Fast LTL pathfinding in partially known environments

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Purpose
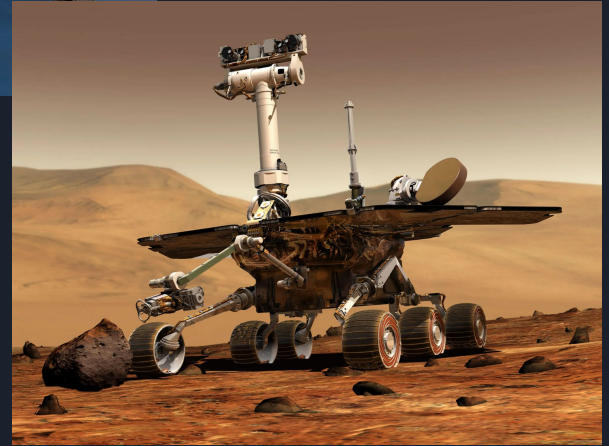

Defense Sector

- Tasked Agent
- Risky Combat Zones

Space Sector

- Detect and avoid risk
- Satellite imagery

Abstract
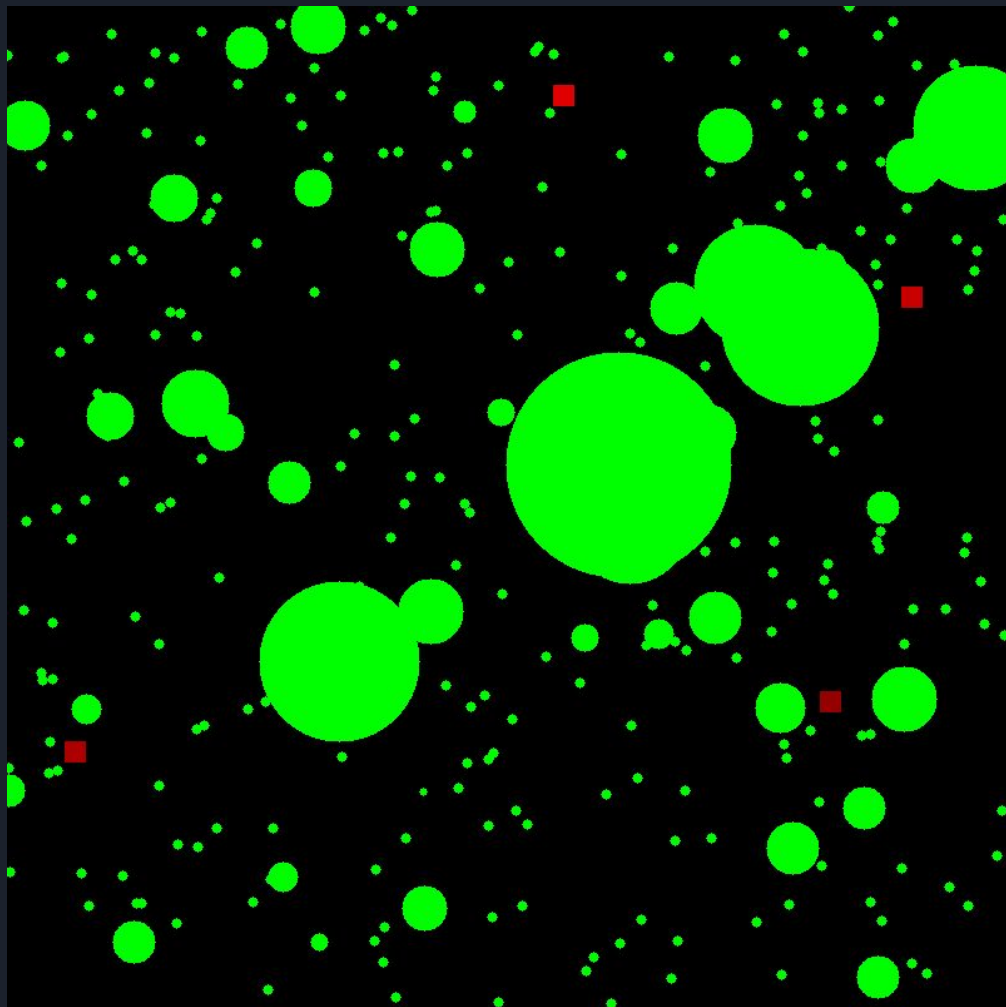
Agent

- Must complete task
- Must not crash

