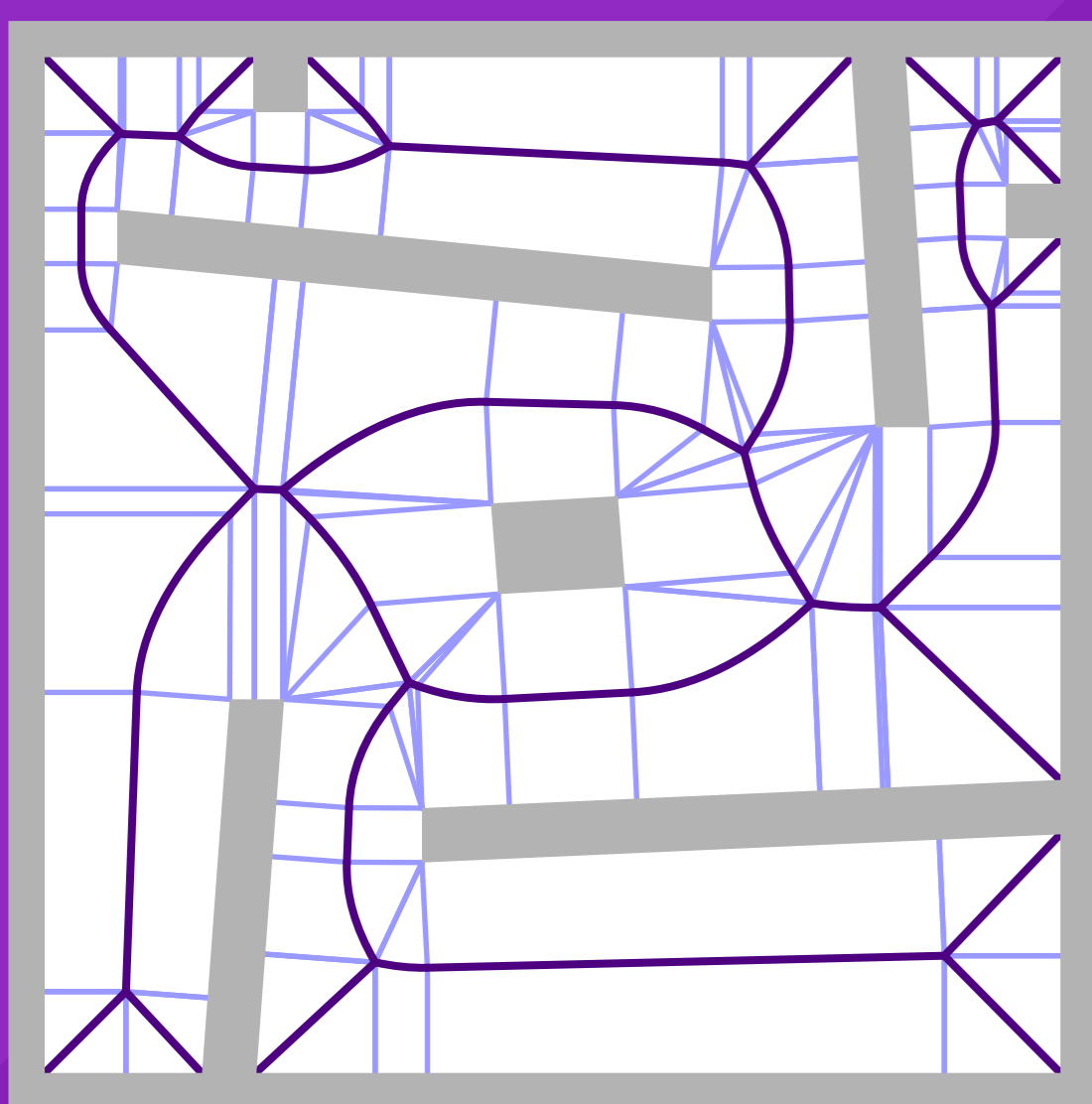
In **dynamic environments**, obstacles can appear, disappear, or move at runtime. When such an event occurs, the navigation mesh should be updated quickly, such that the characters can respond. Recomputing the mesh from scratch is too slow.

