

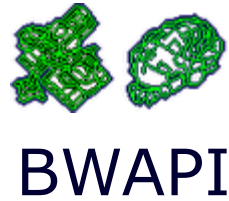
2017 Starcraft AI Competition

Report and Results

David Churchill, Richard Kelly

Memorial University of Newfoundland





Tournament Report

www.StarcraftAICompetition.com

“Results”
2017 Report
(coming soon)

Tournament Format

- Full Game – Starcraft Broodwar
 - Fog of War Enabled
- Round Robin Format
 - 1v1 Games
 - Bots ranked by final win percentage

Game Rules

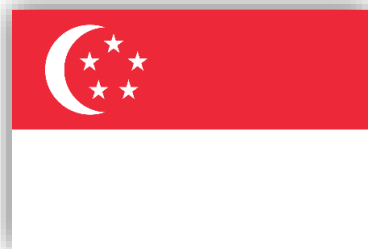
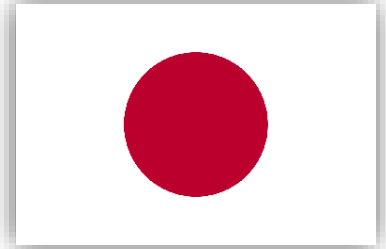
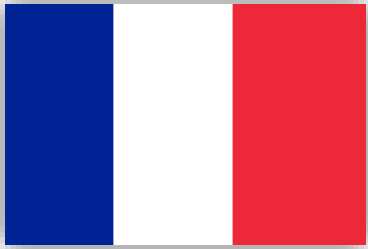
- 60 minute game time-limit
 - Tie break with in-game score
- No cheating or in-game glitches
 - Disqualified if cheating found
- Bots penalized for slow computations
 - Game loss if bot goes over computation limit
- File I/O - Learning

Why Not Starcraft 2?

Starcraft 2 EULA Violations:

- ~~In whole or in part, copy or reproduce (except as provided herein), translate, reverse engineer, derive source code from, modify, disassemble, decompile, or create derivative works based on the Game;~~
- ~~Use cheats, automation software (bots), hacks, or any other unauthorized third-party software designed to modify the Game experience, including without limitation, mods that violate the terms of this License Agreement or the Terms of Use;~~
- ~~Use any unauthorized third party software that intercepts, "mines", or otherwise collects information from or through the Game or the Service, including without limitation any software that reads areas of RAM used by the Game to store information; provided, however, that Blizzard may, at its sole and absolute discretion, allow the use of certain third party user interfaces;~~
- ~~Modify or cause to be modified any files that are a part of the Game in any way not expressly authorized by Blizzard;~~

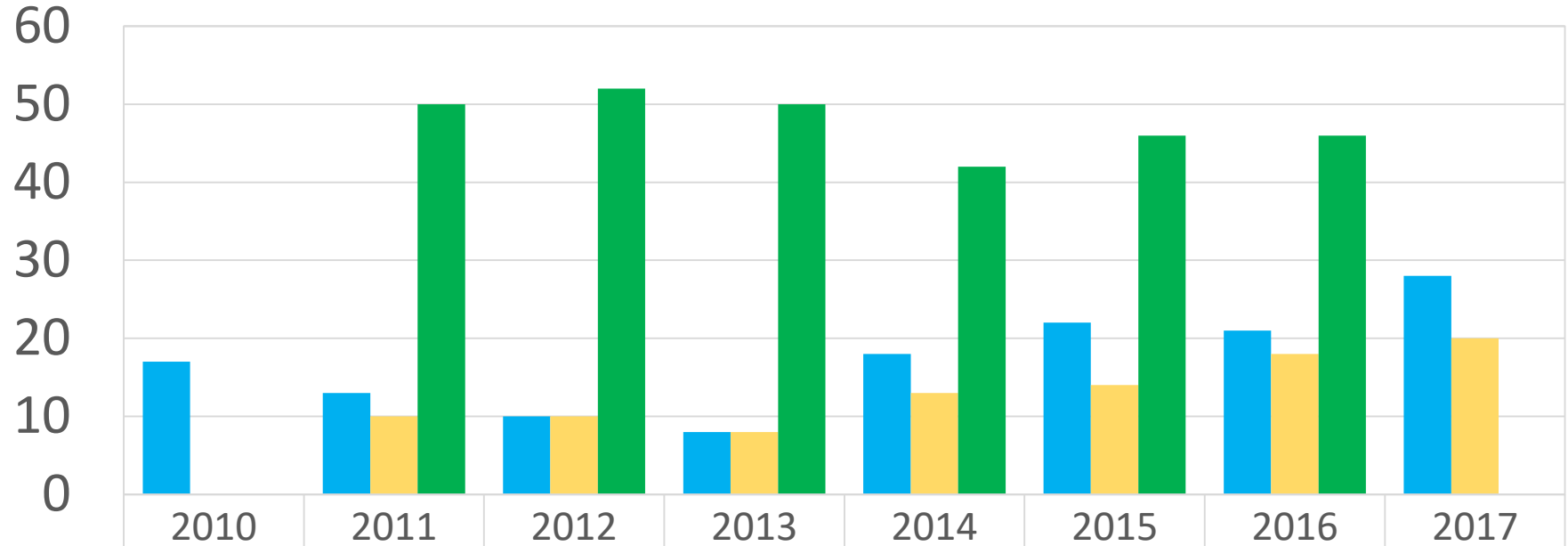
1	AILien	Alexander Stumpp	Independent	Zerg	4.2.0	dll	2017 Registered
2	Arrakhammer	Anthony Van	Stanford University	Zerg	4.1.2	dll	2017 Registered
3	CherryPi	Gabriel Synnaeve	Facebook	Zerg	4.2.0	dll + proxy	2017 Registered
4	cpac	Qiyue Yin	Independent	Zerg	4.1.2	dll	2017 Registered
5	ForceBot	Tom Peeters	Delft University of Technology	Zerg	3.7.4	dll	2017 Registered
6	HannesBredberg	Hannes Bredberg	Royal Institute of Technology, Stockholm	Terran	4.1.2	dll	2017 Registered
7	Iron	Igor Dimitrijevic	Independent	Terran	4.1.2	dll	2017 Registered
8	Juno	Zhu Yuanheng	Independent	Protoss	4.1.2	dll	2017 Registered
9	KillAll	Tang Zhentao	State Key Laboratories, China	Zerg	4.1.2	dll	2017 Registered
10	LetaBot	Martin Rooijackers	Maastricht University	Terran	3.7.4	dll	2017 Registered
11	McRave	Christian McCrave	Independent	Protoss	4.1.2	dll	2017 Registered
12	MegaBot	Anderson Tavares	Universidade Federal de Minas Gerais	Protoss	3.7.4	dll	2017 Registered
13	Microwave	Micky Holdorf	Independent	Zerg	4.1.2	dll	2017 Registered
14	Myscbot	Teguh Budianto	University of Tsukuba	Protoss	4.1.2	dll	2017 Registered
15	Overkill	Sijia Xu	Independent	Zerg	4.1.2	dll	2017 Registered
16	PurpleWave	Dan Gant	Independent	Protoss	4.1.2	proxy	2017 Registered
17	Sling	Tekseon Shin	Independent	Zerg	4.1.2	proxy	2017 Registered
18	Steamhammer	Jay Scott	Independent	Zerg	4.1.2	dll	2017 Registered
19	Tyr	Simon Prins	Independent	Protoss	4.1.2	proxy	2017 Registered
20	UAlbertaBot	David Churchill	Memorial University	Random	4.2.0	dll	2017 Registered
21	Ziabot	Cha Sungguk	Independent	Zerg	4.1.2	dll	2017 Registered
22	ZZZKBot	Chris Coxe	Independent	Zerg	4.2.0	dll	2017 Registered
23	Aiur	Florian Richoux	Université de Nantes	Protoss	3.7.4	dll	2016 Returning
24	GarmBot	Aurélien Lermant	EPITA University	Zerg	3.7.4	proxy	2016 Returning
25	IceBot	Kien Nguyen Quang	Ritsumeikan University	Terran	3.7.4	dll	2016 Returning
26	Skynet	Andrew Smith	Independent	Protoss	3.7.4	dll	2016 Returning
27	Xelnaga	Ho-Chul Cho	Sejong University	Protoss	3.7.4	dll	2016 Returning
28	Ximp	Tomas Vajda	Independent	Protoss	3.7.4	dll	2016 Returning






