

# Using a Team of General AI Algorithms to Assist Game Design and Testing

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# Introduction

- > Games evolve
- > Modifications need to be tested
  - > Human play-testing
  - > Agent-based playtesting
  - X Low adaptability, time consuming

→ Use of a team of General Agents

- > Rules
- > Levels
- > NPCs
- > Game parameters
- ✓ General goals, flexibility, adaptability

# Introduction

# Background

- > *General Video Game Playing*
- > *Automatic Testing*
- > *AI Assisted Game Design*

## General Video Game Playing (GVGP)

> Frameworks: ALE, GVGAI framework, OpenAI Gym, Project Malmö (+ others)

> Algorithms: Tree Search, Evolutionary Algorithms (EA), Reinforcement Learning (RL)

→ Variety of algorithms + active community

# Background

# Automatic Testing & AI Assisted Game Design

- > Quality Assurance (QA) of the game
  - > Automatic testing
    - X Game dependent
- ✓ Methodology general enough to be adaptable to different games

## Background

## Automatic Testing & AI Assisted Game Design

- > Intrinsic motivation – simulated-based game testing [1]
- > Procedural Personas [2]
- > Relative Algorithm Performance (RAPP) [3]
- > Computationally Intelligent Collaborative EnviRONment (Cicero) [4] + SeekWhence [5]

- > [1] *S. Roohi et al.*
- > [2] *Holmgård et al.*
- > [3] *S. Nielsen et al.*
- > [4][5] *T. Machado et al.*

# Background

# Methodology

- > *Overview*
- > *The Team*
- > *Reports*
- > *Logging System*

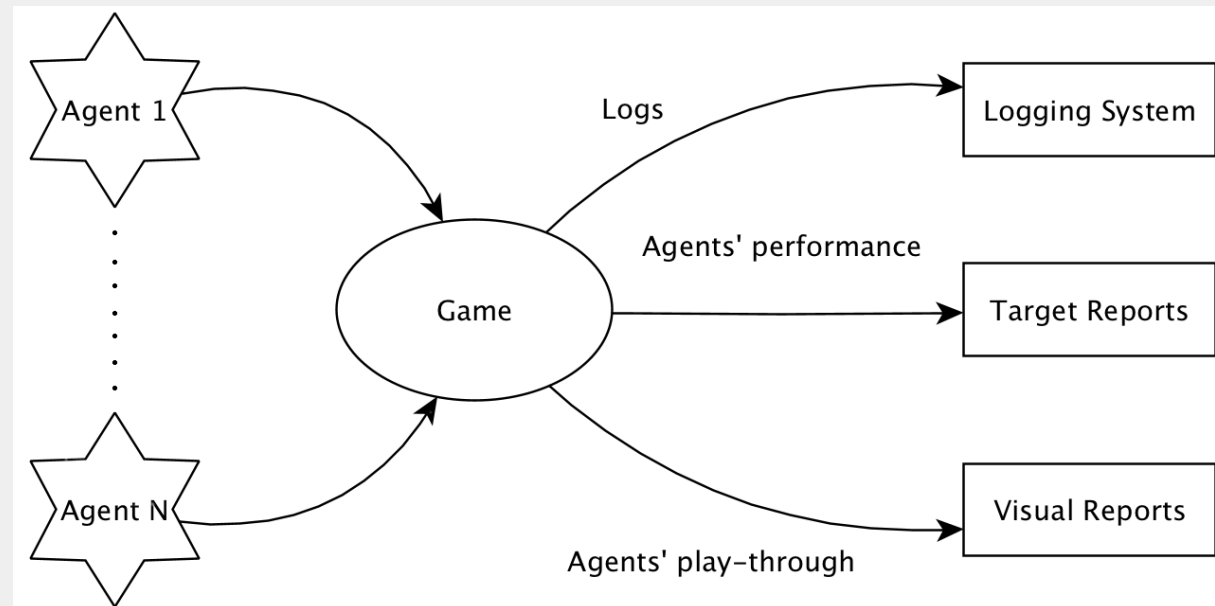


## Overview

> General team with differentiated objectives

→ Different behaviors, diverse information

→ Flexibility, adaptability



## The Team

- > Player-types [1]
- > Player motivation profile [2]
- > Diversifying heuristics for GVGP [3]
- Differentiated general objectives

> [1] R. Bartle

> [2] N. Yee

> [3] C. Guerrero-Romero et al.

