CE810 - Game Design 2

Artificial Intelligence

Joseph Walton-Rivers & Piers Williams

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University of Essex

Artificial Intelligence

- Production Rule Agents

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- Monte-Carlo Tree Search

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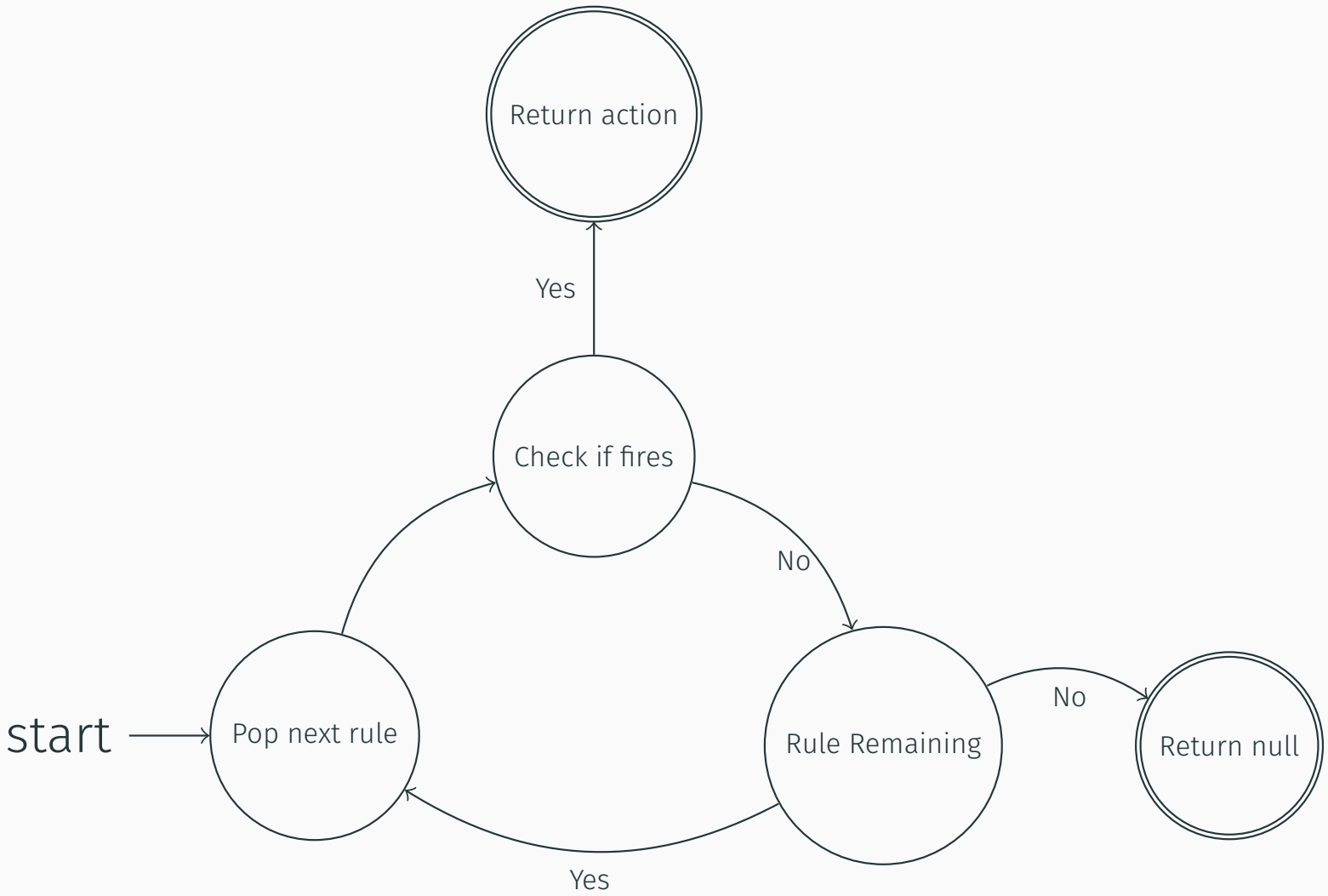
- Monte-Carlo Tree Search
- Genetic Algorithms
- Neural Networks