We present **real-time algorithms** for **local** insertions and deletions of obstacles in the Explicit Corridor Map (ECM) navigation mesh.

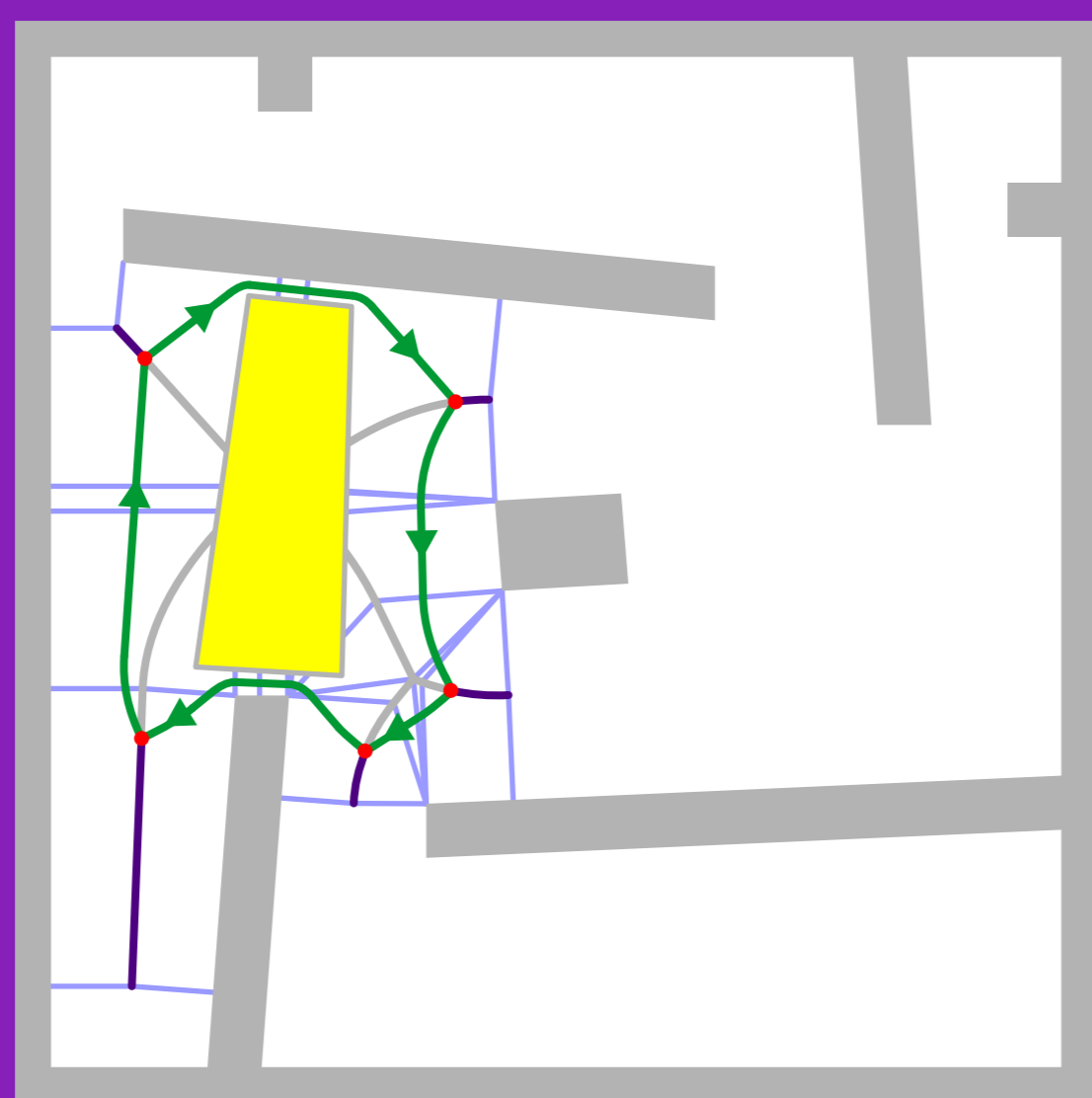


Photo: AP Photo/Skagit Valley Herald, Frank Varga. Published on www.pennlive.com, May 24 2013.

