Principles of Computer Game Design and Implementation

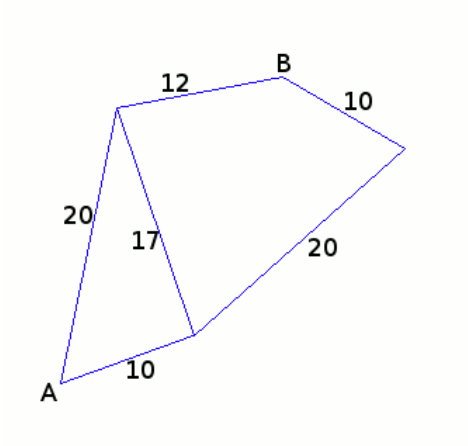
Lecture 28

Outline for today

- Pathfinding 2

Tackling Paths

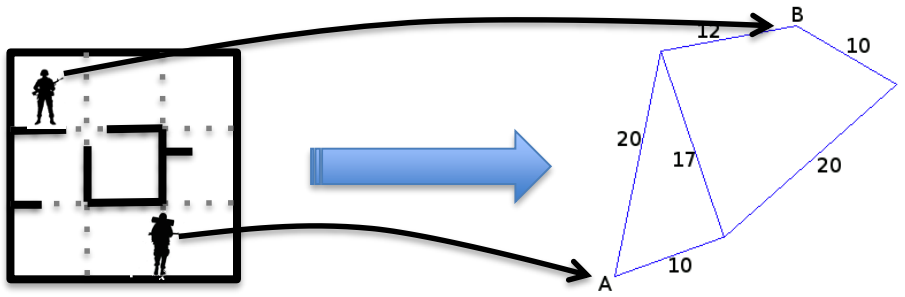
- Characters “live” in a computer world
  - Even developers may not know exact location
    - Physics simulations



- Pathfinders operate on discrete structures

World Representation

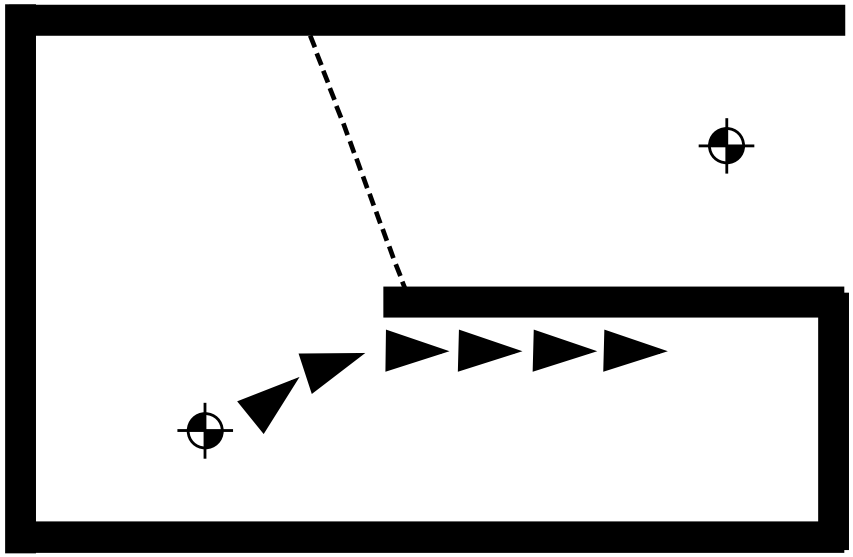
To use pathfinding



- Division Scheme
  - Quantisation and Localisation
    - Converting positions into nodes and back
  - Generation
    - Who and how define the mapping
  - Validity
    - Being able to fulfil the plan