Tournament Statistics

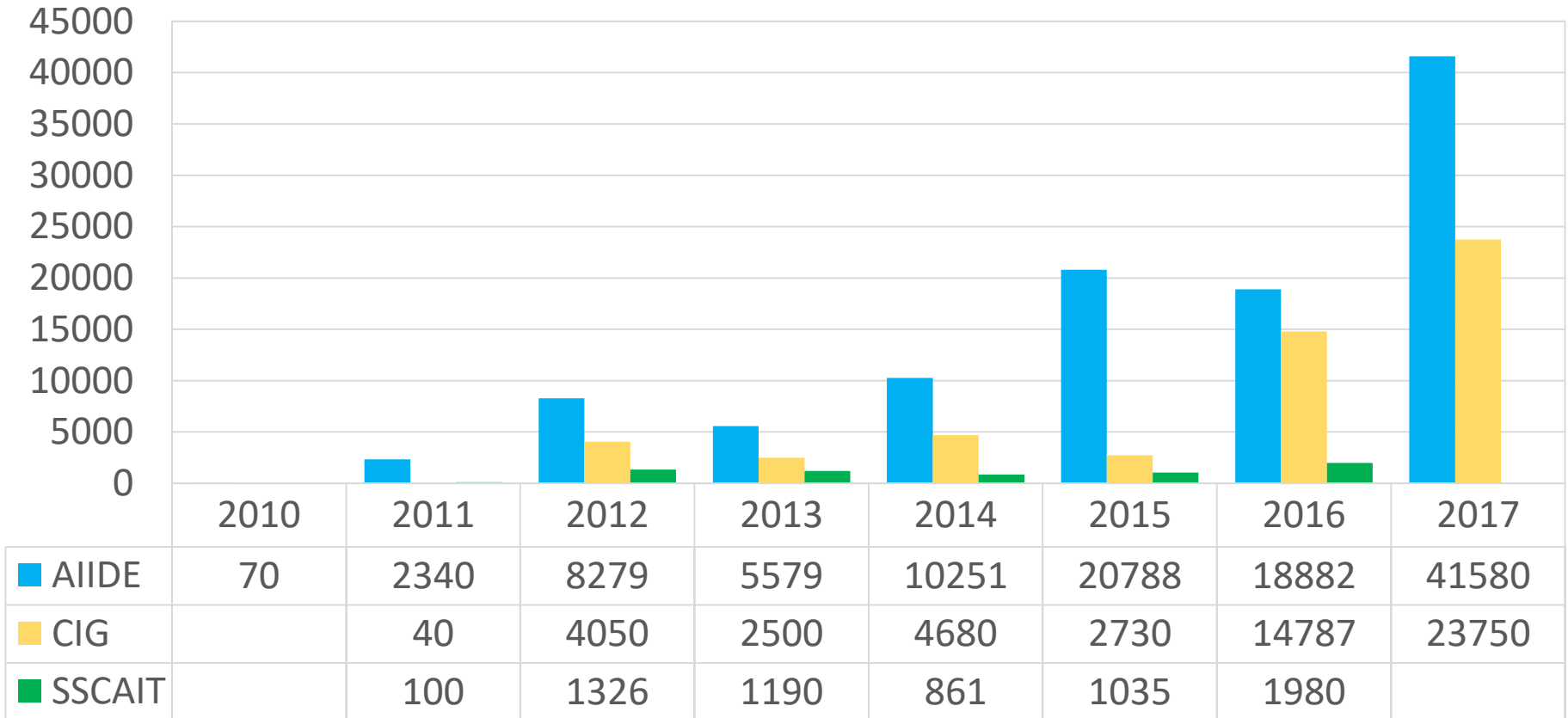
- Played on 16 virtual machines
- Tournament ran for 2 weeks
- 41,580 games played in total
- 2970 games per bot
- 110 games per bot pairing

