



Balancing Nightmares: an AI Approach to Balance Games with Overwhelming Amounts of Data

GDC2019 March 21, 2019
SQUARE ENIX CO., LTD.

Advanced Technology Division
Kazuko Manabe, Shigeru Awaji

Who are we?



Kazuko Manabe

AI Engineer

Advanced Technology Division
SQUARE ENIX CO., LTD.

- Console game development
- Tool development
- Currently: QA, Game balance



Who are we?



Shigeru Awaji
Online Engineer
Advanced Technology Division
SQUARE ENIX CO., LTD.

- Designed and created general Windows desktop applications and databases
- Cooperate using data analysis on more than 20 projects over the course of 3 years

Contents

- ▶ Introduction of Grimms Notes Repage
- ▶ Game balance using AI
 - ▶ Proposed method
 - ▶ Experiments and their results
 - ▶ Applications to other games
- ▶ System configuration for balance adjustment
- ▶ What could we do next?

Grimms Notes Repage

- ▶ Action battle game for smartphones
- ▶ Over 17 million downloads

Party preparation



Battle

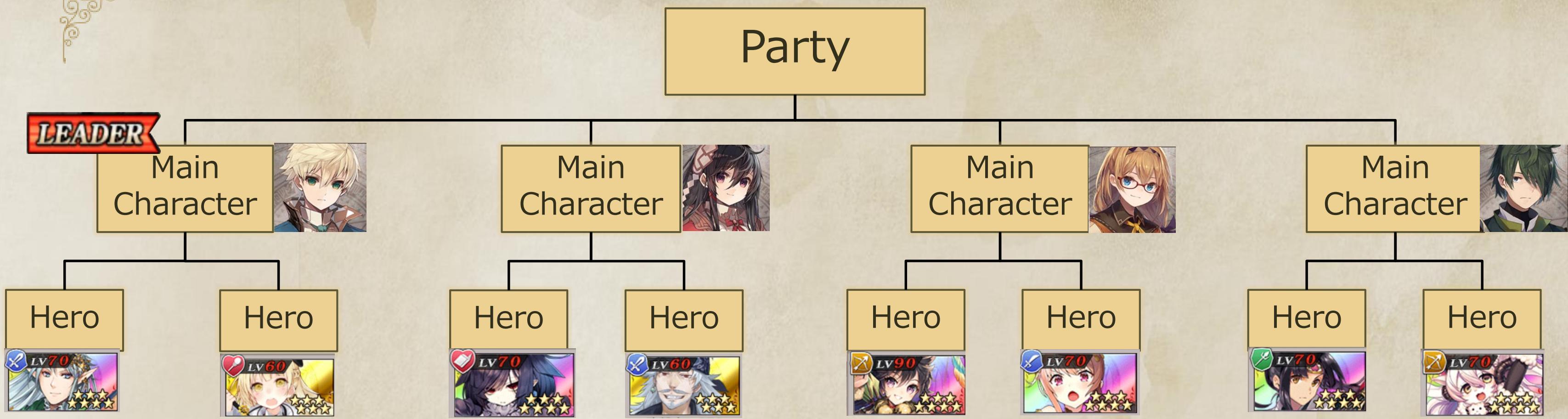


Reward, Enhancement

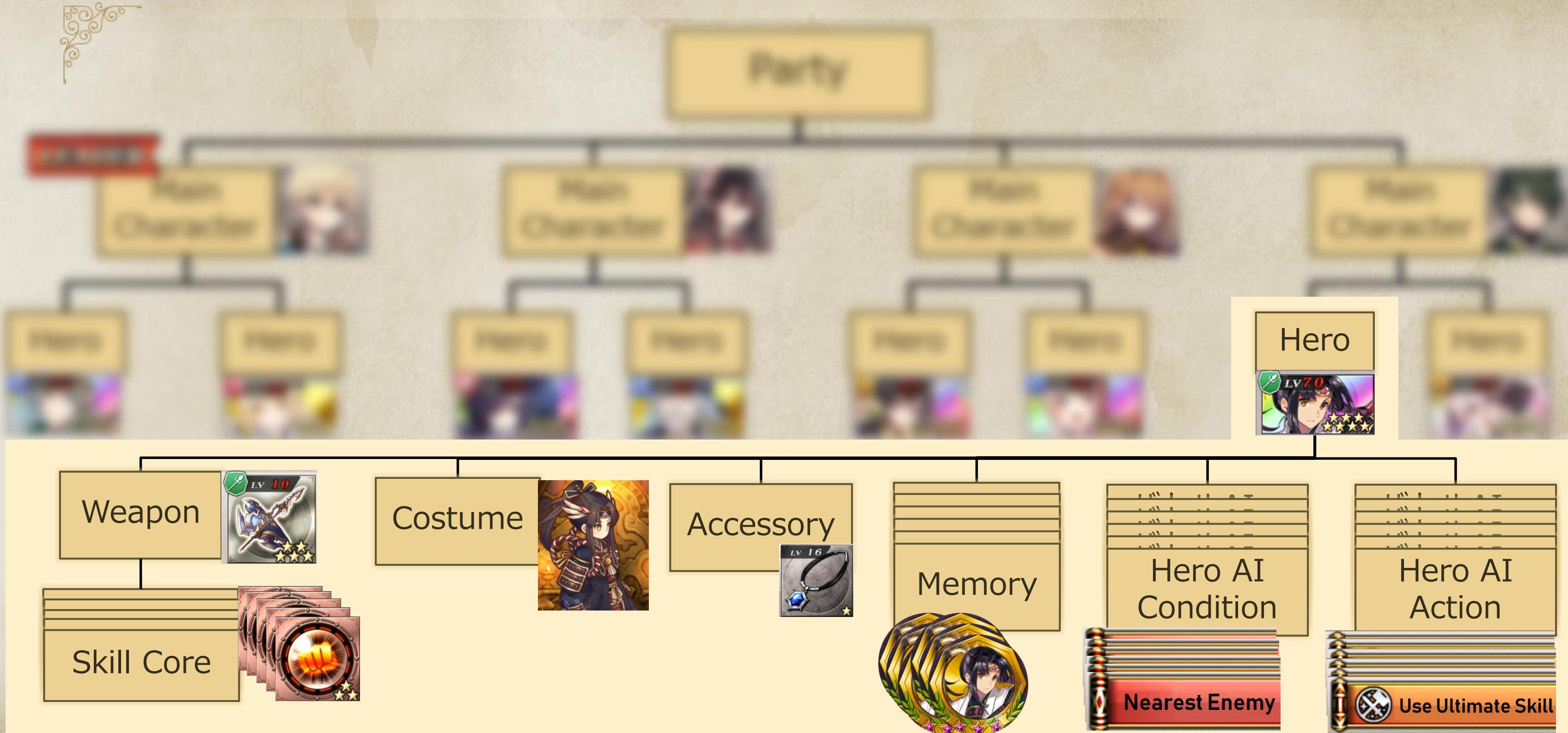


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Definition of “Party” in *Grimms Notes Repage*

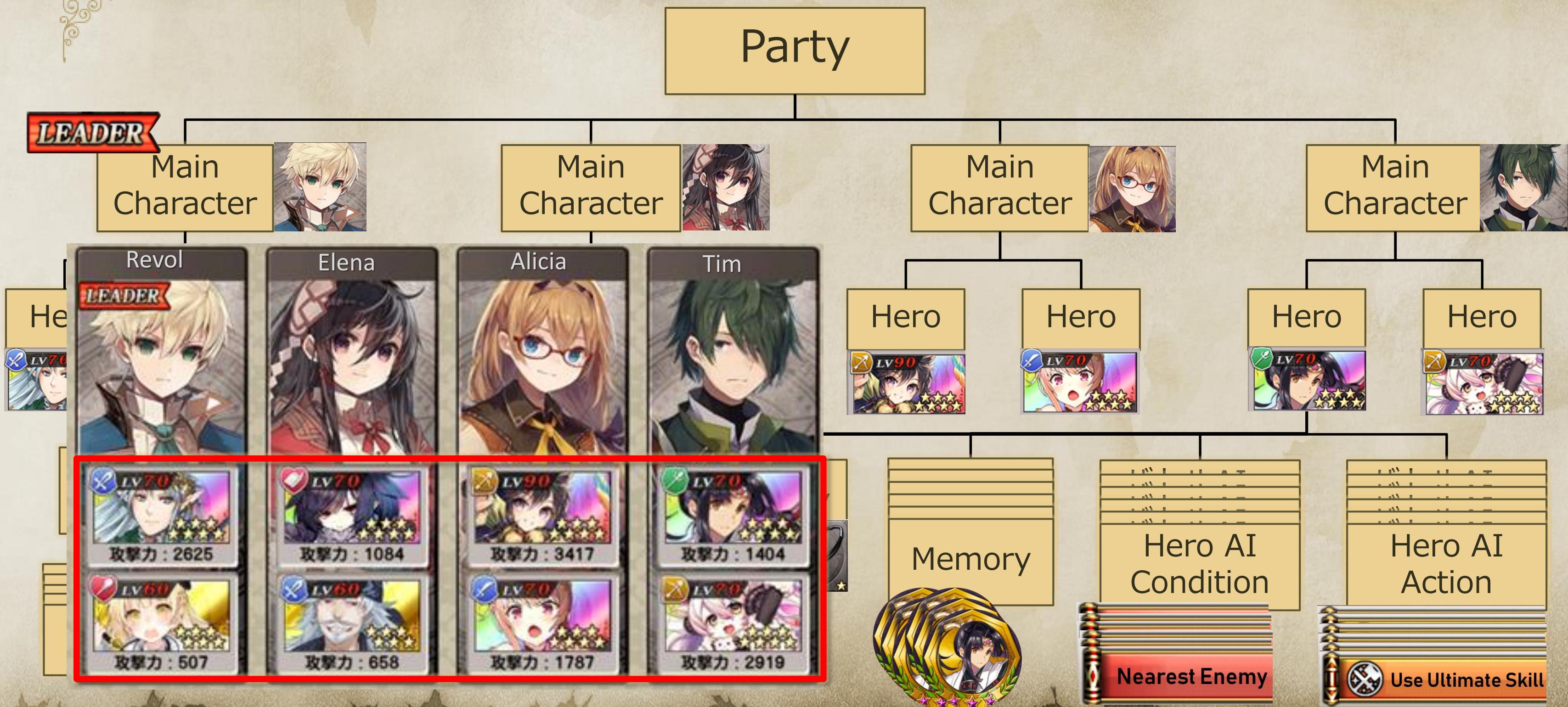


Definition of “Party” in *Grimms Notes Repage*





Definition of “Party” in *Grimms Notes Repage*



Balancing *Grimms Notes Repage*, a Nightmare?

- ▶ Main characters: 8
 - ▶ Select a leader
 - ▶ Hero: 80
 - ▶ Weapon: 60
 - ▶ Skill core * 5: 65
 - ▶ Costume: 3
- ▶ Accessory: 4
- ▶ Hero AI * 6:
 - ▶ Conditions: 30
 - ▶ Actions: 20

(Approximate estimate)

Combinations:

$$\frac{8!}{4! \times (8 - 4)!} \times 4 \times 80^8 \times 60^8 \times 65^{(8*5)} \times 3^8 \times 4^8 \times \frac{30!}{(30 - 6)!}^8 \times 20^{(6*8)}$$

$\approx 1.0 * 10^{182}$

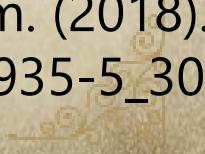
Challenge: Impossible to check all combinations of elements in a party in limited time

Idea: If there are elements which have effects that are too strong in the game, the strongest party should have these elements.

Optimization-based falsification*:

"It utilizes global optimization methods to guide the tests towards a possibly small region in the input space that lead to an incorrect system behavior"

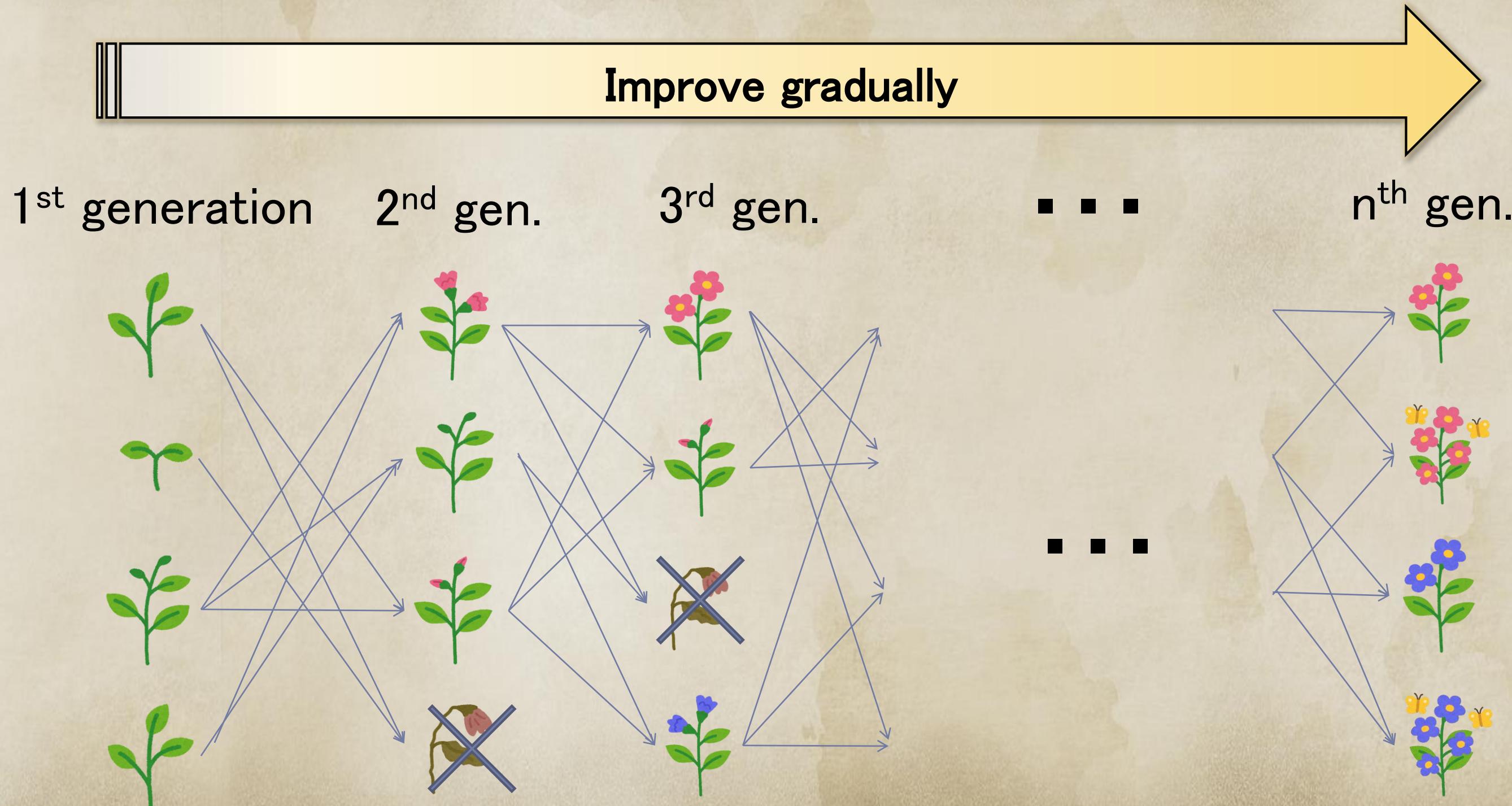
* Tuncali, Cumhur & Hoxha, Bardh & Ding, Guohui & Fainekos, Georgios & Sankaranarayanan, Sriram. (2018). Experience Report: Application of Falsification Methods on the UxAS System. 10.1007/978-3-319-77935-5_30.