Risky Environment

Environment

- Risky objects (green)
  - Warhead craters
  - Debris
- LTL targets
  - Pickup areas
  - Temporary bases
  - Downed personnel
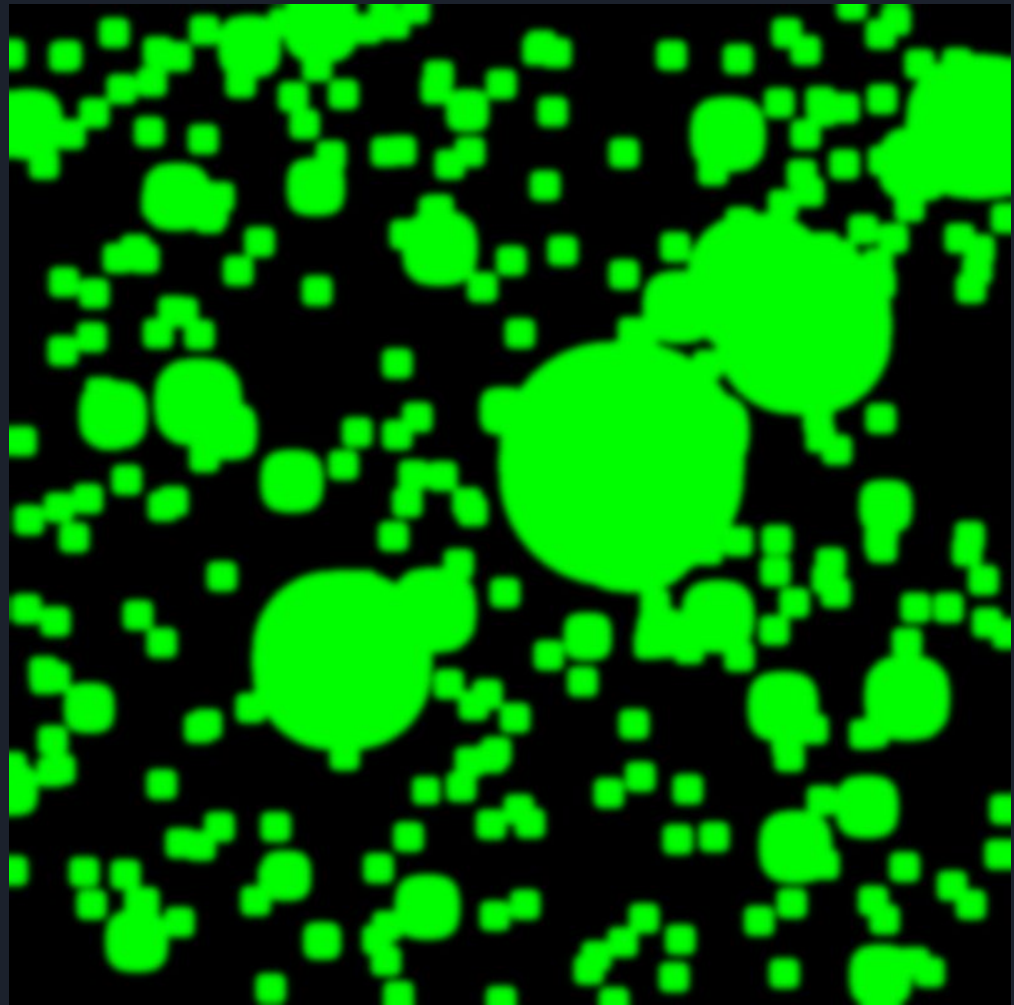 - Downed tanks
  - Drilling sites

Satellite Imagery

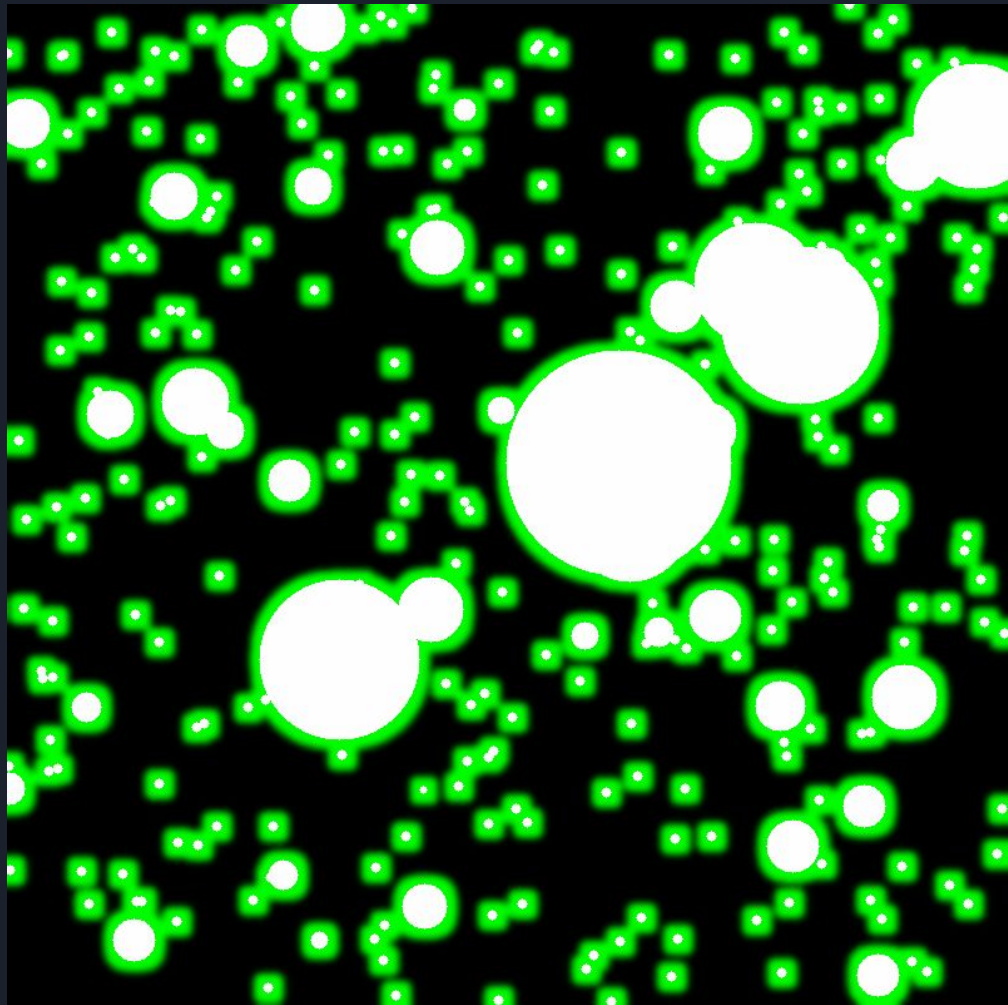In the real world, satellite imagery isn't at the best resolution