Starcraft AI Competitions - Total Entrants

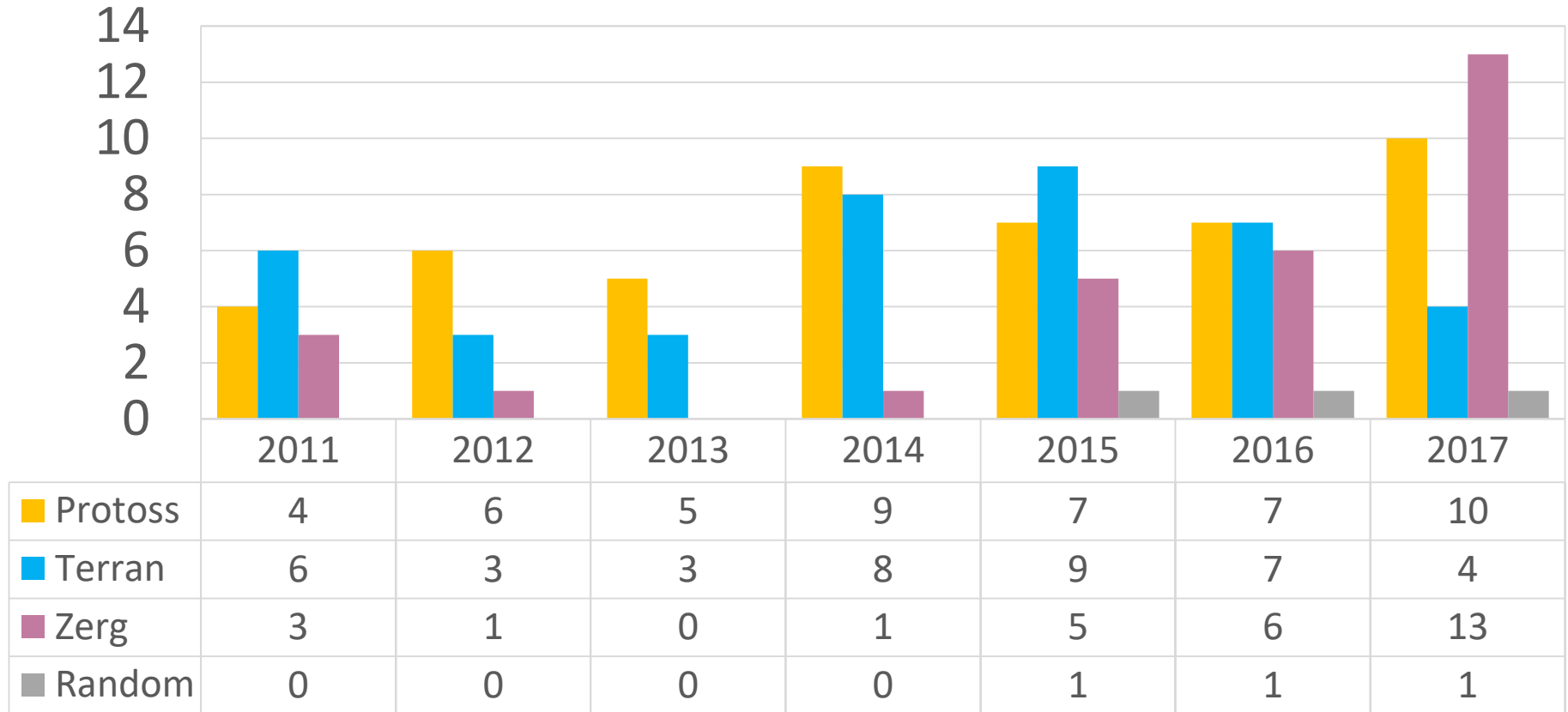


 AIIDE	17	13	10	8	18	22	21	28
 CIG		10	10	8	13	14	18	20
 SSCAIT		50	52	50	42	46	46	

Starcraft AI Competitions - Total Games Played

