StarCraft: Brood War

Literature presentation

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Overview

1. StarCraft: Brood War
2. Related work
3. Implementation
4. Benchmarks
5. Summary

StarCraft: Brood War

The Game

StarCraft: Brood War (1998)

Blizzard Entertainment

Real-time strategy game

Gameplay


TERRAN
Dominate the battlefield with superior firepower
ENTER
PROTOSS
Annihilate your enemies with psionic powers and advanced technologies
ENTER
ZERG
Overrun entire planets with the unyielding might of the Swarm
ENTER

Gameplay

- Resource management
  - Minerals
  - Vespene gas
- Building construction
- Warfare

Current AI

- Four difficulty levels
  - "easy" to "insane"
- Noted problems
  - Unresponsive
  - Exploitable bugs

AI Competitions

- Student StarCraft AI Tournament (SSCAIT)[1]
- AIIDE Starcraft AI Competition[2]
- ▸ Link

[1] http://sscaitournament.com/
[2] https://webdocs.cs.ualberta.ca/ cdavid/starcraftaicomp/

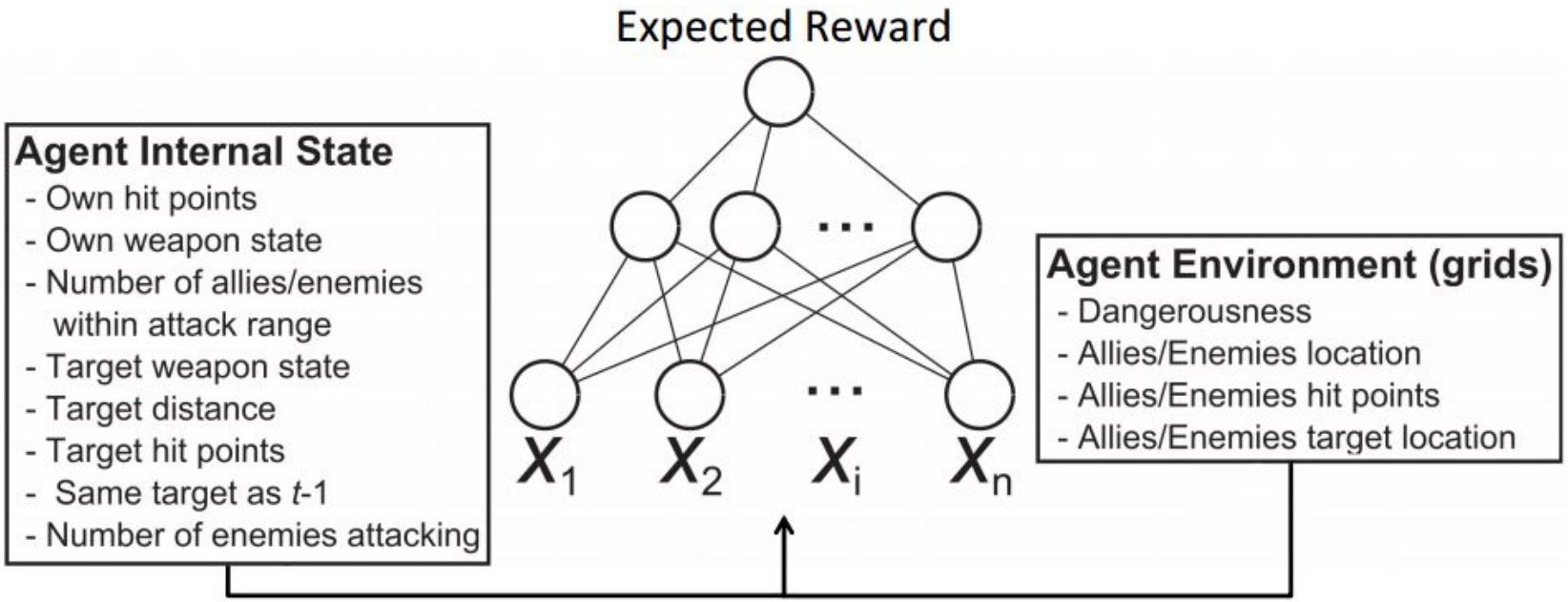
Related work

StarCraft AI techniques

Tactical Decision-Making	Strategic Decision-Making and Plan Recognition
Reinforcement Learning	Case-Based Planning
Game-Tree Search	Hierarchical Planning
Bayesian models	Behaviour Trees
Case-Based Reasoning	Goal-Driven Autonomy
Neural Networks	State Space Planning
	Spatial Reasoning
	Deductive Reasoning
	Probabilistic Reasoning