Risk must be assumed surrounding objects

Objects may have been moved by environment, other agents, or antagonists
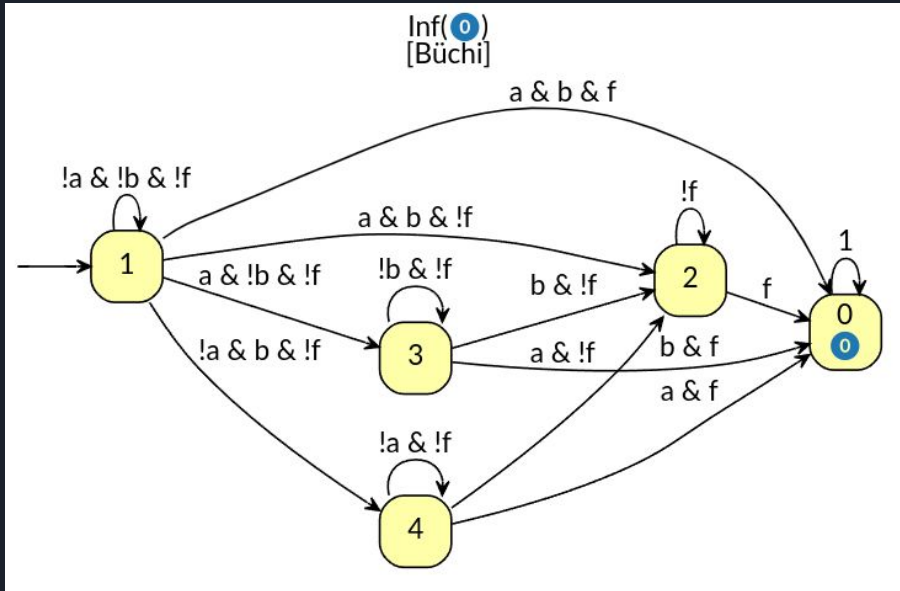
Satellite Imagery
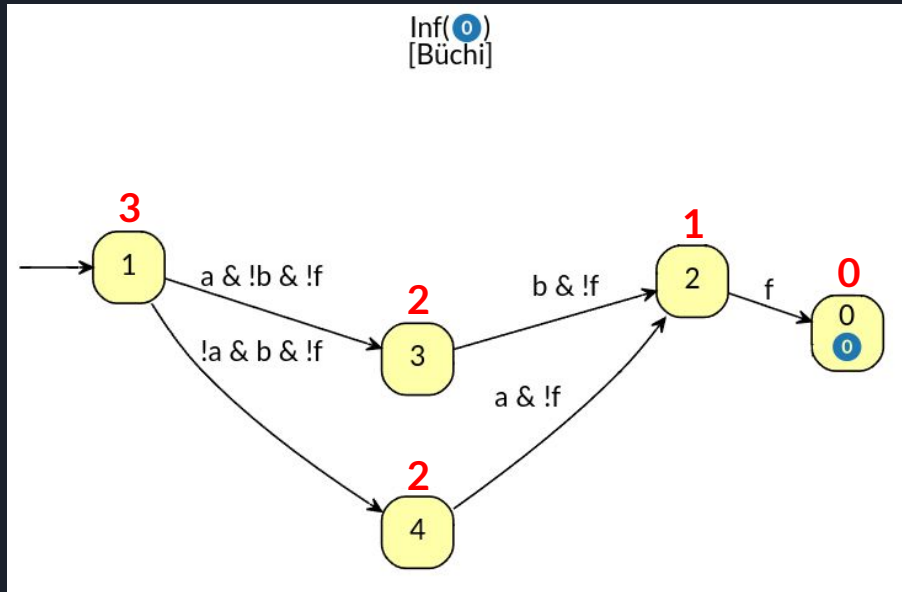
Task - Linear Temporal Logic

Ff & (!f U a) & (!f U b)

f, a, b are axioms

Can represent

- A physical location
- A intrinsic value
- A extrinsic value

LTL pathfinding

Ff & (!f U a) & (!f U b)

Heuristic Function

- Distance to accepting state

Multiple transition axioms are ignored in the slides for brevity

Better h-functions exist, which will be discussed later as its not programmatically finished
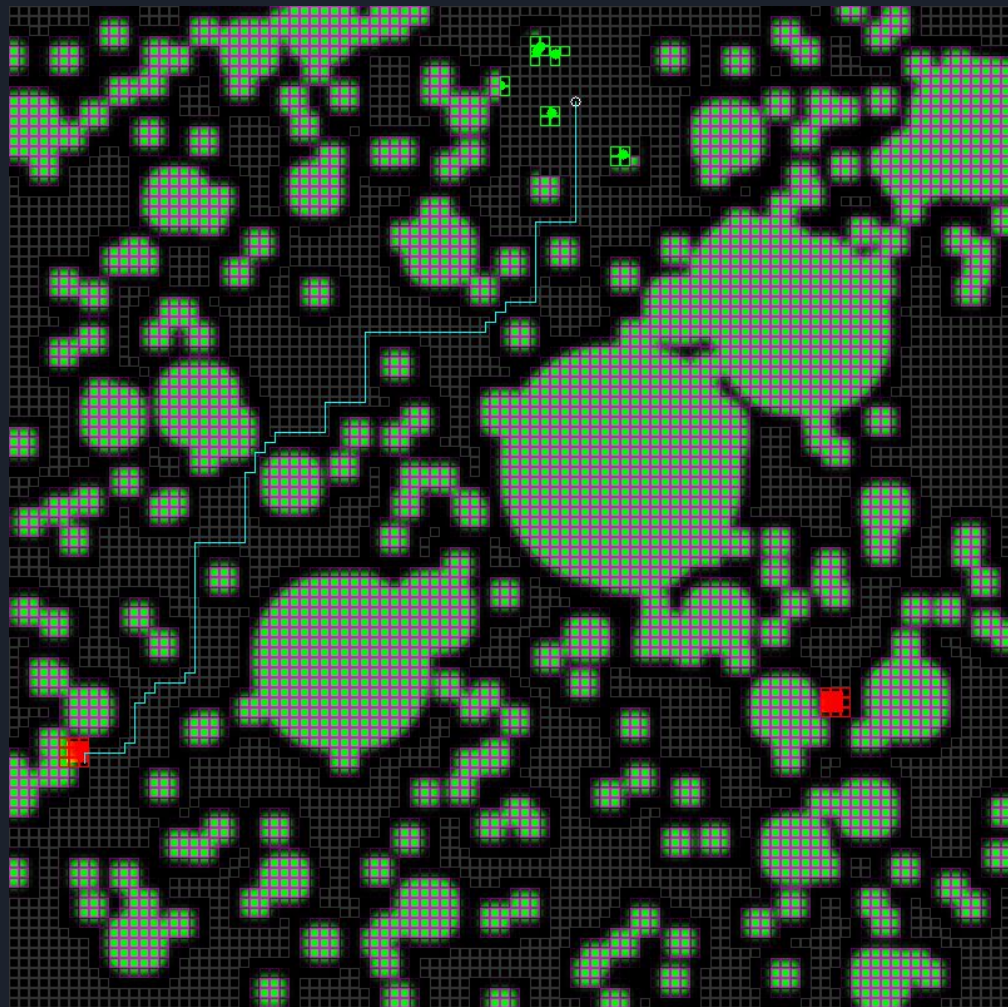
Pathfinding