We did it!



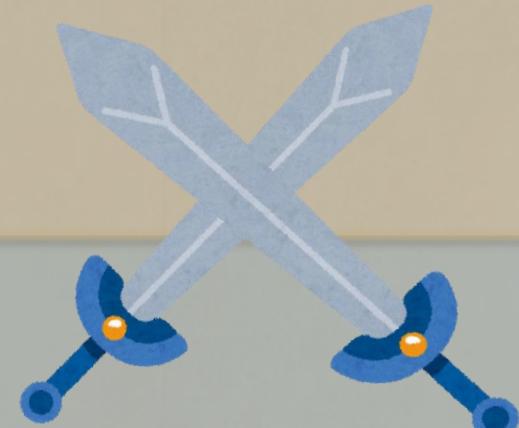
The Method: Genetic Algorithm(GA)



Corresponding terms

Genetic Algorithm

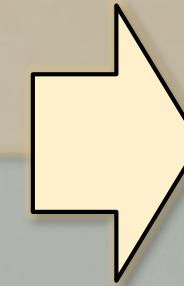
Environment



Battle

Grimms Notes

Fitness



Battle
result

Individual



Party

Why GA?

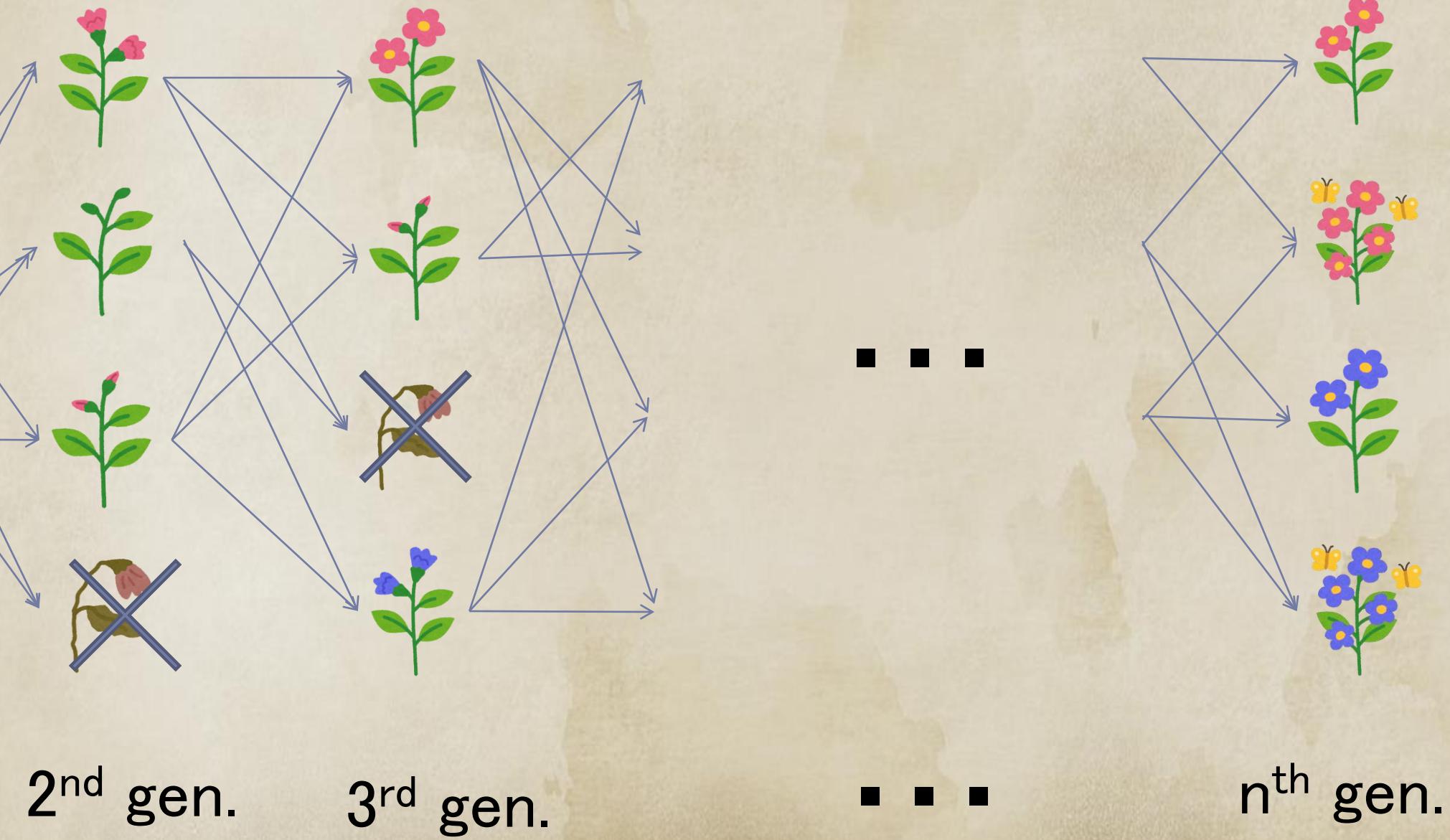
- ▶ The algorithm is simple and easy to handle
- ▶ It has a long history; there are many papers on GA
- ▶ We can get a suboptimal solution in limited time
- ▶ We can stop the execution whenever we want

GA is suitable for product development

GA Process

- ▶ 1. Create initial parties with randomly chosen genes
 - ▶ Set the initial parties as the 1st generation
- ▶ 2. Evaluate the parties in the latest generation
- ▶ 3. Select the best parties
- ▶ 4. Crossbreed the parties
- ▶ 5. May mutate a few parties (based on probability)
 - ▶ Set the created new parties in Step 4 and Step 5 as the next generation
- ▶ 6. Stop in a specified condition or back to Step 2
 - ▶ Ex. Stop if specified time has elapsed

1. Create initial parties with randomly chosen genes



2. Evaluate the parties



Evaluate = Measure fitness for environment

Environment = Battle

Party

IN



Results

OUT

2. Evaluate the parties – Battle types in Grimms Notes

PvE: Player vs. Environment

- ▶ Battle against monsters (CPU)
- ▶ PvP: Player vs. Player
- ▶ One-to-one battle between human players

Auto-play battle

- ▶ After starting the battle, players can do nothing

2. Evaluate the parties – Analyze the features of the battles

| | PvE | PvP |
|---------------------------------|---------------------------------------|--------------------------------|
| Victory condition | Wipe out the enemies or beat the boss | The most remaining life points |
| Rewards | Materials | Arena Points |
| Opponents | Can choose opponent | Cannot choose opponent |
| The number of challenges | Unlimited | Limited |
| Defeat penalty | Nothing | Lose Arena Points |

2. Evaluate the parties – Analyze the features of the battles

| PvE | |
|---------------------------------|---------------------------------------|
| Victory condition | Wipe out the enemies or beat the boss |
| Rewards | Materials |
| Opponents | Can choose opponent |
| The number of challenges | Unlimited |
| Defeat penalty | Nothing |

2. Evaluate the parties – Evaluation for PvE



Evaluation policy

| Victory | Defeat |
|-------------|--------------|
| Battle-time | Damage dealt |

Specialized for the game

2. Evaluate the parties – Analyze the features of the battles

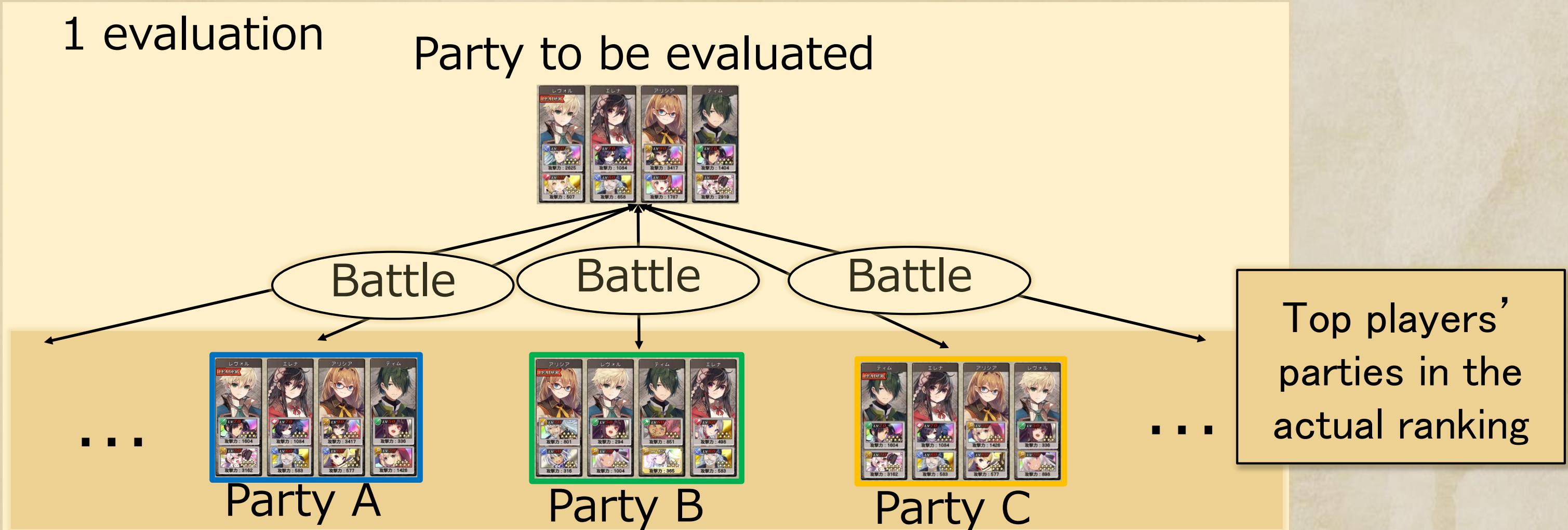
| | | PvP |
|--------------------------|--------------------------------|-----|
| Victory condition | The most remaining life points | |
| Rewards | Arena Points | |
| Opponents | Cannot choose opponent | |
| The number of challenges | Limited | |
| Defeat penalty | Lose Arena Points | |

To measure the winning percentage

▶ Fight with parties of different fighting styles

1 evaluation

Party to be evaluated



▶ Use the average of the battle results as the evaluation value

2. Evaluate the parties – Evaluation for PvP



Evaluation policy

| Victory | Defeat |
|-------------------------------------|-------------------------------------|
| Difference of remaining life points | Difference of remaining life points |
| + fixed bonus points | ---- |

Specialized for the game

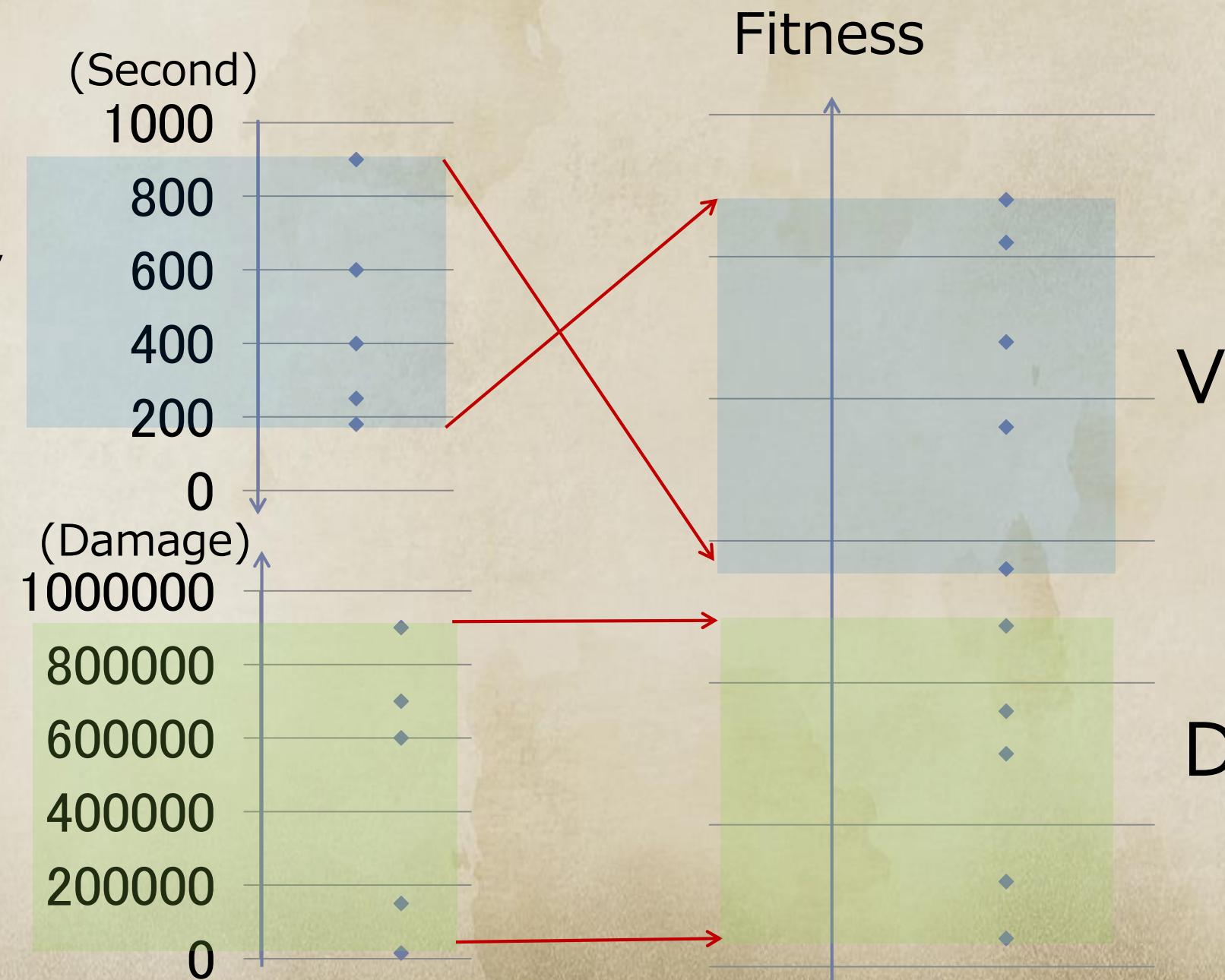
2. Evaluate the parties

➤ Mapping values in different units to the same axis

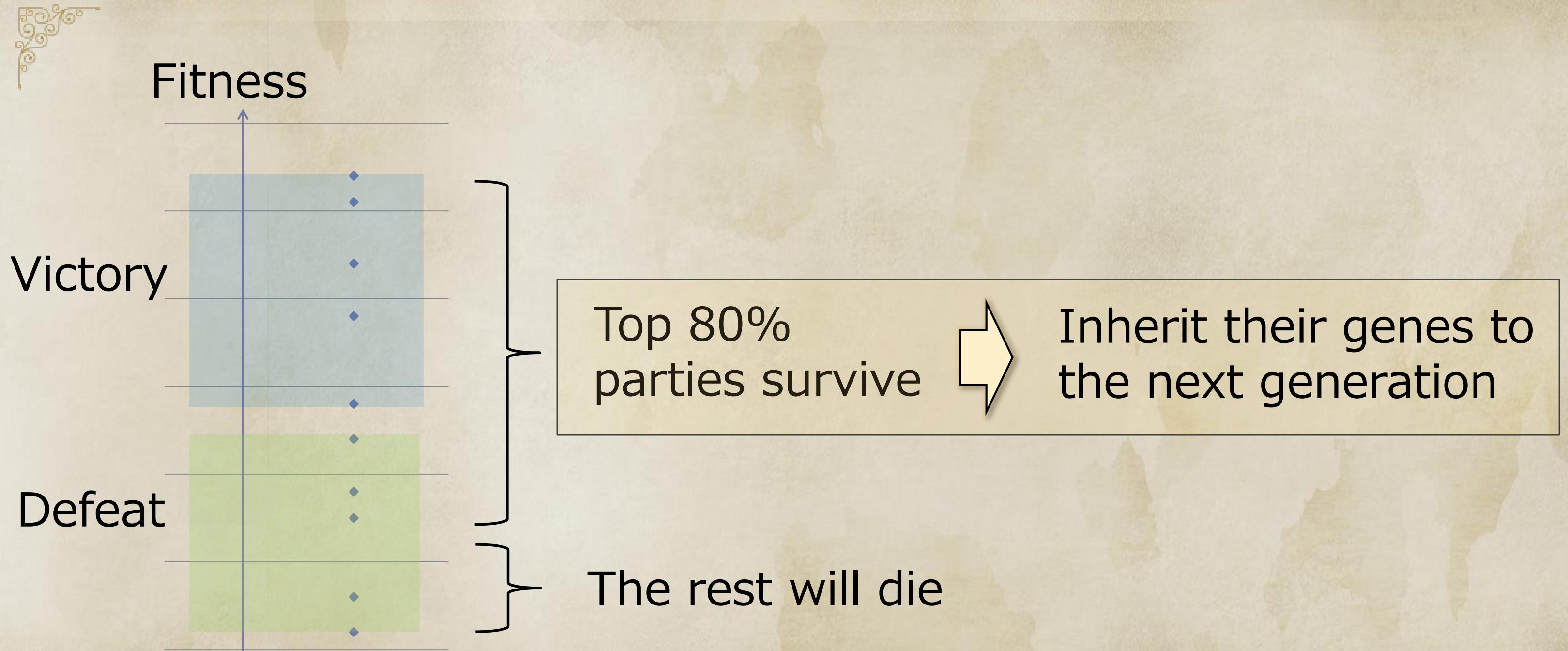
Case of PvE:

Victory

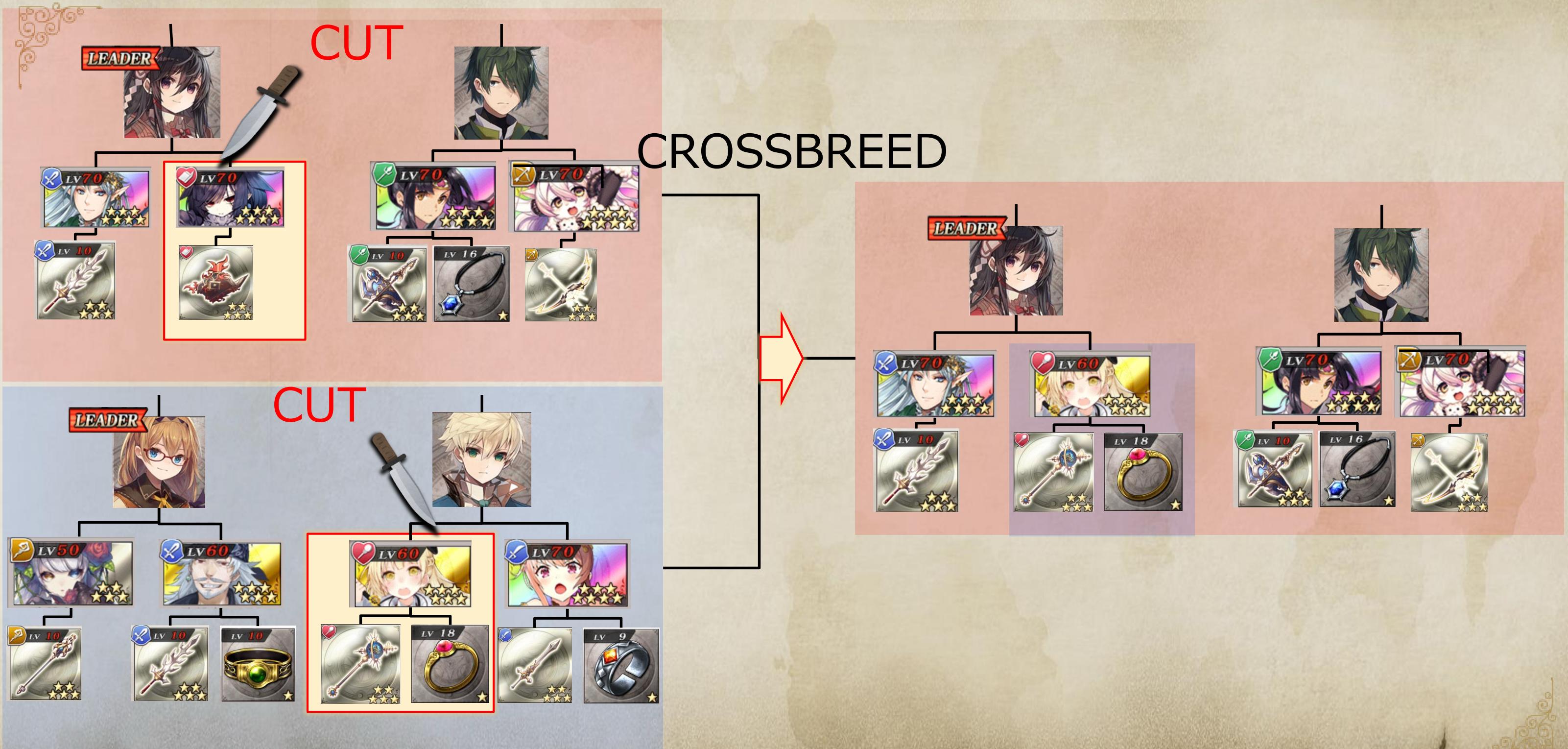
Defeat



3. Select the best parties



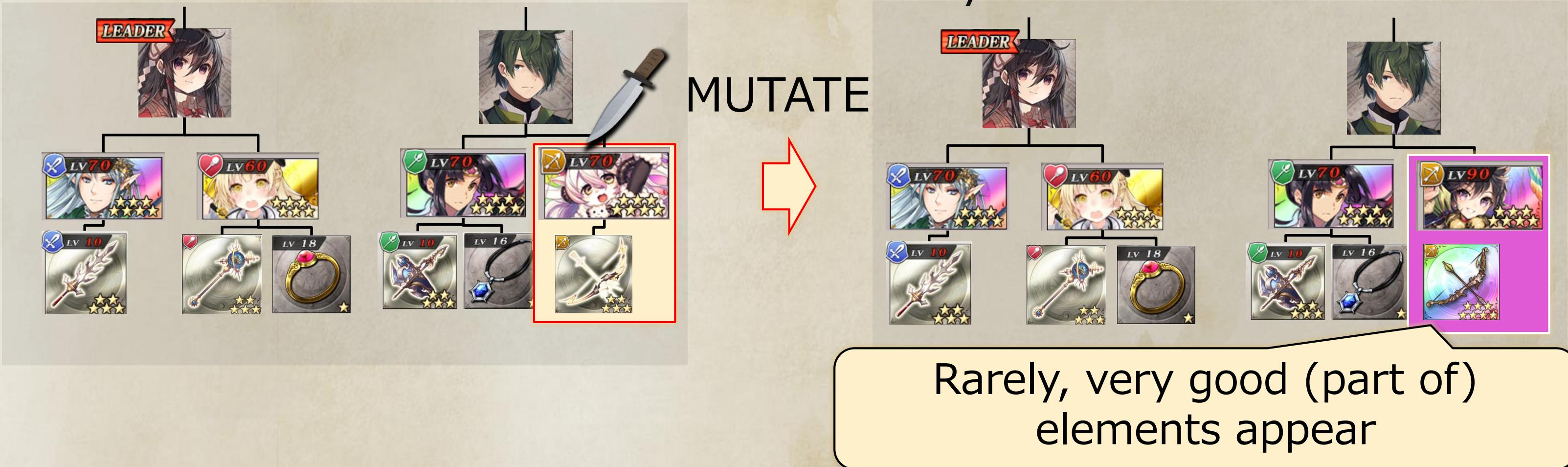
4. Crossbreed the parties: One-Point Crossover



5. Mutate a part of the parties

Mutation probability: 5%

Cut and replace a subtree randomly



- ▶ This is an important step to improve the coverage quality

2-5. Create parties from previous generation



1st gen.

2nd gen.

3rd gen.

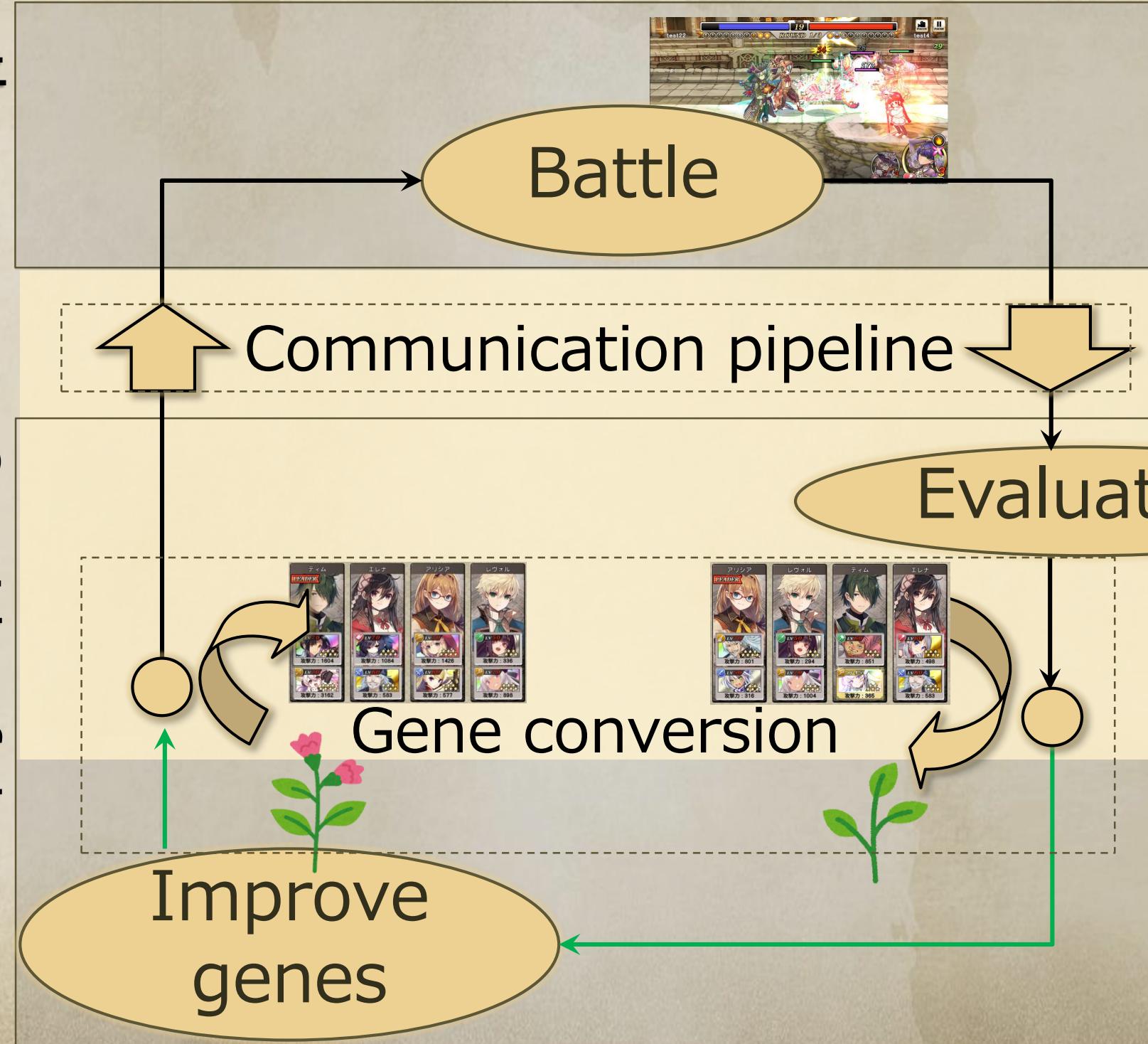
nth gen.

