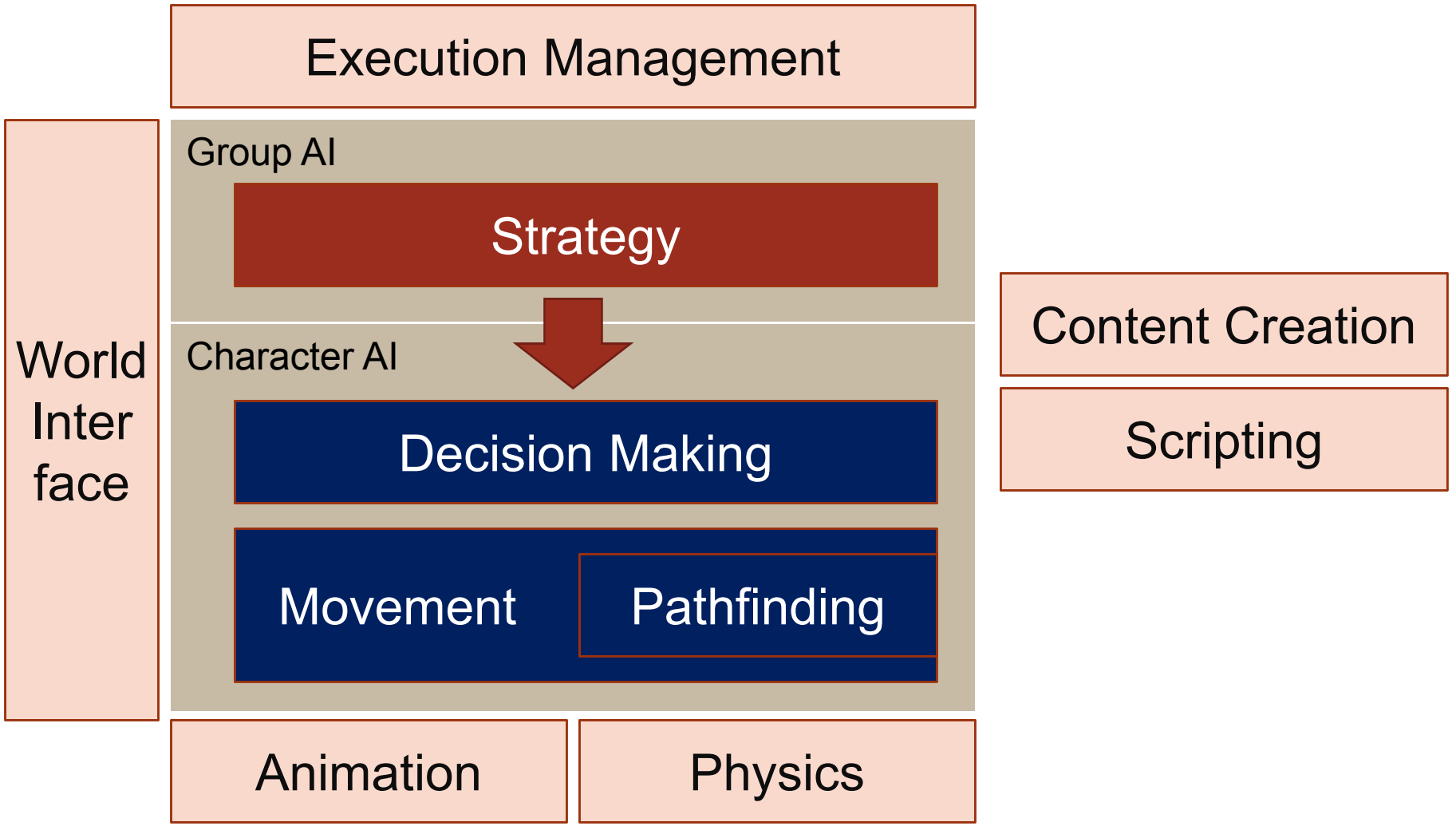
Tactical and Strategical AI

Artificial Intelligence for Games


Execution Management
World Inter face
Group AI
Strategy
Character AI
Decision Making
Movement
Pathfinding
Content Creation
Scripting
Animation
Physics

Waypoint Tactics

Artificial Intelligence for Gaming

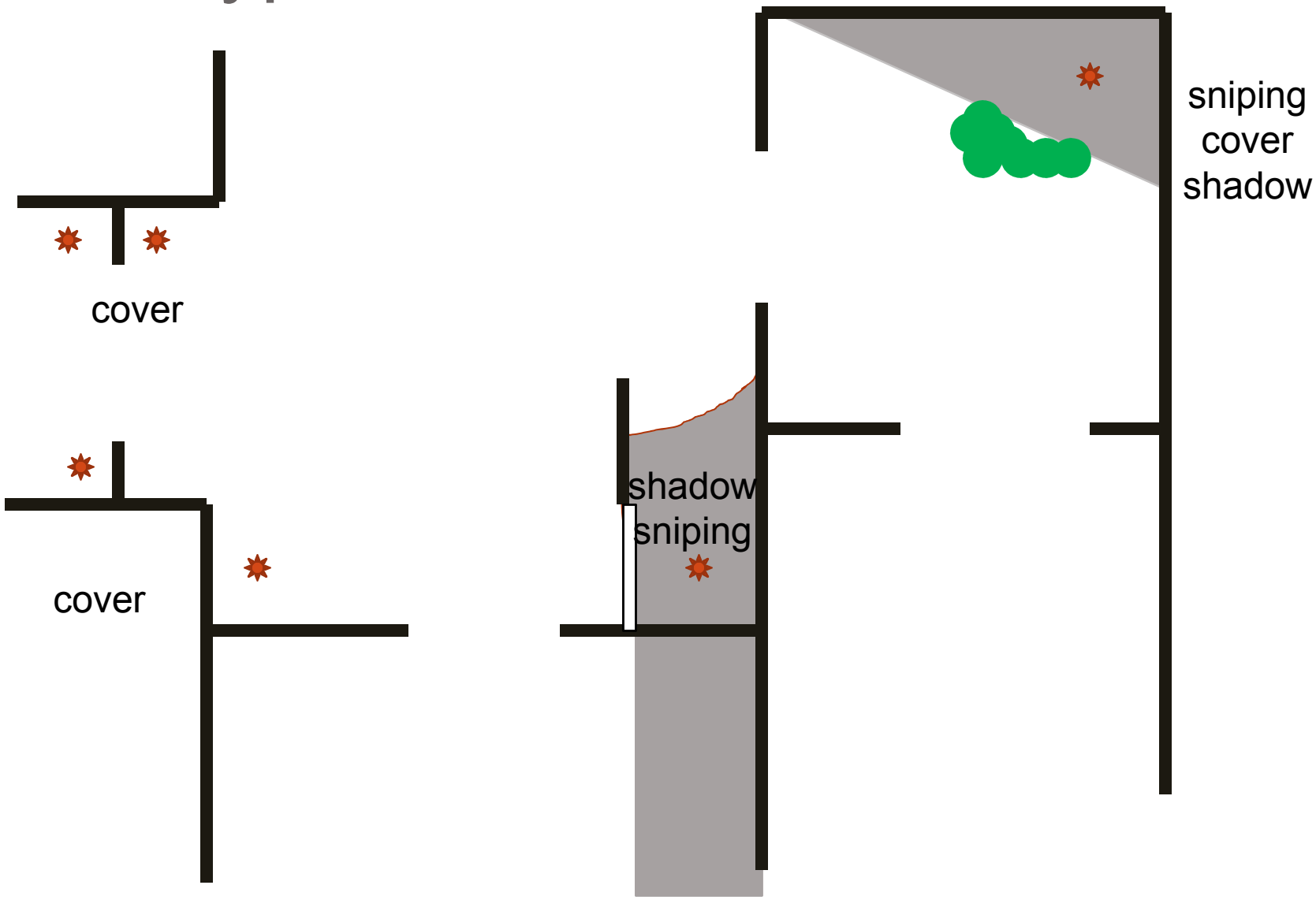
Waypoint Tactics

- Waypoint: single position in a game
  - Pathfinding uses nodes
  - Now: associate those nodes with different tactical situations
- Tactical locations (a.k.a. rally points)
  - Waypoints for tactical situations (not only rally points)
  - Usually used to represent
    - defensive locations (cover points)
    - sniper points
    - ambush points
    - ...

