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Computer Games Technology

—Dynamic Skeleton-Based Path Finding—

Hans W. Guesgen
Computer Science Department

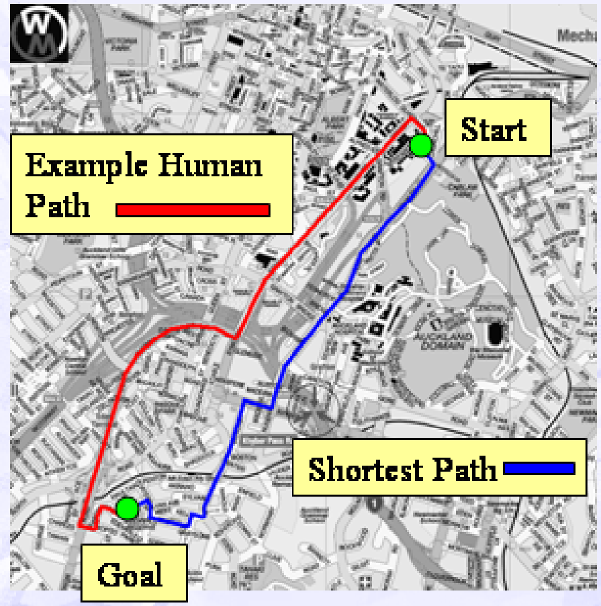
THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

Origins

- Paul Shotbolt's graduate project in 2003.
- Presented at the European Conference on Artificial Intelligence 2004.

Introduction

- Many existing computer-game wayfinding techniques favour mathematical or graphical approaches and ignore the possibility of knowledge re-use.
- Humans re-use knowledge to solve wayfinding problems.
- Due to the difference in approach, solutions obtained by humans and computers differ qualitatively.



A human prefers to re-use known routes (skeleton paths), and might adopt a semantically shorter path that translates to a longer real-world path.

Introduction

- In computer games, differences between simulated-human behaviour and actual human behaviour make characters less convincing.
- A goal of the game designer is the suspension of disbelief of the player. This is impeded by unconvincing character behaviour.
- Therefore, more human-like behaviour is needed to prevent onset of disbelief.

Some computer players unerringly opt for the shortest route to their goal.

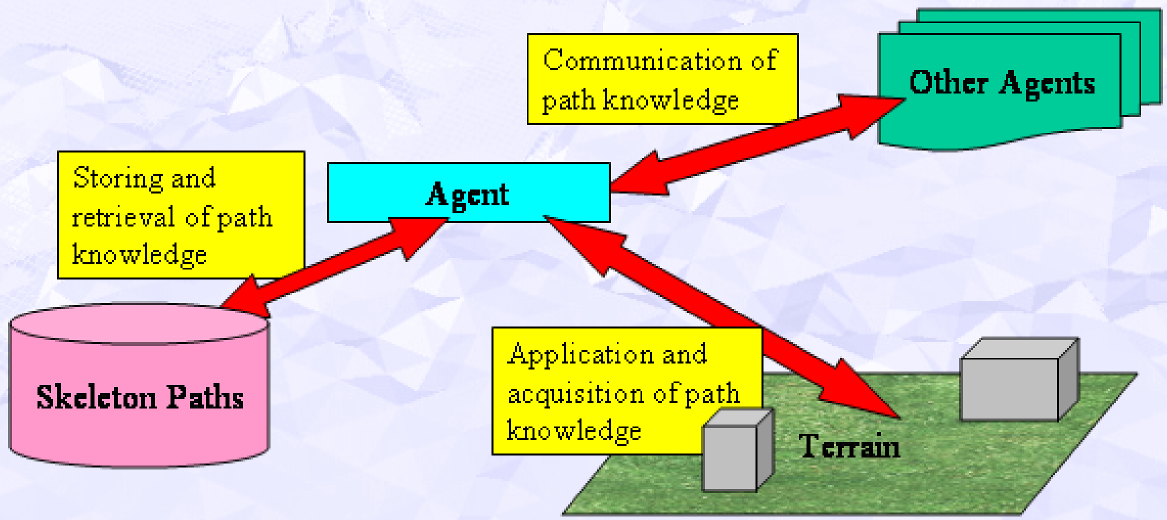
Human players will often alternate between a number of skeleton paths.