Improve gradually



Overview

In the game Outside of the game



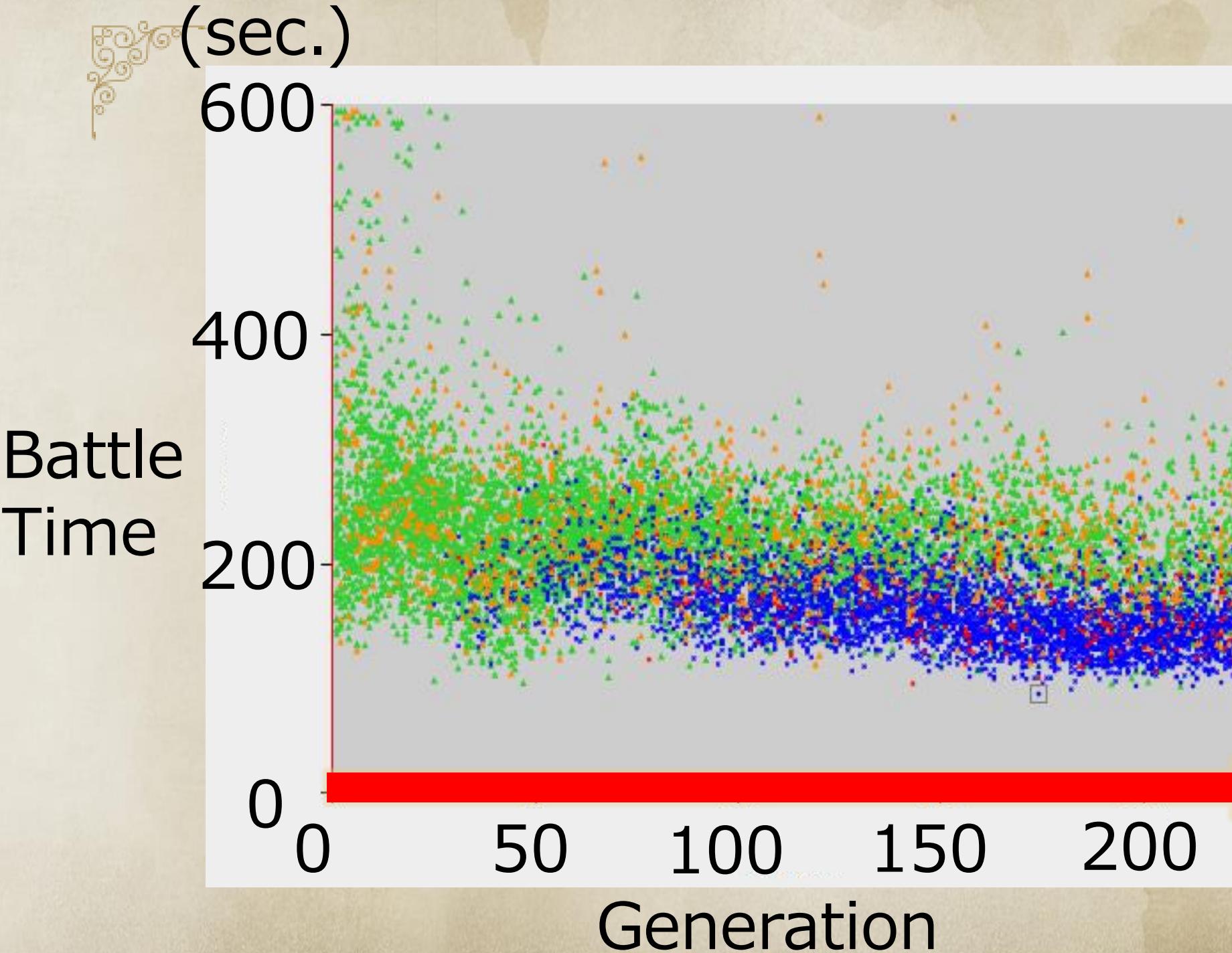
Use the actual game almost directly

Customize

Applicable to other games

Shared process

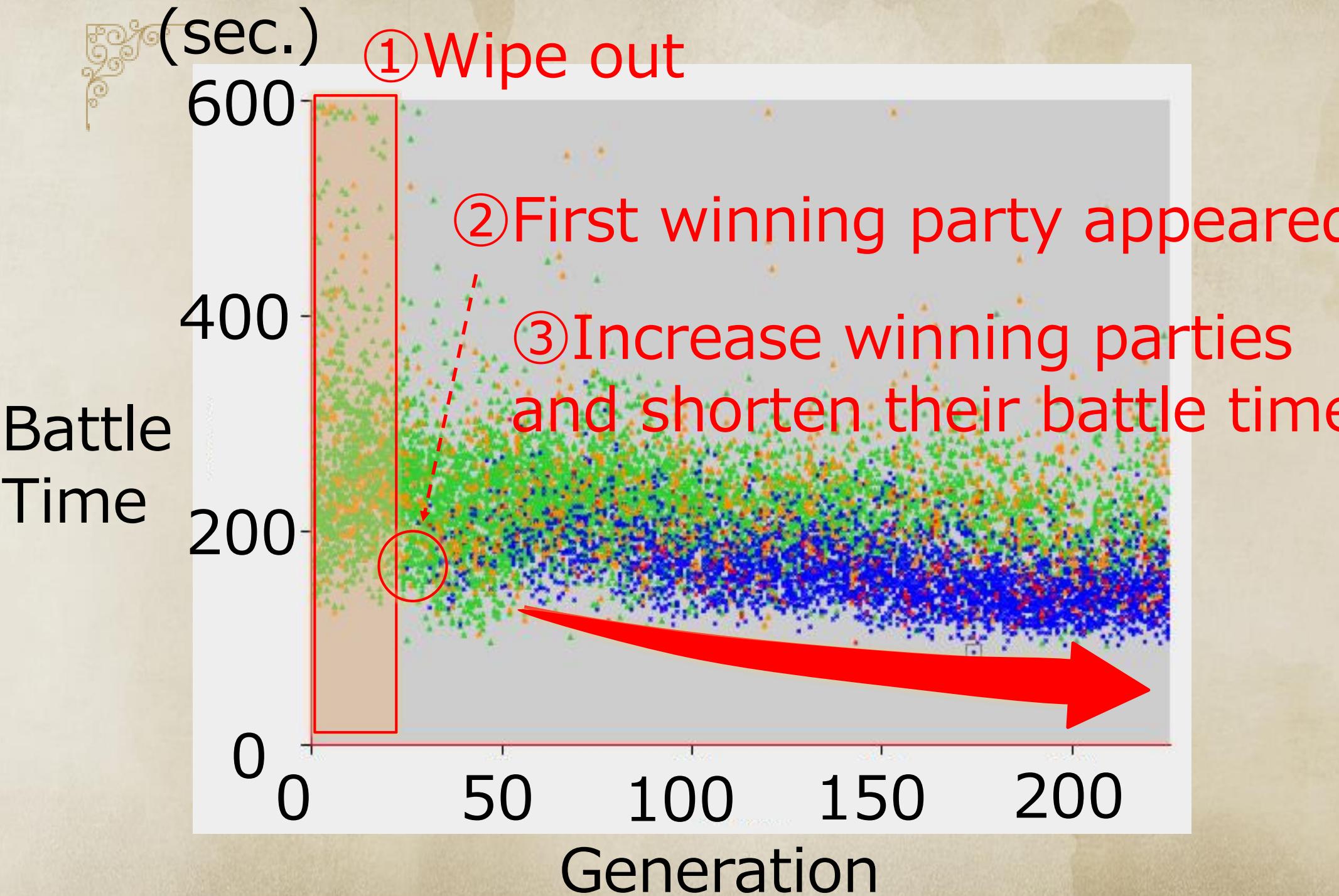
Change of fitness values in PvE



- Victory party ●
- Defeat party ●
- (Mutated victory party ●)
- (Mutated defeat party ●)



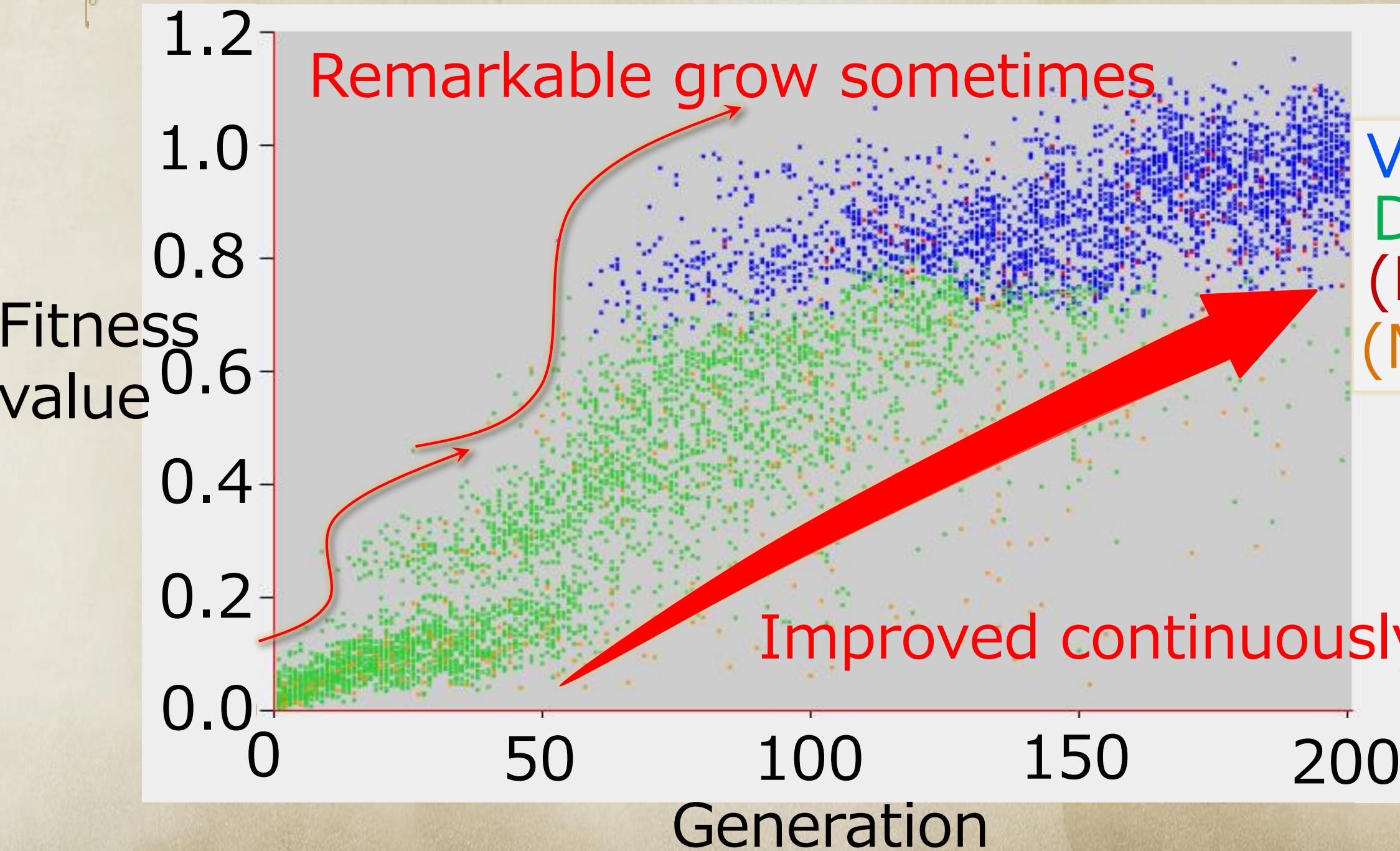
Change of fitness values in PvE



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- Defeat party ●
- (Mutated victory party ●)
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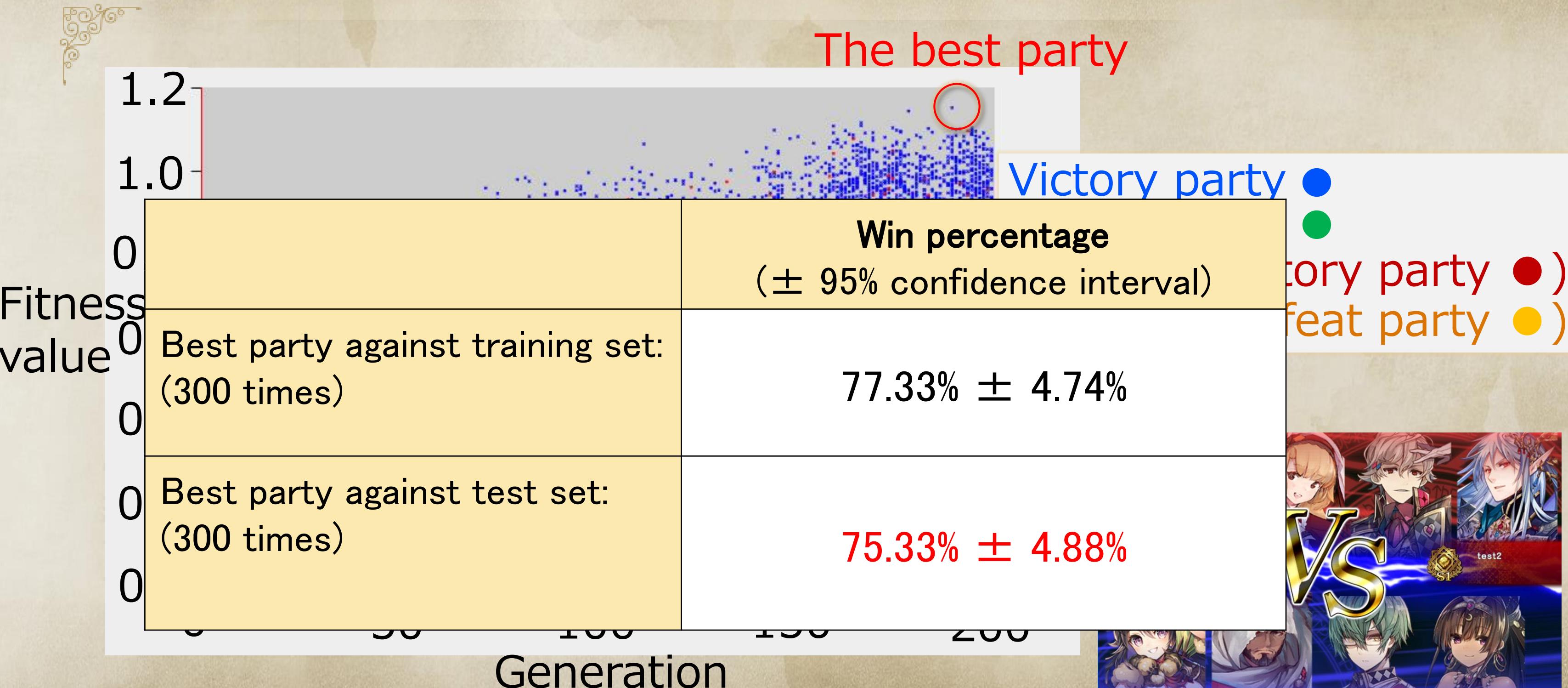
Change of fitness values in PvP



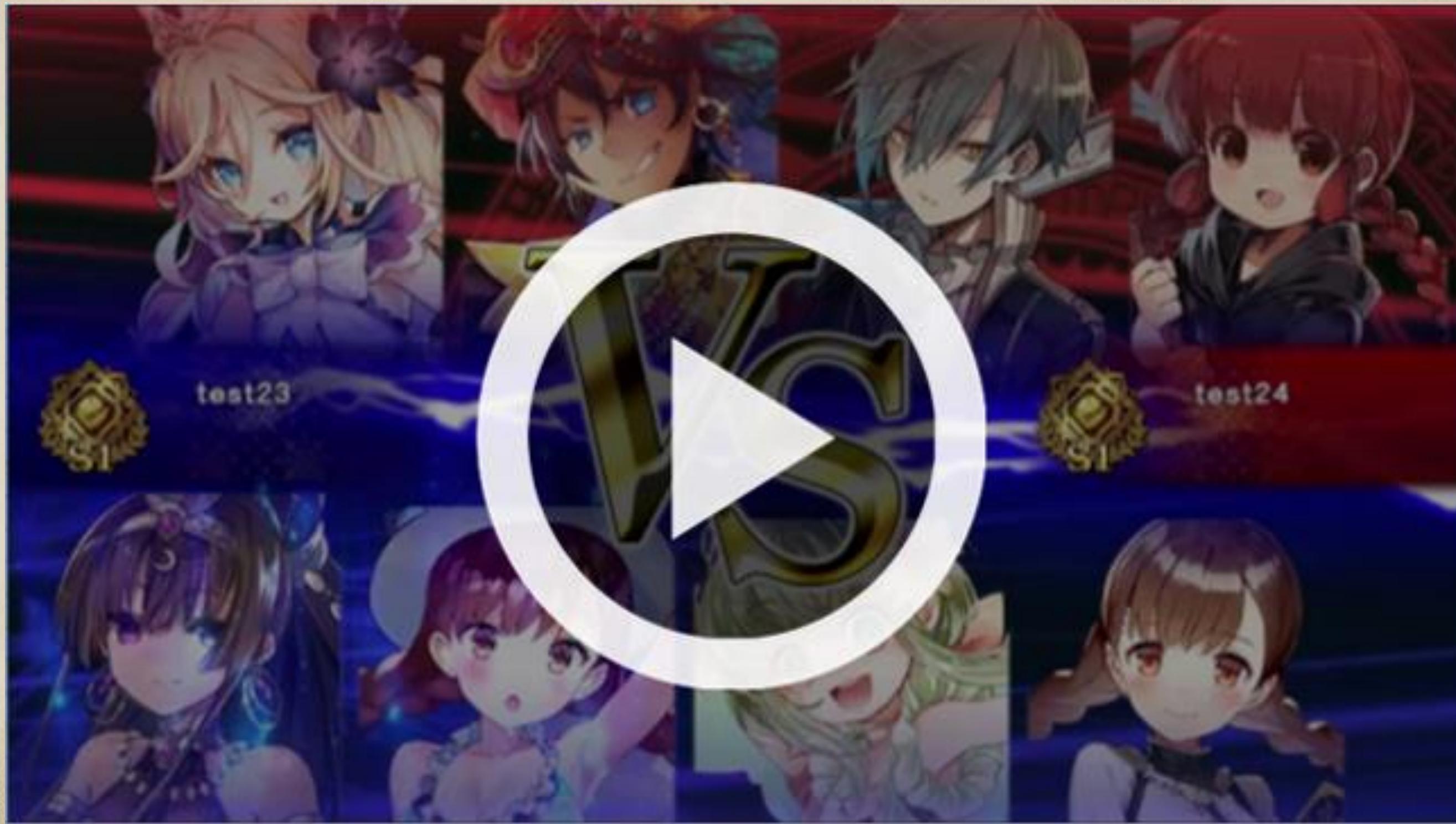
Victory party ●
Defeat party ●
(Mutated victory party ●)
(Mutated defeat party ●)