Waypoint Tactics

- Waypoints are not necessarily useful for pathfinding
  - Usually many more waypoints
    - Generated by hand
    - Or generated automatically

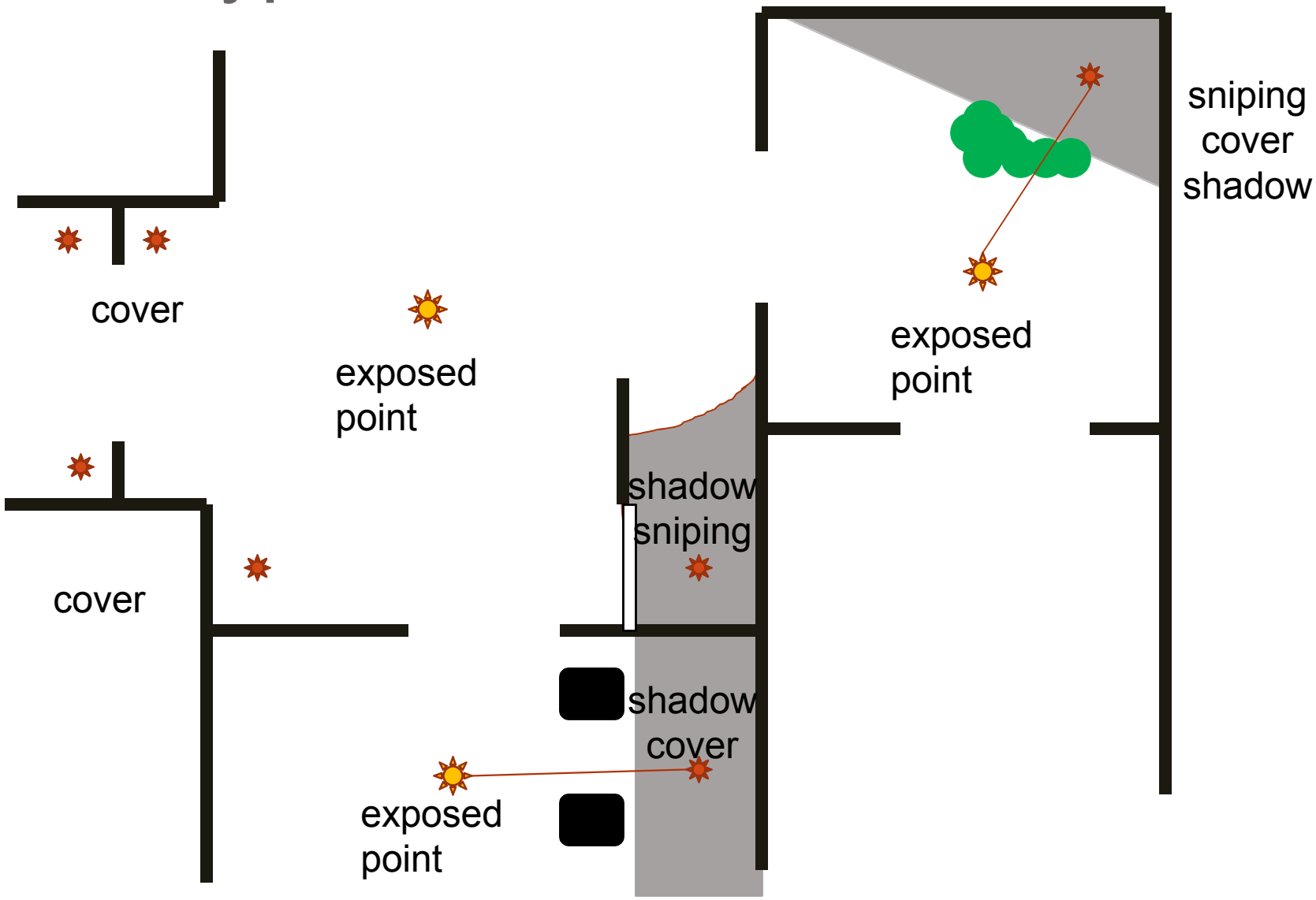
Waypoint Tactics



Waypoint Tactics

- More sophisticated methods
  - Ideal sniper position has good cover and wide view of enemy
    - Sniper points are both cover points and reconnaissance points
  - Need only store primitive properties of waypoints
    - When looking for an ambush point:
      - based on cover
      - based on shadow
      - based on exposure
    - Preferable for smaller number of characters and simple conditions
    - If not, can preprocess and label waypoints with labels for more complicated properties

Waypoint Tactics

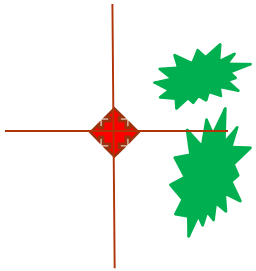


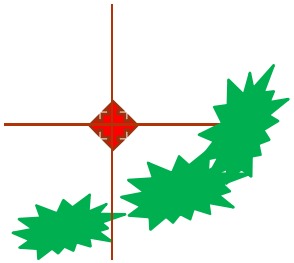
Waypoint Tactics

- Context Sensitivity
  - Tactical value of any type of point depends on the situation
    - Attitude of a character determines whether a cover point really provides cover
    - Sniping points depend on enemy position for their aptitude
  - Evaluation
    - Precompute multiple values:
      - Enemy position in all four directions
    - Casts ray to actual enemy position to see whether cover is provided