Dynamic skeleton-based wayfinding

- A wayfinding system incorporating knowledge re-use. This involves aspects of case-based reasoning and inter-agent communication.
- Differs from most existing game wayfinding techniques which do not involve knowledge re-use.
- In effect, CBR principles applied to existing wayfinding techniques, to better simulate human wayfinding. Our test environment used A*, however other wayfinding systems should be equally appropriate.
- May lead to faster but less-optimal wayfinding.

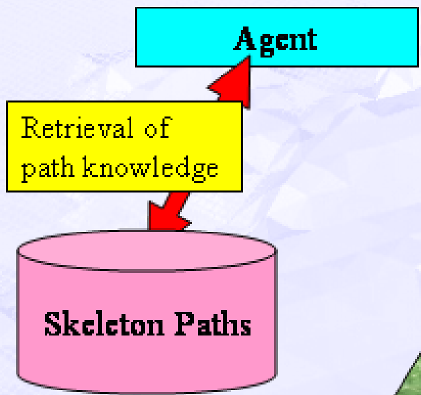
Approach

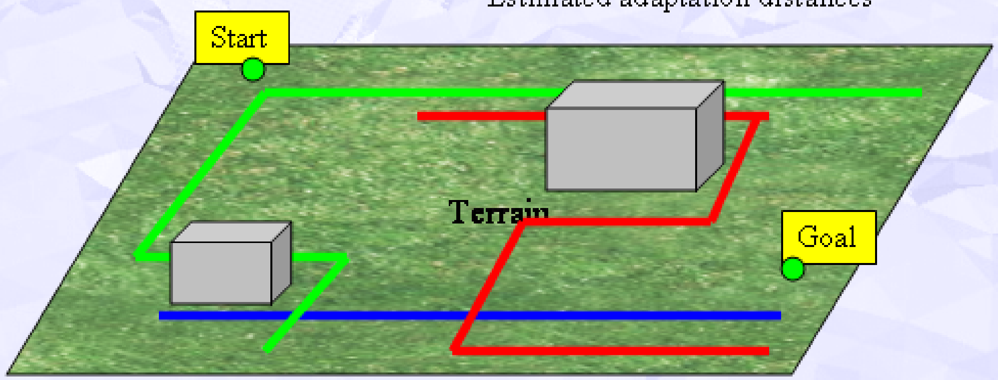
- A set of known skeleton paths is gradually accumulated, and these paths are adapted to solve new wayfinding problems.
- Agents communicate path-knowledge to each other allowing cooperative problem-solving.



Skeleton-path selection

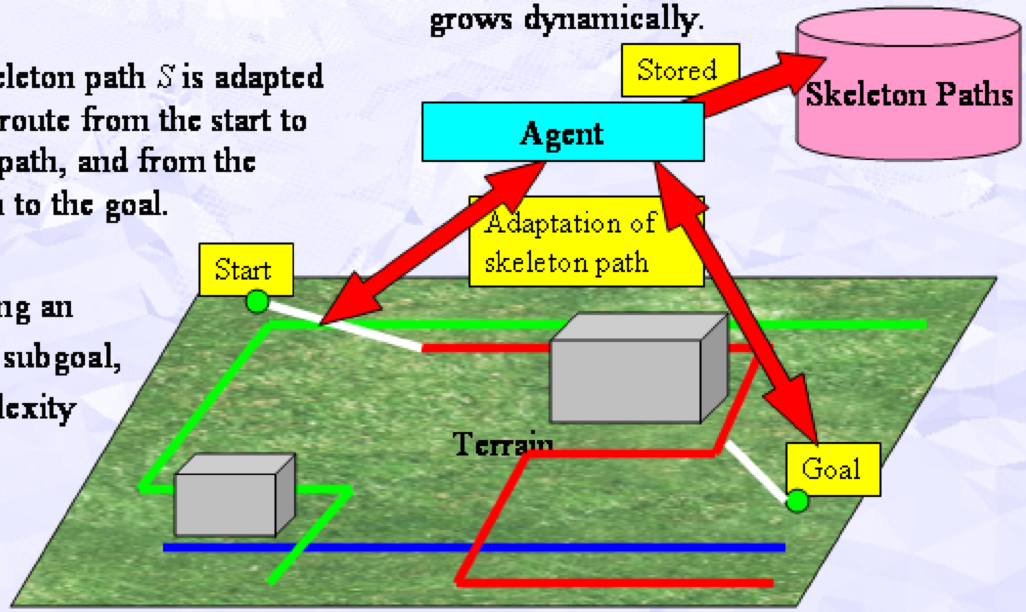
- **Selecting a known skeleton path for adaptation to solve a new problem.**
- **An appropriate path S is selected depending on:**
  - Amount of prior use
    - By both this agent and known other agents
  - Path length
  - Orientation and curvature
  - Estimated adaptation distances