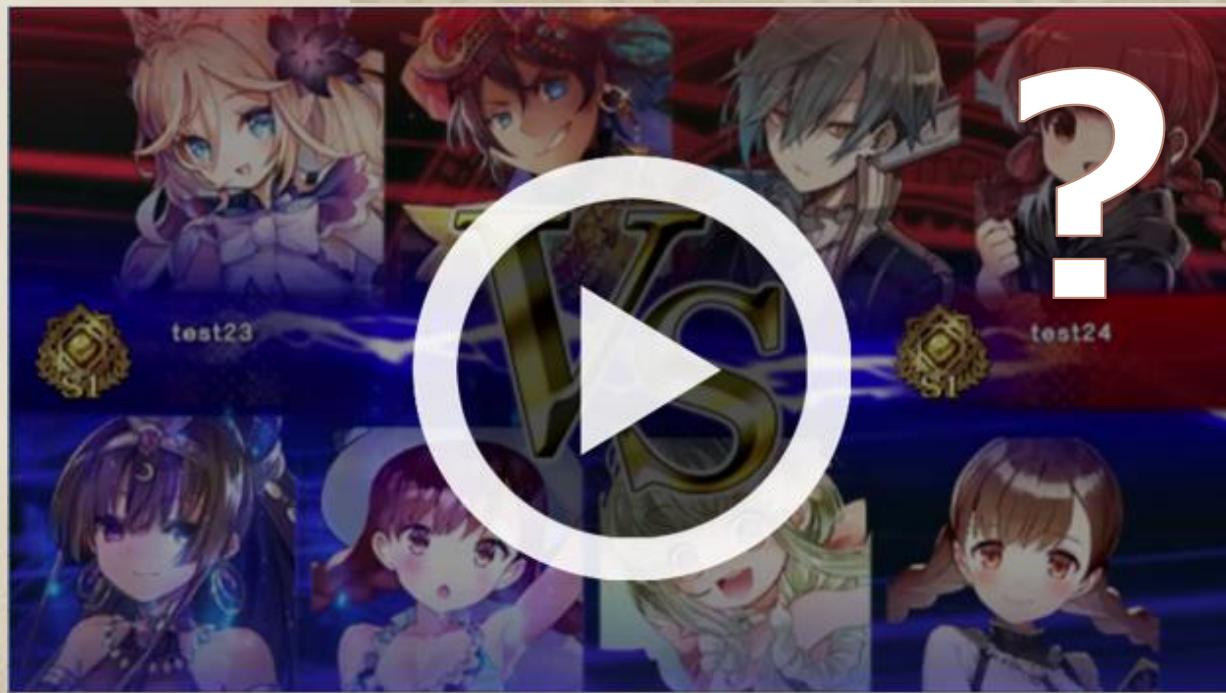
Change of fitness values in PvP



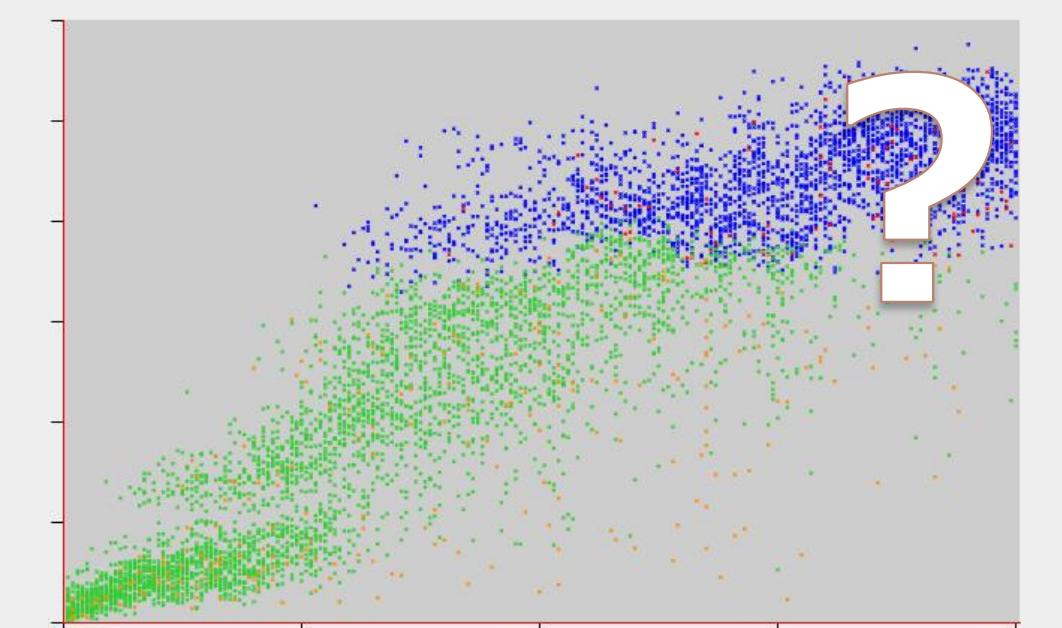
The best party – What was good?



Visualization of the information



This party is strong?
OK, but why?



Visualization tool

- ▶ The visualization should not be costly, and it should be easy to add features, or change existing ones
 - ▶ Requirements keep changing!
 - ▶ Apache Zeppelin
 - ▶ Python / R / Java (Scala)
 - ▶ JDBC / Hadoop HDFS / Google BigQuery / AWS S3
 - ▶ Ad hoc updatable
 - ▶ Scalability

How to show the achievements made by AI

技術

Fitness
(excellence)

Each row details a match's results and its party composition

| bid | fitness | results | UHADS | 1-Weapon:AI | RolePerformance | memo | 1-2Weapon:AI | RolePerformance |
|---------|---------|---------|-------|-------------|-----------------|--------------------|--------------|-----------------|
| 1141404 | 1.15337 | ★★★★★ | 0CDDC | THC:UUASTW | 47.655(★★★★★) | [ACE] A&H AllAlive | OHC:UUUFF | 0.0(----) |
| 1136519 | 1.14539 | ★★★★★ | 0CDDC | THC:UUUFF | 58.244(★★★★★) | [ACE] A&H AllAlive | OHC:SUBSTW | 0.0(----) |
| 1130954 | 1.11714 | ★★★@★ | 0DDDC | THC:UUUFF | 40.307(★○★@○) | [ACE] A&H AllAlive | OHC:SUFSTW | 5.603(----) |
| 1130848 | 1.11048 | ★★★@★ | 0DDDC | THC:UUUFF | 37.339(★★★@★) | [ACE] A&H AllAlive | OHC:SUFSTW | 4.99(----) |
| 1127984 | 1.10936 | ★★★@★ | 0DDDC | THC:UUUFF | 38.962(★★@★○) | [ACE] A&H AllAlive | OHC:SUBSTW | 0.0(----) |
| 1146588 | 1.10527 | ★★★@★ | 0CDDC | THC:UUBUFW | 42.866(★@★★★) | [ACE] A&H | OHC:UUFBFF | 0.0(----) |
| 1134594 | 1.10517 | @★★★★ | 0CDDC | THC:SUFSTW | 43.031(★@★@★) | [ACE] A&H AllAlive | OHC:UUFBFF | 0.0(----) |
| 1138589 | 1.1034 | ★★★@★ | 0CDDC | THC:UUFSTW | 39.217(★★○★★) | [ACE] A&H AllAlive | OHC:UUFBFF | 5.459(----) |

How to show the achievements made by AI



Summary
of the results

Attention point
for a character

Attention point for
a next character, ...

The screenshot shows a spreadsheet interface with several columns of data. The columns are labeled: bid, fitness, results, UHADS, 1-1Weapon:AI, RolePerformance, memo, 1-2Weapon:AI, and RolePerformance. The data consists of eight rows, each representing a different character or entry. The 'results' column contains star ratings (e.g., ★★★★★, ★★★★☆). The 'UHADS' column contains codes like 0CDDC and 0DDDC. The 'RolePerformance' columns contain numerical values and star ratings (e.g., 47.655(★★★★★), 58.244(★★★★★)). The 'memo' column contains text entries like 【ACE】 A&H AllAlive. The '1-1Weapon:AI' and '1-2Weapon:AI' columns also contain star ratings and numerical values.

| bid | fitness | results | UHADS | 1-1Weapon:AI | RolePerformance | memo | 1-2Weapon:AI | RolePerformance |
|---------|---------|---------|-------|--------------|-----------------|--------------------|--------------|-----------------|
| 1141404 | 1.15337 | ★★★★★ | 0CDDC | THC:UUASTW | 47.655(★★★★★) | 【ACE】 A&H AllAlive | OHC:UUUFF | 0.0(----) |
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| 1134594 | 1.10517 | ◎★★★★ | 0CDDC | THC:SUFSTW | 43.031(★◎★◎★) | 【ACE】 A&H AllAlive | OHC:UUFBFF | 0.0(----) |
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Methods used to make information easier to see

1) Dimensionality Reduction

- Principal Component Analysis

2) Abstraction

- 1) Standard deviation
- 2) Granularity change
- 3) Summarization

1) Dimensionality Reduction

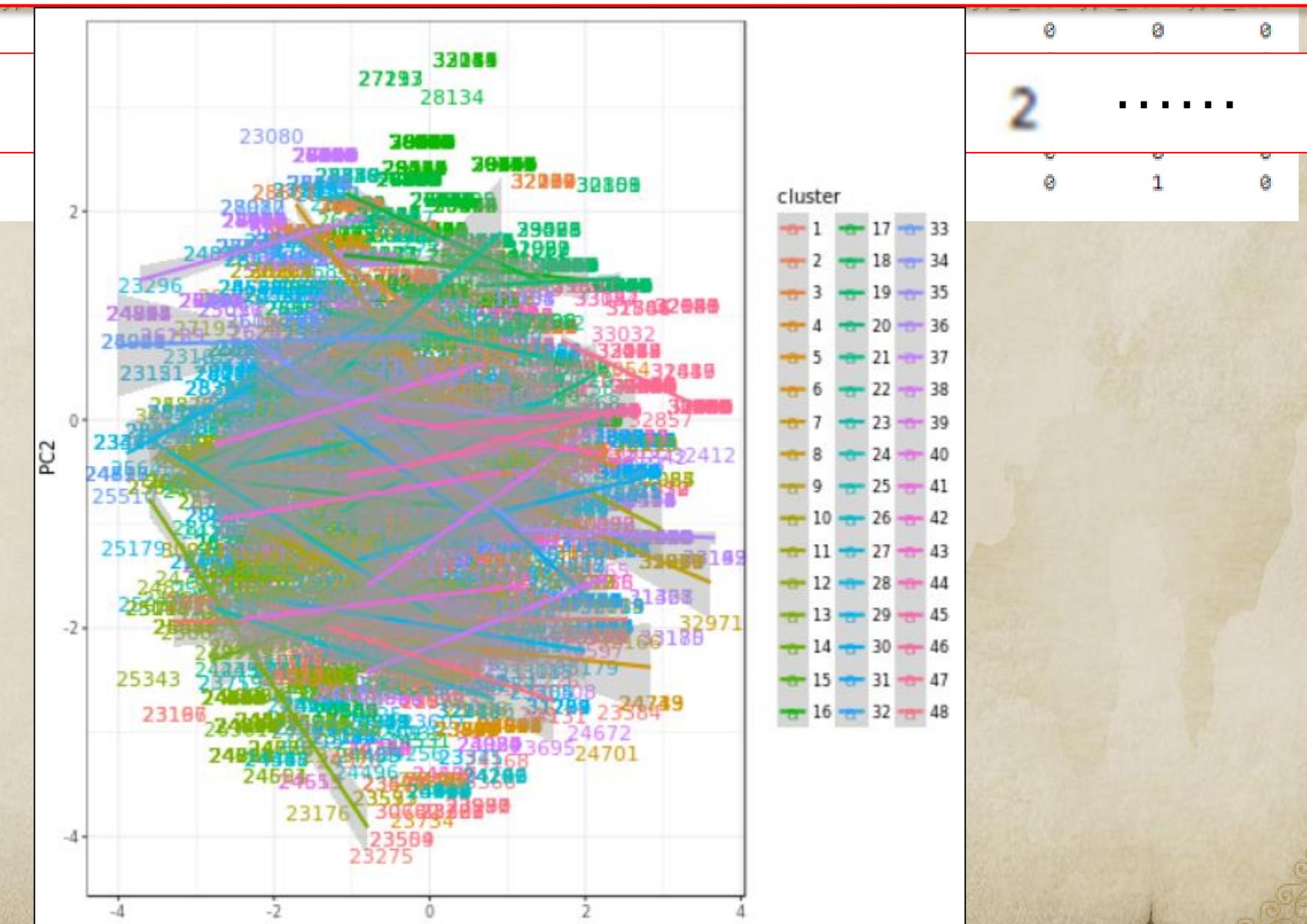
The number of time a specific type of weapon
is equipped in this party

1) Dimensionality Reduction

Party ID Type1 Type2 Type3 ... Type20

| | | | | | | | | |
|--------------|-------|----------|----------|----------|----------|----------|----------|----------|
| 1 | 29842 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| 24944 | | 1 | 1 | 0 | 0 | 1 | 1 | 0 |
| 6 | 30350 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |

21 dimensions to
2 dimensions



1) Dimensionality Reduction

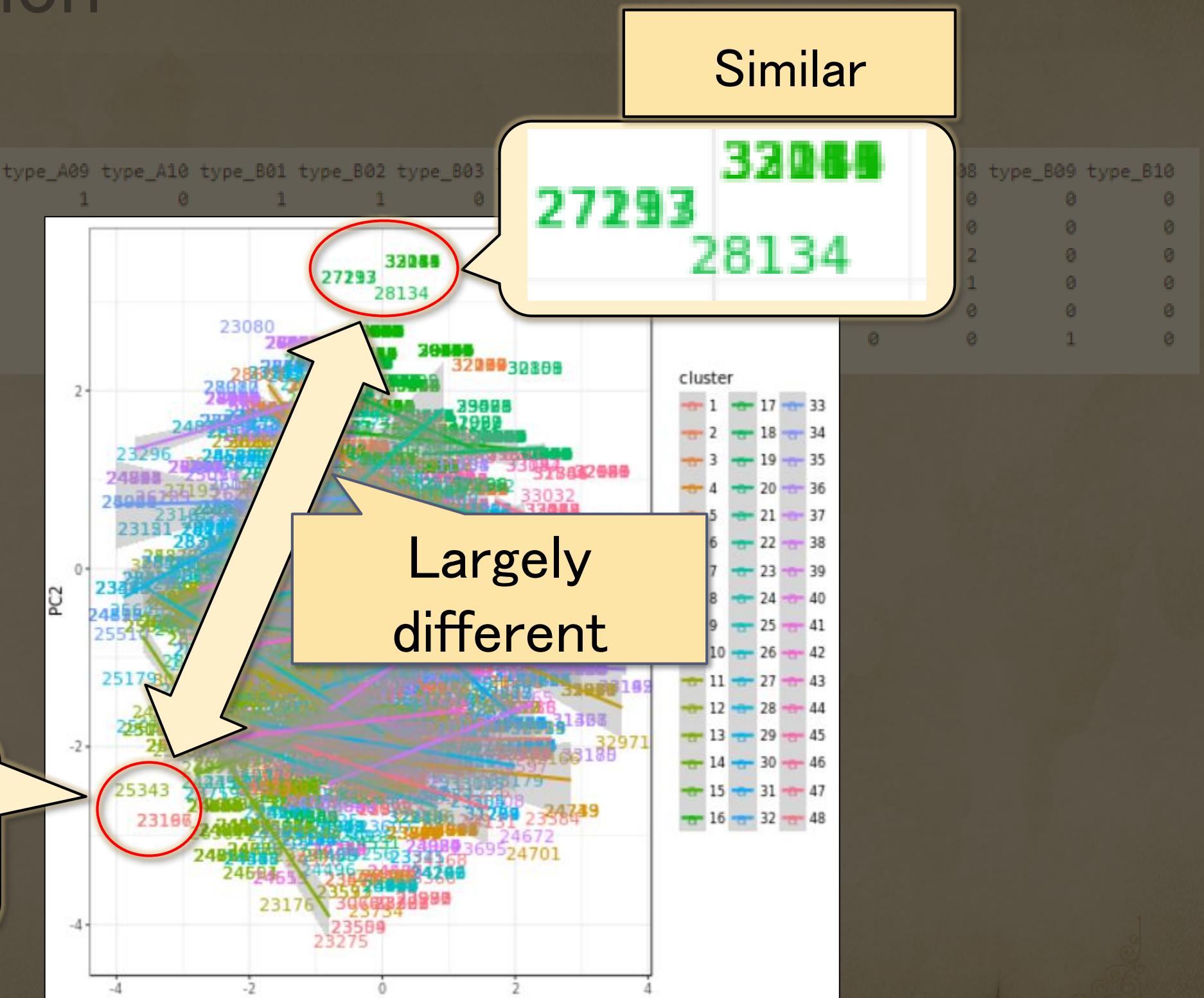


| party_id | type_A01 | type_A02 | type_A03 | type_A04 | type_A05 | type_A06 | type_A07 | type_A08 | type_A09 | type_A10 | type_B01 | type_B02 | type_B03 | type_B04 | type_B05 | type_B06 | type_B07 | type_B08 | type_B09 | type_B10 |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| 1 | 29842 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2 | 30398 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 3 | 24944 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 4 | 23792 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 5 | 23580 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 6 | 30350 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

