A Flexible Toolkit Supporting Knowledge-Based Tactical Planning for Ground Forces

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Motivation

• Improved C2 decision making and planning support through the integration of
  - Battlespace terrain information
  - Operational/situational picture
  - Business rules and constraints

• Following tasks should be supported by a corresponding toolkit / framework:
  - Determination of optimal paths for friendly troops based on different optimization functions
  - Calculation of troop movement projection
  - Determination of visibility and zones of fire
  - Modeling of enemy movement and engagement opportunities
  - Identification of danger zones

• Research Project: C2DSAS (Command and Control Decision Support and Advisory Services)
Main Scope of C2DSAS

- Development and test of data structures and algorithms for
  - C2 decision support
  - Resource optimization
  - Quick replanning in complex situations
- Supporting planning handcrafts by maintaining well defined planning procedures
- Algorithms for
  - Movement planning
  - Engagement planning
  - Visibility and zones of fire
- Efficient data structures for configuration space
- No focus on visualisation
- Development of a prototype framework / toolkit
Configuration Space

- Efficient data structures needed
- In C2DSAS framework: quadtree data structure
- Recursively divide map until resulting cells can be classified (or a minimum cell size is reached)
- Quadtree decreases memory consumption and accelerates all further computations
Example Quadtree Computation

- Different cell sizes
- Basis for search tree construction
Movement Planning

- Different optimization functions such as
  - Time
  - Distance
  - Engagement opportunities
- Directing path calculations
  - Intermediate path points
  - Special areas
Optimal Paths Based on Heuristic Search

- A*-Algorithm
- Intermediate path points for directing search and producing alternatives
- Estimate the probability of enemy contact
Secure Paths

- Identification of danger zones by calculating areas with limited troop formation opportunities along a path
- Green: slightly limited
- Red: extremely limited
- Other areas: unlimited
Special Areas: Inhibition

Movement not possible (No Go)

Movement inhibited (50% inhibition)
Special Areas: Acceleration

Movement accelerated/made possible by bridge building
Troop Movement Projection

Reachable areas for two different time periods
Engagement Planning

- Identification of obstacles and dividing areas
- Identification of possible and favorable engagement areas
Engagement Planning: Minkowski Sum

- Sum of two sets $S$ and $T$ in the euclidean space:
  - $S +_M T = \{s + t \mid s \in S, t \in T\}$
- In 2D:
  - Slide one shape over the borders of another
Example Minkowski Calculation

- Every cell that is not part of an enlarged area constitutes a centre point of a corresponding engagement area.
Visibility and Zones of Fire

- Based on an identified engagement area
- 2D: incorporates dividing areas like forests
- 3D: also incorporates elevation data
Toolkit Architecture
Conclusions

• C2DSAS toolkit constitutes a valuable and generic collection of AI software methods focusing on tactical planning for ground force operations
• No automatic decision making
• Effective support of basic planning handcrafts
• Future work:
  - Development of an intelligent user interface
  - Development / extension of a business rule database
  - Full integration into C2IS of the Austrian Armed Forces
Thank you for your attention!

- Questions?