Production Rule Agents

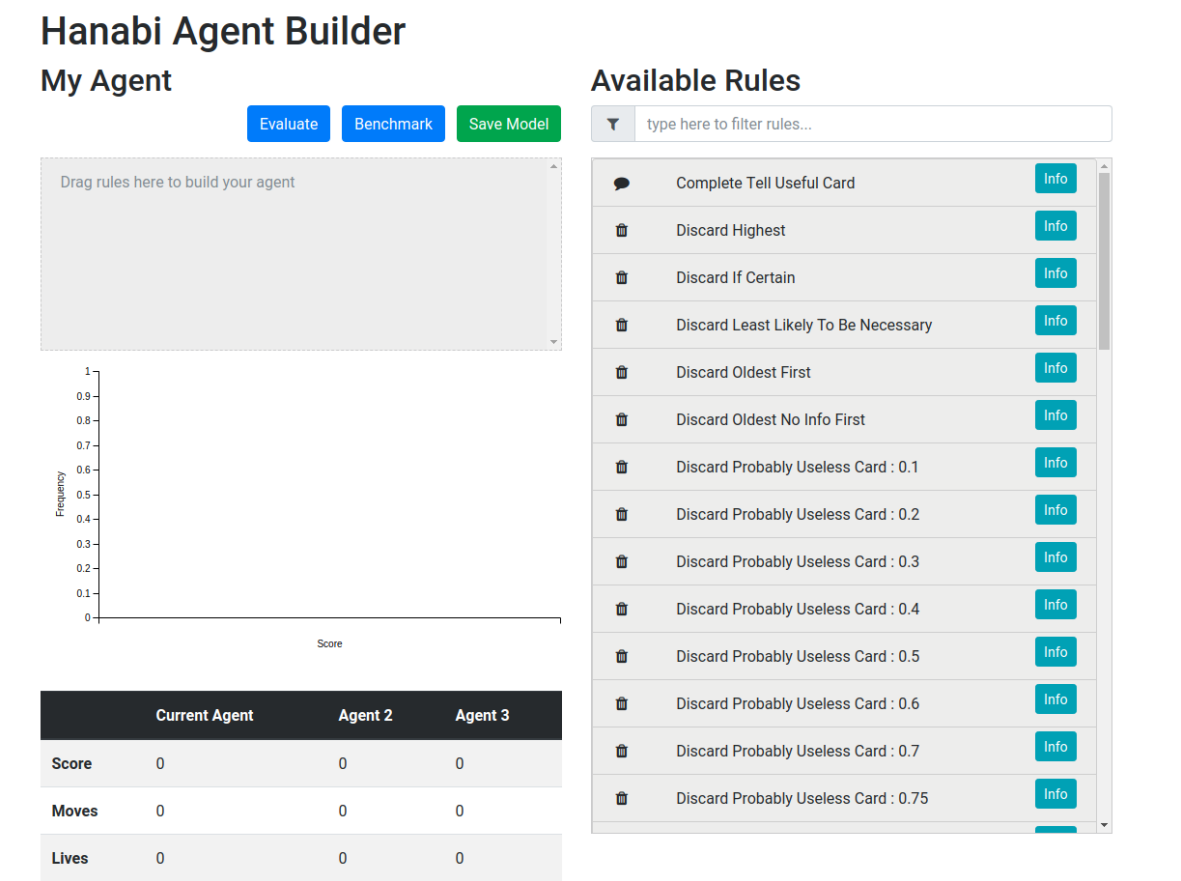
Basic

```java
@FunctionalInterface
public interface Rule {
  boolean couldFire(int playerID, GameState state);
  Action execute(int playerID, GameState state);
}
```

Diagram


Return action
Yes
Check if fires
No
start
Pop next rule
Rule Remaining
No
Return null
Yes

Hanabi



Exercise

Try it out!

Basic-TBS

```
public interface ProductionRule {

Map<UUID, Order> perform(
int playerId,
GameState state,
List<UUID> entities
);

}
```

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- Rules now apply to **0** or more Entities

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- **Remaining** entities considered by lower rules
- Orders generated by rules are **executed** by the rule
  - **Simulating** their effects for other rules
  - Allows **lower** rules to make **informed** decisions
  - Is why **non-determinism** is ill-advised

Built-Ins

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- I suppose we should list the included rules
- And how to **use** them

Built-Ins

AttackMeleeRule	AttackRangedClosestRule
AttackRangedMostDamage-dRule	EnsureEntityRule
Module	NoopProductionRule
RandomRule	Filter
	RunAwayRule
RunTowardsRule	RunTowardsResource
UseActionOnEntity	UseActionOnResource

Some rules are similar - Will cover them together

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  - What a **single** Entity does
  - Removes Entity from consideration for you

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  - These rules do **not** check
  - They can issue an **invalid** order

EnsureEntity

Example

EnsureEntity[blue_town:blue_civilian:3]

- Producer, Product, Quantity

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- Uses BuildOrder.

Run Rules

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RunTowards[0.0]

RunAway[0.5]

RunTowardsResource[gold]

- Causes Entity to travel

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UseActionOnResource[BuildOnResource[gold_mine:gold]:gold]

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- Attack actions could have been written with this
- But they predate this

Filter Rules

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Filter[AttackMelee:abstract_knight]

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- Takes 1 or more type as an array

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  - Same way you did for Actions
  - Dynamically scanned at runtime

Production Rule Agents

”RangedRush”:”PRA[EnsureBase,EnsureWorker,EnsureArchery,BuildGoldMine,BuildWoodMine,EnsureEntity[abstract_civilian:farm:3],TravelToGold,TravelToWood,EnsureArcher,ArcherAttack,ArcherChase,WorkerEvade]”,