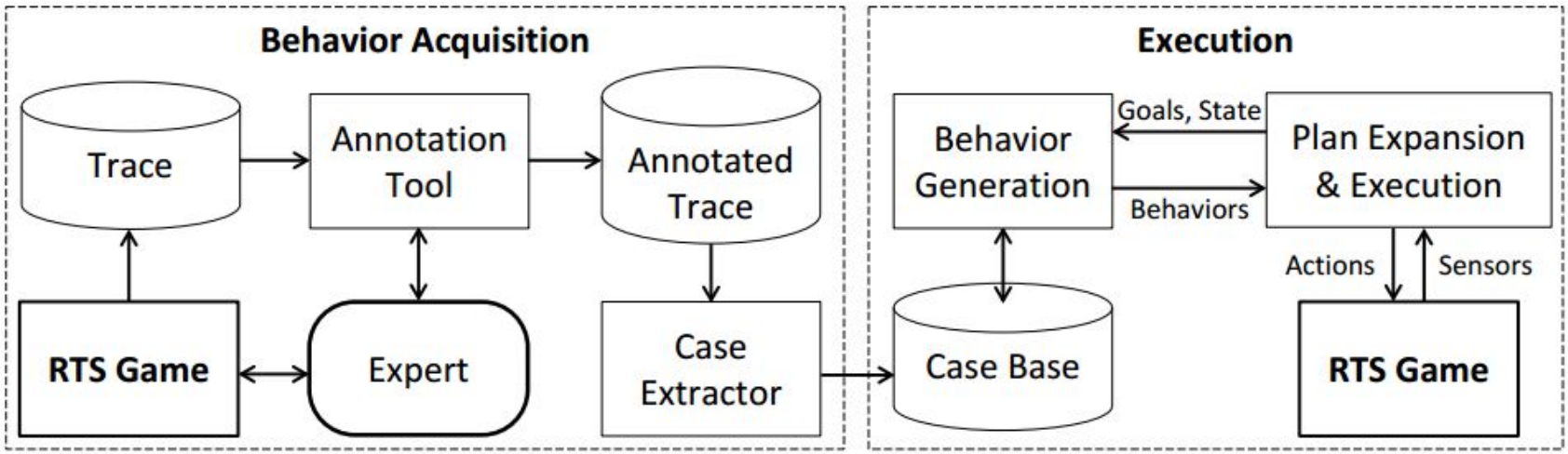
[0]Robertson, Glen, and Ian D. Watson. "A Review of Real-Time Strategy Game AI." AI Magazine 35.4 (2014): 75-104.

Reinforcement learning and neural network



[0]Shantia, Amirhosein, Eric Begue, and Marco Wiering. "Connectionist reinforcement learning for intelligent unit micro management in starcraft." Neural Networks (IJCNN), The 2011 International Joint Conference on. IEEE.

Case-based planning



[0]Ontañón, Santiago, et al. "Case-based planning and execution for real-time strategy games." Case-Based Reasoning Research and Development. Springer Berlin Heidelberg, 2007. 164-178.

Game-Tree Search

- High complexity
- Only works for small armies
- Unavailability of a suitable simulator

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[0]Uriarte, Alberto, and Santiago Ontañón. "High-level representations for game-tree search in RTS games." Tenth Artificial Intelligence and Interactive Digital Entertainment Conference. 2014.