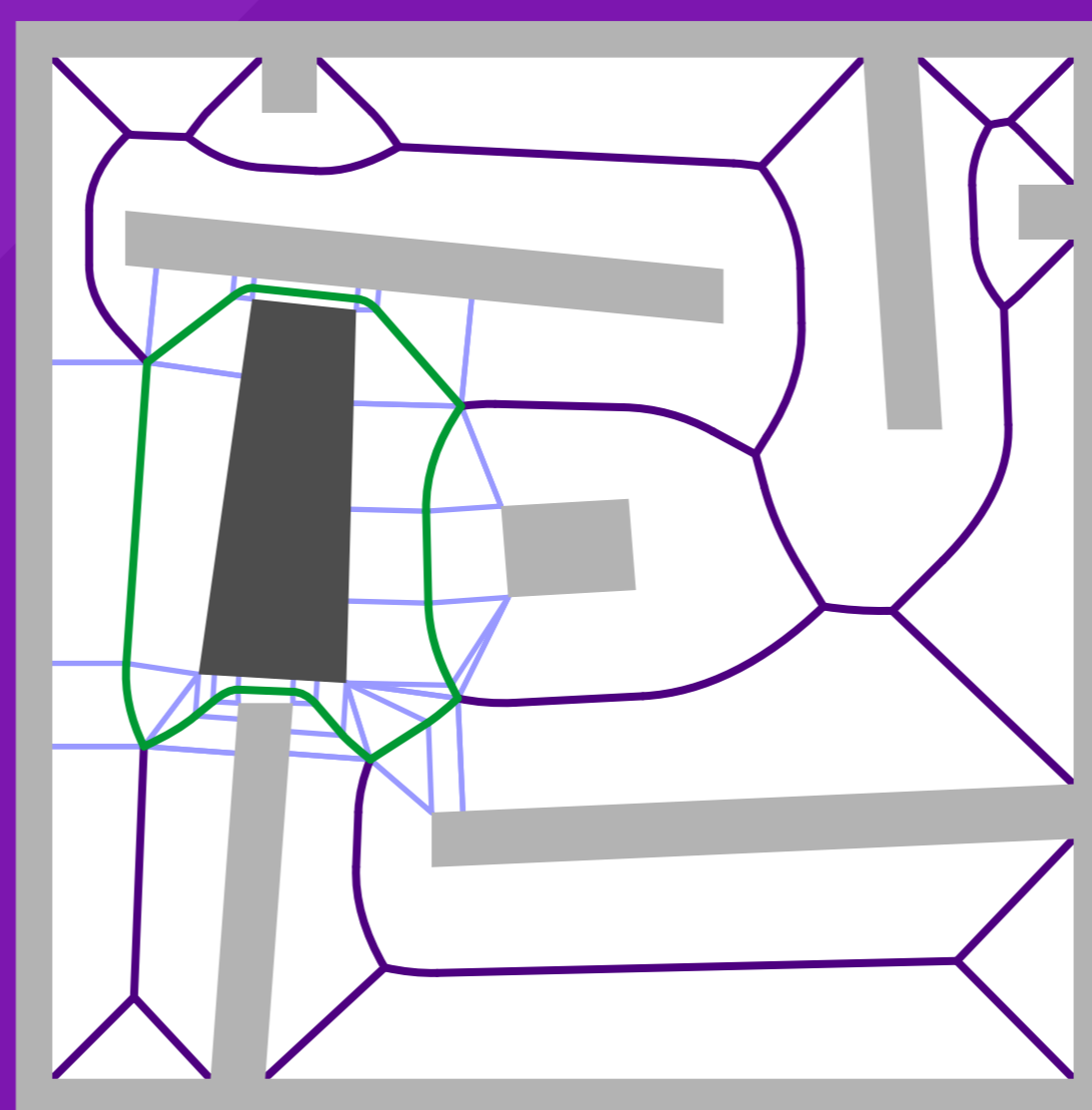
### LEVEL 2: INSERT



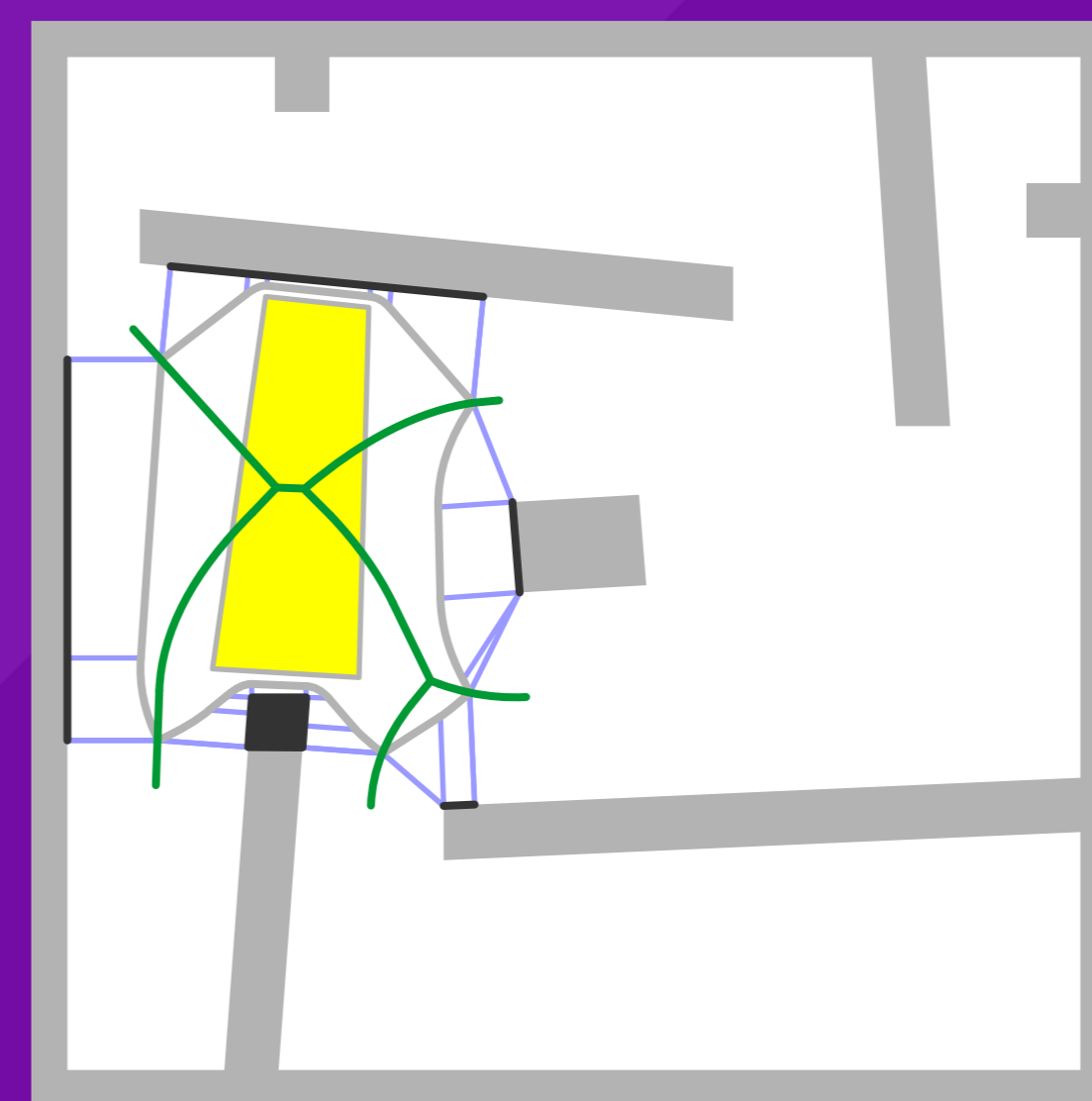
Explicit Corridor Map