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- More on that later

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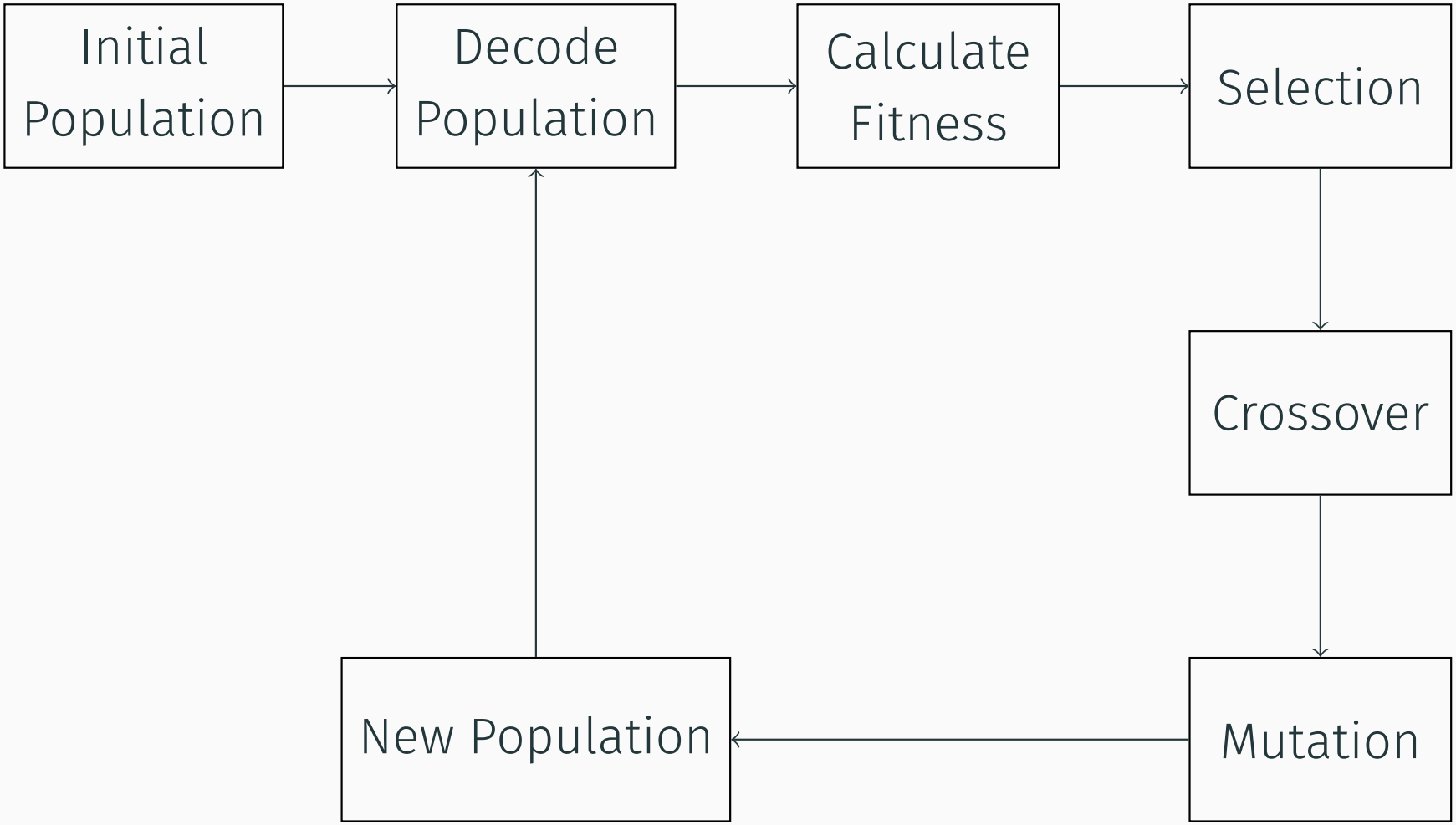
- Even more apologies to those that have encountered RHEA's

Genetic Algorithms



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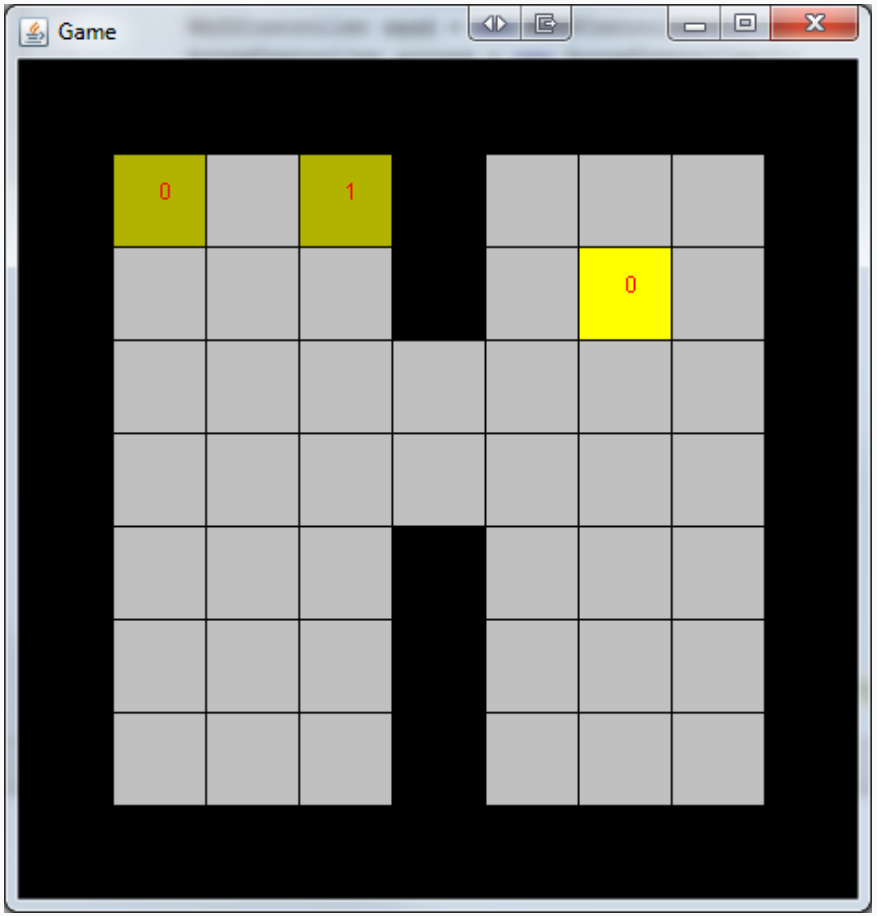
- Asteroids assignment had one built in
- But how to play a game with a GA?