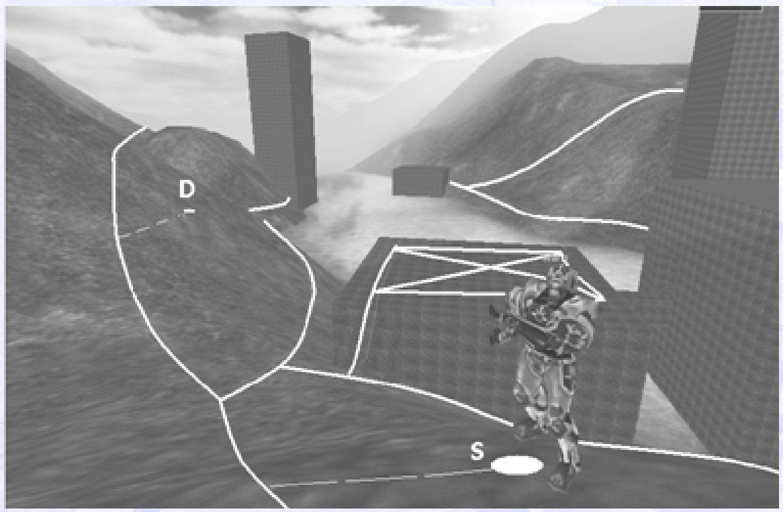


Skeleton-path adaptation

- Adapting a chosen skeleton path to solve a new problem.
- A chosen skeleton path S is adapted by finding a route from the start to the skeleton path, and from the skeleton path to the goal.
- By introducing an intermediate subgoal, search complexity is reduced.
- The adapted path is retained in the skeleton-paths case-base, which grows dynamically.