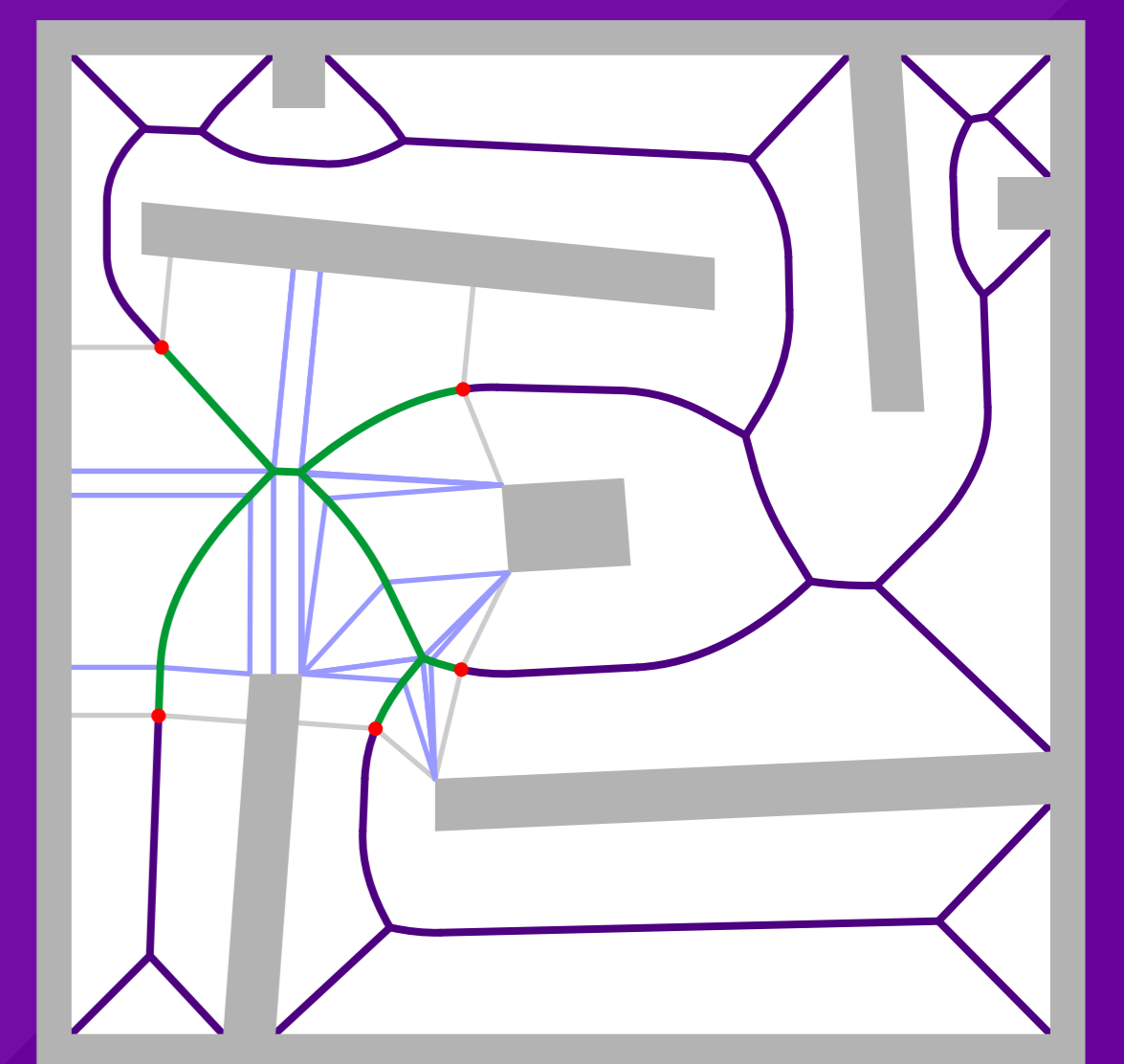
Obstacle insertion



ECM after insertion



Obstacle deletion