Waypoint Tactics

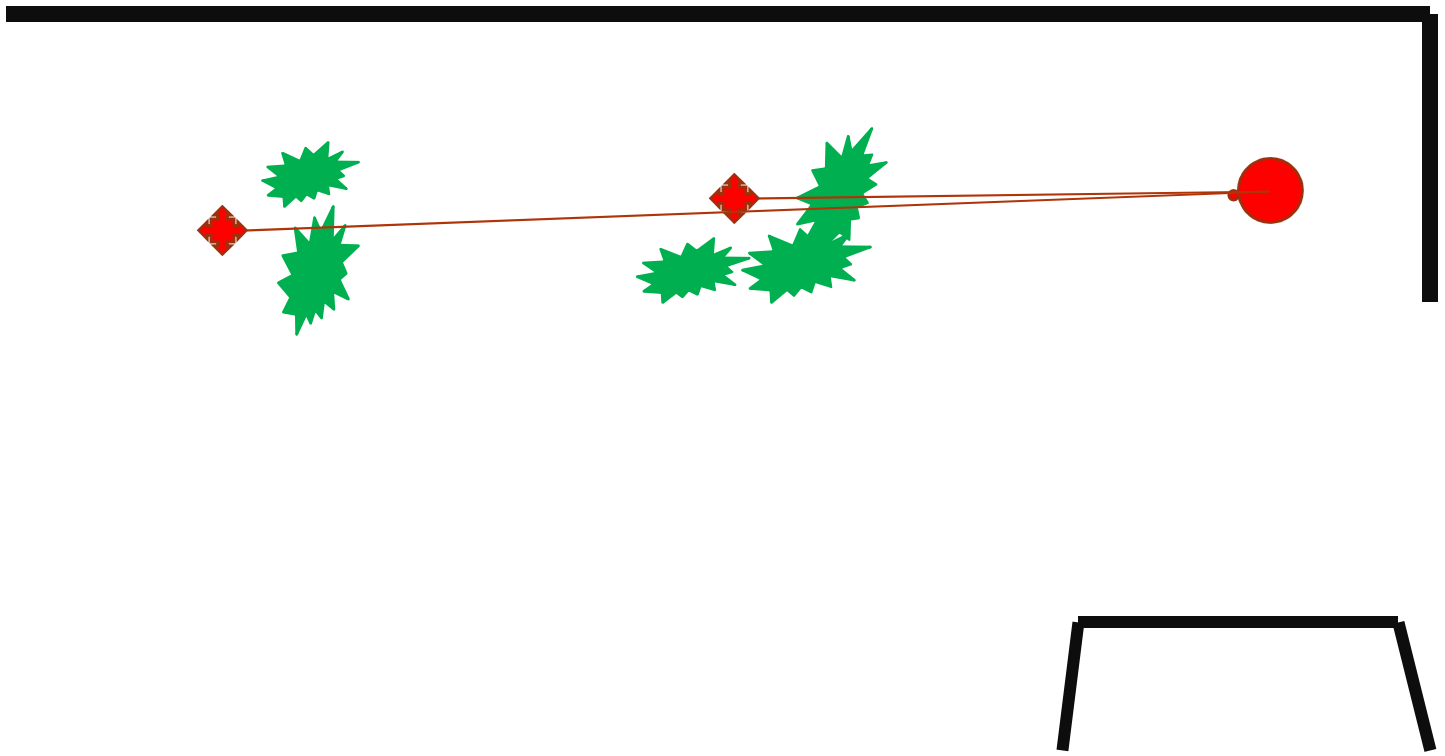
Cover:
N: 3
E: 5
S: 0
W: 0





Cover:
N: 4
E: 5
S: 4
W: 0

Waypoint Tactics



Waypoint Tactics

- Precomputing values
  - Fast: no calculations necessary
  - Can explode:
    - Cover in four directions
    - Two attitudes: standing / crouching
    - Against five types of weapons
    - Total 40 values
- Post-processing
  - Ray-casting can be expensive
    - Some games use 30% of a processing power on line-of-sight calculations

Waypoint Tactics

- Waypoint overview:
  - Many games can use simple labels
  - Context sensitivity through precomputation
  - Post-processing for tactically involved games

Waypoint Tactics

- Using tactical locations
  - Mechanism to include waypoint data into decision making:
    1. Simple decision making process such as a decision tree
    2. Incorporating tactical information into decision making process
    3. Character motion that is always tactical aware

Waypoint Tactics

- Simple tactical experience
  - Character uses a decision tree based on current state: health, ammo, enemy position
  - Decides for reloading
  - Queries tactical waypoints in the vicinity
  - Evaluate for cover
- Drawback: Availability of a nearby cover point is not assured

Waypoint Tactics

- Using tactical information during decision making
  - Binary decisions:
    - Decision tree with a node:
      - Is there a cover point nearby?
    - State machine with state machine
  - Fuzzy logic decision making
    - Incorporates values of waypoints
- Generating nearby decision points
  - need to be fast
  - Use data structures such as quad-trees, binary space partitions, ...
  - Needs to take obstacles into account

Waypoint Tactics

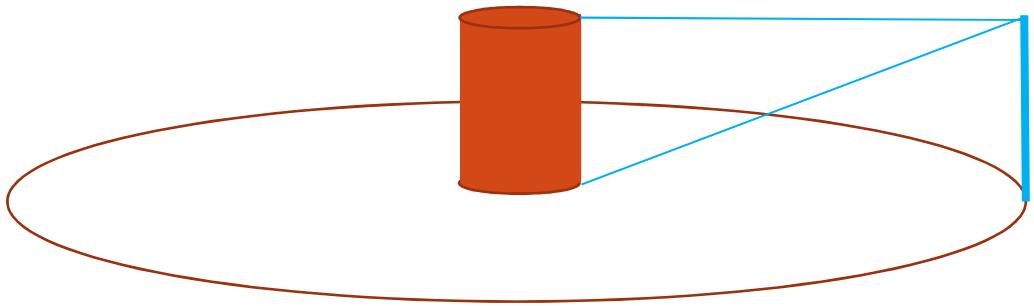
- Tactical Pathfinding
  - Extend A* pathfinding algorithm

Waypoint Tactics

- Generating waypoints
  - Part of level design
  - Use tiling
    - Evaluate center points

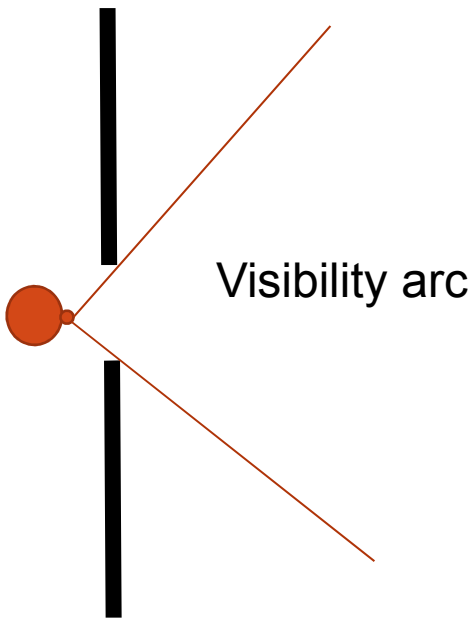
Waypoint Tactics

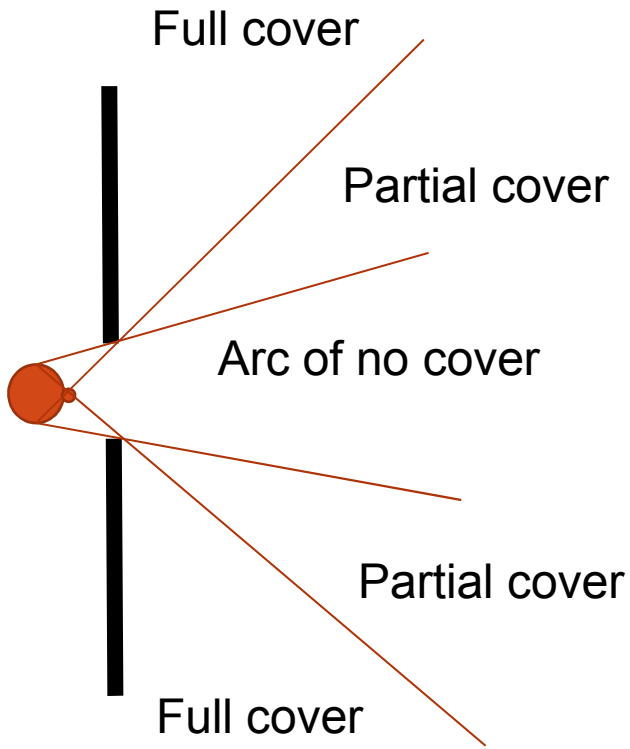
- Cover points
  - Quality evaluated by calculating proportion of successful attacks from different points
    - Create potential enemy locations around point
    - Create different heights of enemy



Waypoint Tactics

- Visibility points
  - Use line-of-sight tests





Waypoint Tactics

- Shadow points
  - Use lighting model of level
  - Test amount of light at different heights over the point

Waypoint Tactics

- Automatic generation of waypoints
  - Watching human players
  - Condensing the waypoint grid
    - Start with points in center of a dense tiling
    - Discard points with low evaluation
      - (Careful: In a room with almost no cover, a modest cover point is important)
    - Condense remaining points
      - If character can move simply between two points, can keep the better of the points

Tactical Analysis

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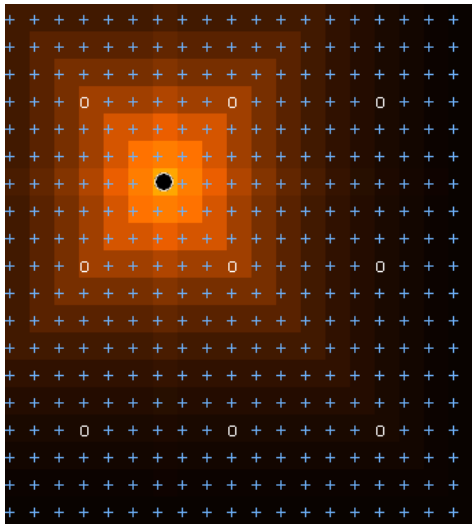
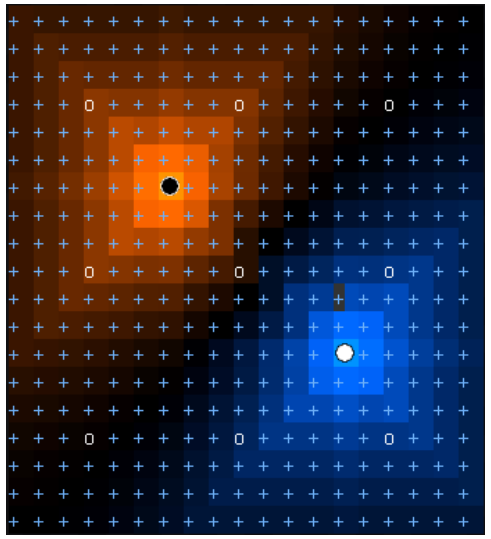
Tactical Analysis