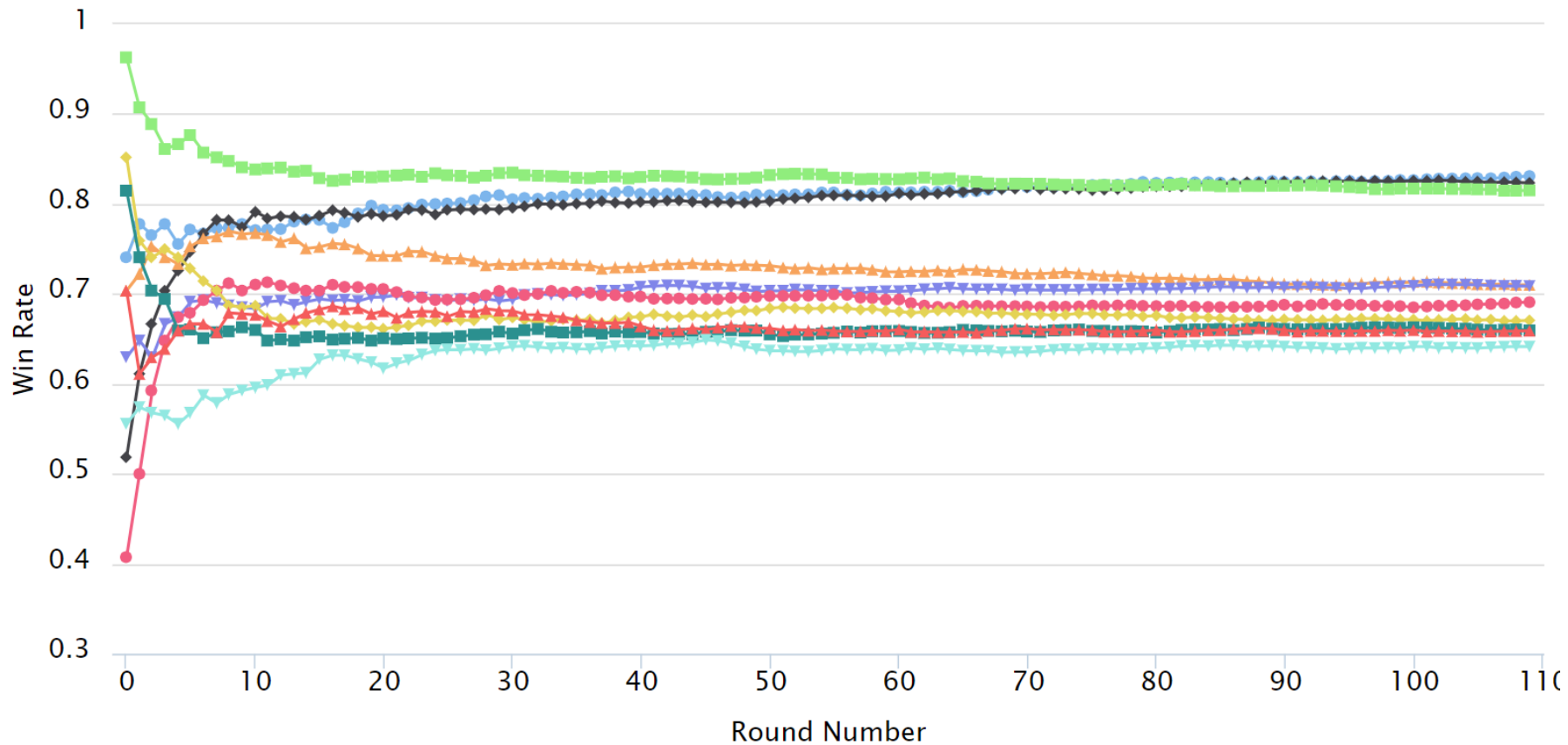


Starcraft AI Competitions - Race Distribution

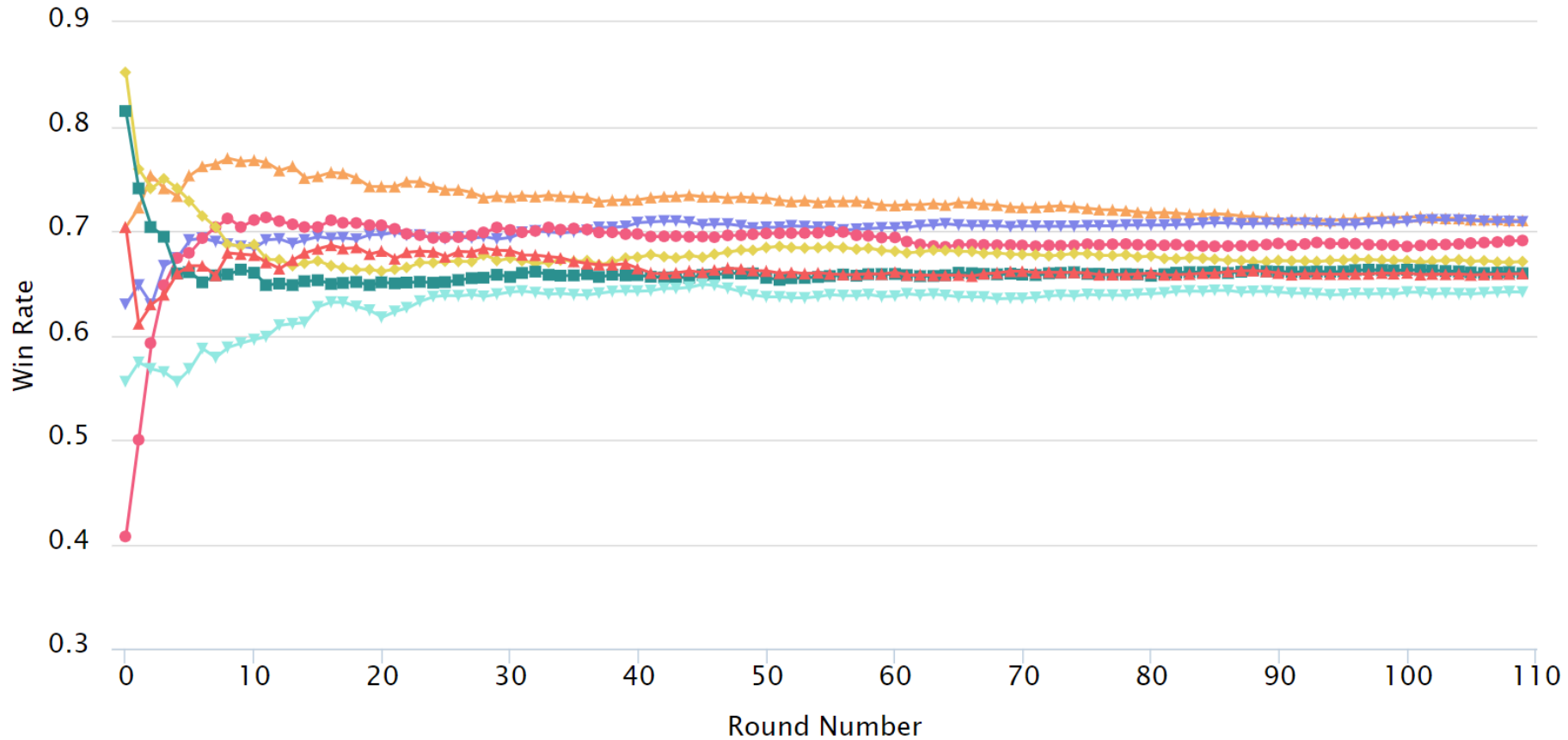


RESULTS

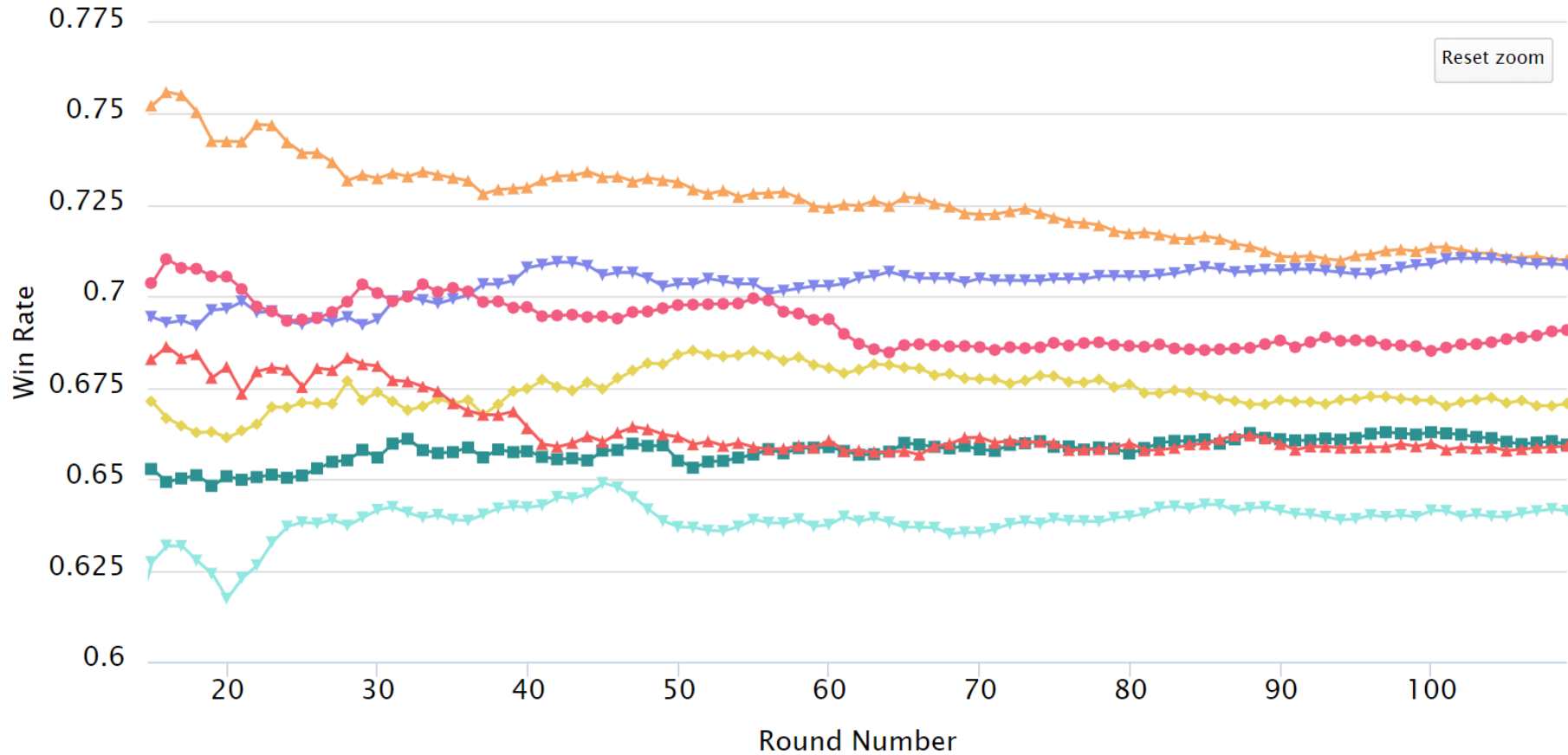
Starcraft AI Competition Win Percentage Over Time