a and b sites are possible

Both sites have equal LTL hfunc weight

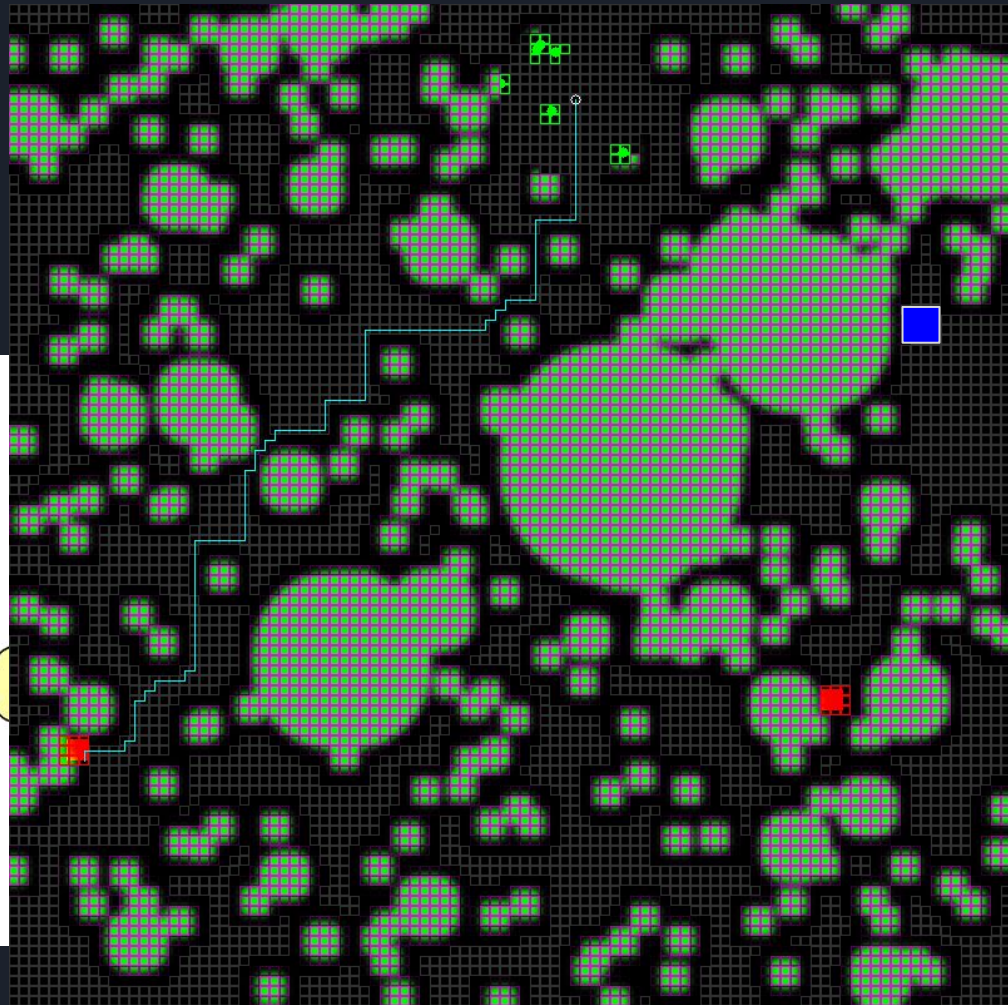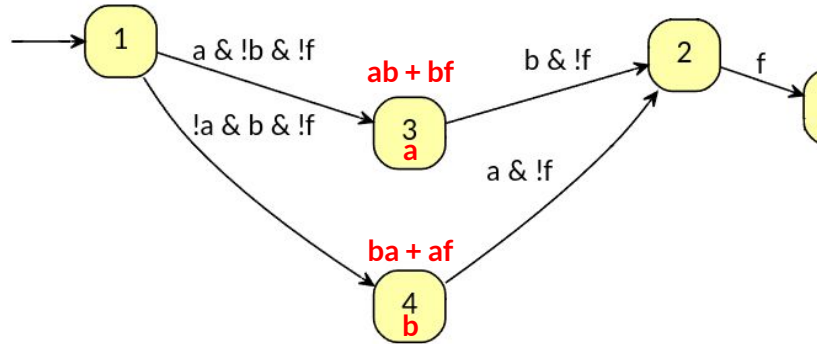Algo will choose one with shortest and least risky phys path