- Represent the game level
  - Tiling with a dense grid
  - Dirichlet domains
- Simple influence maps
  - Each type of unit gives influence





Tactical Analysis

0.25	0.5	0.25	0.125
0.5	1	0.5	0.25
0.25	0.5	0.25	0.125
0.125	0.25	0.125	0.061

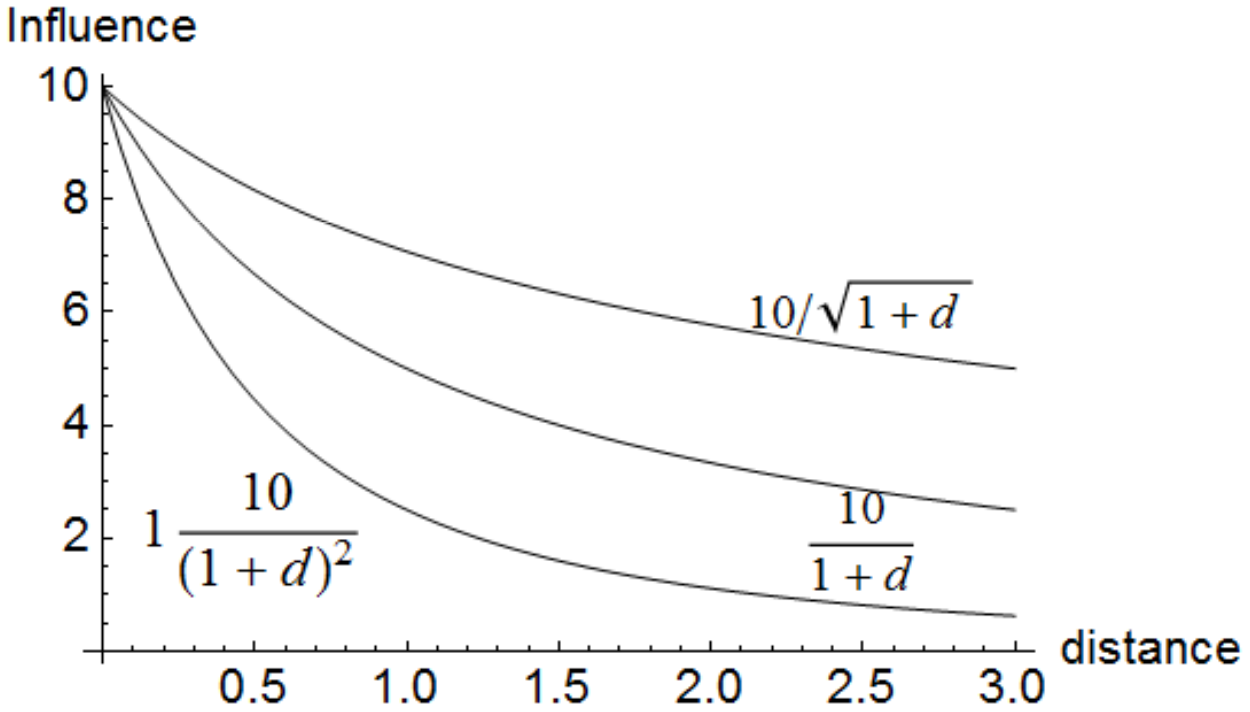
Manhattan geometry

$$\text{influence} = \alpha \cdot \max(0,\ 1 - \frac{\phi}{\phi - \text{d}(\text{avatar}, \text{cell})})$$

Formula for atenuation

Tactical Analysis

Other formulas for atenuation

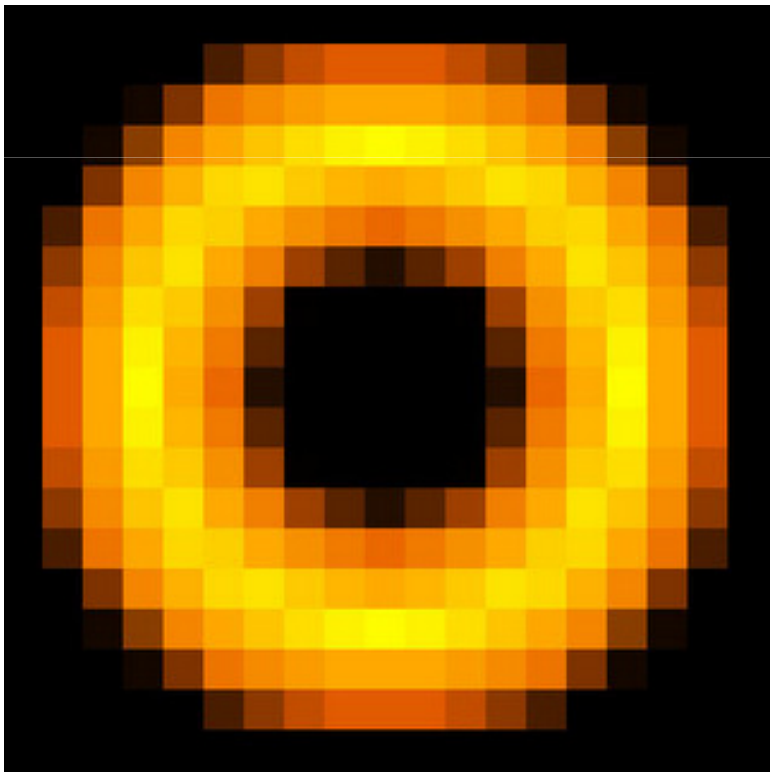


Tactical Analysis

- Cumulative effect of units
  - Add, but limit effect of each unit to a certain circle
  - Use a convolution filter
  - Use only the highest influence unit to calculate influence