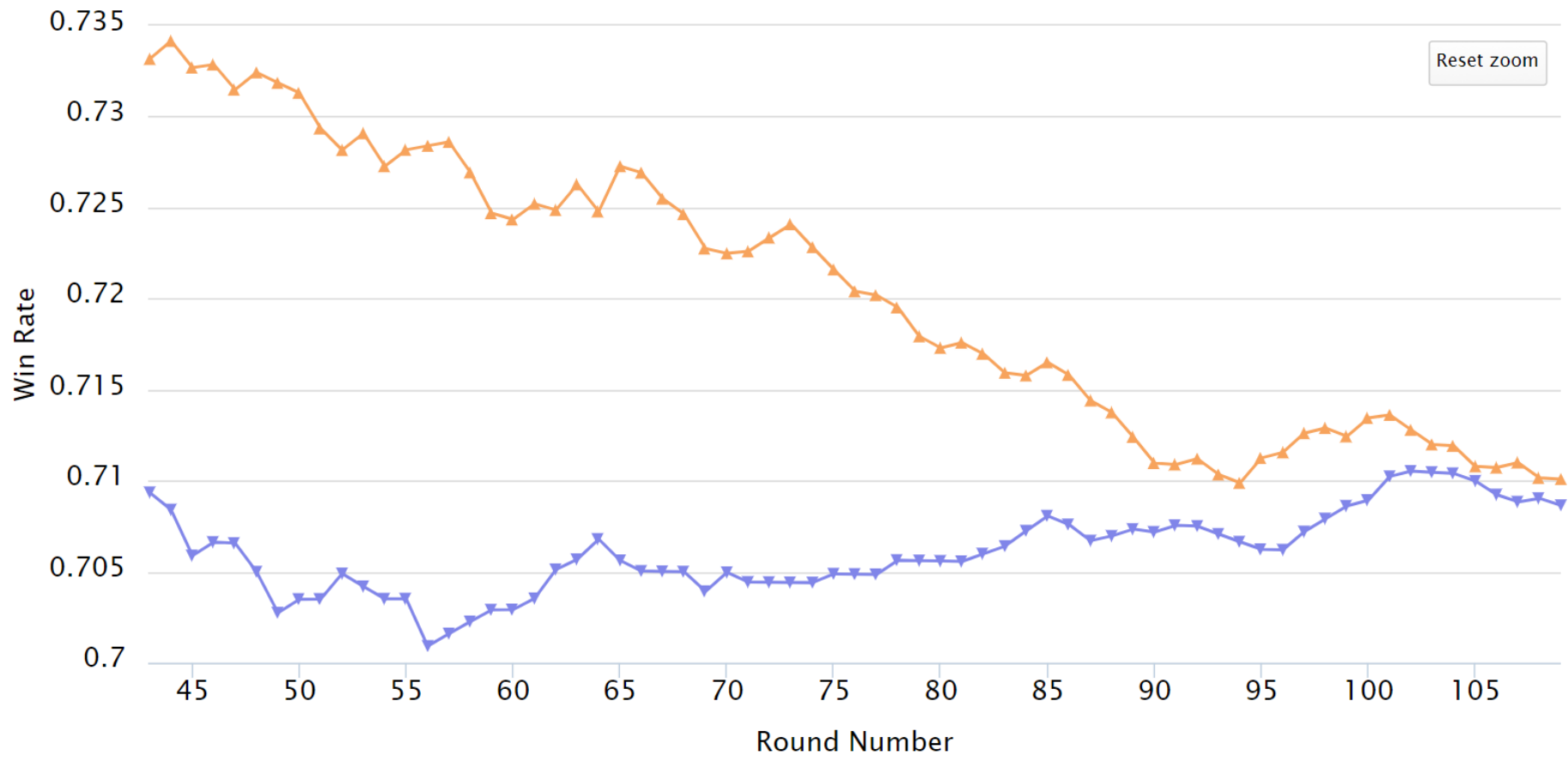
Starcraft AI Competition Win Percentage Over Time



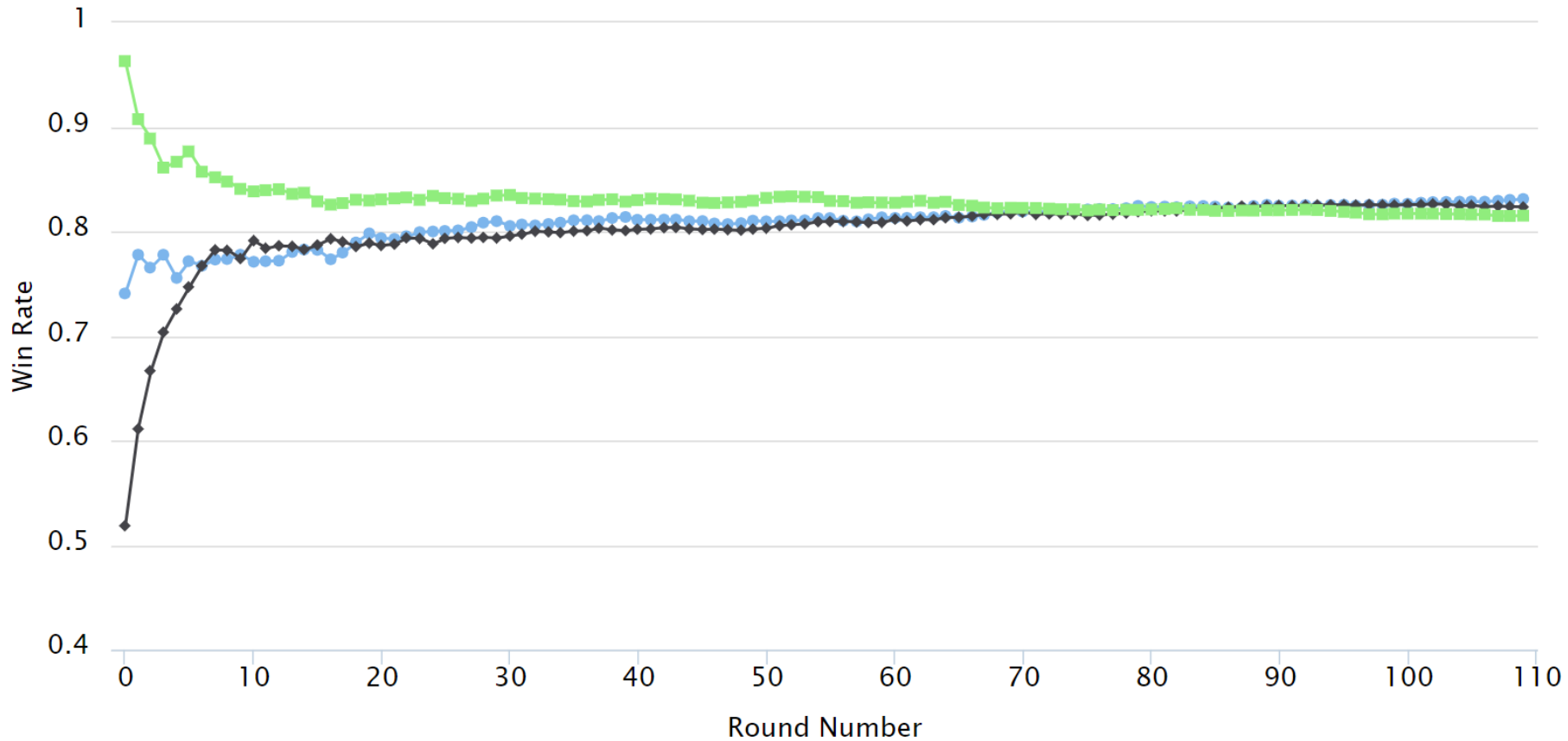
Starcraft AI Competition Win Percentage Over Time