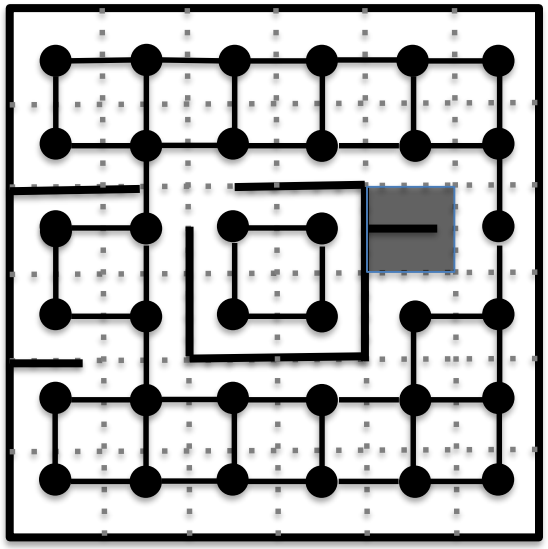
Bad Quantisation

- Errors in quantisation can lead to invalid plans



- Plans have to agree with steering

Tile-Based Graphs

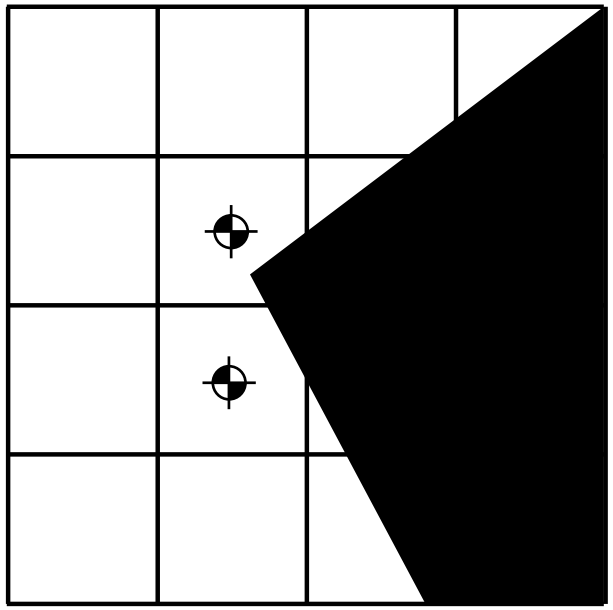


- `tileX = (int) (x/tileSize)`
  `tileY = (int) (y/tileSize)`

Works in square worlds

Tile-Based Graphs: Validity

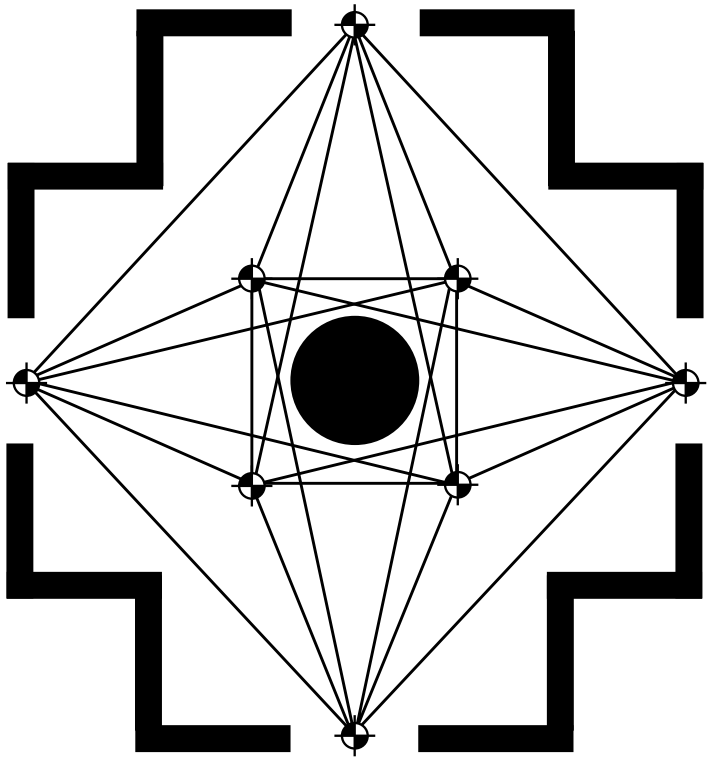
- If wall are not parallel to tiles
- Will steering succeed?
- Not widely used in 3D games



Waypoints

Locations on map + edges

- Identified by designers
- Computed automatically
  - Corner waypoints
  - Points of visibility