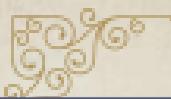
21 dimensions to
2 dimensions

Similar

25343
23100



2) Abstraction – 1) Standard deviation



Status

U = gauge to use Ultimate Skill

HADS = HP/Attack/Defense-Speed

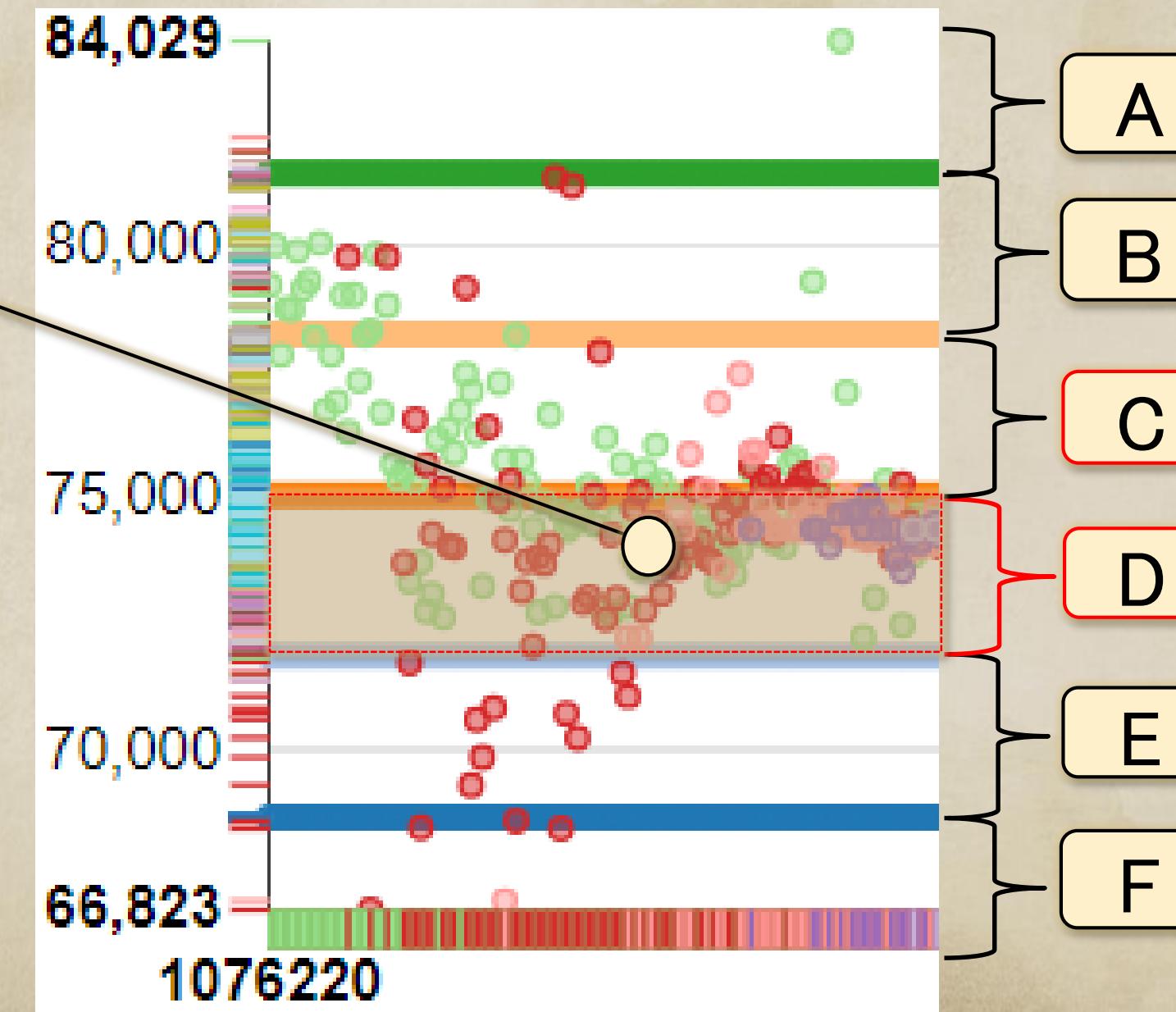
HP: 74000

Is this high?

| bid | fitness | result | UHADS | Weapon:AI | RolePerformance | memo | 1-2Weapon:AI | RolePerformance |
|---------|---------|--------|-------|------------|-----------------|--------------------|--------------|-----------------|
| 1141404 | 1.15337 | ★★★★★ | OCDDC | THC:UUASTW | 47.655(★★★★★) | 【ACE】 A&H AllAlive | OHC:UUUFF | 0.0(----) |
| 1136519 | 1.14539 | ★★★★★ | OCDDC | THC:UUUFF | 58.244(★★★★★) | 【ACE】 A&H AllAlive | OHC:SUBSTW | 0.0(----) |
| 1130954 | 1.11714 | ★★★◎★ | ODDDC | THC:UUUFF | 40.307(★○★◎○) | 【ACE】 A&H AllAlive | OHC:SUFSTW | 5.603(----) |
| 1130848 | 1.11048 | ★★★◎★ | ODDDC | THC:UUUFF | 37.339(★★★◎★) | 【ACE】 A&H AllAlive | OHC:SUFSTW | 4.99(----) |
| 1127984 | 1.10936 | ★★★◎★ | ODDDC | THC:UUUFF | 38.962(★★◎★○) | 【ACE】 A&H AllAlive | OHC:SUBSTW | 0.0(----) |
| 1146588 | 1.10527 | ★★★◎★ | OCDDC | THC:UUBUFW | 42.866(★◎★★★) | 【ACE】 A&H | OHC:UUFBFF | 0.0(----) |
| 1134594 | 1.10517 | ◎★★★★ | OCDDC | THC:SUFSTW | 43.031(★◎★◎★) | 【ACE】 A&H AllAlive | OHC:UUFBFF | 0.0(----) |
| 1138589 | 1.1034 | ★★★◎★ | OCDDC | THC:UUFSTW | 39.217(★★○★★) | 【ACE】 A&H AllAlive | OHC:UUFBFF | 5.459(----) |

2) Abstraction – 1) Standard deviation

HP: 74000



= Volume zone

2) Abstraction – 1) Standard deviation

Status value

| HP/Attack/Defense-Speed | | | | | | | |
|------------------------------|---------|---------|-------|------------|----------------|---|--|
| 74000 / 27000 / 21000 / 1100 | | | | | | | |
| bid | fitness | results | UHADS | 1 | THC:JASTW | 47.655(★★★★★) | [ACE] A&H AllAlive OHC:UUUFF 0.0(----) |
| 1141404 | 1.15337 | ★★★★★ | 0CDDC | THC:UUUFF | 58.244(★★★★★) | [ACE] A&H AllAlive OHC:SUBSTW 0.0(----) | |
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2) Abstraction – 2) Granularity change

Characteristics of the Hero AI

| bid | fitness | results | UHADS | 1-1Weapon:AI | RolePerformance | memo | 1-2Weapon:AI | RolePerformance |
|---------|---------|---------|-------|--------------|-----------------|--------------------|--------------|-----------------|
| 1141404 | 1.15337 | ★★★★★ | 0CDDC | THC:UUASTW | 47.655(★★★★★) | [ACE] A&H AllAlive | OHC:UUUFF | 0.0(----) |
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| 1130848 | 1.11048 | ★★★@★ | 0DDDC | THC:UUFUFF | 37.339(★★★@★) | [ACE] A&H AllAlive | OHC:SUFSTW | 4.99(----) |
| 1127984 | 1.10936 | ★★★@★ | 0DDDC | THC:UUFUFF | 38.962(★★@★○) | [ACE] A&H AllAlive | OHC:SUBSTW | 0.0(----) |
| 1146588 | 1.10527 | ★★★@★ | 0CDDC | THC:UUBUFW | 42.866(★@★★★) | [ACE] A&H | OHC:UUFBFF | 0.0(----) |
| 1134594 | 1.10517 | @★★★★ | 0CDDC | THC:SUFSTW | 43.031(★@★@★) | [ACE] A&H AllAlive | OHC:UUFBFF | 0.0(----) |
| 1138589 | 1.1034 | ★★★@★ | 0CDDC | THC:UUFSTW | 39.217(★★○★★) | [ACE] A&H AllAlive | OHC:UUFBFF | 5.459(----) |

What was the Hero AI?

For Arena

Condition

1 Negative status

2 Surrounded by enemies

3 Nearest enemy

4 Ultimate Skill gauge is more than 6

5 Enemy party healer

6 Always

For Hero AI: Little Red Riding Hood

Action

Switch hero and use Switch Skill

Ultimate Skill (melee range)

Run away

Attack (long range)

Ultimate Skill (long range)

Act freely

AI / ON

Copy

Paste



0

Add space



Main Character



Hero

Hero

Hero AI Action

Use Ultimate Skill

2) Abstraction – 2) Granularity change

Hero AI Actions:

U : “Ultimate Skill” category

- ▶ “Ultimate Skill immediately”
- ▶ “Ultimate Skill (melee range)”
- ▶ “Ultimate Skill (close range)”
- ▶ “Ultimate Skill (long range)”
- ▶ “Ultimate Skill on the same line”

F : “Full combo attack” category

- ▶ “Full combo (melee range)”
- ▶ “Full combo (close range)”
- ▶ “Full combo (long range)”

S : “Switch” category

- ▶ “Switch hero”
- ▶ “Switch hero and use Switch Skill”

And so on.

2) Abstraction – 2) Granularity change

Characteristics of the Hero AI

| bid | fitness | results | UHADS | 1-1Weapon:AI | RolePerformance | memo | 1-2Weapon:AI | RolePerformance |
|---------|---------|---------|-------|--------------|-----------------|--------------------|--------------|-----------------|
| 1130954 | 1.11714 | ★★★◎★ | 0DDDC | UUUFF | 47.655(★★★★★) | 【ACE】 A&H AllAlive | OHC:UUUFF | 0.0(----) |
| 1130848 | 1.11048 | ★★★◎★ | 0DDDC | UUUFF | 58.244(★★★★★) | 【ACE】 A&H AllAlive | OHC:SUBSTW | 0.0(----) |
| 1127984 | 1.10936 | ★★★◎★ | 0DDDC | UUUFF | 40.307(★○★◎○) | 【ACE】 A&H AllAlive | OHC:SUFSTW | 5.603(----) |
| 1146588 | 1.10527 | ★★★◎★ | 0CDDC | UUUFF | 37.339(★★★◎★) | 【ACE】 A&H AllAlive | OHC:SUFSTW | 4.99(----) |
| 1134594 | 1.10517 | ◎★★★★ | 0CDDC | UUUFF | 38.962(★★◎★○) | 【ACE】 A&H AllAlive | OHC:SUBSTW | 0.0(----) |
| 1138589 | 1.1034 | ★★★◎★ | 0CDDC | THC:UUFSTW | 42.866(★○★★★) | 【ACE】 A&H | OHC:UUFBFF | 0.0(----) |
| | | | | | 43.031(★◎★○★) | 【ACE】 A&H AllAlive | OHC:UUFBFF | 0.0(----) |
| | | | | | 39.217(★★○★★) | 【ACE】 A&H AllAlive | OHC:UUFBFF | 5.459(----) |

2) Abstraction – 2) Granularity change

The diagram features two yellow rectangular boxes at the top. The left box is labeled "High priority" and the right box is labeled "Low priority". A horizontal double-headed arrow connects the two boxes. Below the boxes is a table with 8 rows of data. The first seven rows have a red border around their "UUFUFF" column. The last row has a blue border around its "THC:UUFSTW" column. The table columns are: bid, fitness, results, UUFUFF, memo, 1-2Weapon:AI, and RolePerformance.