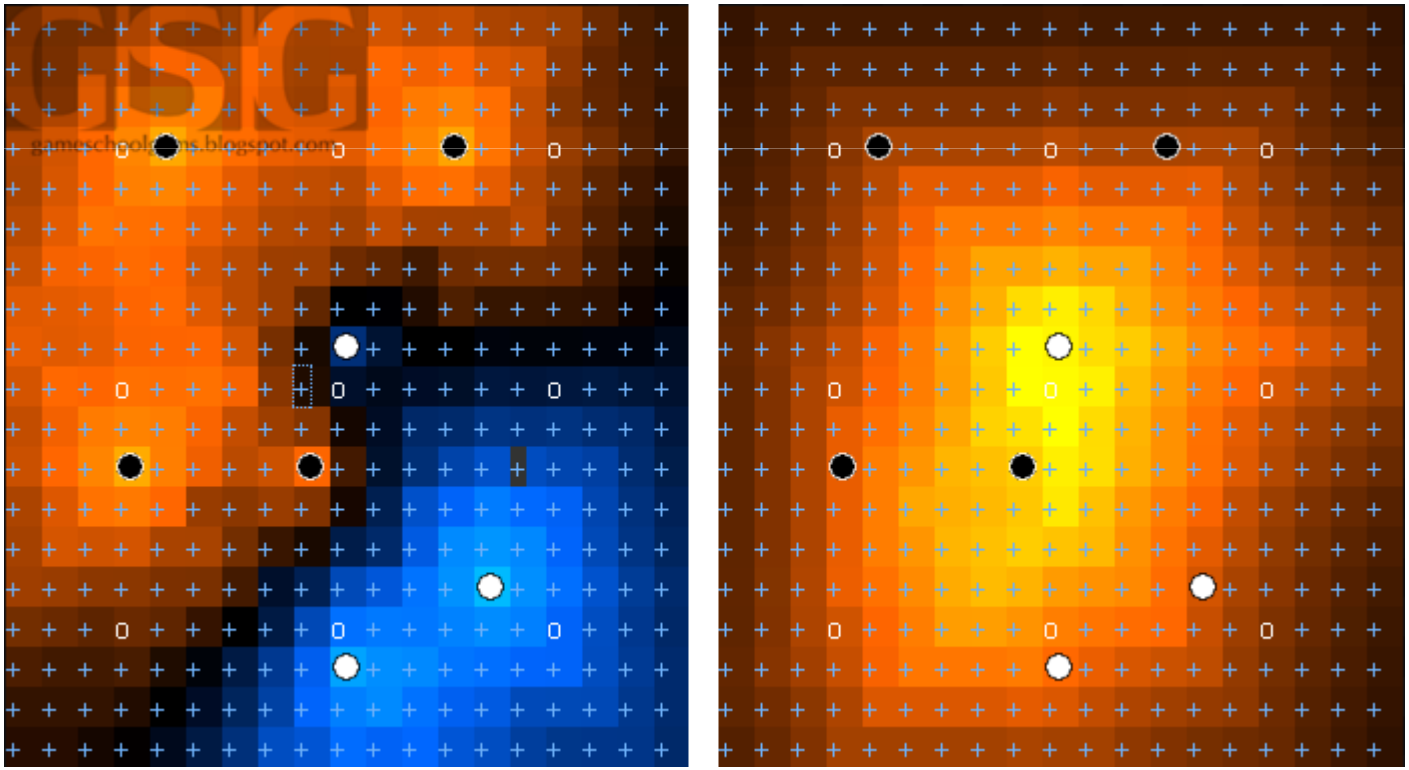
Tactical Analysis

- Influence can depend on the type of unit
  - Artillery: Influence only in a certain ring around unit



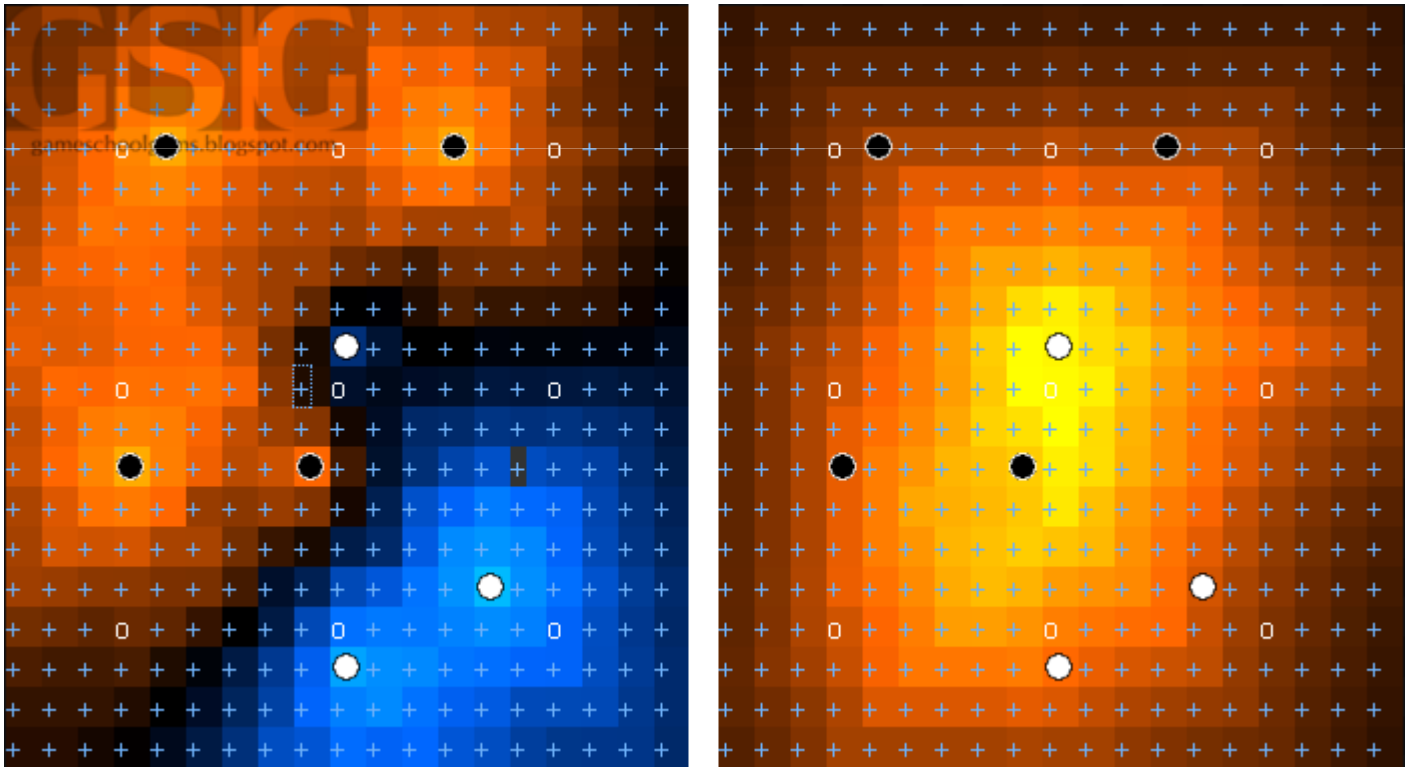
Tactical Analysis

- Use of tactical map:
  - Difference between influences with and without enemy



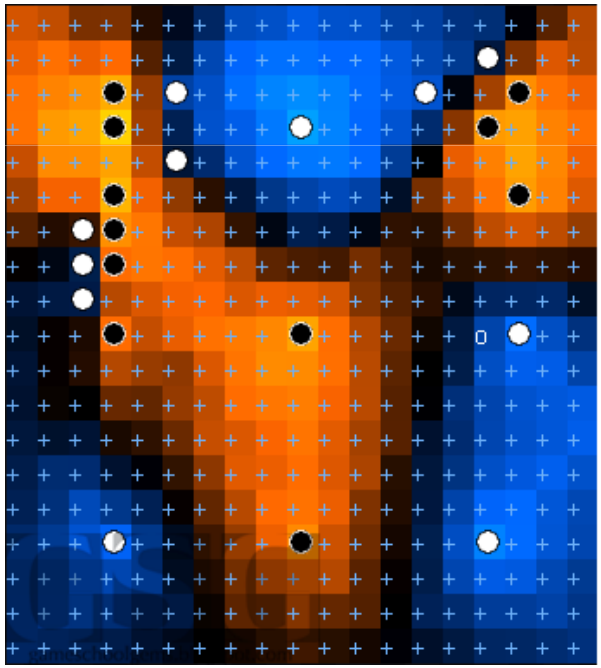
Tactical Analysis

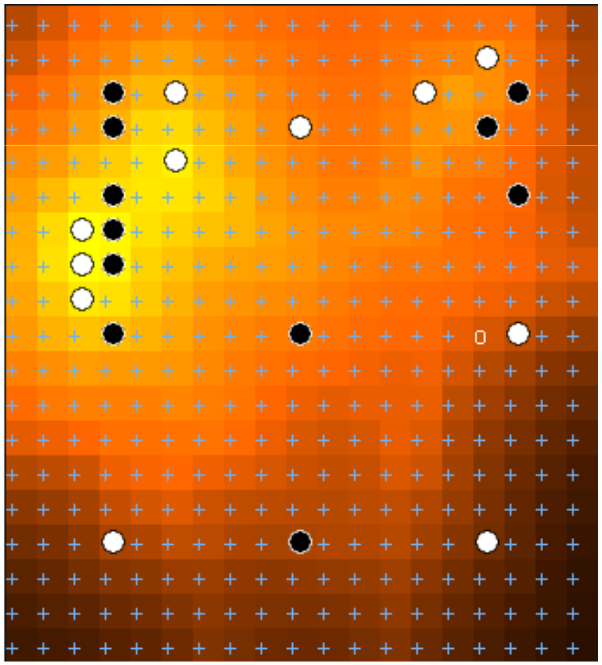
- Use of tactical map:
  - White piece in center is surrounded by black influence: vulnerable