Simpler Games

- Consider this game



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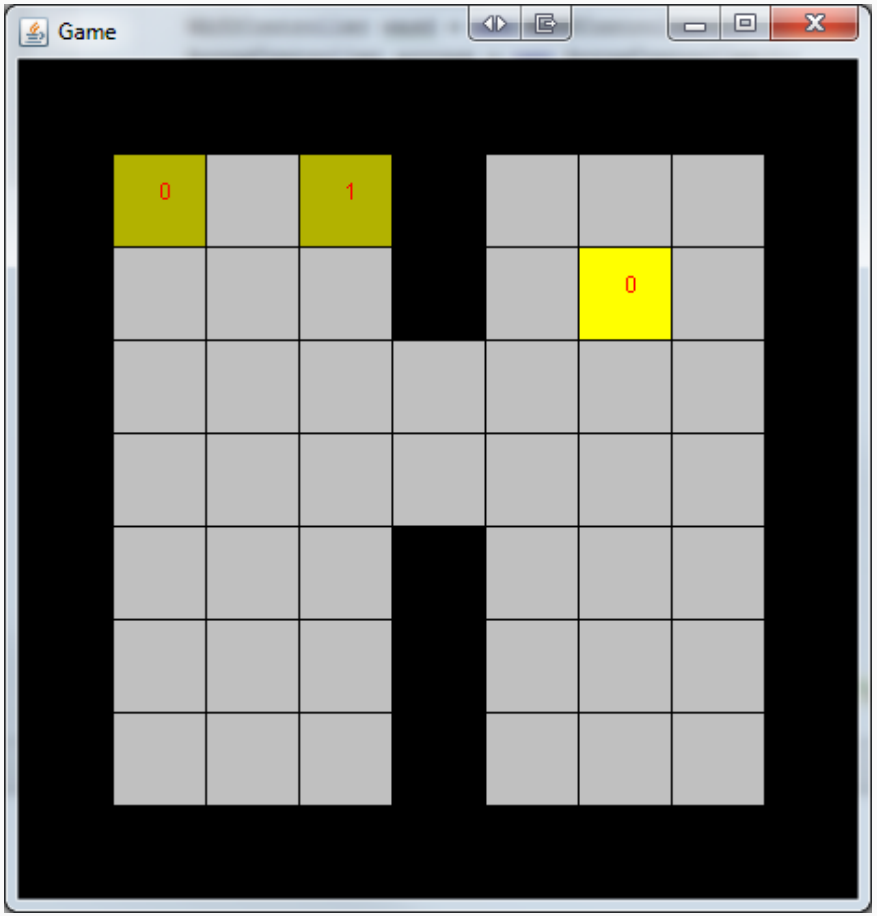

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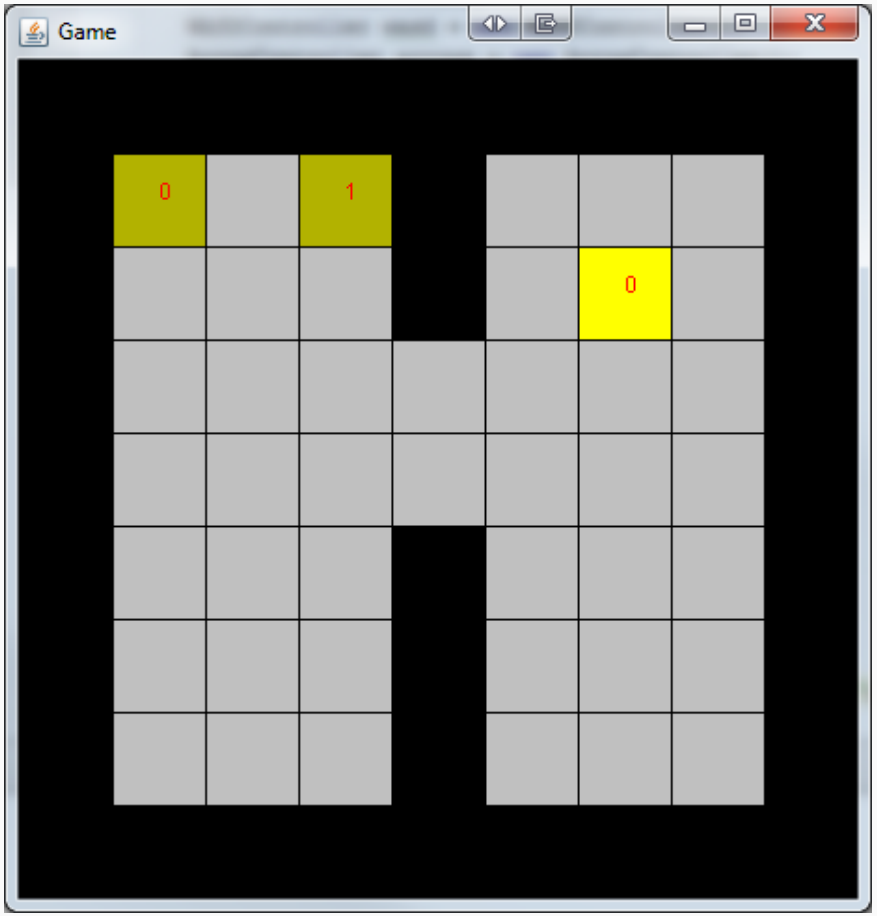

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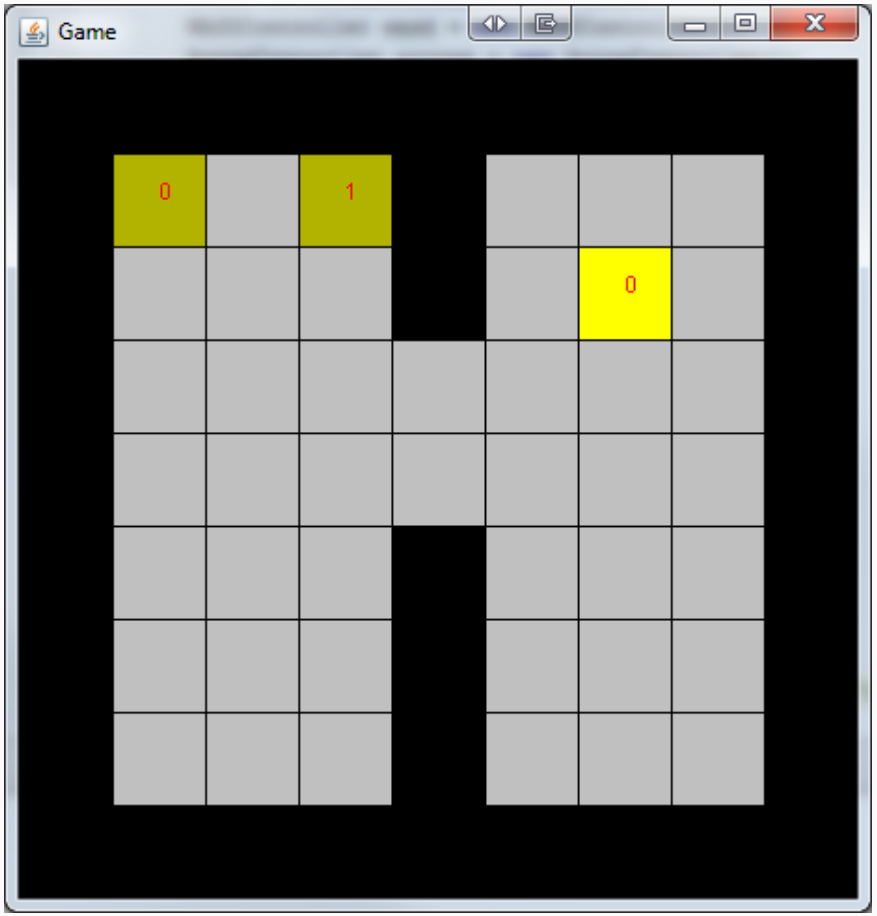