WIP: max cumulative risk

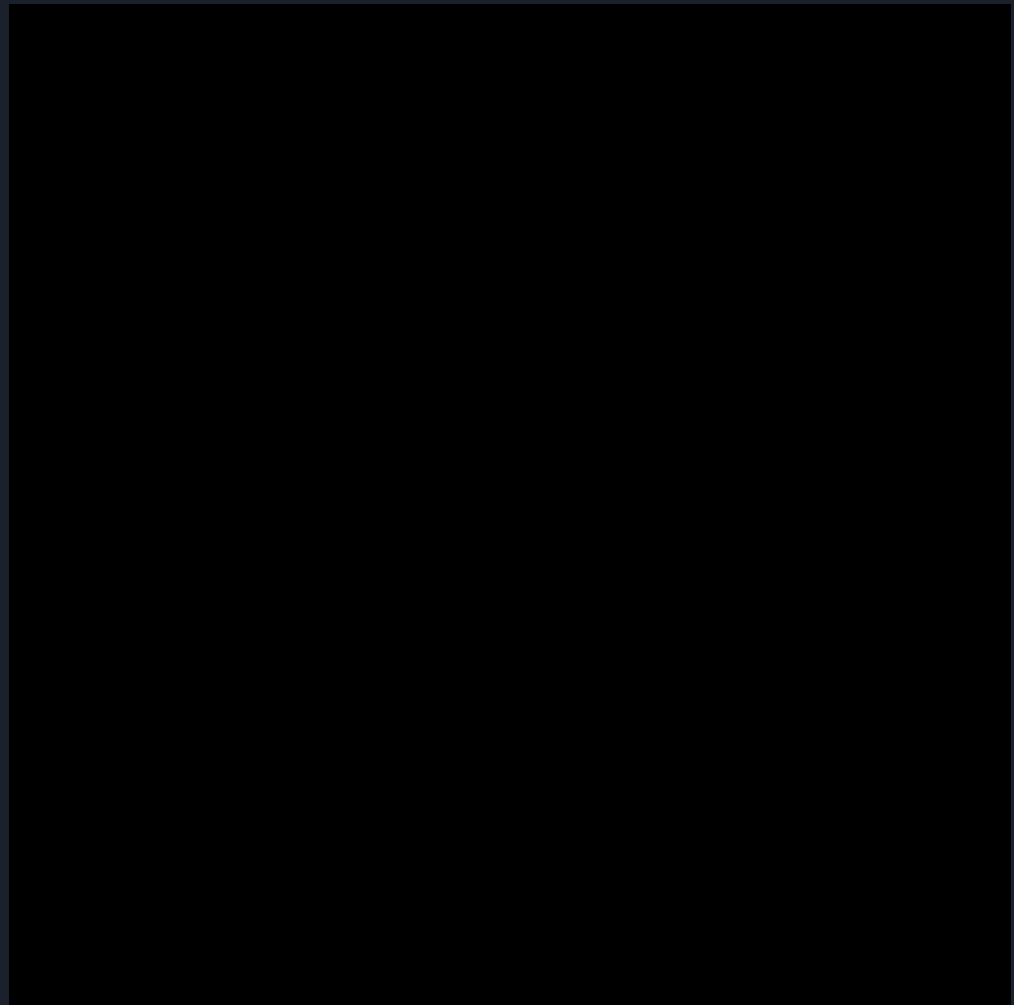WIP: max absolute risk

Pathfinding

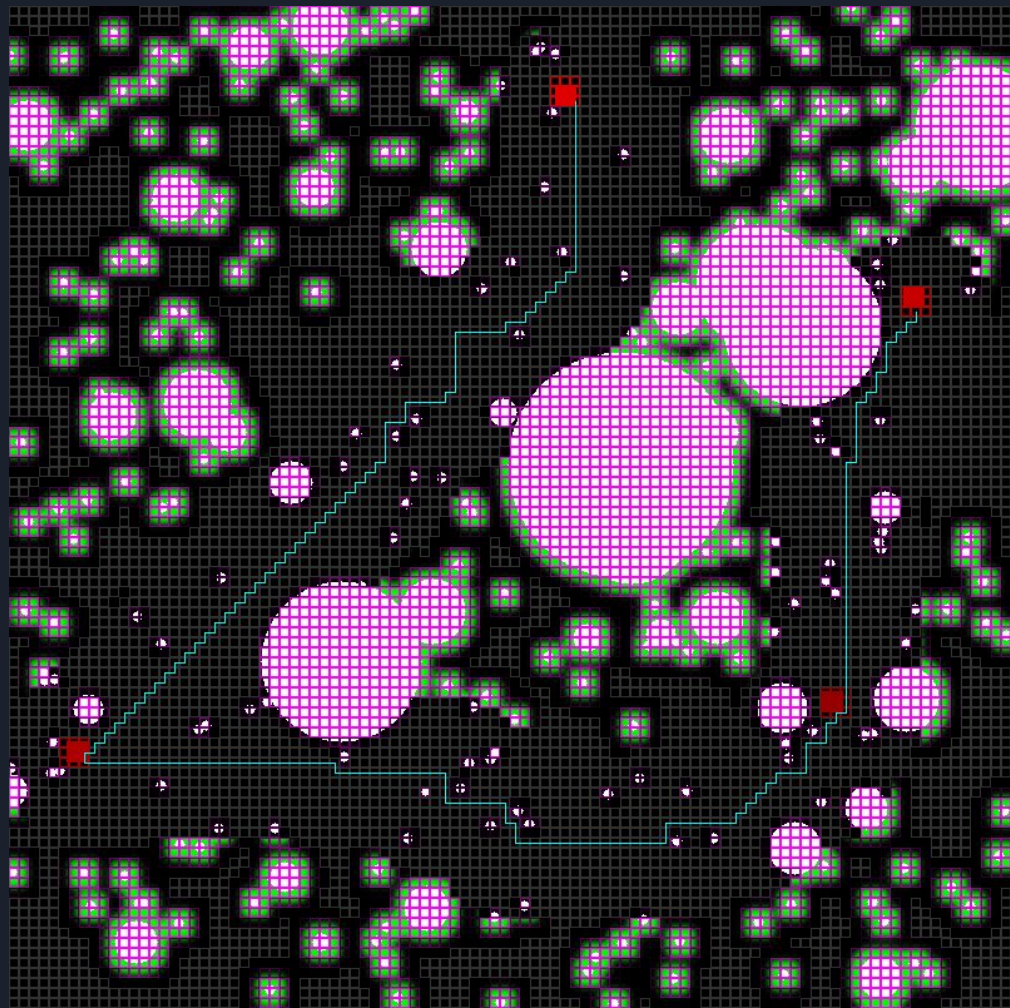## Ff & (!f U a) & (!f U b)