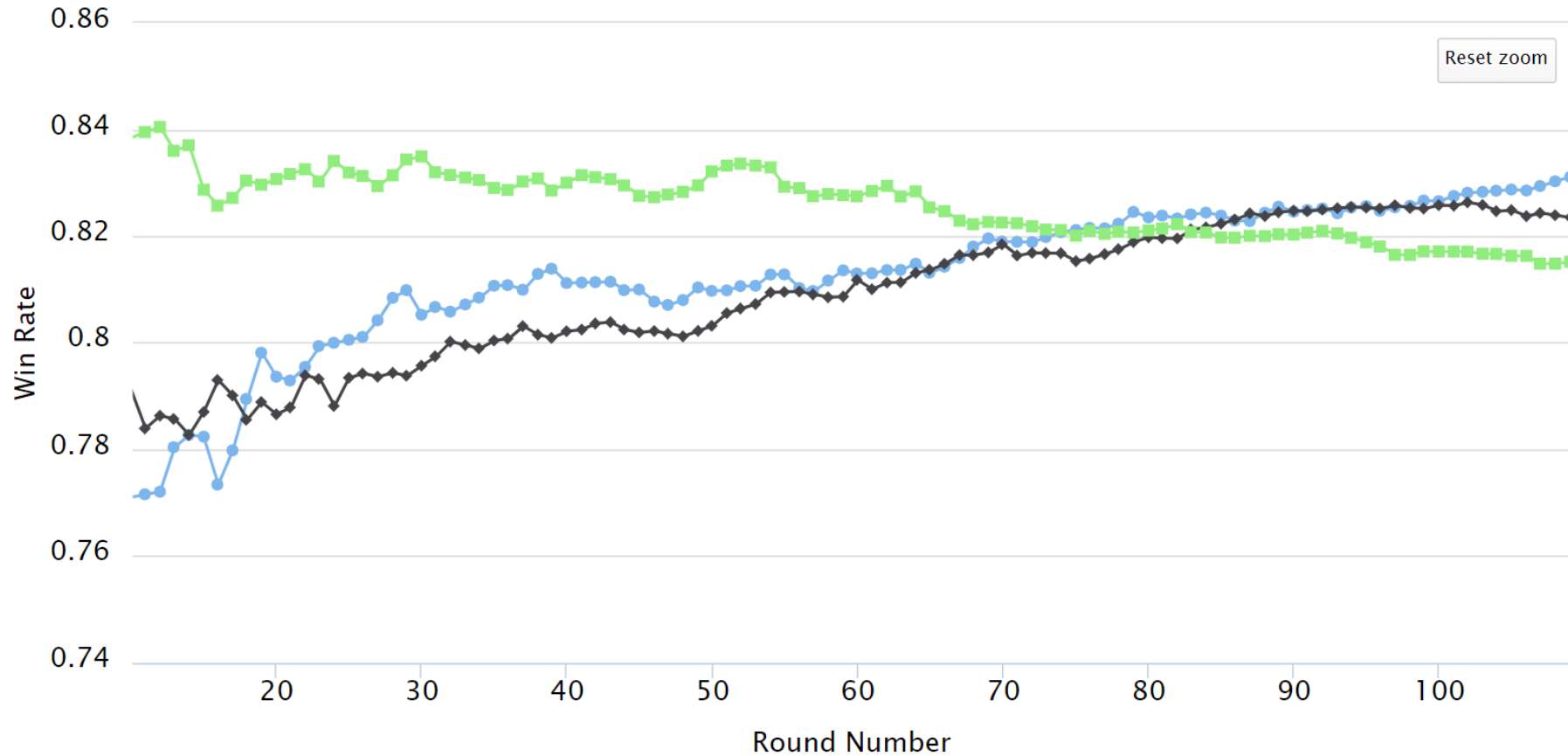
Starcraft AI Competition Win Percentage Over Time



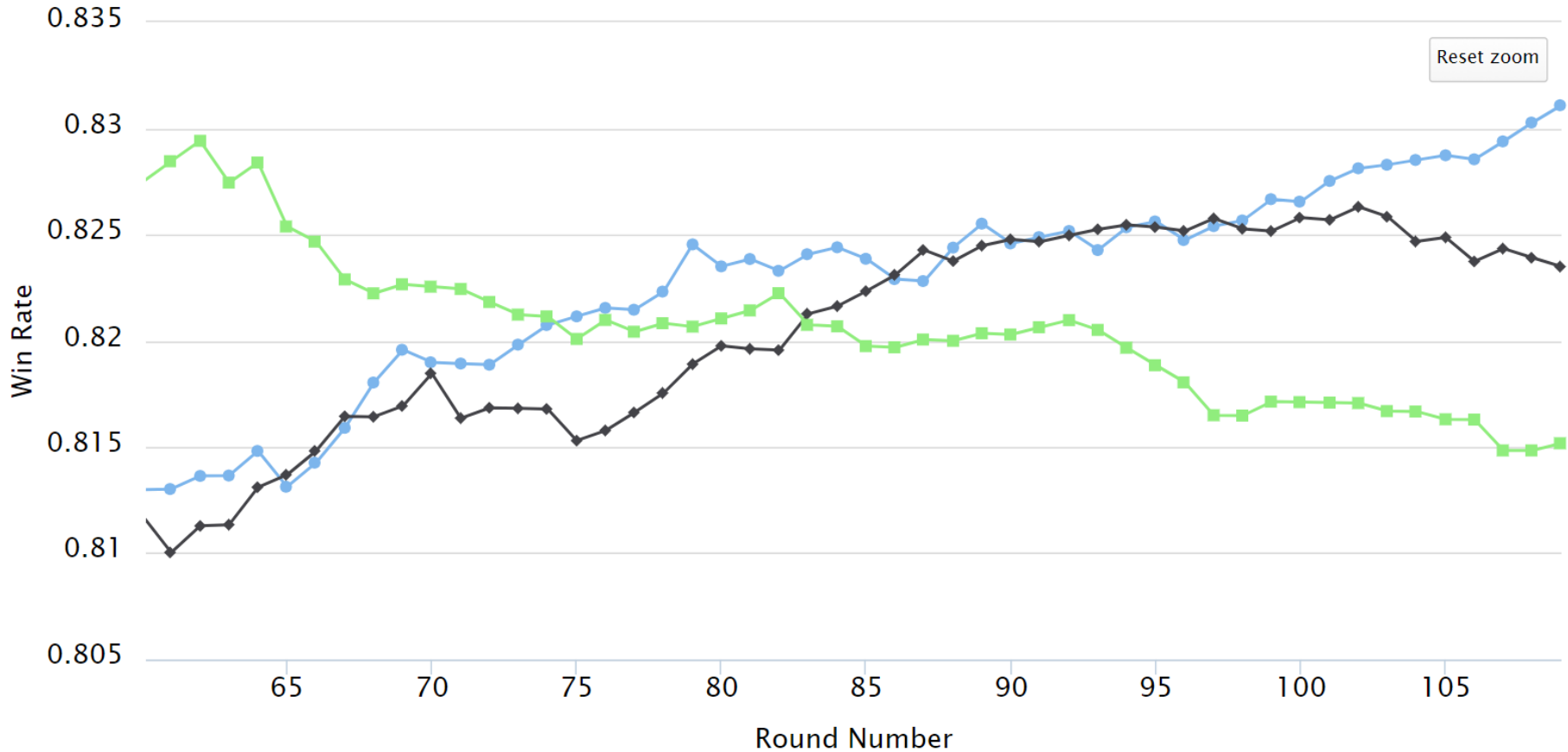
Starcraft AI Competition Win Percentage Over Time