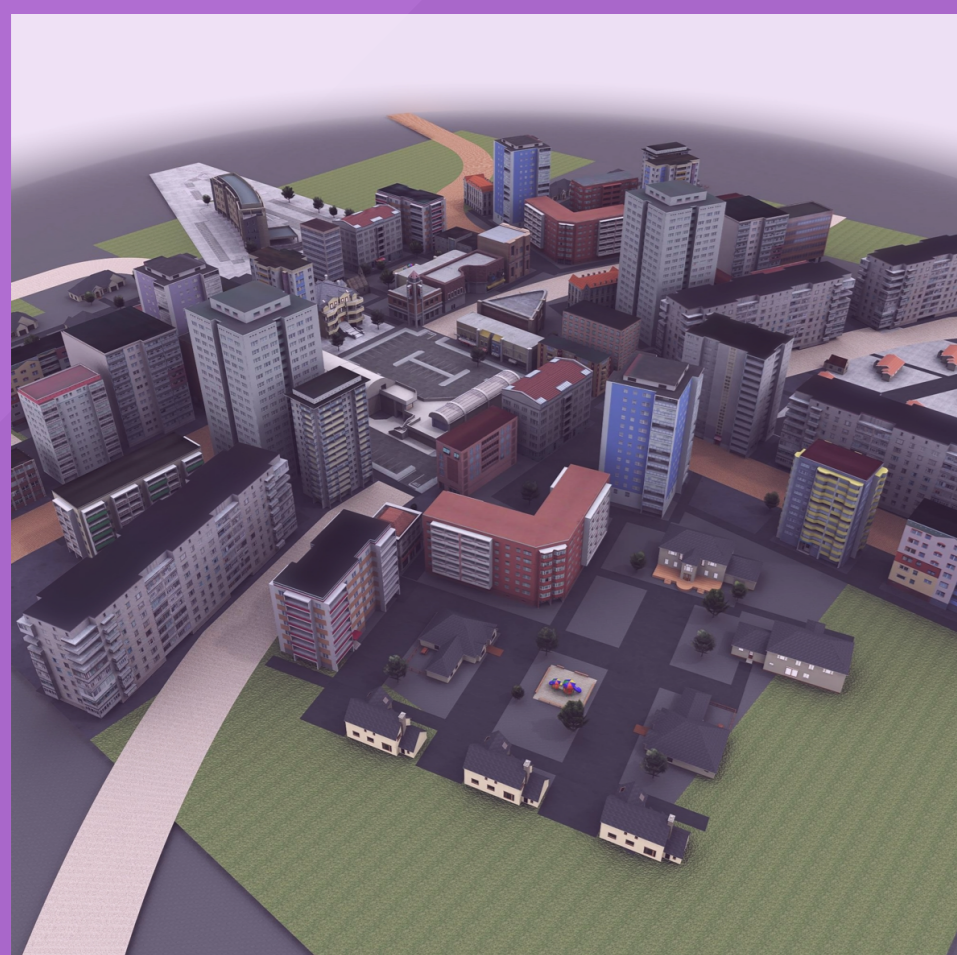


ECM after deletion

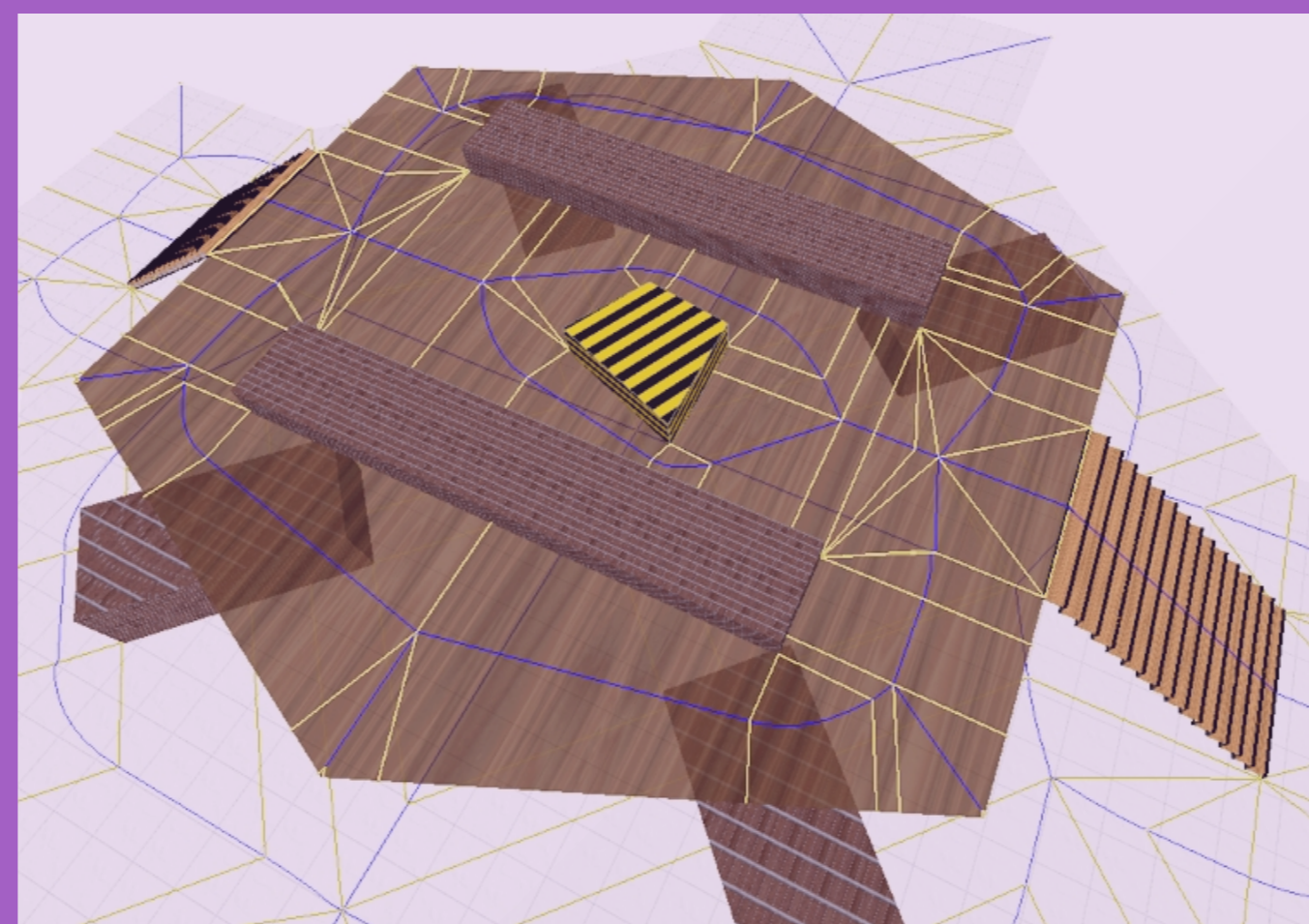
When an obstacle is **inserted**, we trace the new ECM edges around this obstacle, by traversing the existing graph and computing intersections.

When an obstacle is **deleted**, we find its neighbouring obstacles, compute the ECM for those neighbours, and stitch it into the main graph.