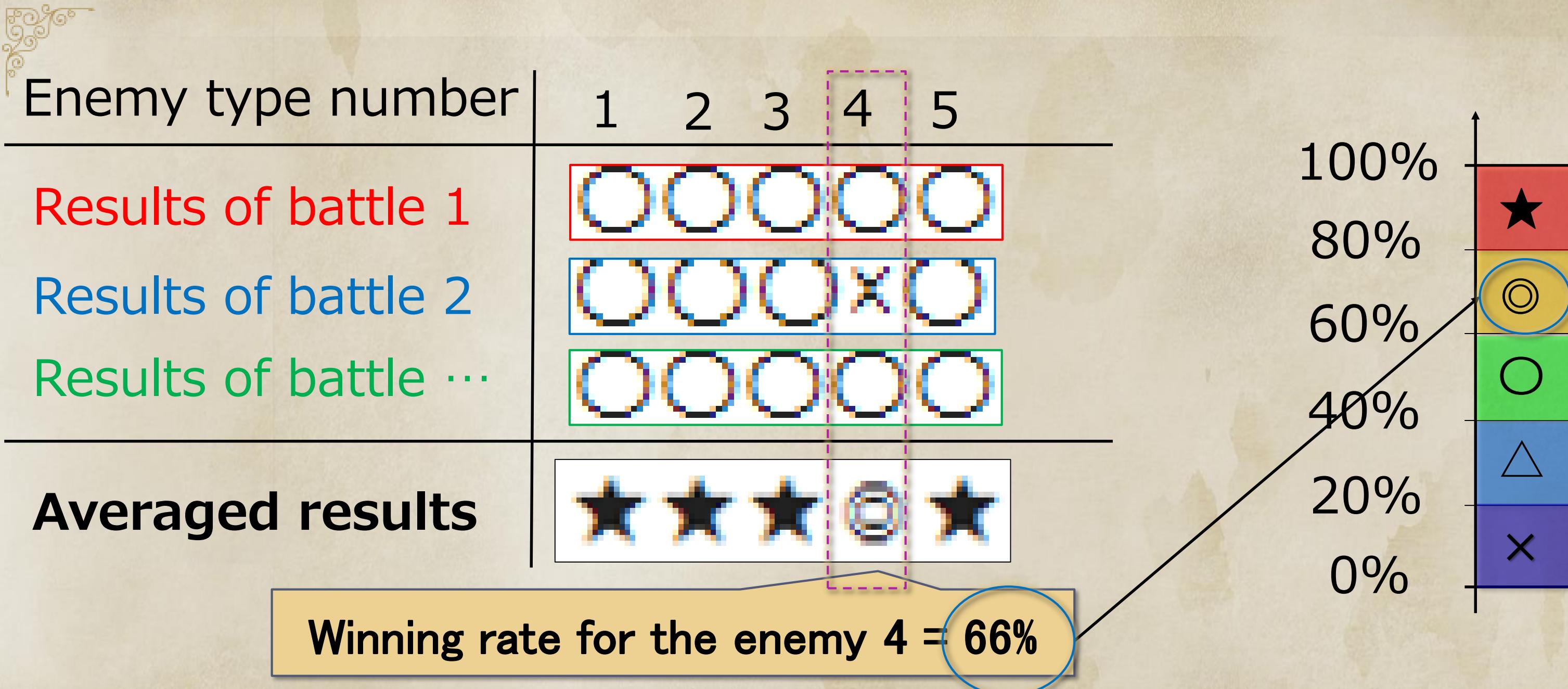
| bid | fitness | results | UUFUFF | memo | 1-2Weapon:AI | RolePerformance |
|---------|---------|-------------|------------|---------------|--------------------|------------------------|
| 1141404 | 1.15337 | ★★★★★ 0CDDC | UUUFF | 47.655(★★★★★) | 【ACE】 A&H AllAlive | OHC:UUUFF 0.0(----) |
| 1136519 | 1.14539 | ★★★★★ 0CDDC | UUUFF | 58.244(★★★★★) | 【ACE】 A&H AllAlive | OHC:SUBSTW 0.0(----) |
| 1130954 | 1.11714 | ★★★◎★ 0DDDC | UUUFF | 40.307(★○★◎○) | 【ACE】 A&H AllAlive | OHC:SUFSTW 5.603(----) |
| 1130848 | 1.11048 | ★★★◎★ 0DDDC | UUUFF | 37.339(★★★◎★) | 【ACE】 A&H AllAlive | OHC:SUFSTW 4.99(----) |
| 1127984 | 1.10936 | ★★★◎★ 0DDDC | UUUFF | 38.962(★★◎★○) | 【ACE】 A&H AllAlive | OHC:SUBSTW 0.0(----) |
| 1146588 | 1.10527 | ★★★◎★ 0CDDC | UUUFF | 42.866(★◎★★★) | 【ACE】 A&H | OHC:UUFBFF 0.0(----) |
| 1134594 | 1.10517 | ◎★★★★ 0CDDC | UUUFF | 43.031(★◎★◎★) | 【ACE】 A&H AllAlive | OHC:UUFBFF 0.0(----) |
| 1138589 | 1.1034 | ★★★◎★ 0CDDC | THC:UUFSTW | 39.217(★★○★★) | 【ACE】 A&H AllAlive | OHC:UUFBFF 5.459(----) |

2) Abstraction – 2) Granularity change

Express excellence
by the kind of marks

| bid | fitness | results | HADS | 1-1Weapon:AI | RolePerformance | memo | 1-2Weapon:AI | RolePerformance |
|---------|---------|---------|-------|--------------|-----------------|--------------------|--------------|-----------------|
| 1141404 | 1.15337 | ★★★★★ | 0CDDC | THC:UUASTW | 47.655(★★★★★) | 【ACE】 A&H AllAlive | OHC:UUUFF | 0.0(----) |
| 1136519 | 1.14539 | ★★★★★ | 0CDDC | THC:UUFUFF | 58.244(★★★★★) | 【ACE】 A&H AllAlive | OHC:SUBSTW | 0.0(----) |
| 1130954 | 1.11 | ★★★★★ | 0CDDC | THC:UUFUFF | 40.307(★○★○○) | 【ACE】 A&H AllAlive | OHC:SUFSTW | 5.603(----) |
| 1130848 | 1.11048 | ★★★@★ | 0DDDC | THC:UUFUFF | 37.339(★★★@★) | 【ACE】 A&H AllAlive | OHC:SUFSTW | 4.99(----) |
| 1127984 | 1.10936 | ★★★@★ | 0DDDC | THC:UUFUFF | 38.962(★★@★○) | 【ACE】 A&H AllAlive | OHC:SUBSTW | 0.0(----) |
| 1146588 | 1.10527 | ★★★@★ | 0CDDC | THC:UUBUFW | 42.866(★@★★★) | 【ACE】 A&H | OHC:UUFBFF | 0.0(----) |
| 1134594 | 1.10517 | ○★★★★ | 0CDDC | THC:SUFSTW | 43.031(★○★○★) | 【ACE】 A&H AllAlive | OHC:UUFBFF | 0.0(----) |
| 1138589 | 1.1034 | ★★★@★ | 0CDDC | THC:UUFSTW | 39.217(★★○★★) | 【ACE】 A&H AllAlive | OHC:UUFBFF | 5.459(----) |

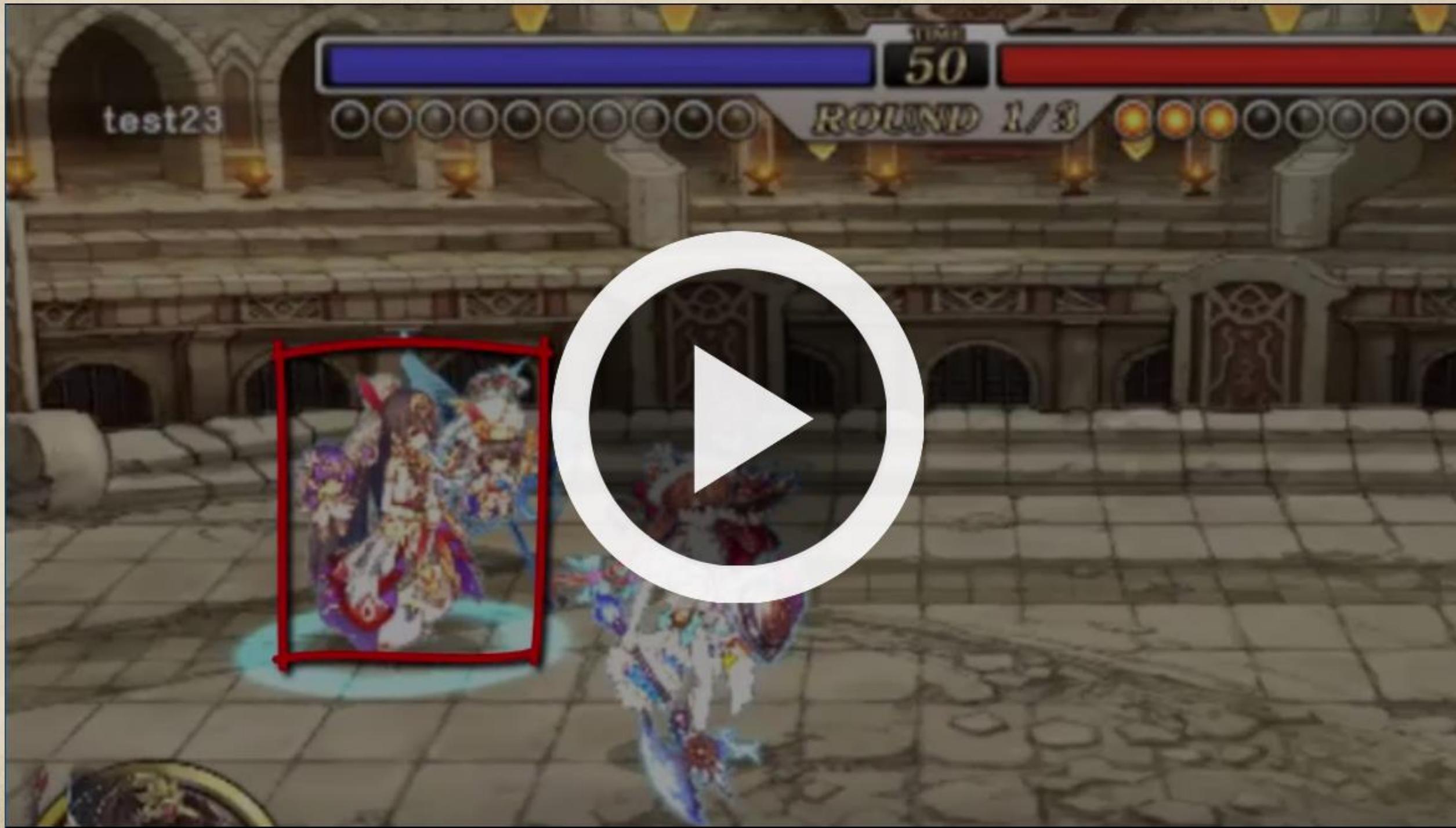
2) Abstraction – 2) Granularity change



2) Abstraction – 3) Summarization

| bid | RolePerformance | memo | 1-2Weapon:AI | RolePerformance | memo | ... |
|---------|---------------------|--------------------|----------------|--------------------|------------|-------------|
| 1141404 | 47.655(★★★★★) | 【ACE】 A&H AllAlive | OHC:UUUFF | 0.0(----) | DoNotFight | |
| 1136519 | 58.2 | 【ACE】 A&H AllAlive | OHC:SUBSTW | 0.0(----) | DoNotFight | |
| 1130954 | 40.307(★○★○○) | 【ACE】 A&H AllAlive | OHC:SUFSTW | 5.603(----) | DoNotFight | |
| 1130848 | 1.11048 ★★★○★ 0DDDC | THC:UUUFF | 37.339(★★★○★) | 【ACE】 A&H AllAlive | OHC:SUBSTW | DoNotFight |
| 1127984 | 1.10936 ★★★○★ 0DDDC | THC:UUUFF | 38.962(★★○★○○) | 【ACE】 A&H AllAlive | OHC: | DoNotFight |
| 1146588 | 1.10527 ★★★○★ 0CDDC | THC:UUBUFW | 42.866(★○★★★) | 【ACE】 A&H | OHC: | AllAlive |
| 1134594 | 1.10517 ○★★★★ 0CDDC | THC:SUFSTW | 43.031(★○★○★) | 【ACE】 A&H AllAlive | OHC:UUFBFF | 0.0(----) |
| 1138589 | 1.1034 ★★★○★ 0CDDC | THC:UUFSTW | 39.217(★★○★★) | 【ACE】 A&H AllAlive | OHC:UUFBFF | 5.459(----) |