## Methodology

## The Team

### > Differentiated general objectives

- Winner
- Map explorer
- Novelty explorer
- Curious
- Competence seeker
- Record breaker
- Collector
- Killer
- Risk analyst
- Semantic
- Scholar

## Methodology

## Reports & Logging System

- > Generated by agents' playthrough
- > Choose the team based on the characteristics of the level/game
- > To check the validity of the design of the game
  - Performance-target based reports
  - Visual reports
  - Logging System

# Methodology

## Performance-target based reports

- > Evaluating the game based on the expected performance in the behavior of the agents
- > Results in the performance of the agents depends on the type of game [1]
  - Exploration Maximization Heuristic (EMH)
    - > 80% in small / open maps
    - < 45% in large maps / not completely accessible

> [1] C. Guerrero-Romero et al. :  
"Beyond Playing to Win:  
Diversifying Heuristics for GVGA1"

## Methodology

> Reports & Logging System

## Performance-target based reports

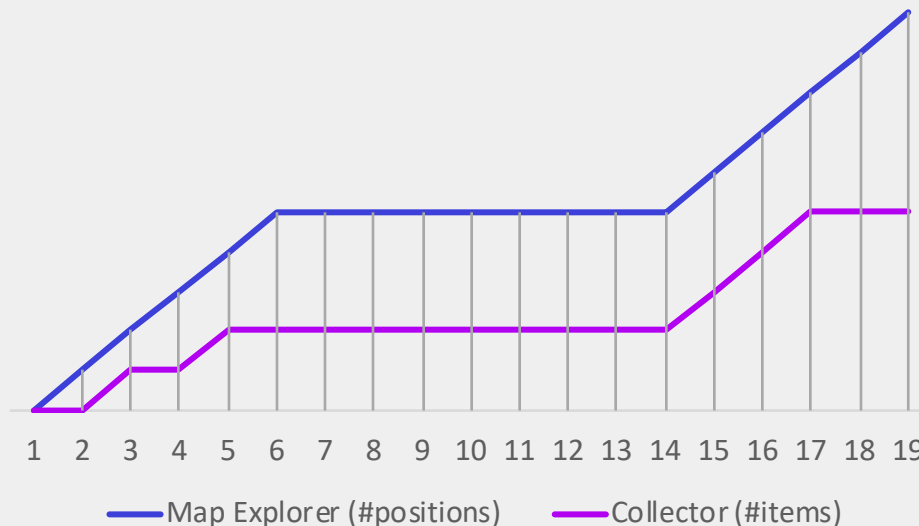
- > Provide an estimation of the expected performance of each of the type of agents
  - error for each estimation
  - ✓ adjust design based on the results
- > **Example:** Easily accessible level hard to win
  - high performance for Map explorer
  - Low performance for Winner

## Methodology

> Reports & Logging System

## Visual reports

- > Show how the information retrieved by the agents evolved during the play-through
  - Graph with the values by time
- > Analyse the shape and evolution of the graph



## Logging System

- > Tracks the information resulting from running each of the agents
  - Detect anomalies and broken states
- > A team with different behaviors
  - More game states to log
- > Different strategies and measurements [1]
  - Agent-based, interpreted, direct and indirect [2]

> [1] M. Nelson, "Game Metrics Without Players: Strategies for Understanding Game Artifacts"

> [2] V. Volz et al., "Gameplay Evaluation Measures"

## Methodology

> Reports & Logging System



## Variations

- > Agents with different levels of mastery/skills
  - bigger range of choices
  - richer information available
- > Combine agents results
  - greater level of detail

# Methodology

# Limitations

- > *Reinforcement Learning*
- > *Planning Algorithms*
- > *Parameter Optimisation*
- > *The Challenge of General AI*

## Reinforcement Learning (RL)

- > Offline training
- > Performance depends on the complexity of the environment → rewards delayed on time

✓ Arcade Games (ALE), *AlphaGo*, *Doom*...