Tactical Analysis

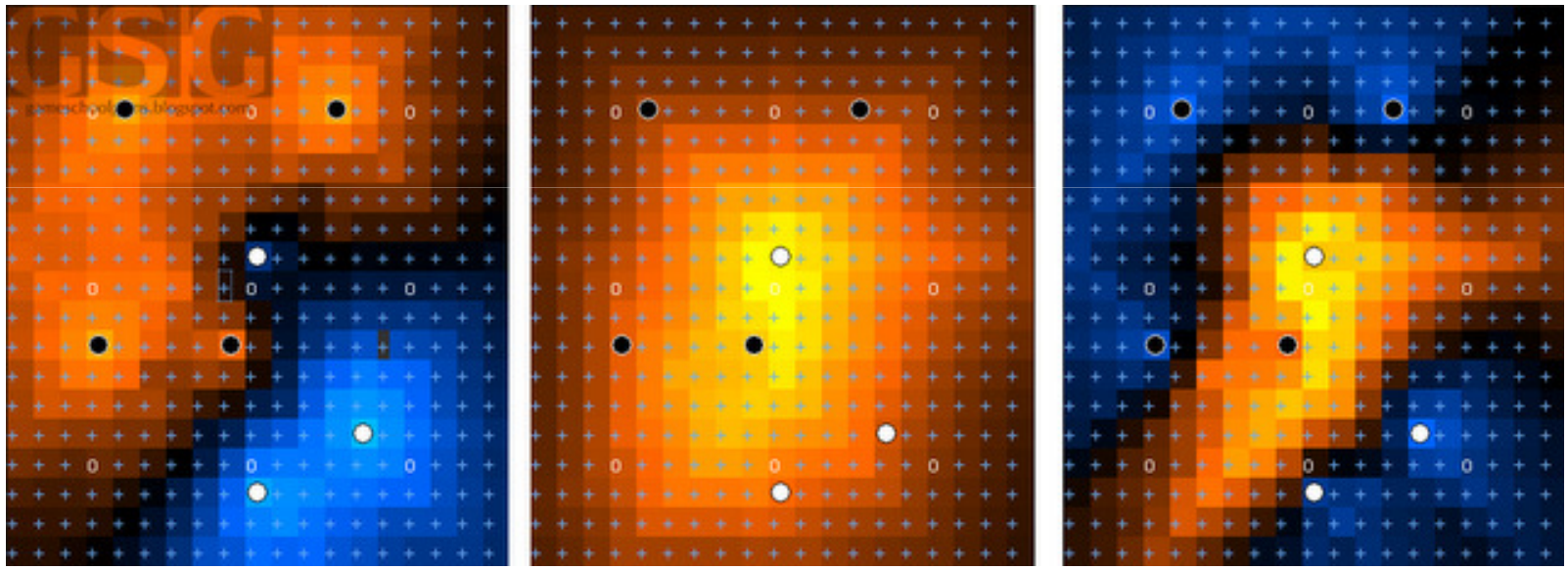
- Tension Map:
  - Difference between influences:





Tactical Analysis

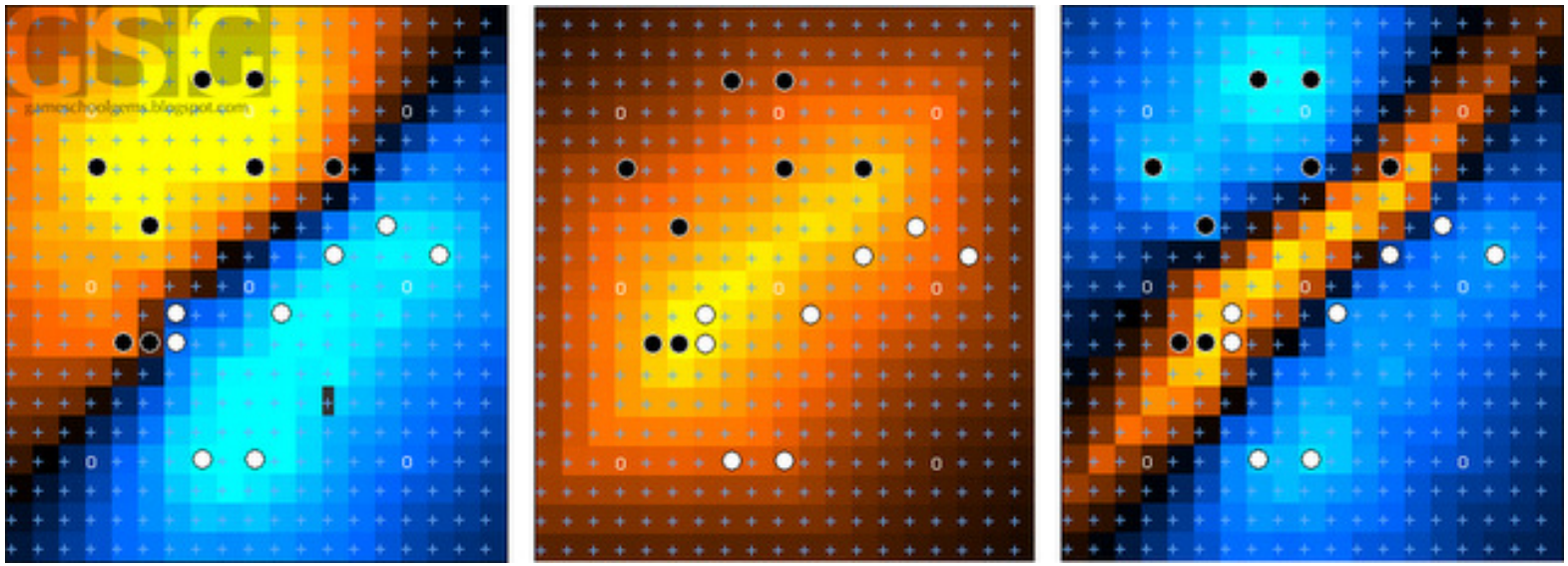
- Tension minus my influence gives vulnerability



