Tactical and Strategical AI

Artificial Intelligence for Games
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

- 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

- 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
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

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

Influence formula:

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

Manhattan geometry
Tactical Analysis

Other formulas for attenuation

![Graph showing various attenuation formulas](image)
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
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

Artificial Intelligence for Gaming
Coordinated Actions

- Strategy
- Tactical Analysis
- Planning
- Group Movement
- Individual Movement
- Individual Movement
- Individual Movement
- Individual Movement
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

Player

Action recognition (rule based)

Strategy

Tactical Analysis

Group Movement

Individual Movement

Individual Movement

Individual Movement

Individual Movement
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