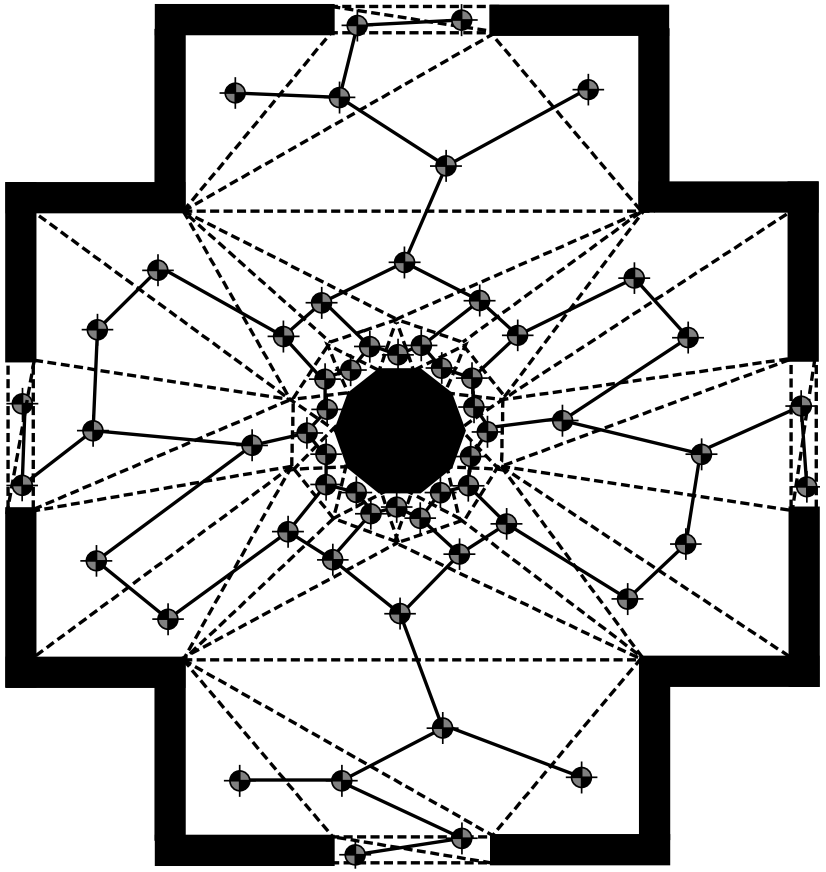


Popular game AI technique

- Half-life

Navigation Mashes

- In modern games models are built from polygons (triangles)