Pathfinding
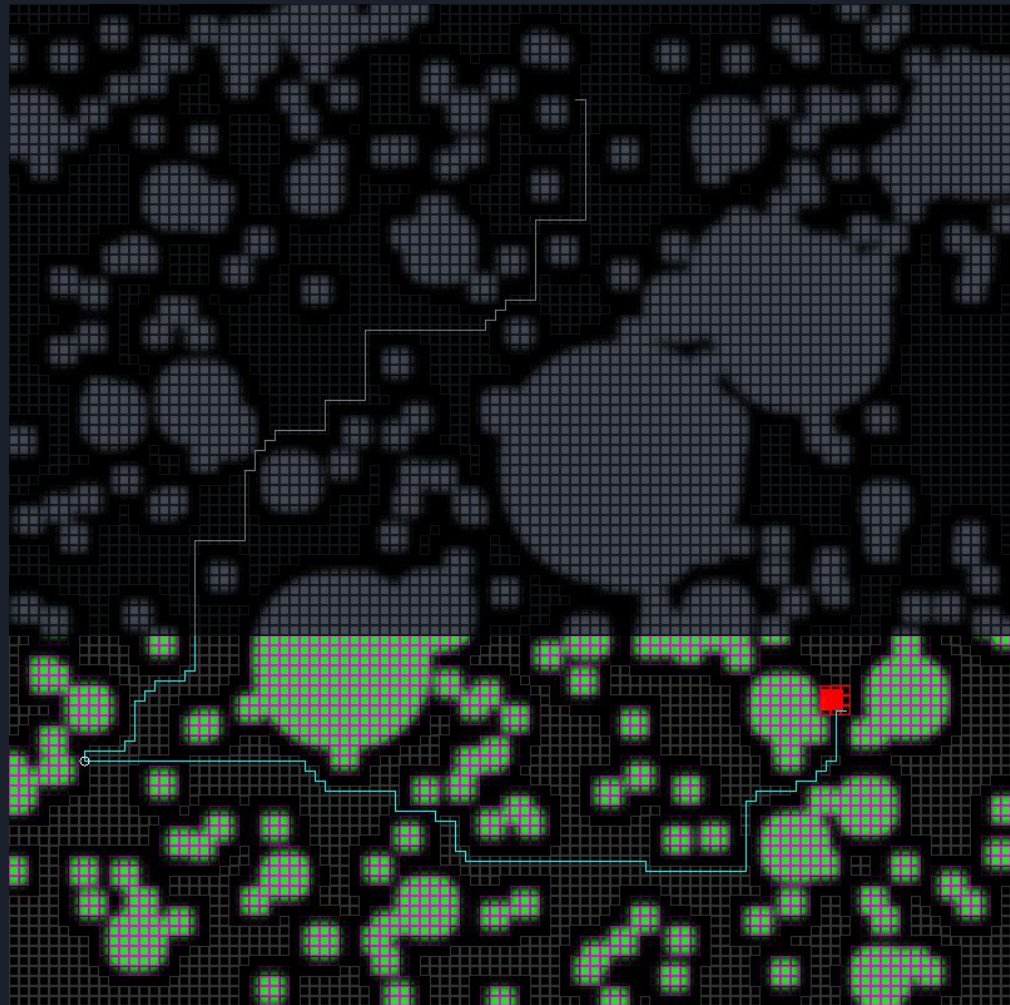
Dynamic Risk

Partial A* (WIP)