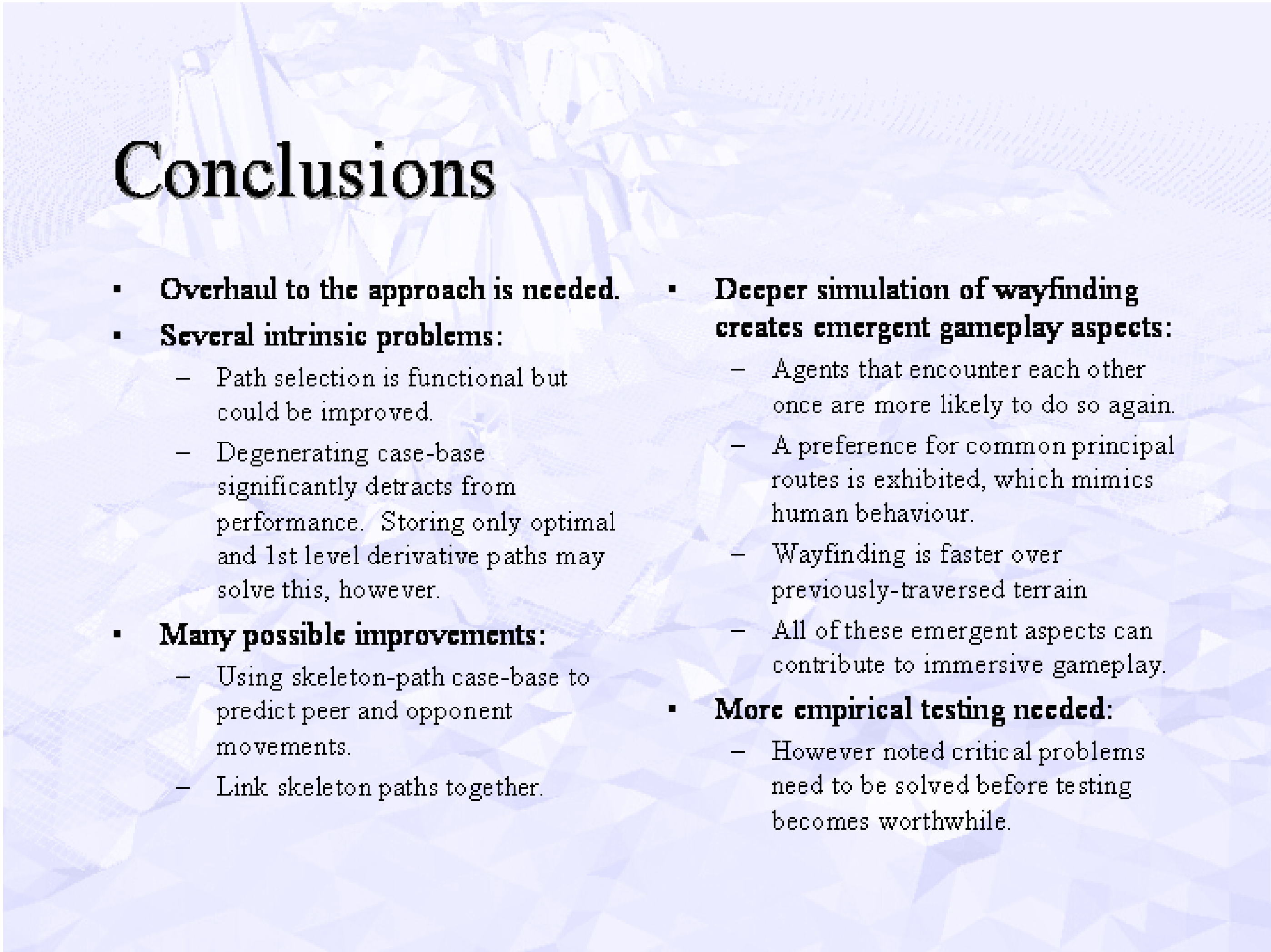
In Vivo



- The Torque Game Engine from Garage Games was adapted.
- An inter-agent communication system using semantic networks was implemented.
- The skeleton-based wayfinding system was built over this both this communication system and a basic A* implementation.

Evaluation

- Benefits:
  - More human-like paths chosen.
  - More human-like cooperation between route-finding agents.
  - Wayfinding can be more efficient.
  - An emergent positive-feedback loop causes agents to prefer common routes and thus encounter each other more frequently.
- Problems (classic CBR issues)
  - The skeleton path case-base is difficult to maintain automatically, and can become degenerate if significantly sub-optimal paths are stored.
  - Skeleton-path selection is a non-trivial task that is compounded by a degenerating case-base.


Conclusions
Overhaul to the approach is needed.
Several intrinsic problems:
– Path selection is functional but could be improved.
– Degenerating case-base significantly detracts from performance. Storing only optimal and 1st level derivative paths may solve this, however.
Many possible improvements:
– Using skeleton-path case-base to predict peer and opponent movements.
– Link skeleton paths together.
Deeper simulation of wayfinding creates emergent gameplay aspects:
– Agents that encounter each other once are more likely to do so again.
– A preference for common principal routes is exhibited, which mimics human behaviour.
– Wayfinding is faster over previously-traversed terrain
– All of these emergent aspects can contribute to immersive gameplay.
More empirical testing needed:
– However noted critical problems need to be solved before testing becomes worthwhile.