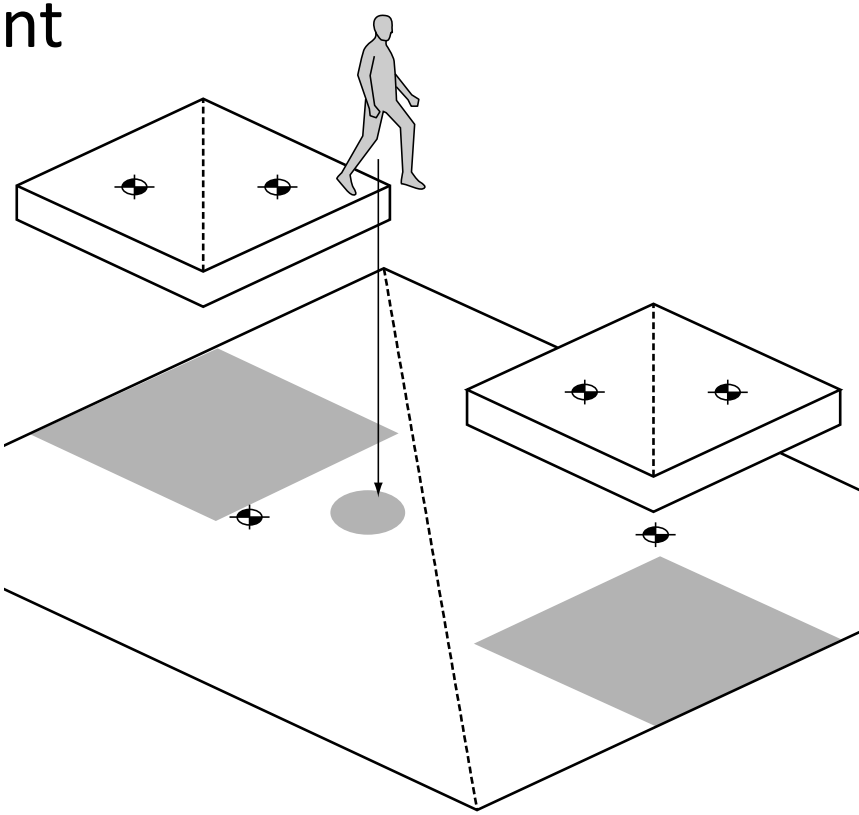


- A character can always pass between adjacent polygons

- Fully automated generation of graphs

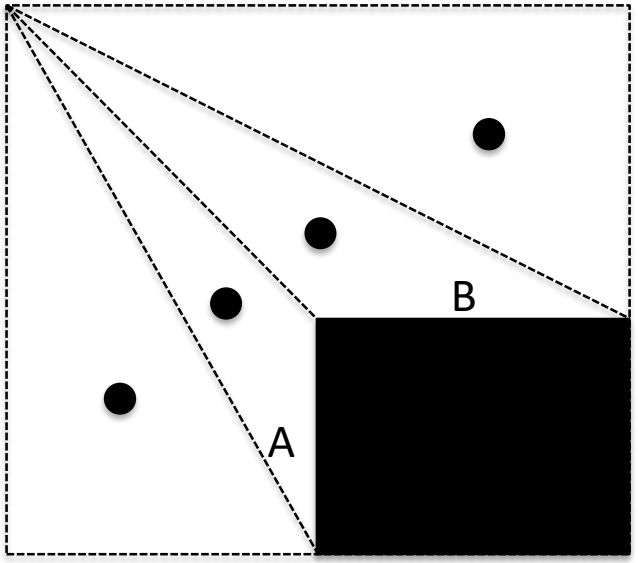
Correct Quantisation

- Several levels in the model
  - Take elevations into account when mapping to a graph node



Validity of Plans

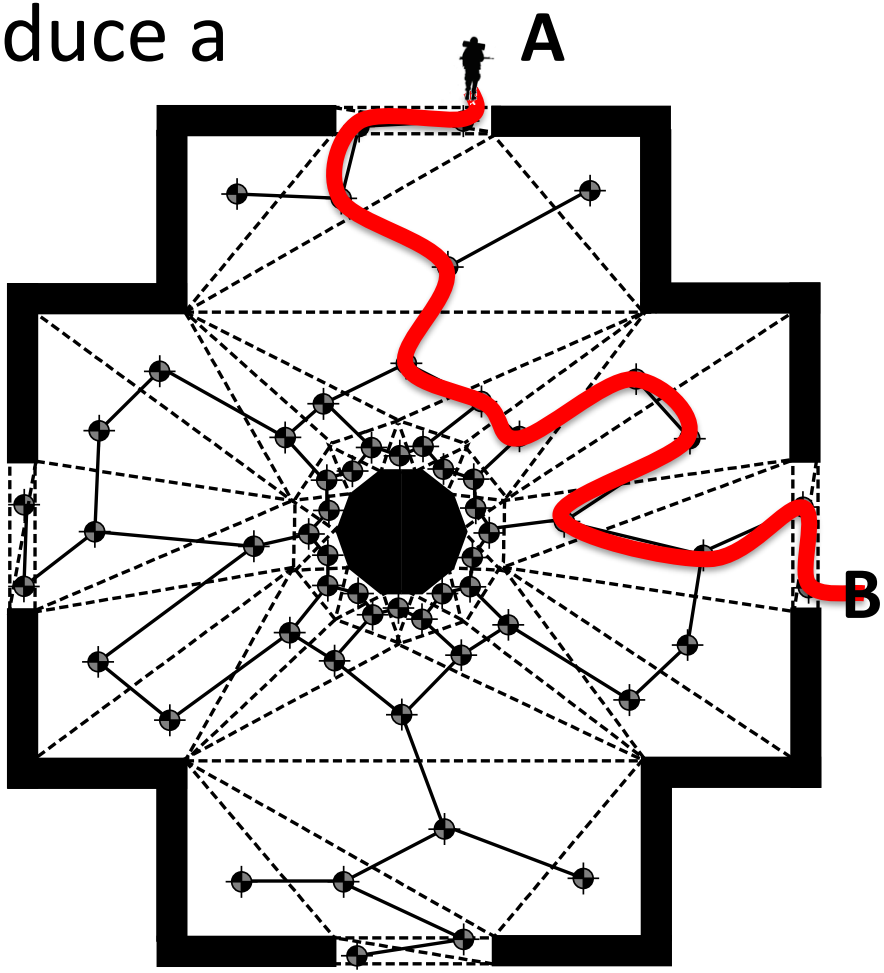
- Character can always pass between adjacent polygons
- No direct pass between A and B
- Floor plan is done by *designers* and they avoid this