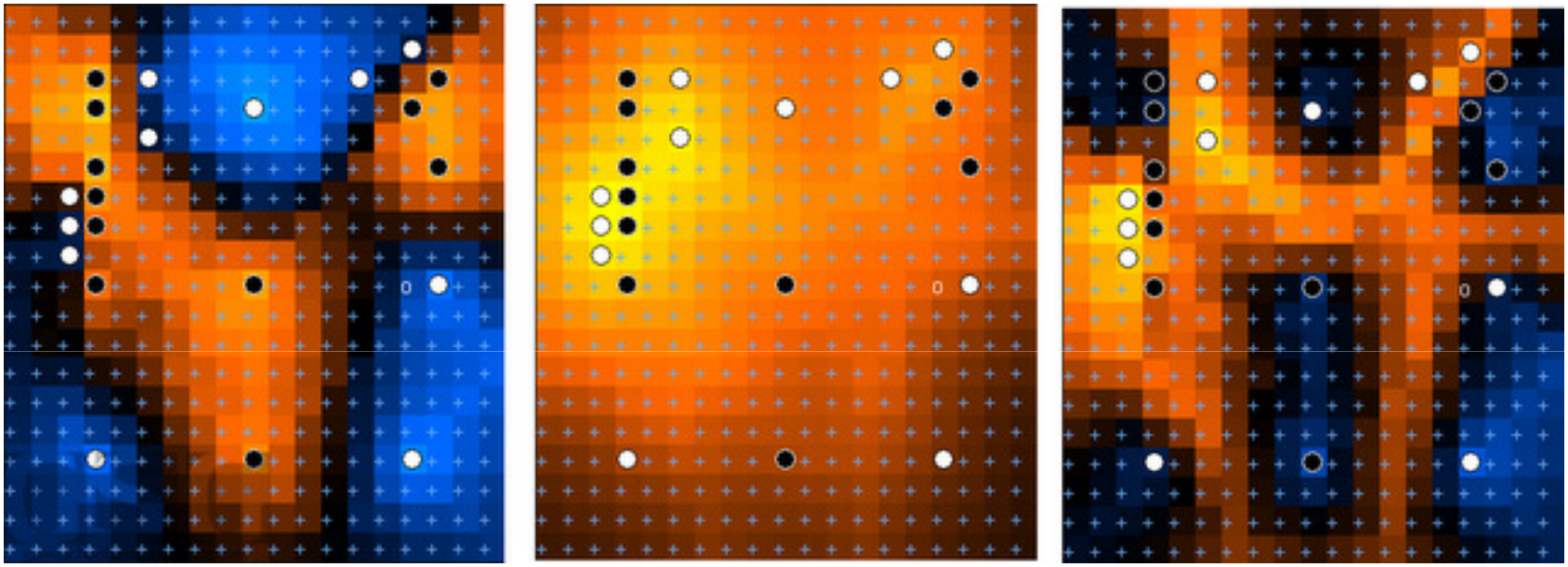
Tension Influence Vulnerability

Tactical Analysis

- Example:
  - Well-defined frontline
  - Conflict in middle



Tactical Analysis



Tactical Pathfinding

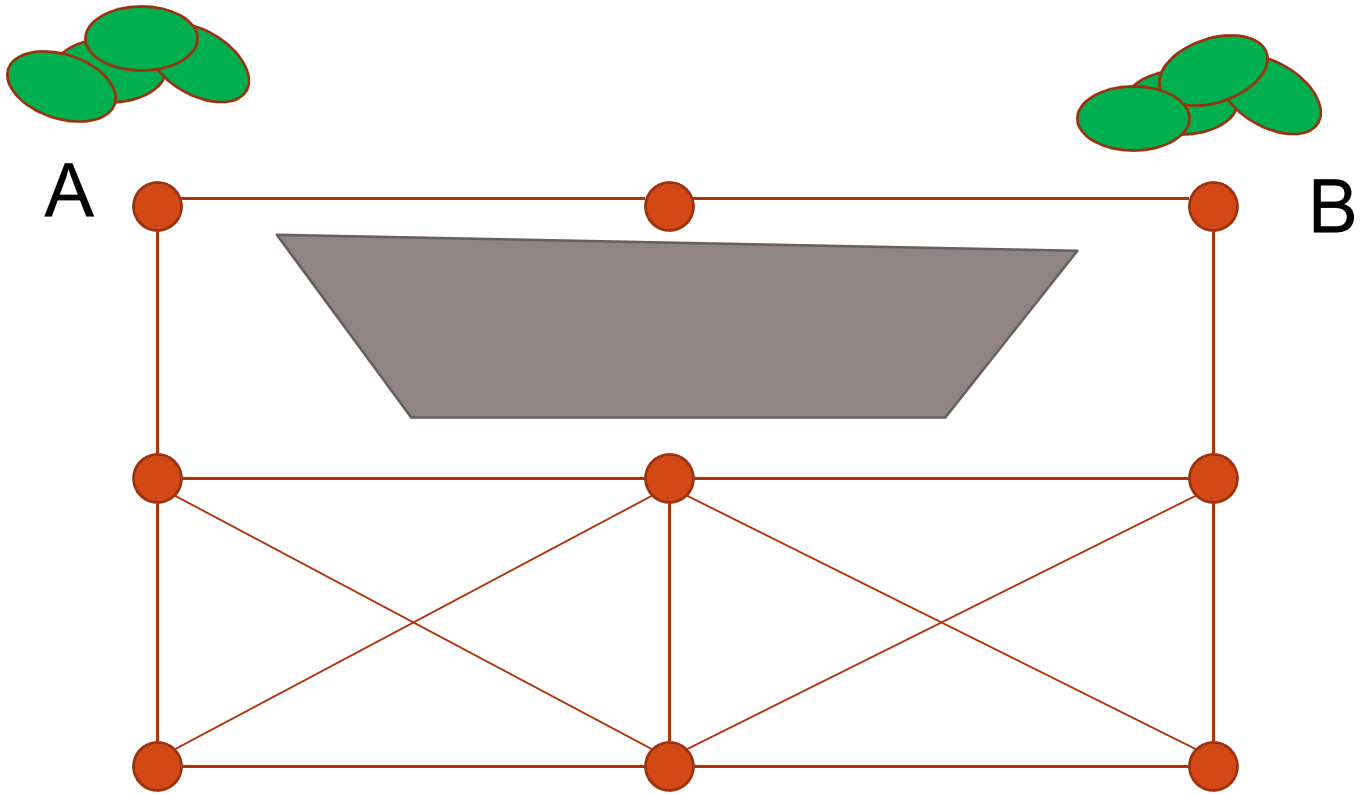
Artificial Intelligence for Gaming

Tactical pathfinding

- Tactical pathfinding
  - Incorporates the tactical evaluation into costs of paths
  - Connection cost depends on
    - Distance
    - Tactical quality of each connection
  - Tactical quality of connection is stored
    - With waypoints
      - (Average the tactical quality of the two endpoints, but face problems)

Direct connection between A and B exposes character

Can only see this with lots of waypoints



Tactical pathfinding

- Modify pathfinding heuristics
  - Euclidean distance heuristic can lead to underestimate tactically excellent routes