X *Starcraft*

# Limitations

## Planning Algorithms

- > Forward model
- > Budget, roll-outs
- Parameter optimisation

Limitations

## Parameter optimisation

- > Impact in the GVGP algorithms' performance
  - Roll-outs
  - Population size in GA
- > Time consuming
- > Offline & online approaches
  - Agents **must be** well tuned to fit the expectations

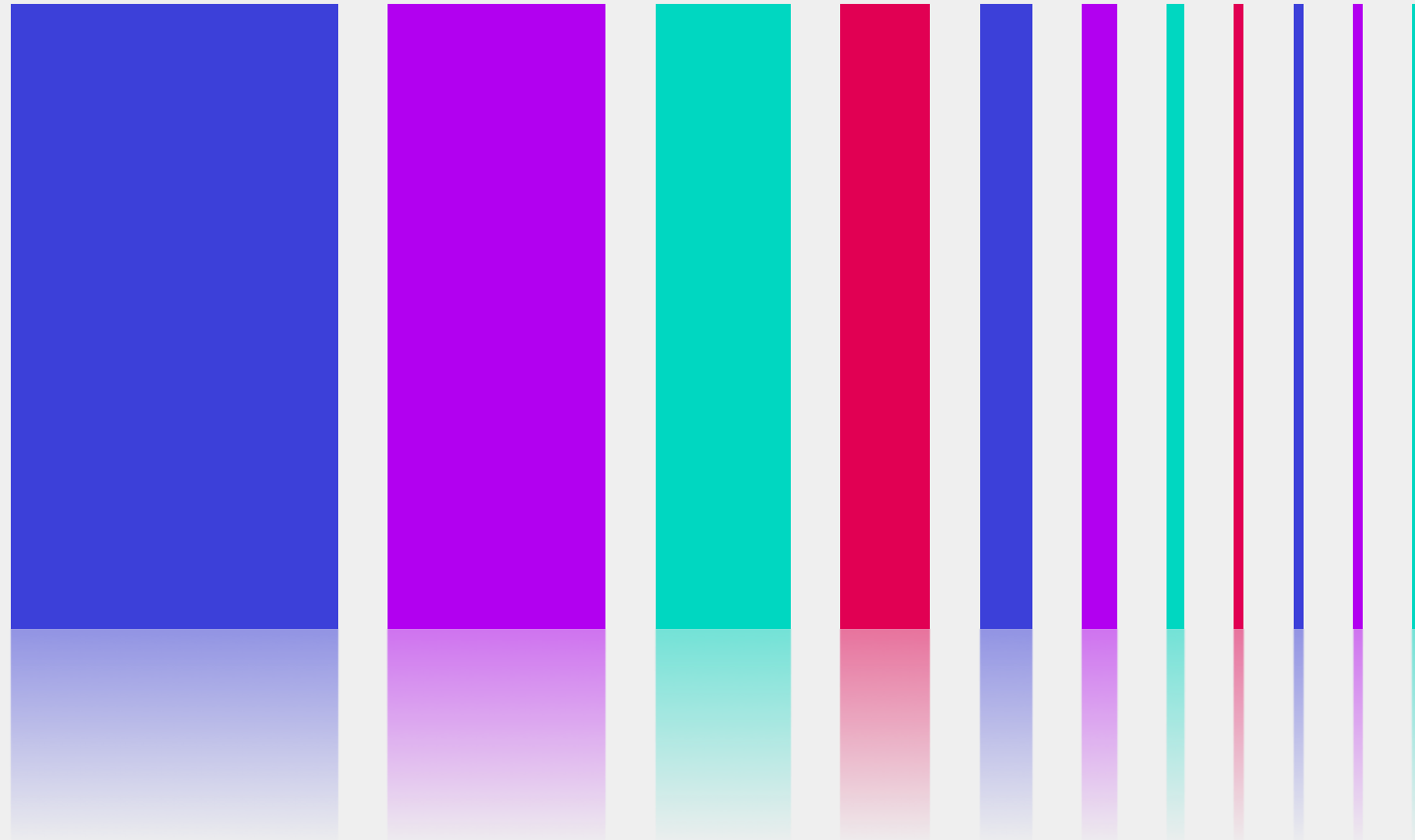
## Limitations

## General AI Challenge

- > Not possible to use in-game information as a guide
- > Not good enough (yet) to generalise to every type of game
- > Variety of problems to apply to
- > Ongoing research

# Limitations

# Recap



Questions?

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