Goals

- Main Goal
  - Challenging and fun experience for every type of player that can also compete against other bots.
- Sub Goals
  - Multiple difficulty levels
  - AI can adapt during the game
  - Agent based

Implementation

Approaches

- Goal-driven Autonomy
- Hierarchical Planning
- Spatial Reasoning
- Heat maps

BWAPI

- Information
  - Obtain list of unit actions: Attack, Move, Build.
  - Obtain current data of visible unit: Position, HP, Mana, isIdle.
  - Obtain global data about any unit type: MaxSpeed, Damage, MaxHP, Size, isFlyer.
- Unit micro-management
- Resource allocation

[0]http://code.google.com/p/bwapi/

Attack Sequence	isAttacking	isAttackFrame	Additional Notes
1. Unit is Idle	`False`	`False`	Unit may be idle or performing another command (i.e.: move)
2. Issue Attack Cmd	`False`	`False`	Player gives order to attack a target unit
3. Turn to Face Target	`False`	`False`	May have 0 duration if already facing target
4. Approach Target	`False`	`False`	May have 0 duration if already in range of target
5. Stop Moving	`False`	`False`	Some units require unit to come to complete stop before firing
6. Begin Attack Anim	`True`	`True`	Attack animation starts, damage not yet dealt
7. Anim Until Damage	`True`	`True`	Animation frames until projectile released
8. Mandatory Anim	`True`	`True`	Extra animation frames after damage (may be 0)
9. Optional Anim	`True`	`True`	Other command can be issued to cancel extraneous frames
10. Wait for Reload	`True`	`False`	Unit may be given other commands until it can shoot again
11. Goto Step 3	`False`	`False`	Repeat the attack

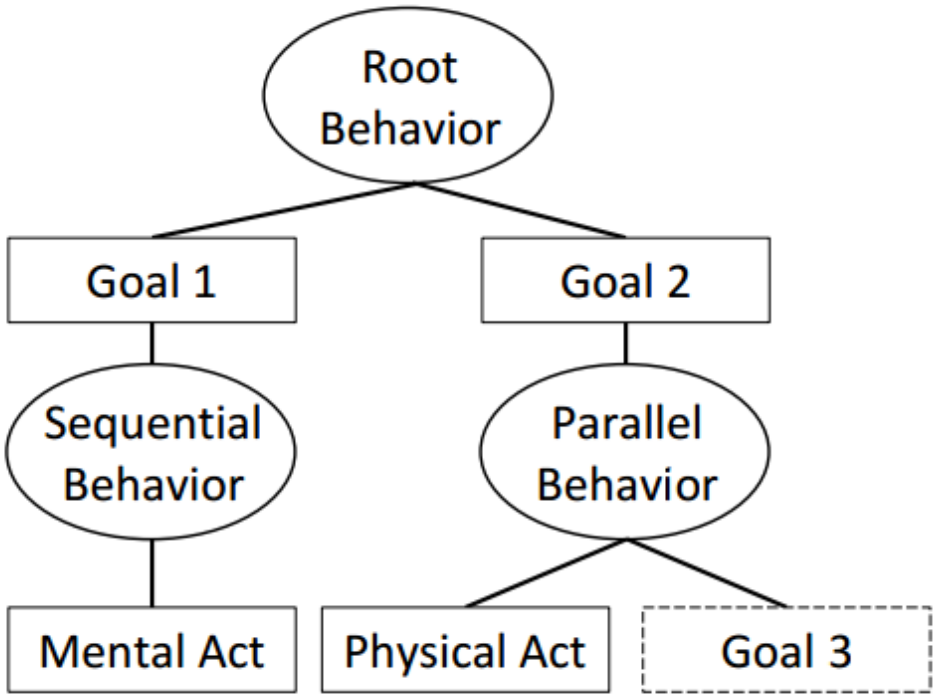
Table 1: The attack sequence of a unit.

[0]Churchill, David, and Michael Buro. "Incorporating search algorithms into RTS game agents." AI and Interactive Digital Entertainment Conference, AIIDE (AAAI). 2012.