Tactical pathfinding

- Modify graph:
  - Need to add waypoints that are not tactical

Coordinated Actions

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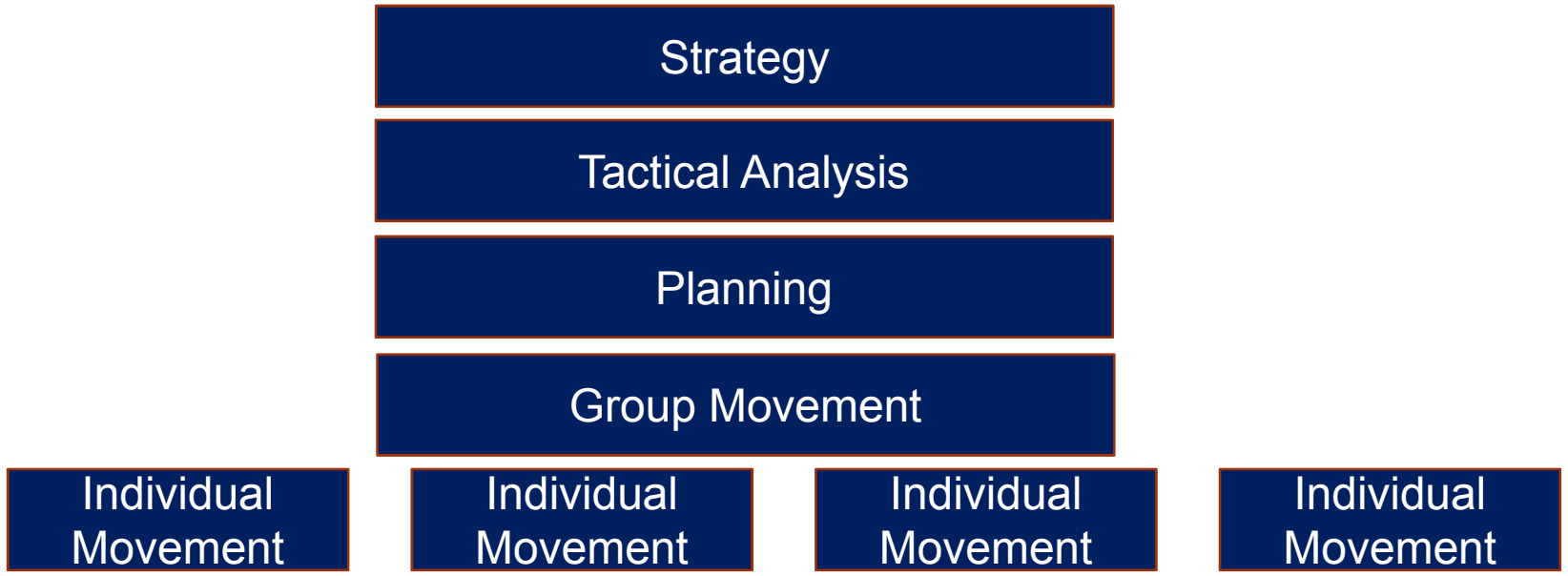
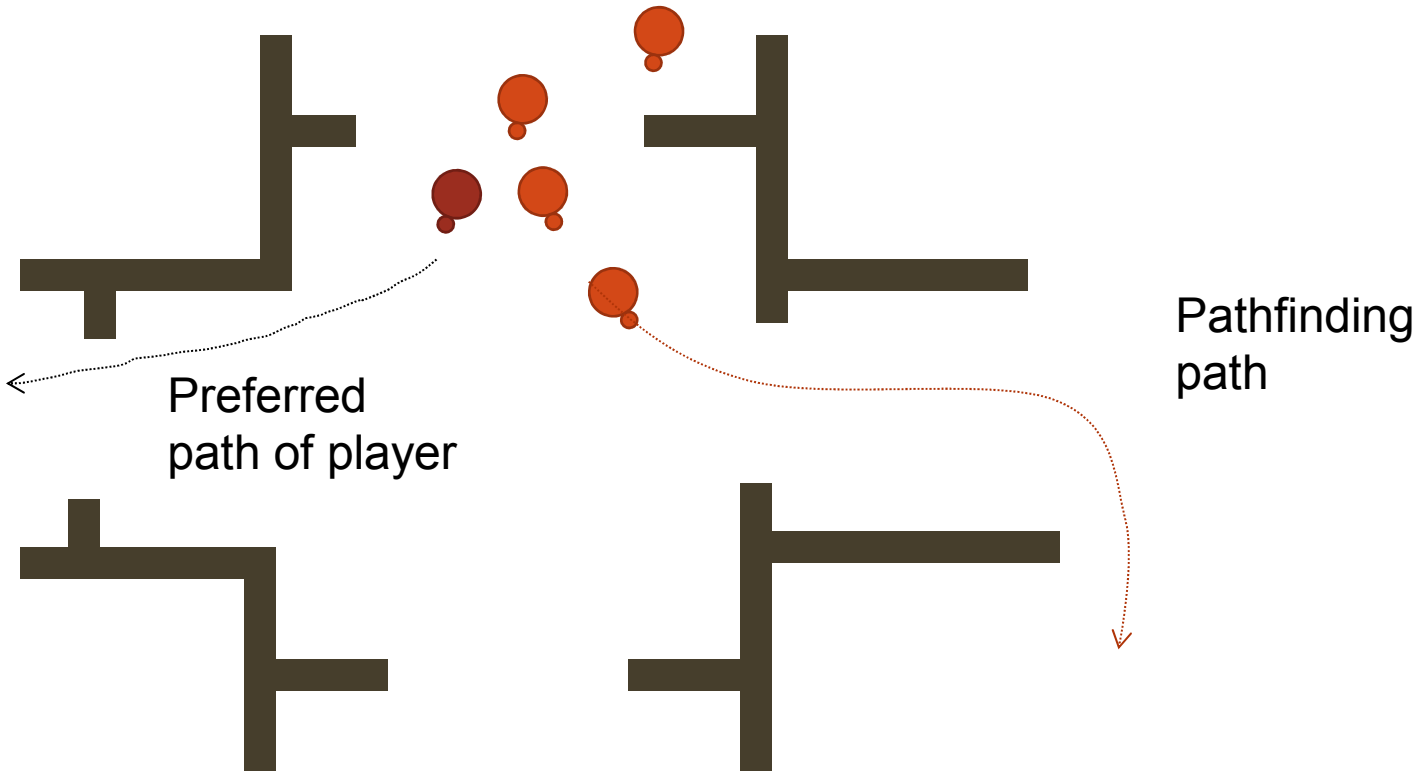
Coordinated Actions



Coordinated Action

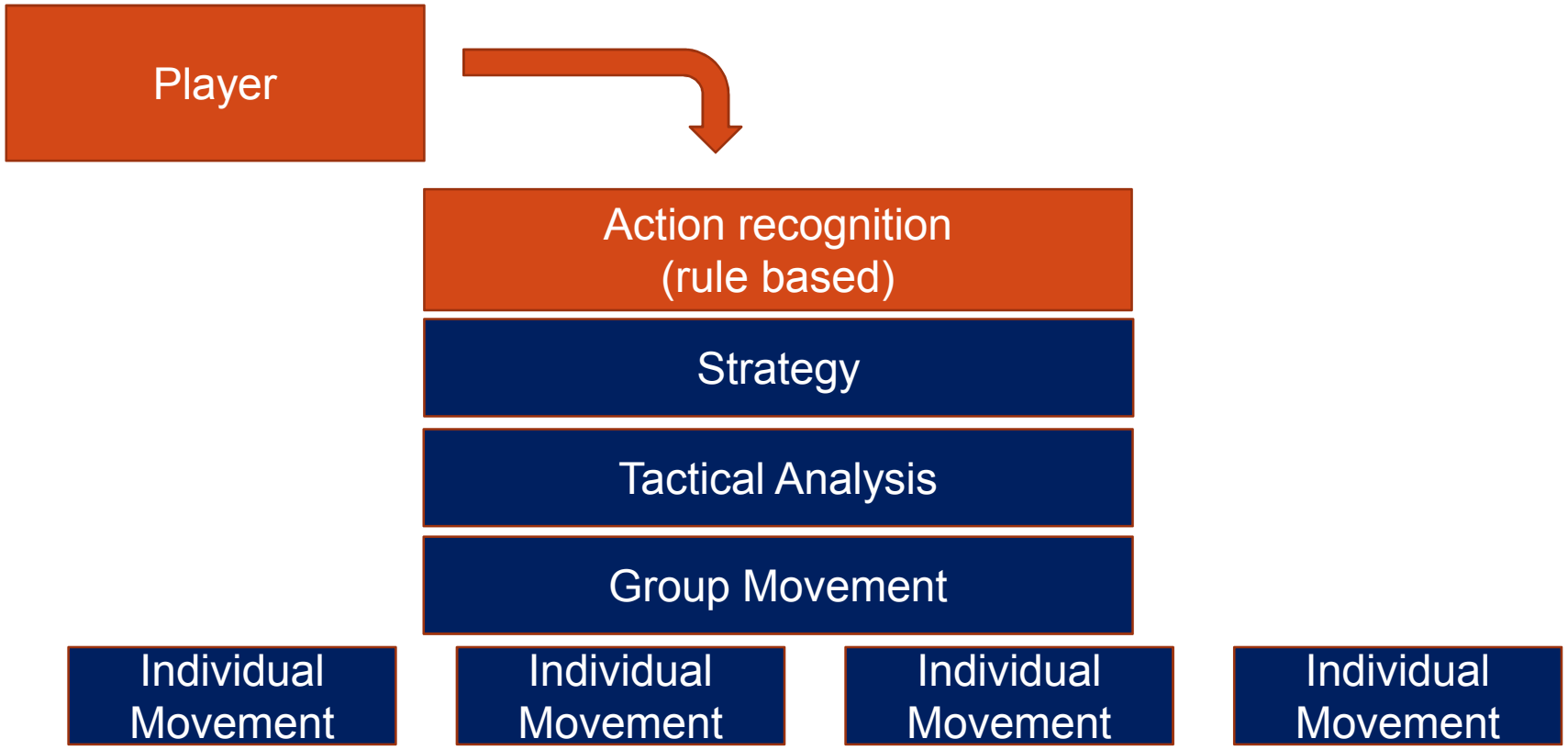
- Incorporating players does not mix well with multi-tiered AI



Coordinated Action

- Integration of player
  - Explicit player orders
  - Different structuring of multi-tier AI

Coordinated Action



Coordinated Action

- Emergent cooperation
  - Characters run their own decision making procedure
    - Taking into account what other characters are doing
  - Tune decision making so that cooperate actions *emerge*

Coordinated Action

- Scripted actions
  - Special situations in sports
    - Football
    - Soccer: corner kick, free shot
    - Baseball: double play, bunt
  - Military tactics
    - Entering a potential hostile room
      - Teams moves into position outside
      - Throws stun grenade
      - Move into corner of room
      - Flank inside of doorway