Simpler Games

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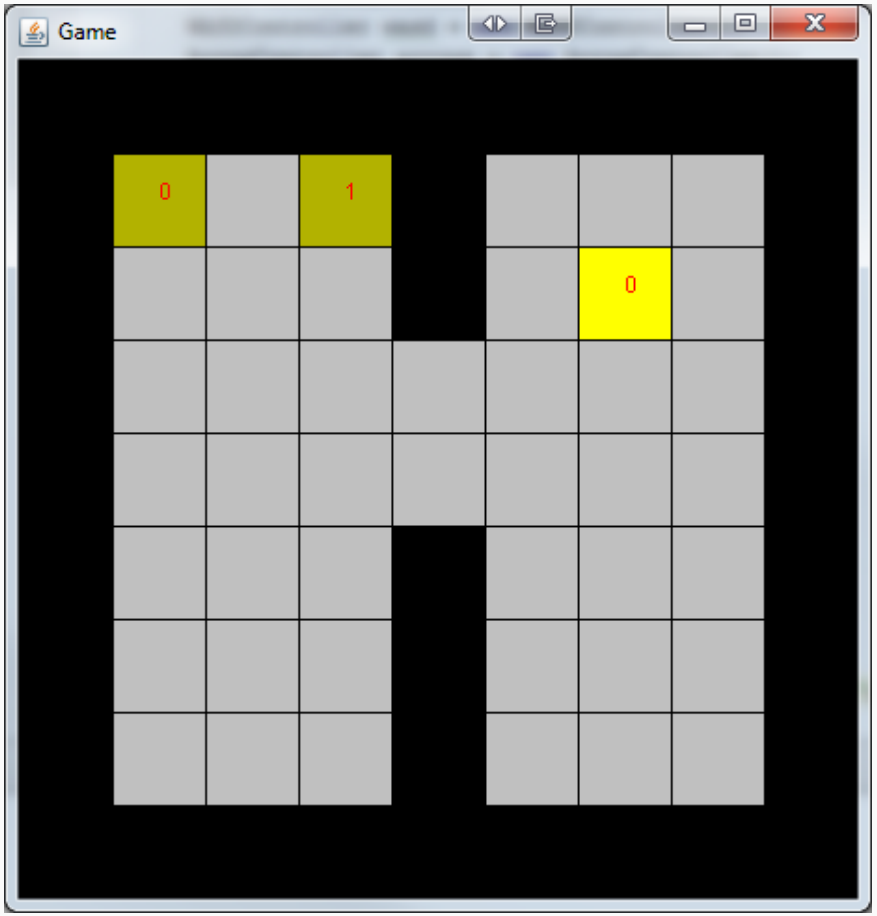
- More like a maze
- Get each Agent to the goal
- 5 possible moves
- Controller returns a single move per turn



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- Length of the sequence increases parameters for GA

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- Locking the agent to consider each move *N* times
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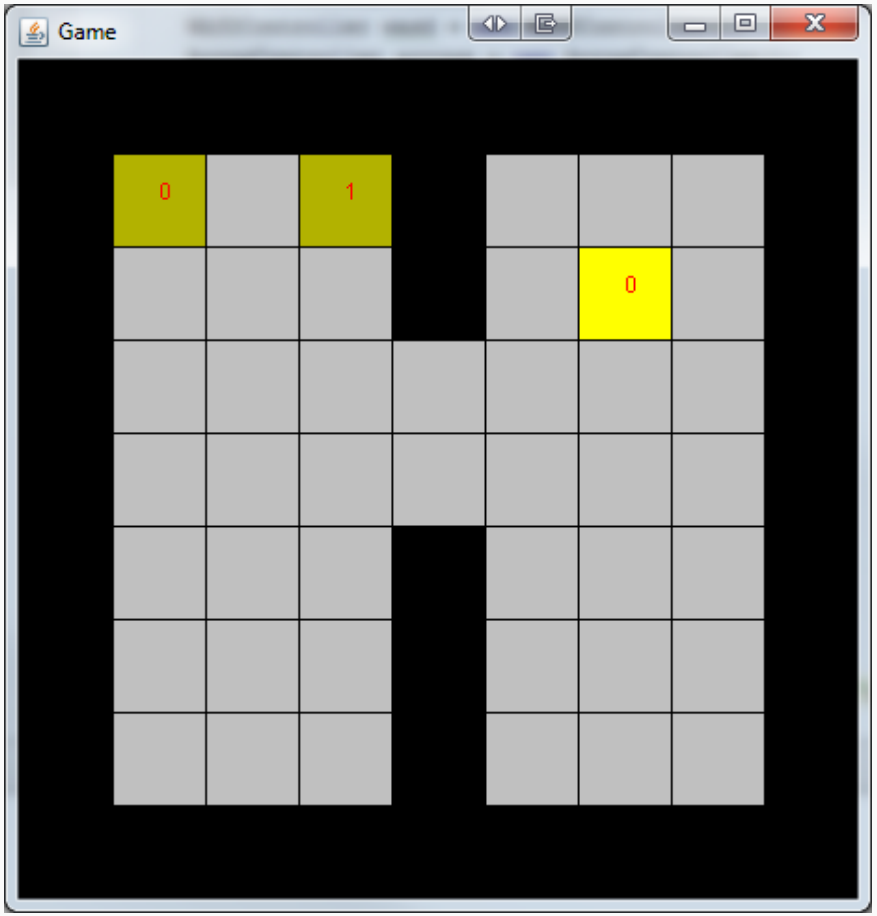
- Works great in real-time engines like PTSP
- Getting *N* wrong means poor performance

Problem with Macro Actions

- What if N is 2?