Chunky Paths

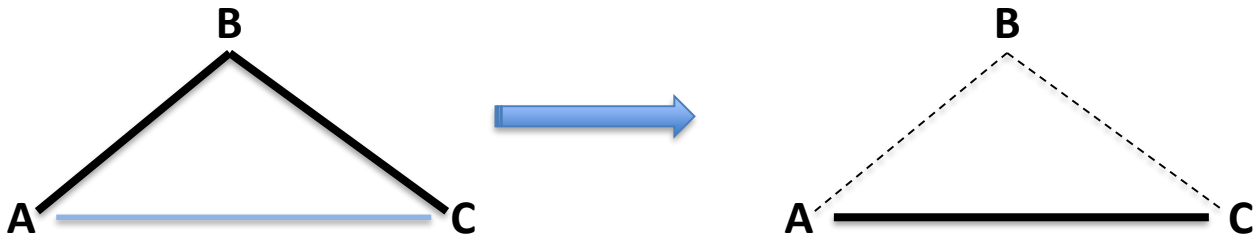
- Pathfinding may not produce a natural movement

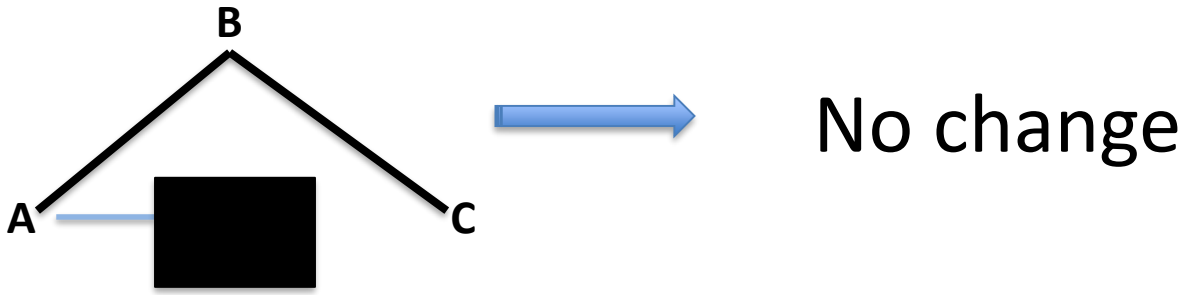
- After a path is found
  - It needs to be smoothed