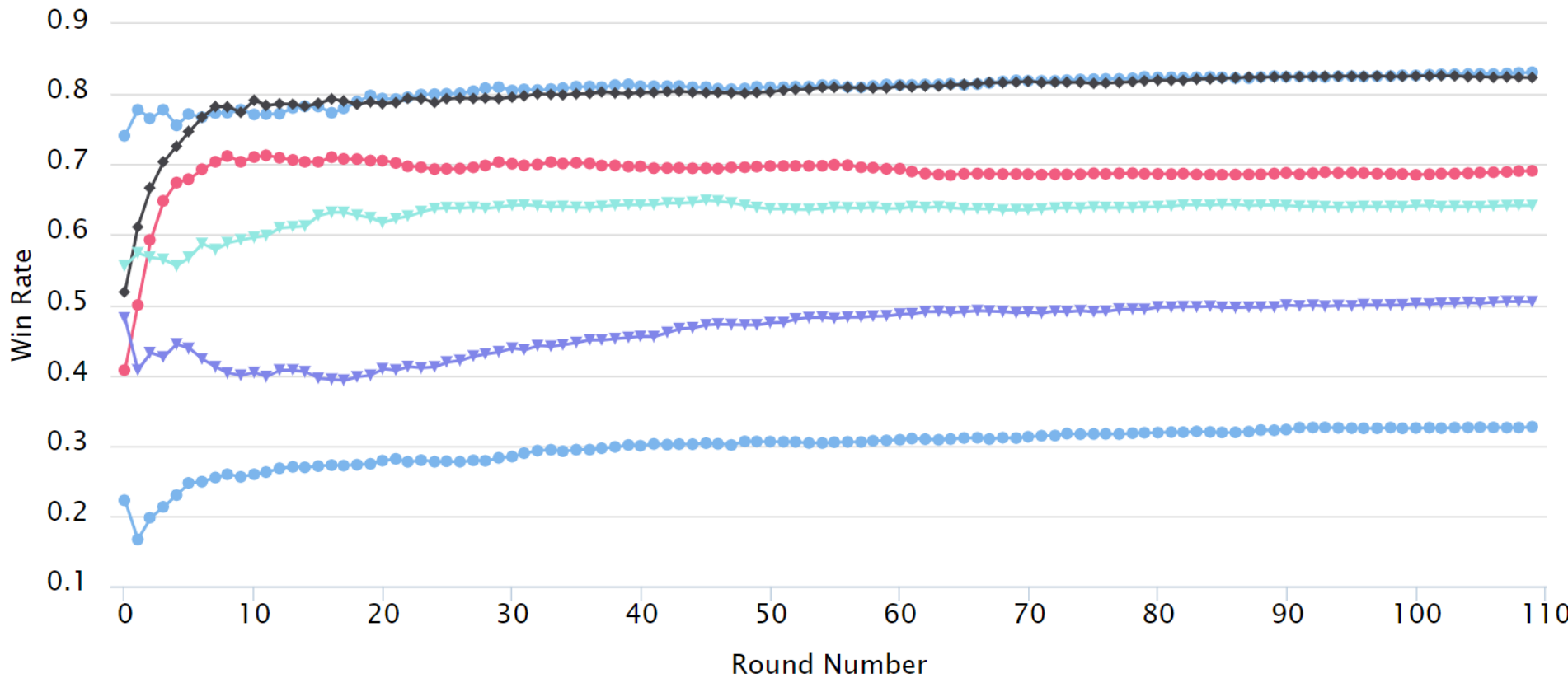
Starcraft AI Competition Win Percentage Over Time



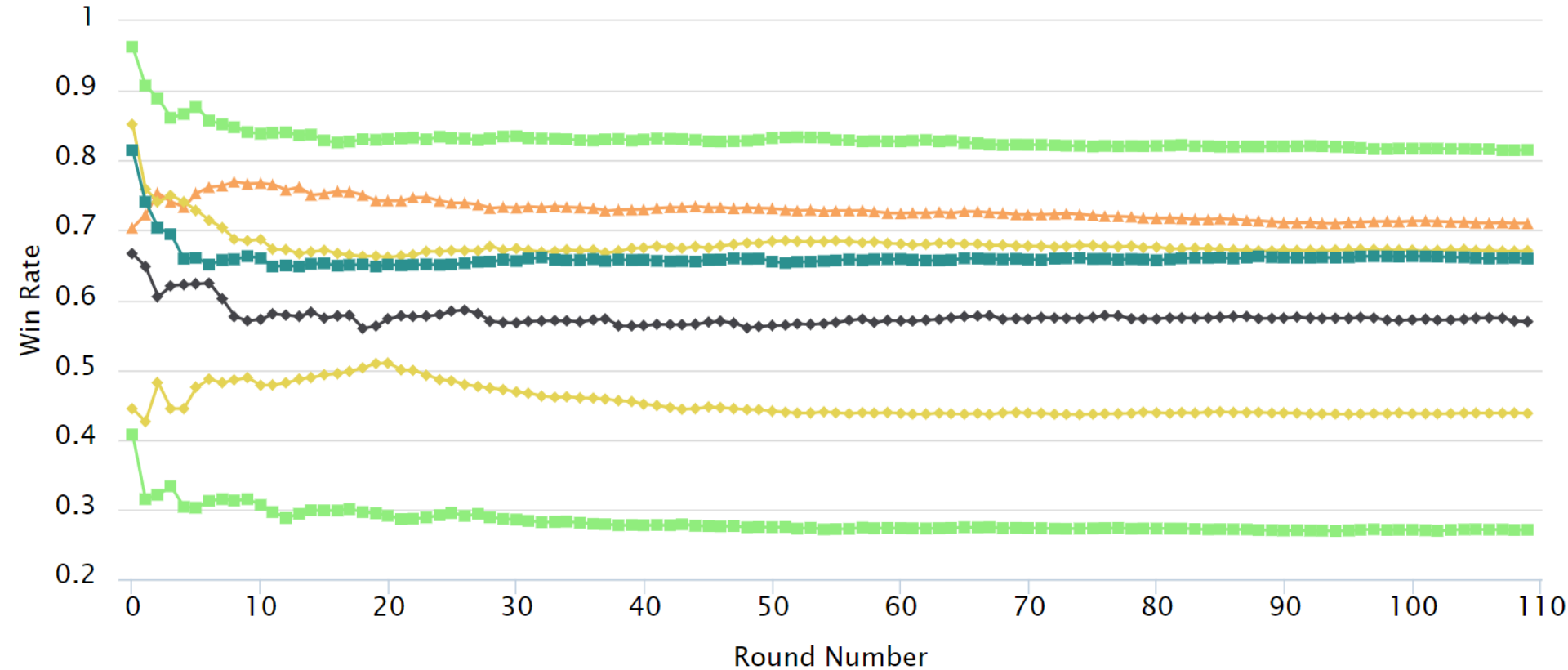
Starcraft AI Competition Win Percentage Over Time



Starcraft AI Competition Win Percentage Over Time



Starcraft AI Competition Win Percentage Over Time



Rock Paper Scissors?