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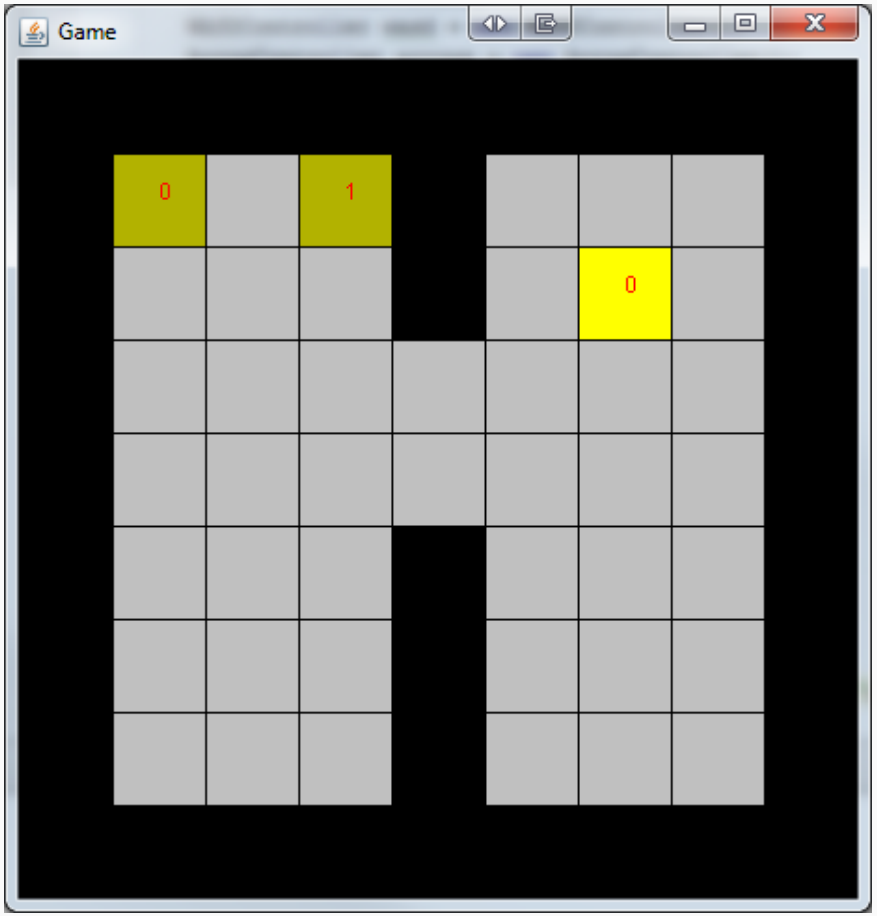
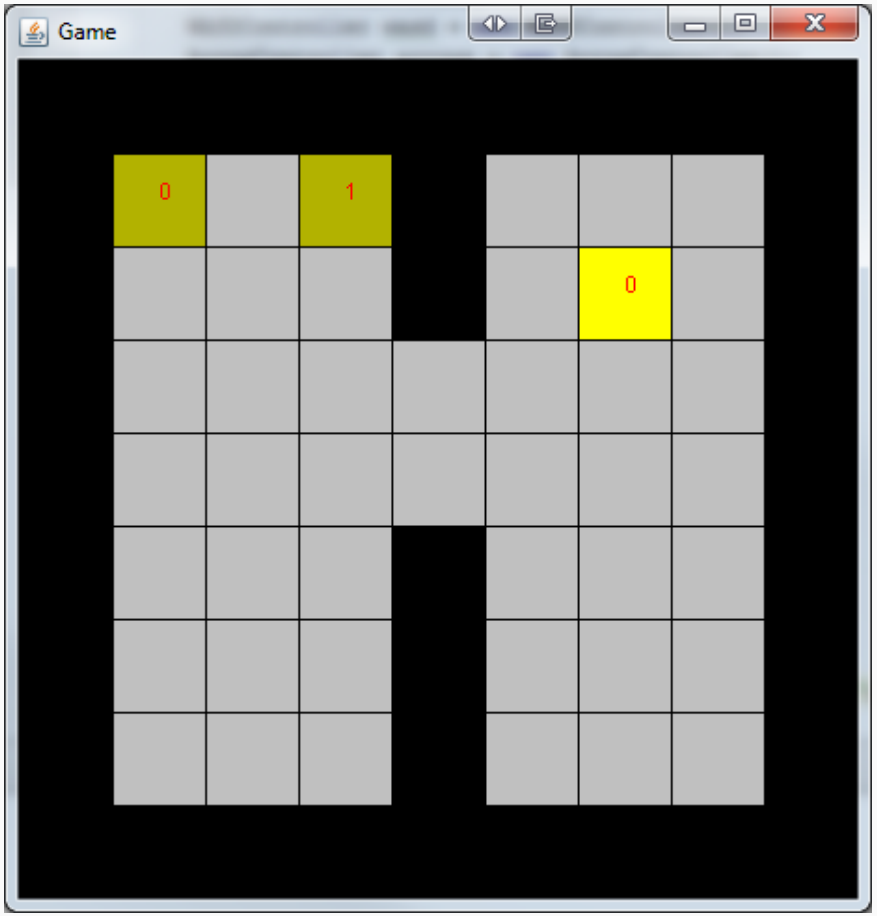