String Pulling

- Move **A** – **B** – **C**
  - If **C** can be seen from **A**, drop **B**

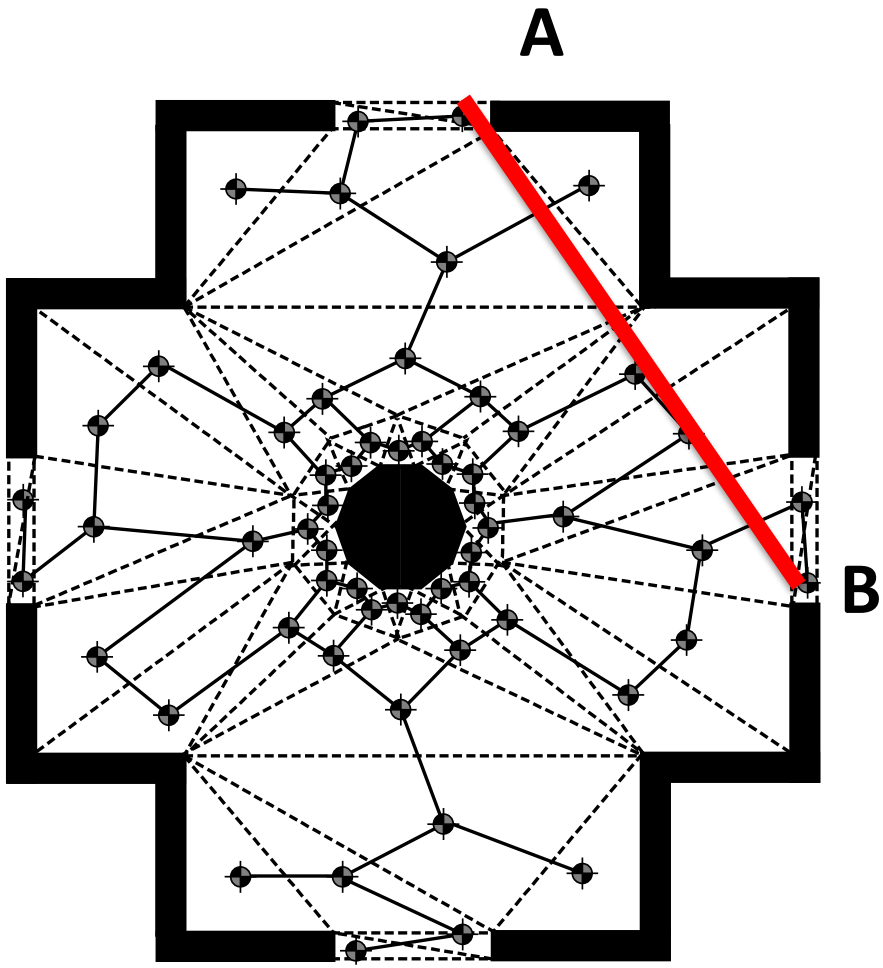




No change

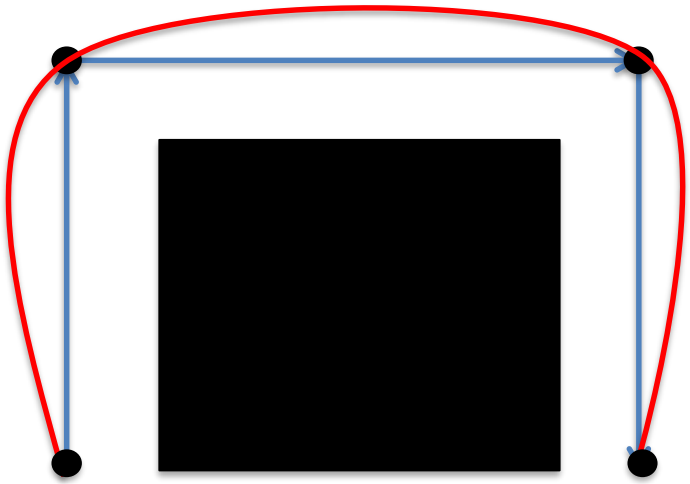
Example

- Extreme case
- Even if there are obstacles, string pulling gives better paths



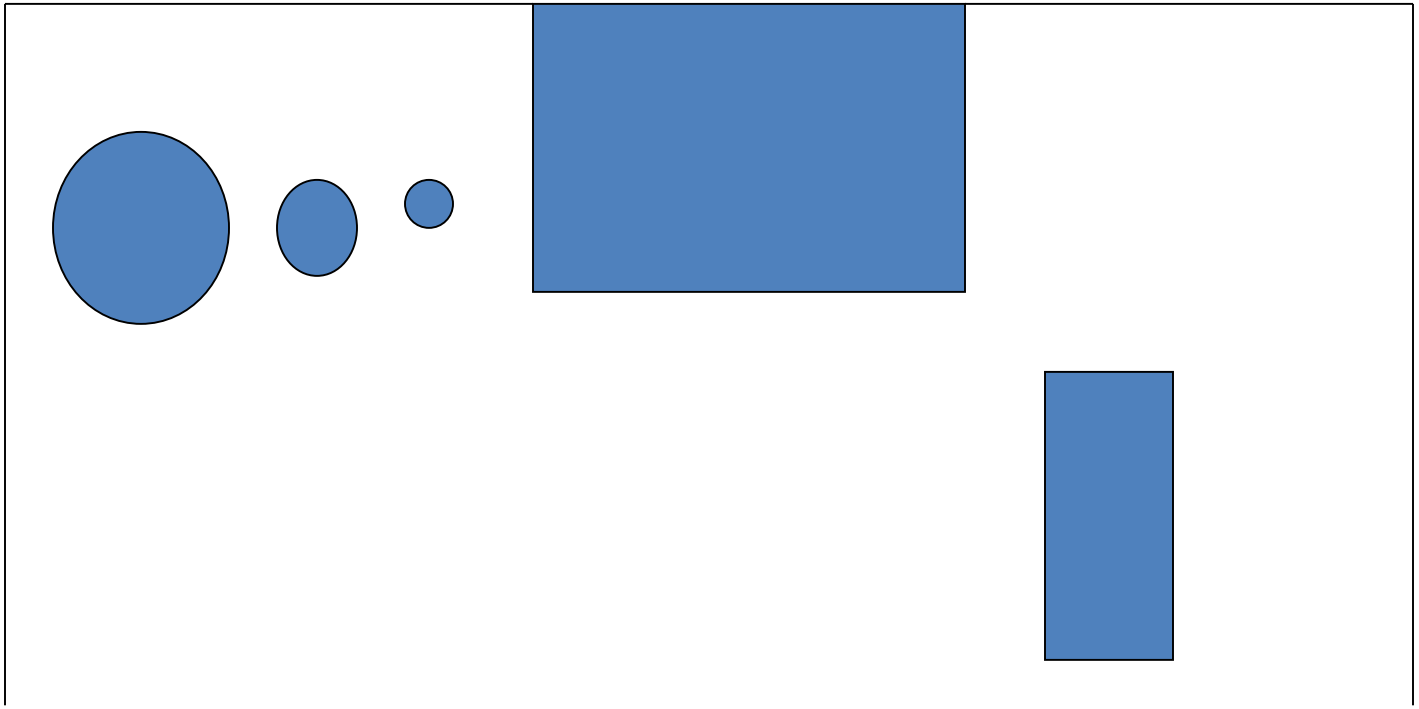
Splines

- Chunky paths can be further smoothed by converting them to ***splines***