Pathfinding

Pathfinding
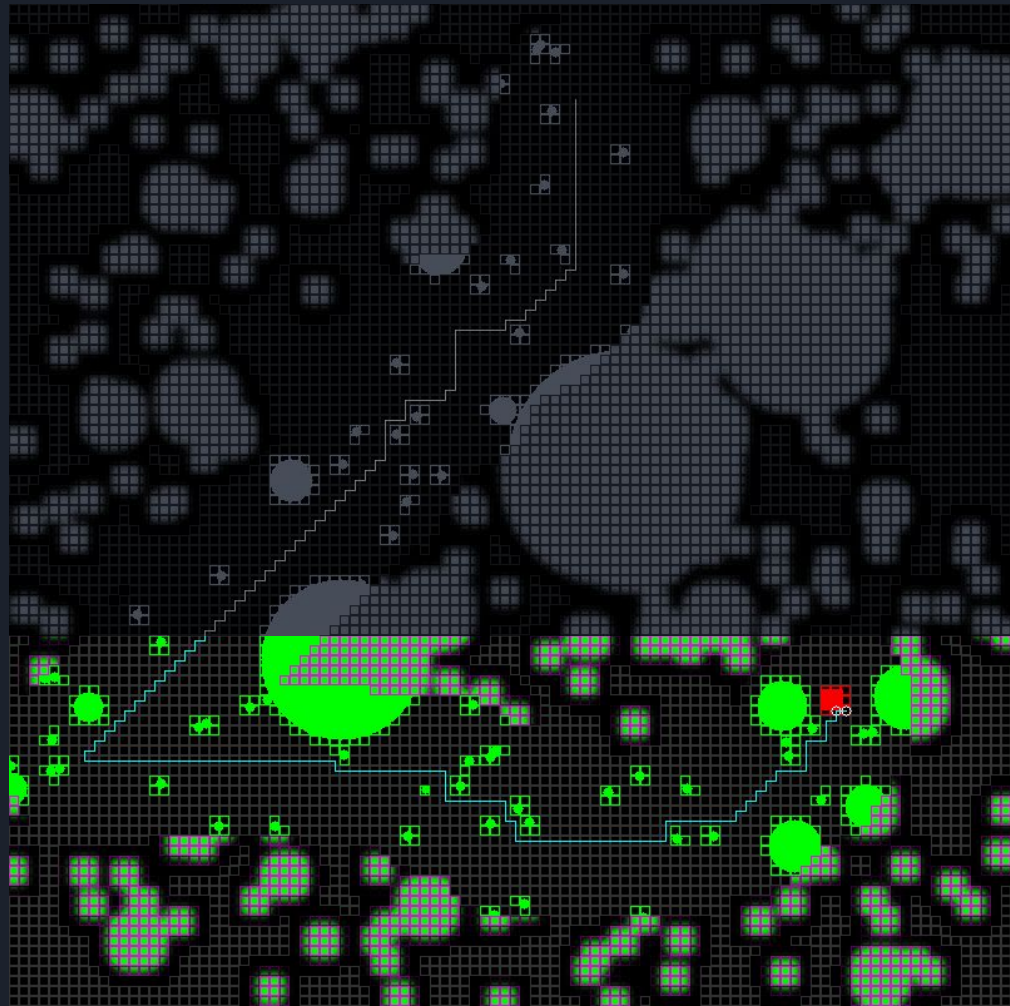
no risk updates
full astar

len: 104

Pathfinding
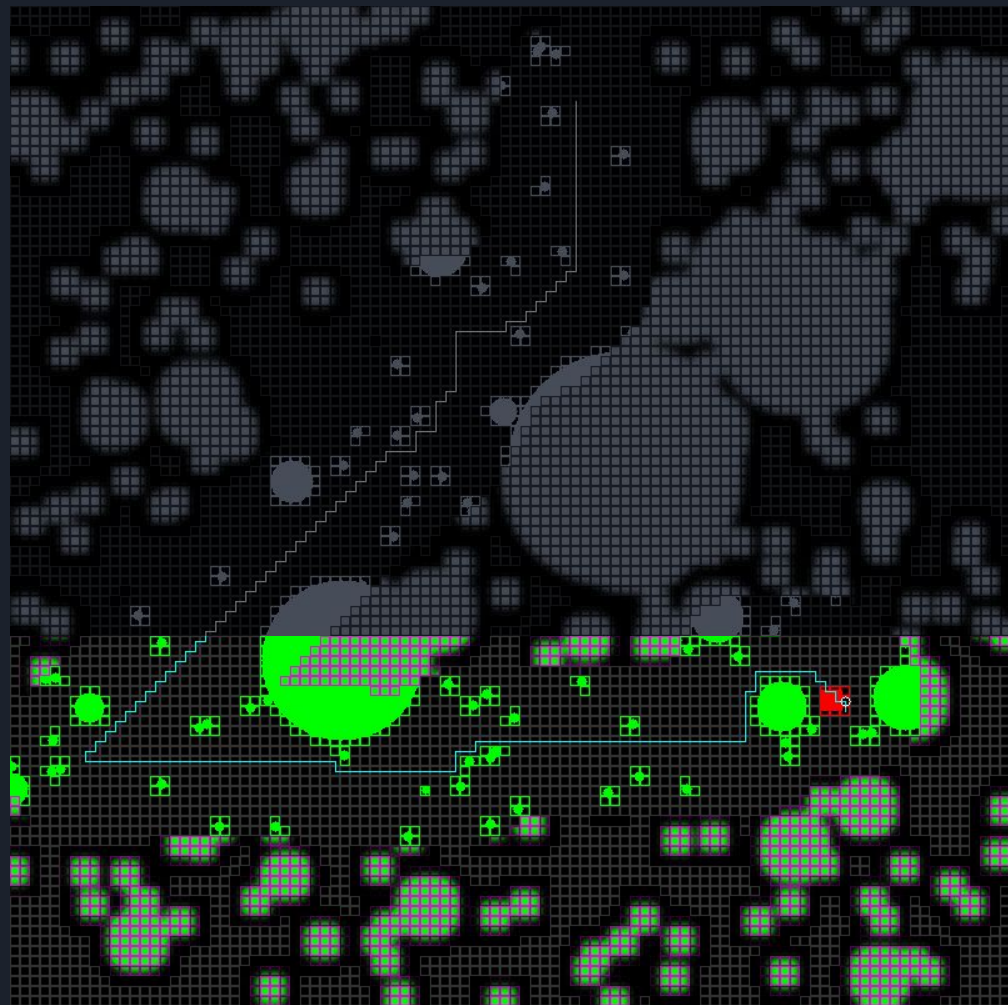
with risk updates partial astar