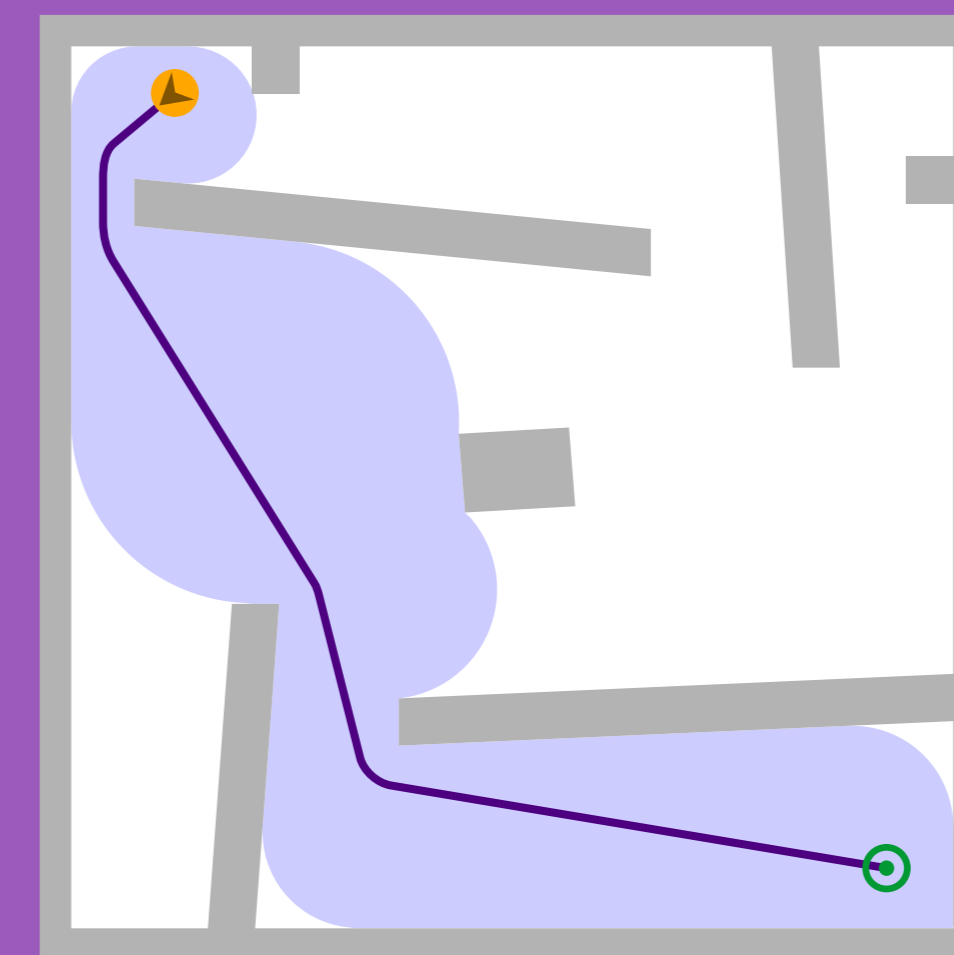
### LEVEL 4: RESULTS



Running times depend only on the affected area; **fast updates** (< 5 ms) in large environments



Dynamic obstacles in **multi-layered** (3D) environments



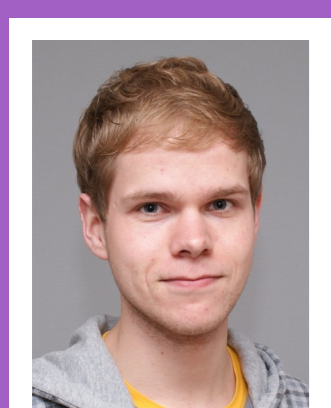
Responsive characters and efficient **re-planning** algorithms

### LEVEL 5: CROWD SIMULATION

**Crowd simulation** is used in games and in serious applications, e.g. for predicting the safety at crowd events, such as concerts or football matches. It is a crucial part of **crowd management**: simulating an event in advance may prevent accidents and disasters.

The **ECM framework** by Wouter van Toll and Roland Geraerts has been licensed by simulation companies for this purpose. Next to dynamic obstacles, our software simulates:

- characters with different sizes, preferences, and goals;
- smooth and efficient collision avoidance;
- tens of thousands of characters in real-time.



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