  - Curves that *approximate* paths
    - Some maths required (see wikipedia)



Passable Edges

- Not every agent can pass



- Need to adapt graphs for agents

Following Paths

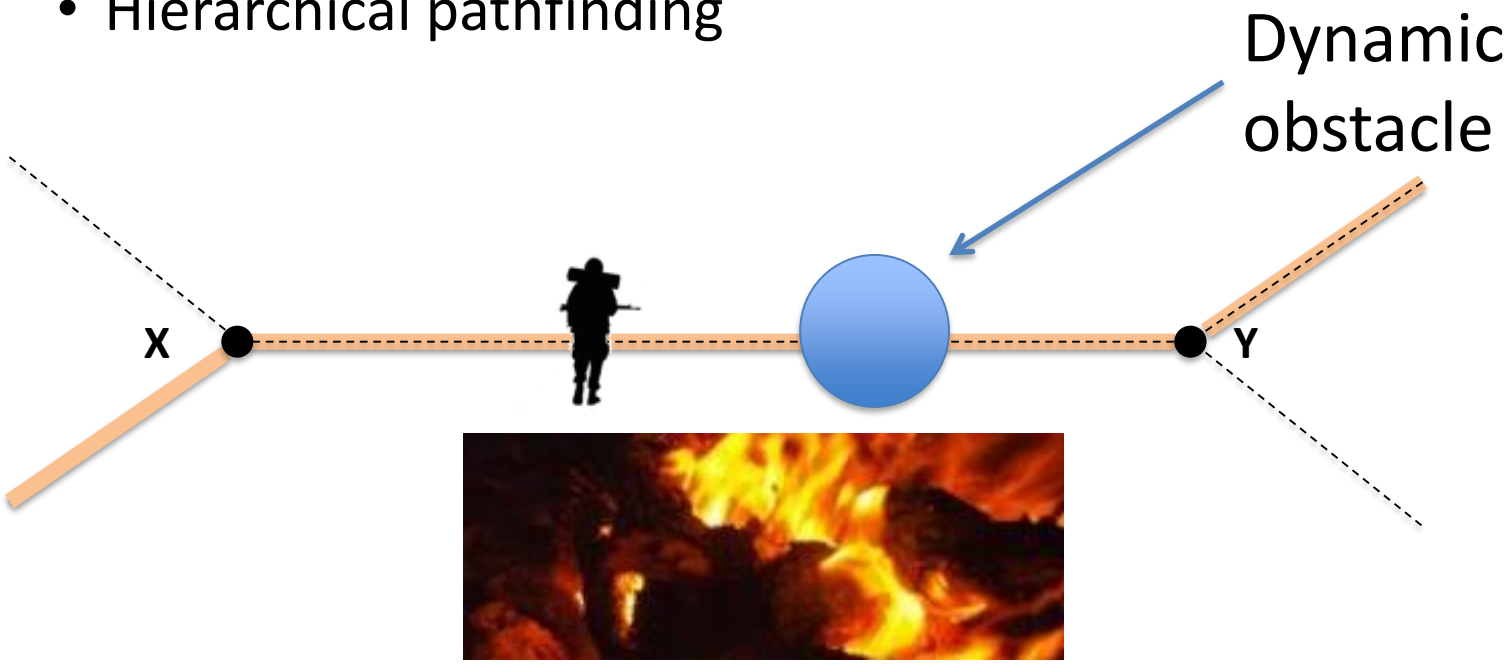
- We assume that if a move is planned it can be executed
  - Validity of a division scheme
- What is the world changes
  - Other agents move about?