Goal-driven Autonomy

- Identifying when goals need to be updated
- Creating units
  - Economy
  - Military
- Performing actions
  - Gathering resources
  - Attacking
  - Defending
- Early game vs. Mid game

Goal-driven Autonomy



[0]Weber, Ben George, Michael Mateas, and Arnav Jhala. "Applying Goal-Driven Autonomy to StarCraft." AIIDE. 2010.

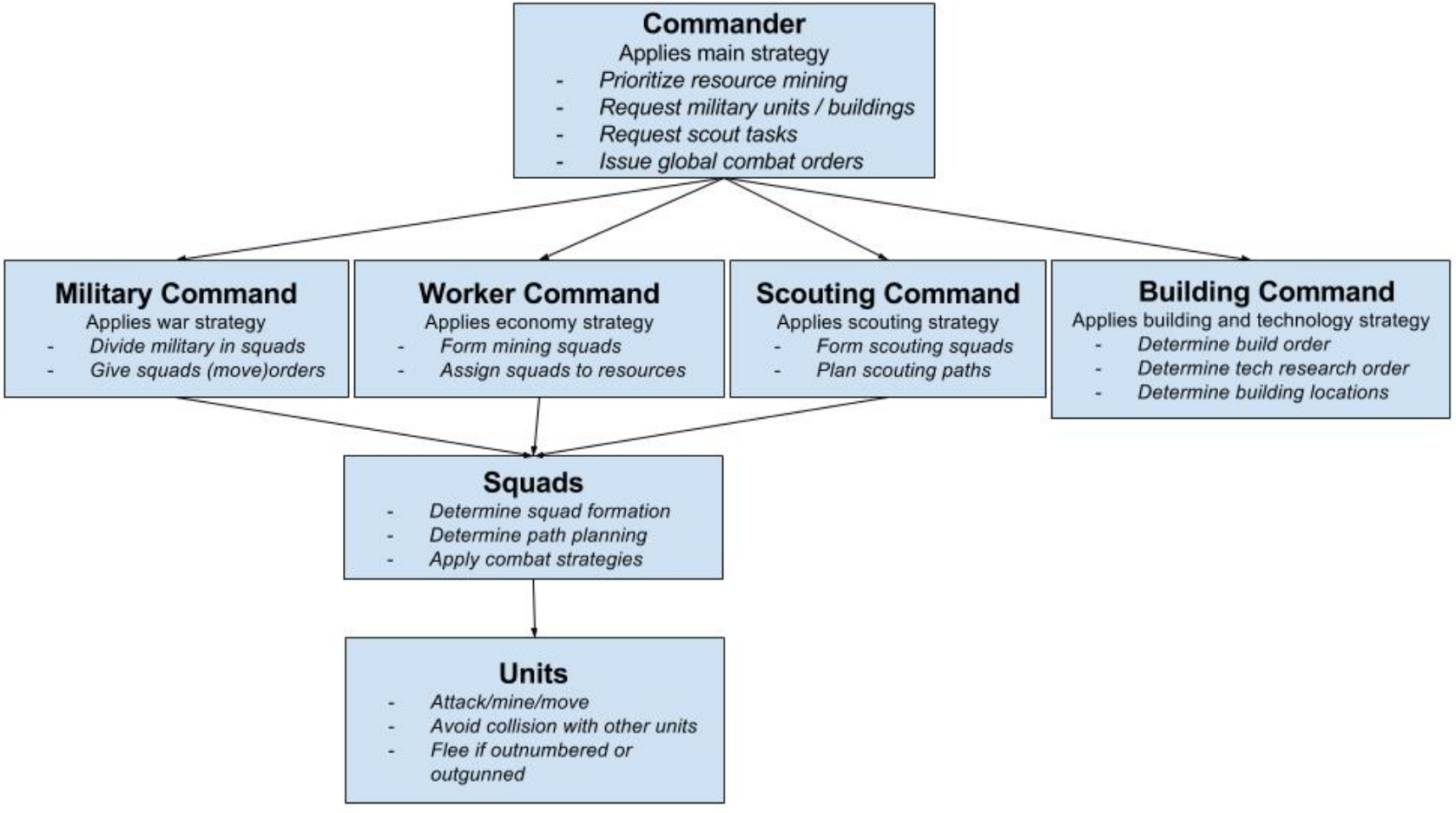
Hierarchical Planning

Commander: Bobbot

- Military Control
  - Unit move orders, squads & micro management
- Worker Control
  - Resource gathering
- Building Control
  - Build order & build requests
- Scouting
  - Map exploration (spatial reasoning)