len: 98

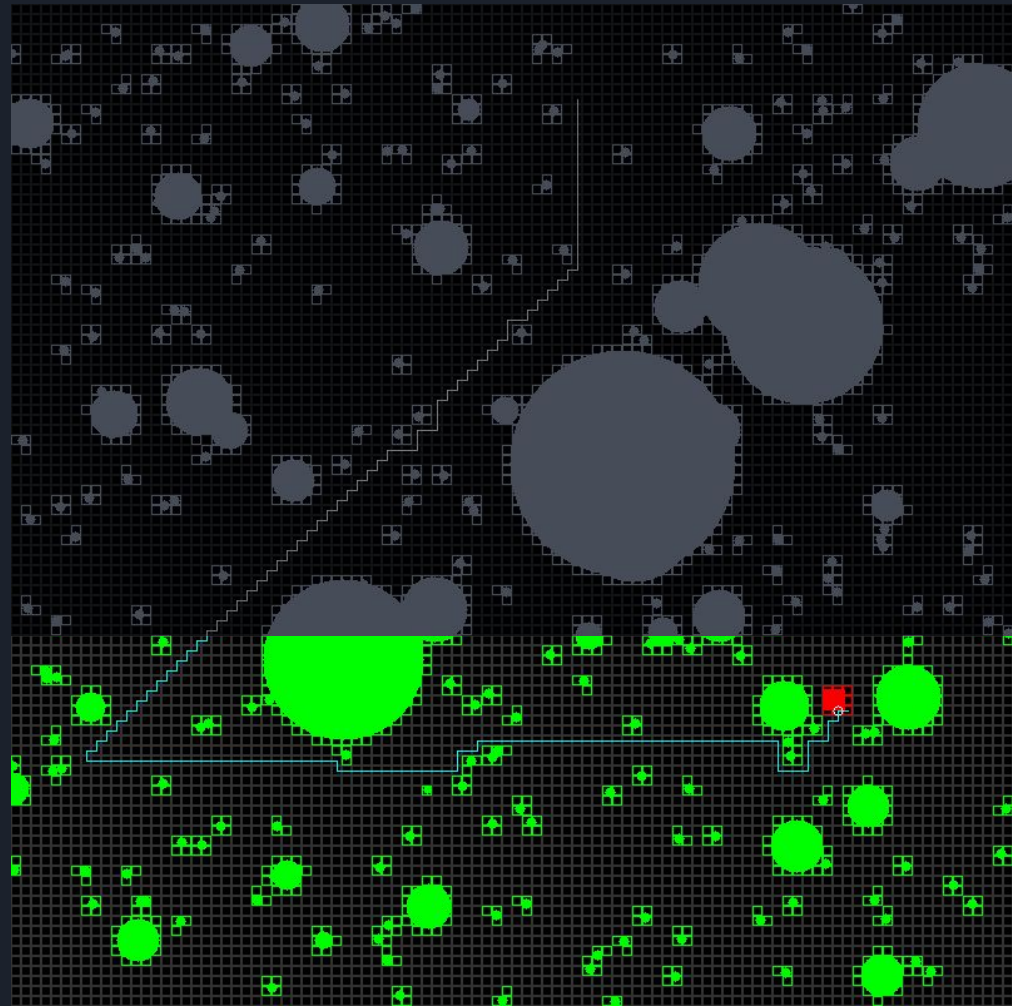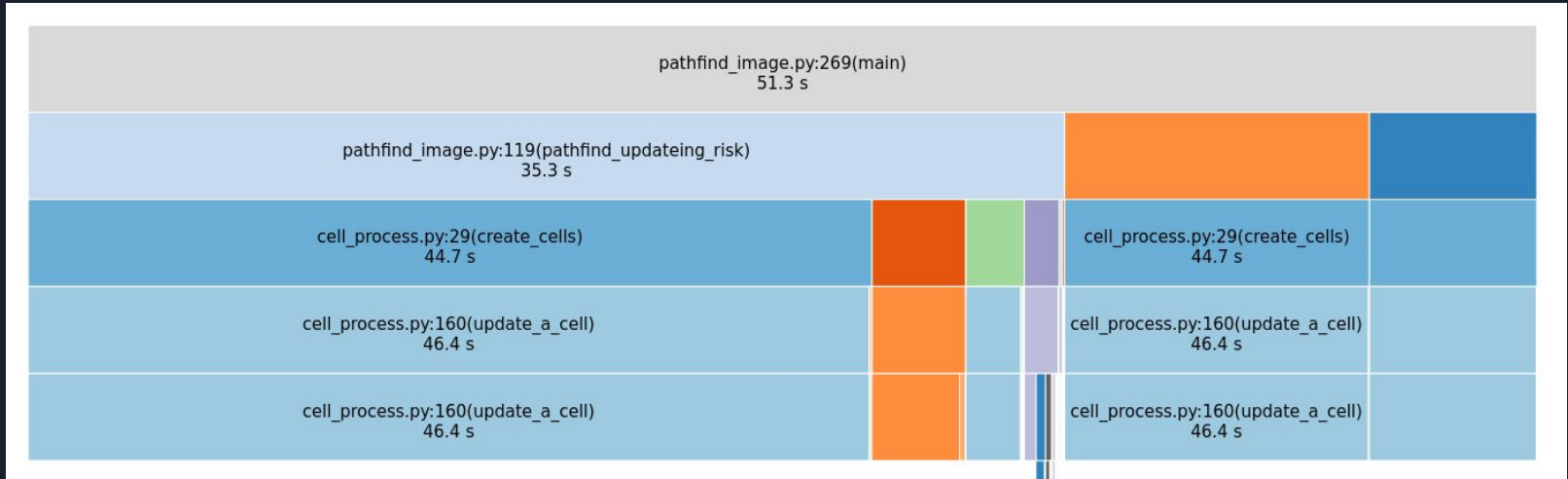# Pathfinding

with risk updates
full astar

len: 90

Pathfinding

no risk
full astar

len: 90

Timing

Timings on image are correct but misleading

Entire Script - 51.7s

Final Image Creation (debugging) - 10.4s

Algo - 41.3s

- Pre-processing - 35.8s
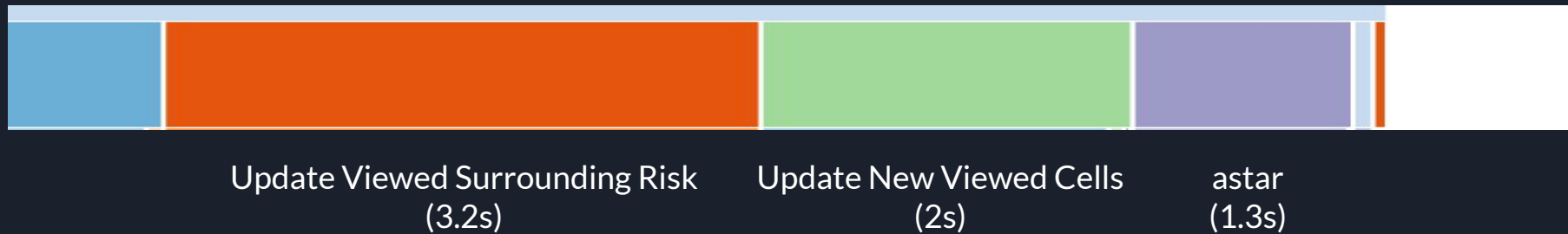- Updating risk - 5.1s
- Astar - 1.2s

Timing

Pathfinder algorithm   Create Final Path Image   Find LTL targets

Timing

pathfind_image.py:119(pathfind_updateing_risk)
35.3 s

cell_process.py:29(create_cells)
44.7 s

Extract Cells From
Satellite Image

Timing

Update Viewed Surrounding Risk (3.2s)

Update New Viewed Cells (2s)

astar (1.3s)

Questions?

Constructive Criticism?