Possible Solutions

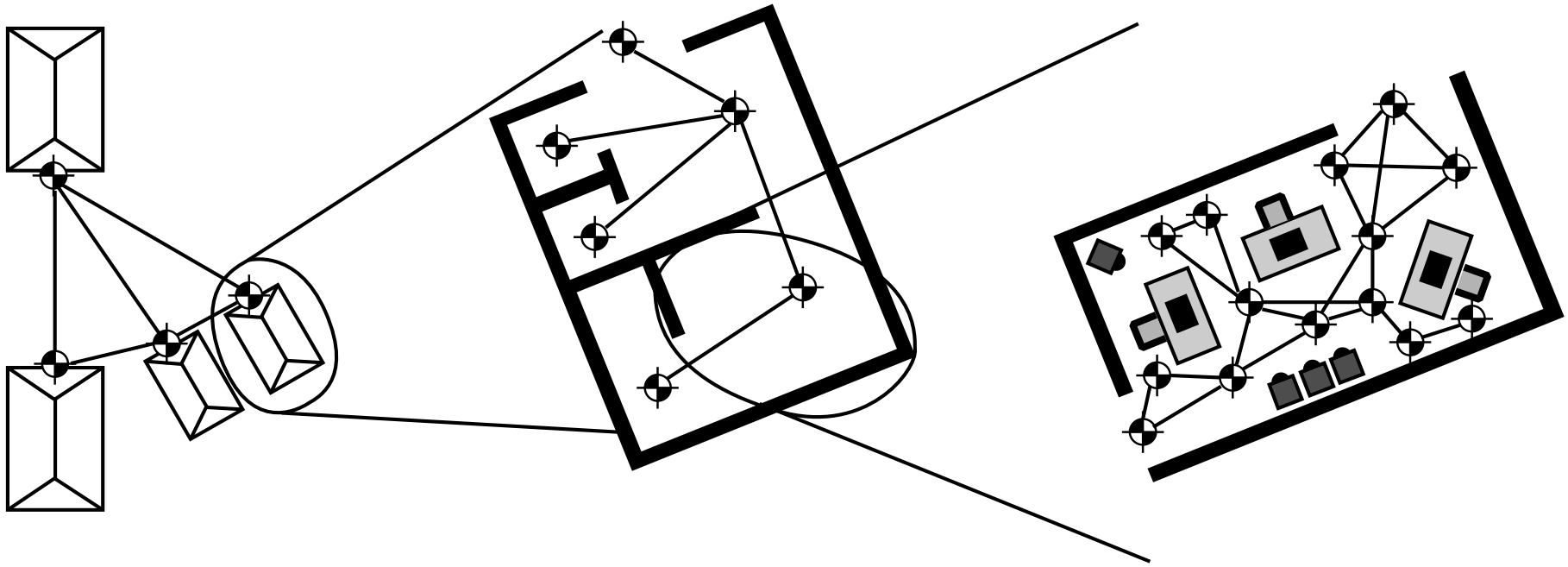
- Leave space between agents
  - Different pathfinding graphs for different agents
    - ☹
  - Centralised pathfinding
  - May not be natural (e.g. tanks)
- Assume there is no path
  - ☹
- Navigate around the obstacle
  - Steering / Pathfinding

Beware of the Pit

- Pathfinder requires to move X ➔ Y
  - Steering can fail
    - Navigation meshes are much better
      - Easier to re-plan (full information about passable areas)
    - Hierarchical pathfinding



Hierarchical Pathfinding



May not discover shortest path

Other Pathfinding Topics

- Cooperative pathfinding
  - Finding a path for a group of agents
- Variable terrain cost
  - Penalise paths near existing units
- Pathfinding using the GPU
- Pathfinding in dynamic environments
- …

Pathfinding: Summary

- Algorithmically, not very difficult
  - A*
  - Choice of heuristics is important
    - Do not fear inadmissible heuristics!
- Linking model and graph can be tricky
  - A number of methods
  - Trend towards navigational meshes
    - Some developers disagree
- Paths often require smooting