[0]Weber, Ben George, Michael Mateas, and Arnav Jhala. "Building Human-Level AI for Real-Time Strategy Games." AAAI Fall Symposium: Advances in Cognitive Systems. Vol. 11. 2011.

Hierarchical Planning



Spatial Reasoning

- Reasoning about positions and actions
- Terrain analysis
  - Connection between the regions
  - Choke points
  - Predict locations of the enemy
  - Influence maps (for combat and threat levels)

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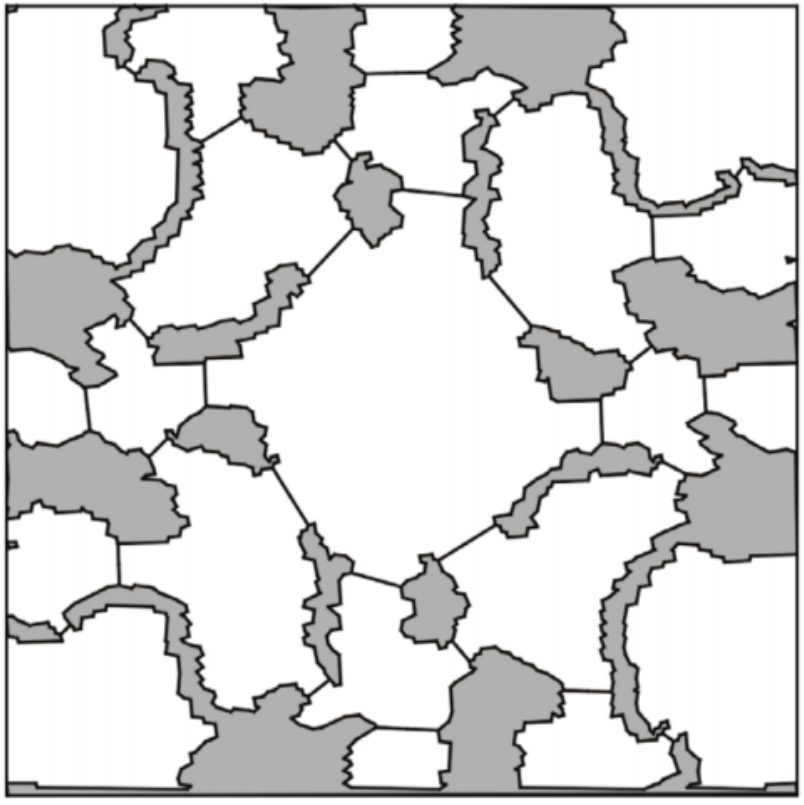
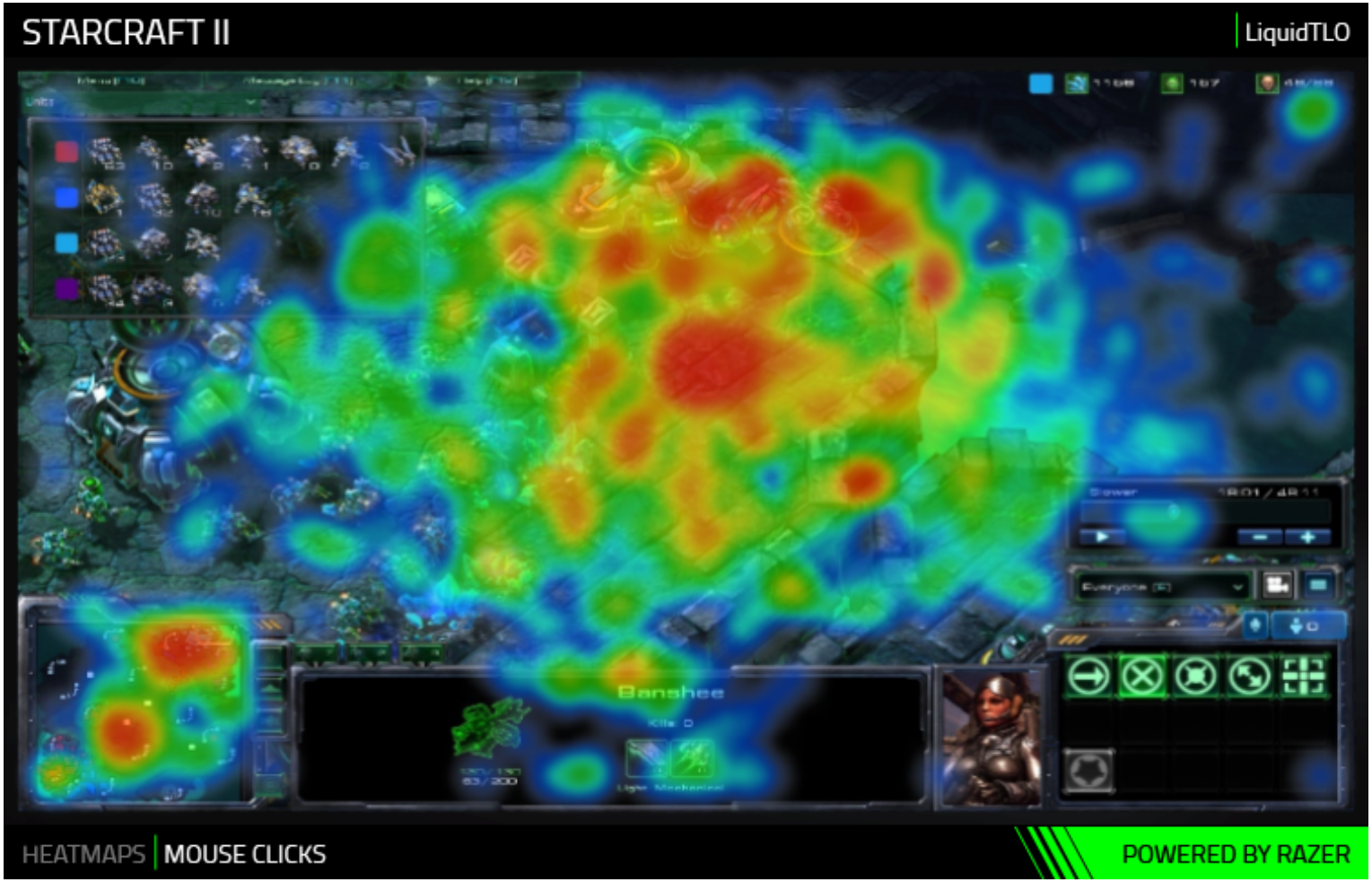
[0]Weber, Ben George, Michael Mateas, and Arnav Jhala. "A Particle Model for State Estimation in Real-Time Strategy Games." AIIDE. 2011.

Spational Reasoning - Terrain Analysis



This figure shows how different regions are connected along with possible choke points.
Technique: Potential Fields - Kabanza et al. (2010) uses this for threat identification & Enemy location prediction (Influence Maps).

Heat maps



[0]http://www.razerzone.com/de-de/synapse/stats

Benchmarks

Benchmarks

- Win / Lose Ratio
- Units lost vs. Units killed
- Resource Manager
- Survival Time

Win / Lose Ratio

- Main Criteria
- 100 Bot runs against

Units lost / killed

- Units lost
  - Military
  - Economy
- Units killed
  - Military
  - Economy

Resource Management

- Total resources gathered
- Resource savings vs. resource spending

Survival Time

- Survival time

Summary

Summary

- Starcraft
- Related Work
- Goals
- Implementation using BWAPI
  - Goal-driven Autonomy
  - Hierarchical Planning
  - Spatial Reasoning
- Benchmarks