- A beats B, B beats C, C beats A
- 2017 Competition:

1 > 2 > 10 > 6 > 3 > 5
> 8 > 9 > 4 > 7 > 1

	Bot	Win %	2016
6 th			
7 th			
8 th			
9 th			
10 th			

	Bot	Win %	2016
6 th			
7 th			
8 th			
9 th			
10 th	Steamhammer	64.14	-

	Bot	Win %	2016
6 th			
7 th			
8 th			
9 th	Tyr	65.91	21 st
10 th	Steamhammer	64.14	-

	Bot	Win %	2016
6 th			
7 th			
8 th	Arrakhammer	65.95	-
9 th	Tyr	65.91	21 st
10 th	Steamhammer	64.14	-

	Bot	Win %	2016
6 th			
7 th	McRave	67.07	-
8 th	Arrakhammer	65.95	-
9 th	Tyr	65.91	21 st
10 th	Steamhammer	64.14	-

	Bot	Win %	2016
6 th	CherryPi	69.09	-
7 th	McRave	67.07	-
8 th	Arrakhammer	65.95	-
9 th	Tyr	65.91	21 st
10 th	Steamhammer	64.14	-

	Bot	Win %	2016
1 st			
2 nd			
3 rd			
4 th			
5 th			

	Bot	Win %	2016
1 st			
2 nd			
3 rd			
4 th			
5 th	Microwave	70.86	-

	Bot	Win %	2016
1 st			
2 nd			
3 rd			
4 th	cpac	71.01	-
5 th	Microwave	70.86	-

CPAC

- Junge Zhang, Xun Zhang, Qiyue Yin, Dong Zhan, Shihong Deng, Huikai Wu, Peixi Peng, Wenzhen Huang, Jing Kong, Debang Li, Yange Fang, Tairan Zhang, Junliang Xing
- Institute of Automation, Chinese Academy of Sciences (CASIA)
- First time competing in the competition
- Bot developed over several months

CPAC

- Based on Steamhammer bot
- Some new strategies
- Some machine learning
- “We train a multilayer perceptron network for fighting unit production when the build order queue is empty

	Bot	Win %	2016
1 st			
2 nd			
3 rd	Iron	81.52	1 st
4 th	cpac	71.01	-
5 th	Microwave	70.86	-

Iron

- Igor Dimitrijevic, France
- R&D Software Developer
- Placed 1st in 2016 competition
- Wrote bot called Stone for 2015 (19th)
- Iron is based on Stone, but re-coded
- Began Development of Iron in 2016

Iron – AI System

- Iron is mainly a Multi-Agent system.
- Each controlled unit is an Agent.
- Robustness of the overall behavior is the main goal (avoid blocking situations, indecision, predictability).
- To get this robustness, each Agent is made highly autonomous
- At anytime, Agents can switch between 25 behaviors
- Runs the same build order every game, and attempts to react and change to what opponent builds

Iron - Economy

- For each type of unit to train, each type of building to build, and each tech to research, there is a specialized Agent called Expert.
- Experts tell how urgent it is to spend resources for their task.
- Experts are autonomous, which is good for robustness.
- Evaluations rely on collected information and (very) rough heuristics.

	Bot	Win %	2016
1 st			
2 nd	PurpleWave	82.35	-
3 rd	Iron	81.52	1 st
4 th	cpac	71.01	-
5 th	Microwave	70.86	-

PurpleWave

- Dan Gant, USA
- Software Engineer
- Started the bot in January 2017
- Majority of bot written in Scala

PurpleWave Strategy

“PurpleWave plays a fairly complete package of pro-style Protoss strategies. Almost anything that's objectively good and can be executed with the existing micro skills and building placement is in there. There are aggressive strategies, economic strategies, and some delightfully cheesy strategies too”

PurpleWave Strategy

PurpleWave's high-level decision-making is structured as a task network. A strategy comprises a graph of modular tasks that allows re-use across different strategies. Each strategy assigns priorities to each of its tasks, which allows for centralized delegation of resources like minerals, supply, or units.

PurpleWave AI System

PurpleWave chooses strategies based on results of previous games against the same opponent, race, map, and number of starting positions. It has a graph of strategy selections, like opening build orders paired with mid game transitions and late-game compositions.

	Bot	Win %	2016
1 st	ZZZKBot	83.11	2 nd
2 nd	PurpleWave	82.35	-
3 rd	Iron	81.52	1 st
4 th	cpac	71.01	-
5 th	Microwave	70.86	-

ZZZKBot

- Chris Coxe, Australia / Britain
- Software Engineer / Developer
- 2015/2016 - 2nd Place

ZZZKBot - Strategy

- Uses several 1-base rush builds:
 - 4-Pool, Speedling, Hydra, Muta
- Techs to Muta / Guardian in late game
- Uses file I/O to record results of games based on which strategies it tried
- Uses hand-coded logic to 'learn and experiment' with which strategy to choose

ZZZKBot – AI System

- “Most of the decisions in the bot are achieved by simple hard-coded prioritization of the various considerations involved. ”
- Uses custom heuristics based on unit type priorities, geometry, etc, and past results

ZZZKBot - Strengths

Strengths: It's a cheesy N-trick pony. All it can do is some simple 1-base rush builds, with little or no follow-up. Its only strength lies in the fact that many existing bots are vulnerable to cheesy builds like this. Now that it has a little inter-game strategy learning logic, it may be able to learn which type of rush is most effective.

ZZZKBot - Weaknesses

Weaknesses: apart from targeting, combat micro is almost non-existent - the only logic for combat micro is whether to wait at my base after morphing (only used in some types of rush while waiting for some tech to finish), or attack (almost all other scenarios), or defend my base (very rare). Also, it never expands.

State of the Art

- No quantum leaps in 2017 so far
- Bots are getting stronger
 - Previous entries being beaten badly
 - Some now using machine learning
 - Several using search / simulation
- Most improvement is knowledge-based
 - Manually inspect games, fix obvious errors
 - More complex strategies / architectures

Human vs. Machine



Thank You!

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www.StarCraftAICompetition.com