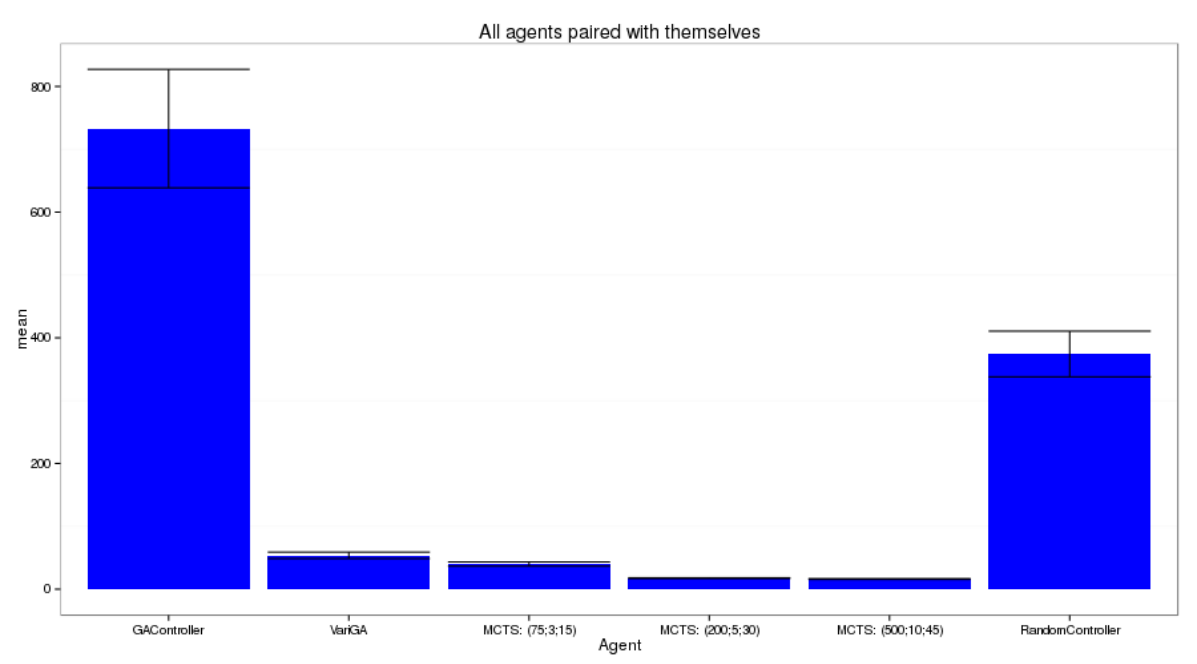
Problem with Macro Actions

- What if *N* is 2?
- Can we reach the Goal?
- MacroActionGA is poor at discrete boards



Solution

- What if *N* wasn't fixed?



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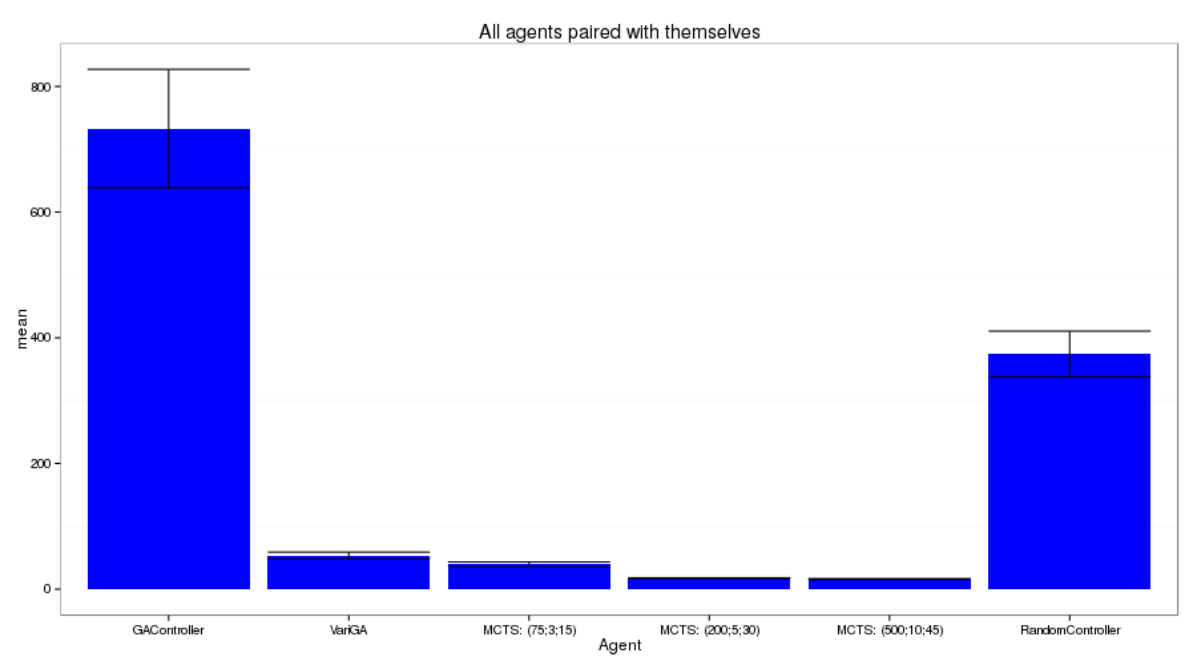

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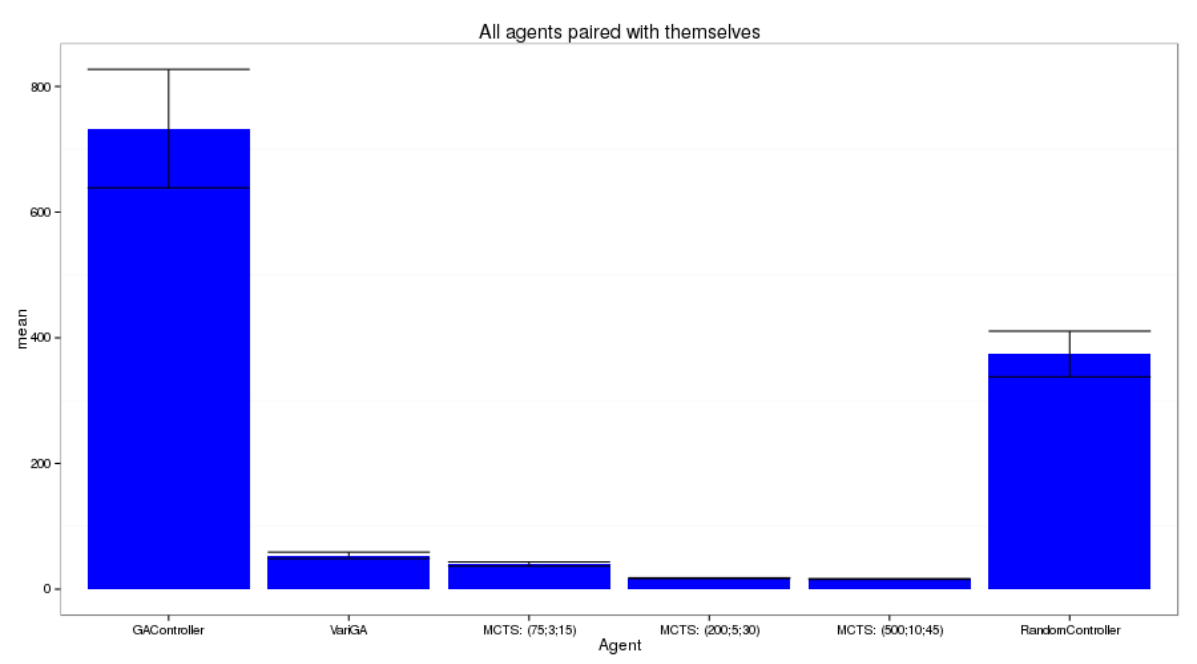

Solution

- What if *N* wasn't fixed?
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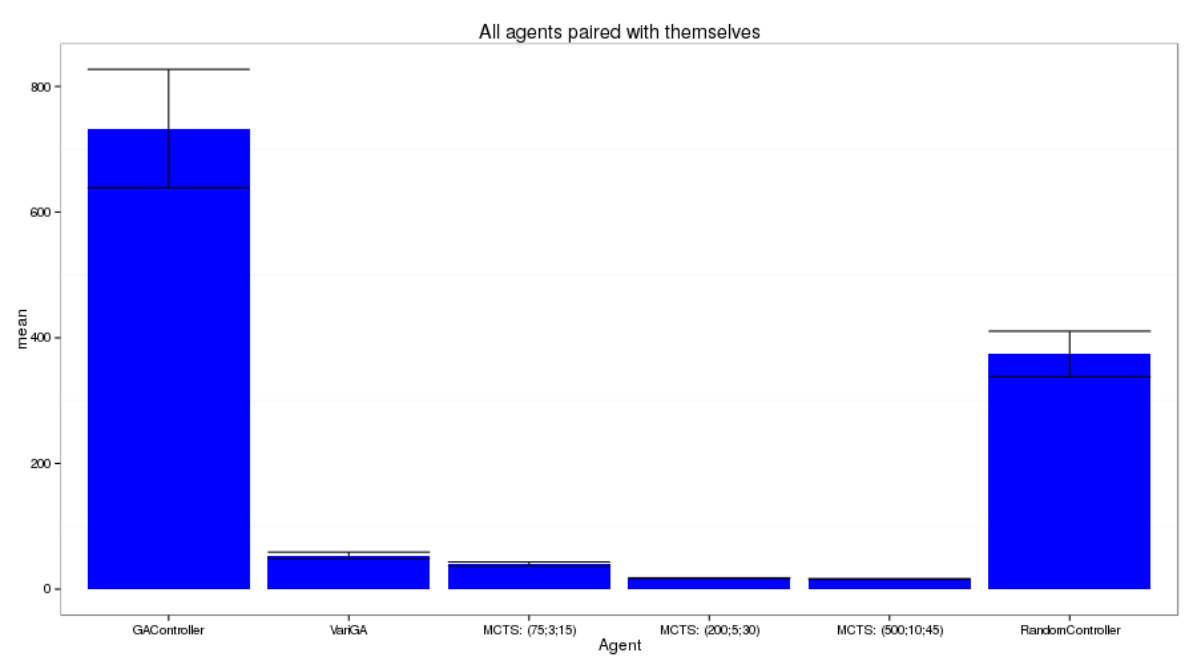
- Learn the values for *N* as well as the actions
- Include them in the GA



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- Need something **higher** level

Strategy Search

- Instead of choosing actions

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- Choose between **strategies**

Strategy Search

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- Choose between **strategies**
- But where will we get those?

Strategy Search

```
Map<EntityType, List<ProductionRuleAgent>> rules;
```

- Choose between PRA's for each **EntityType**

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- Choose between PRA's for each **EntityType**
- Why not per Entity?

Variable Length Macro Action GA

”MedievalGA”:”VLMAGA[1000:10:EandM:abstract_civilian,abstract_town,abstract_knightery,abstract_archery,abstract_knight,abstract_archer:noopRule/ResourceBuilder/BuildBase/BuildMilitary,noopRule/BuildWorker,noopRule/BuildKnights,noopRule/BuildArchers,KnightAttack,ArcherAttack:noop:RangedRush]”

- Will do automatic single actions first

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- Then will follow its learned policy
- Then will use the fallback agent for the rest

Problems

Controller	ops/min	Error
random	512.840	13.846
noop	509.314	5.730
RangedRush	273.362	2.345
MixedRush	284.875	7.453
MedievalGA	3.538	2.286

- An “op” is building a full game and playing it to the end
- MedievalGA is the VLMAGA
- I wish that were an error for MedievalGA