The best character: Scheherazade

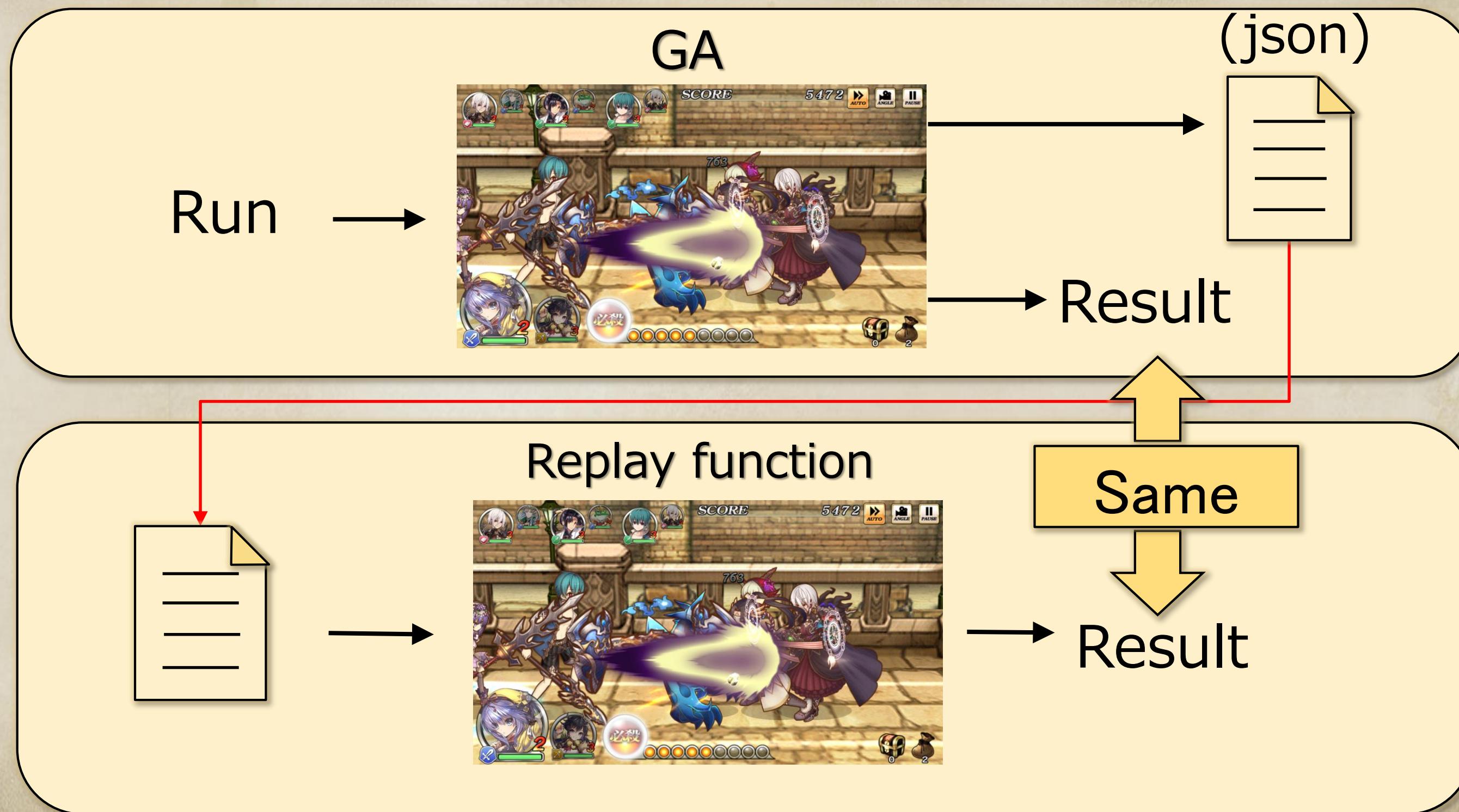


The best support: disable enemies

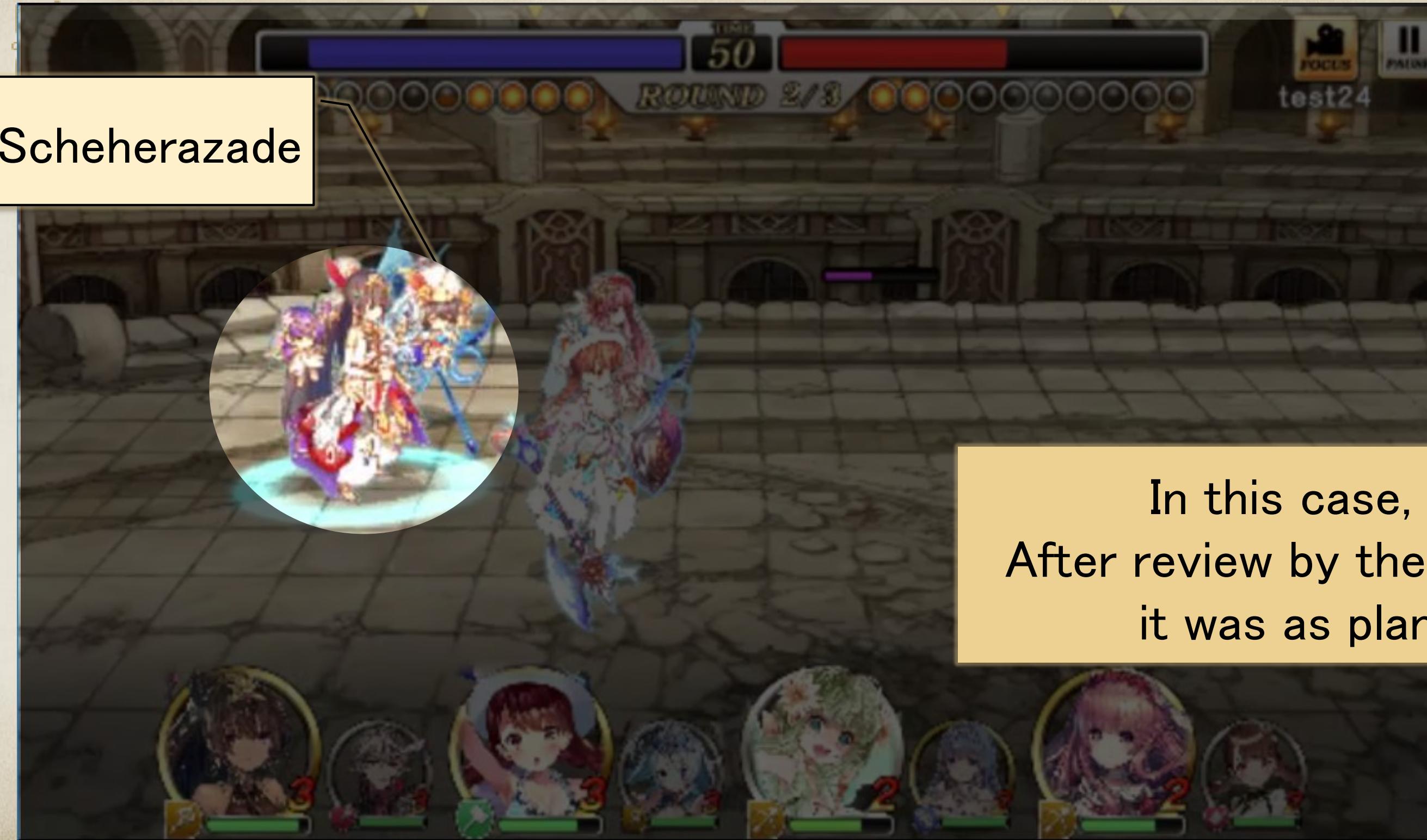


Battle replay function

Battle information



Is “Scheherazade” a balance breaker?



To find other balance breakers

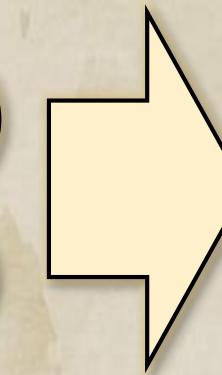


Scheherazade



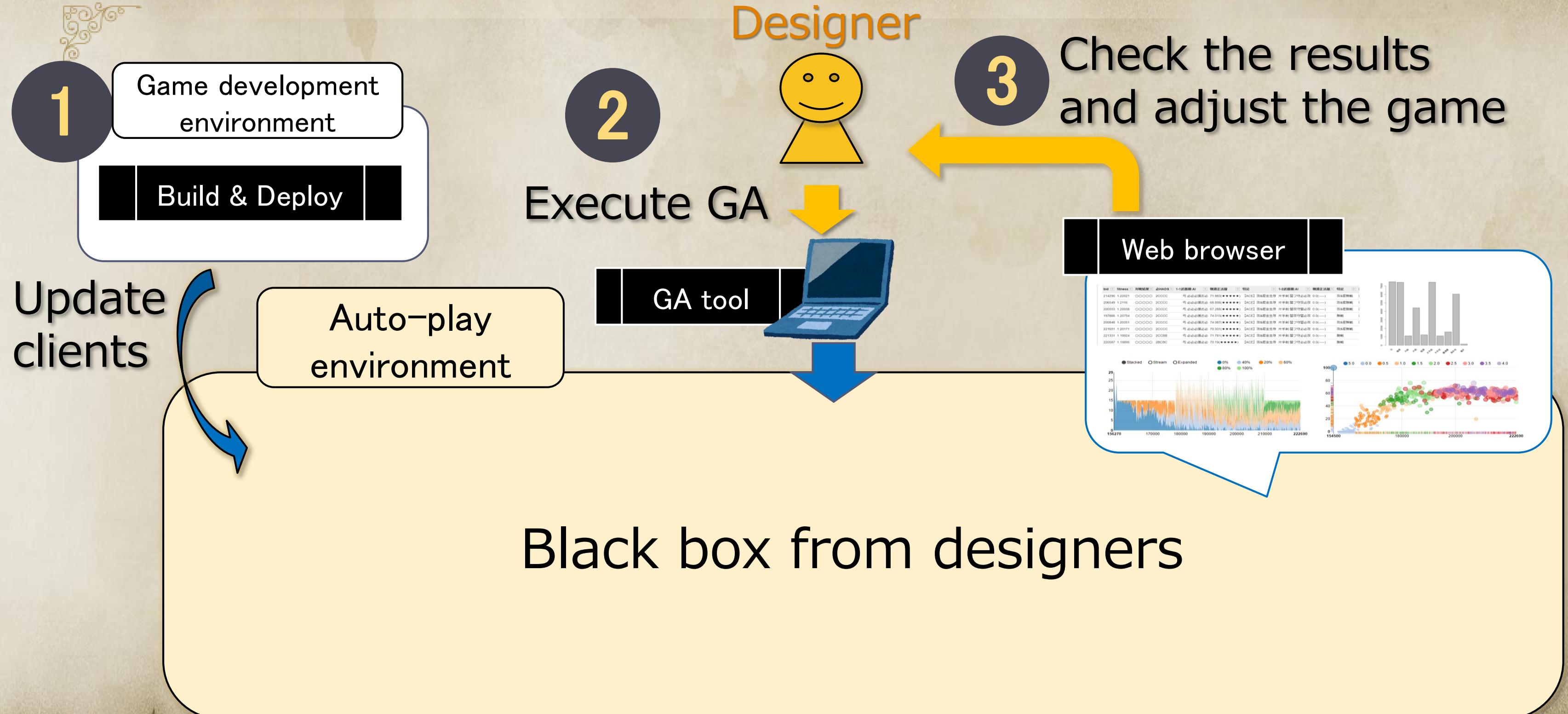
Exclusion

Candidate heroes



Re-execution
of GA

System configuration for balance adjustment



System configuration for balance adjustment

Designer

1

Game development environment

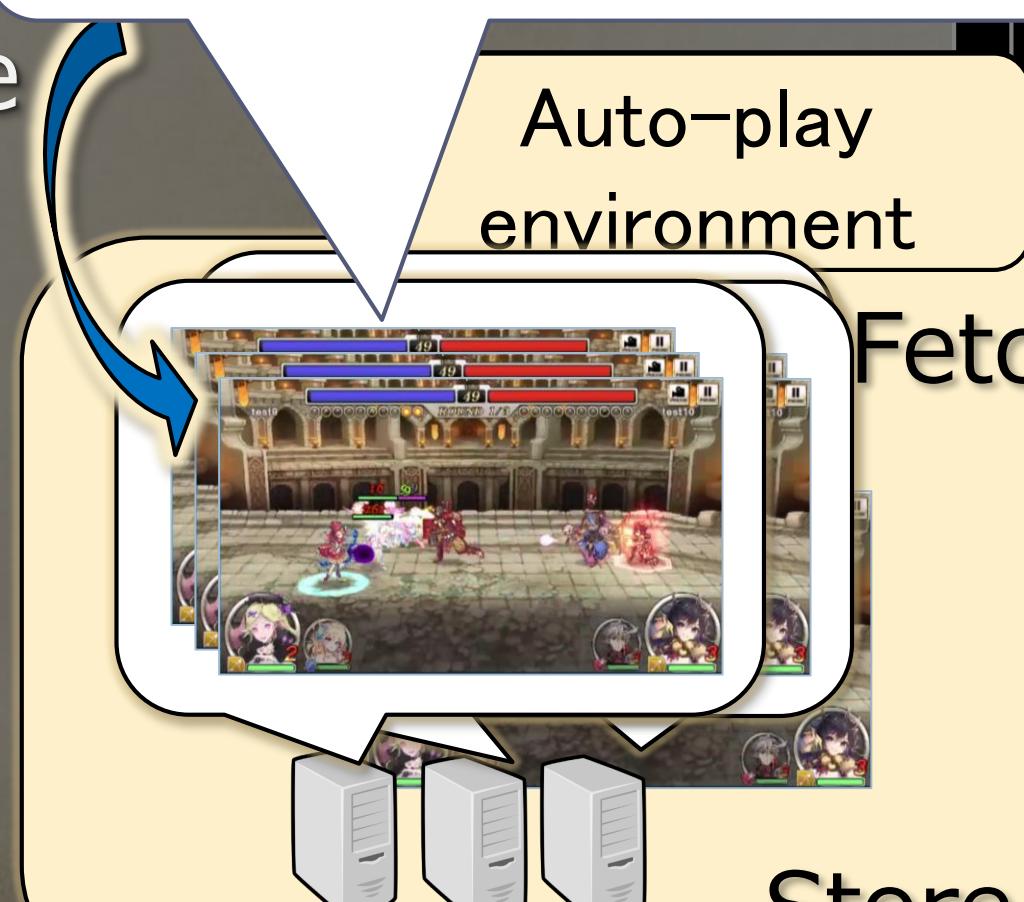
2

Execute multiple game processes on each server

3

Check the results and adjust the game

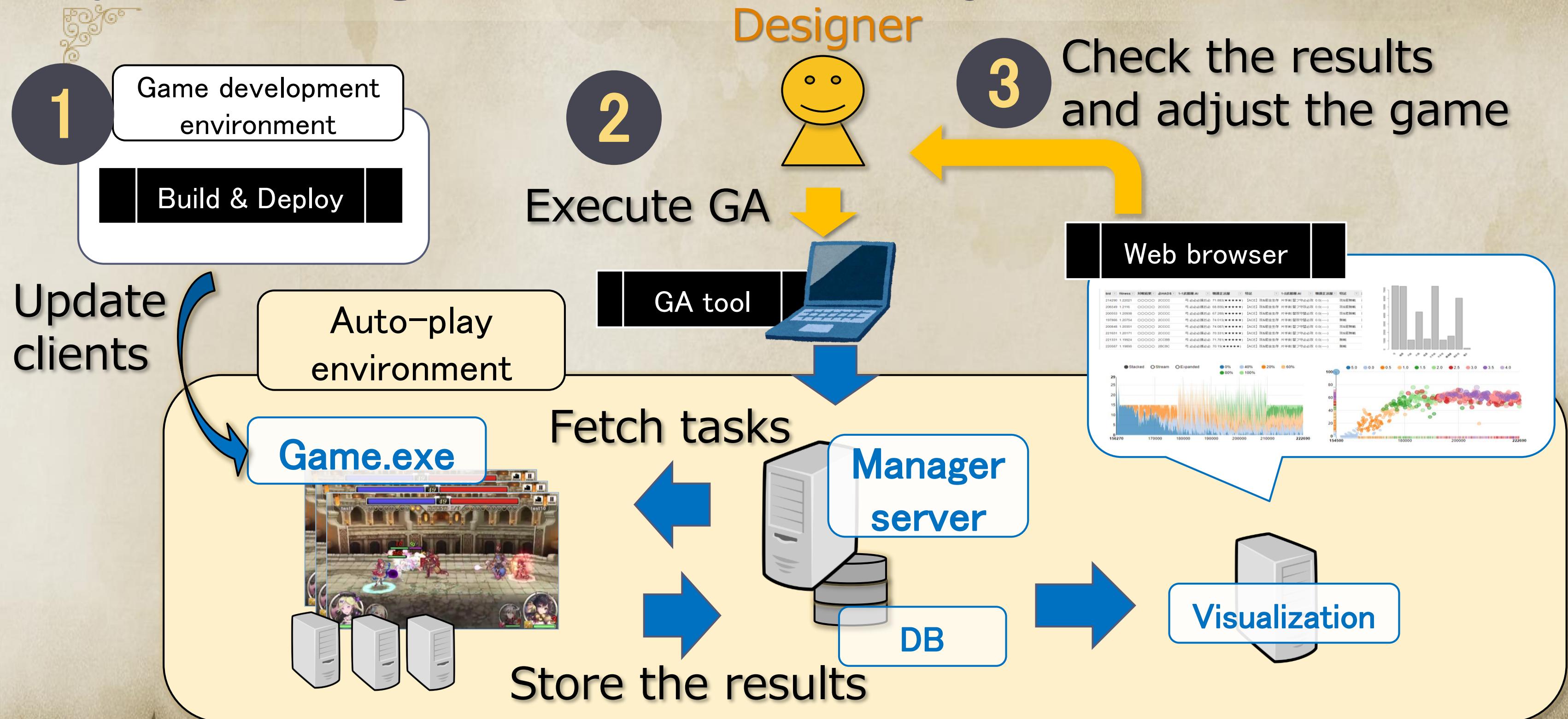
Update clients



Fetch tasks

Store the results

System configuration for balance adjustment

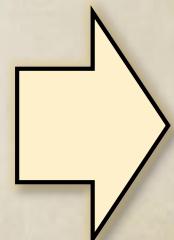


What about performance?

1: Separate simulation

► A simulator that shows battle results by numeric calculation

- + Fast execution: about 1 second / 1 battle
- Not the same precision as actual game
- Updating simulator manually

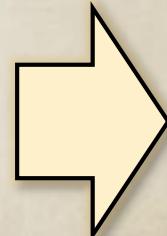


This solution was not kept

2: Use in-game logic

► Connect to the in game logic

- + Guaranteed to be the same as in game
- + Designers can see the results
- SLOW
- COST



This is the current solution



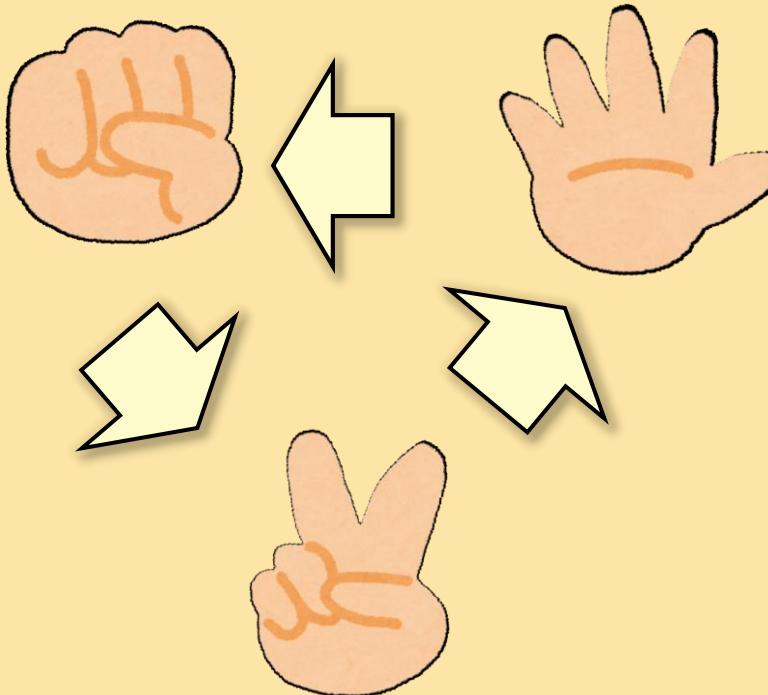
3: What could be the best solution?

- ▶ Use in-game logic
 - ▶ Support accelerated simulation
 - ▶ Run in a cloud
- => These need to be supported by the game code

What could we do next?

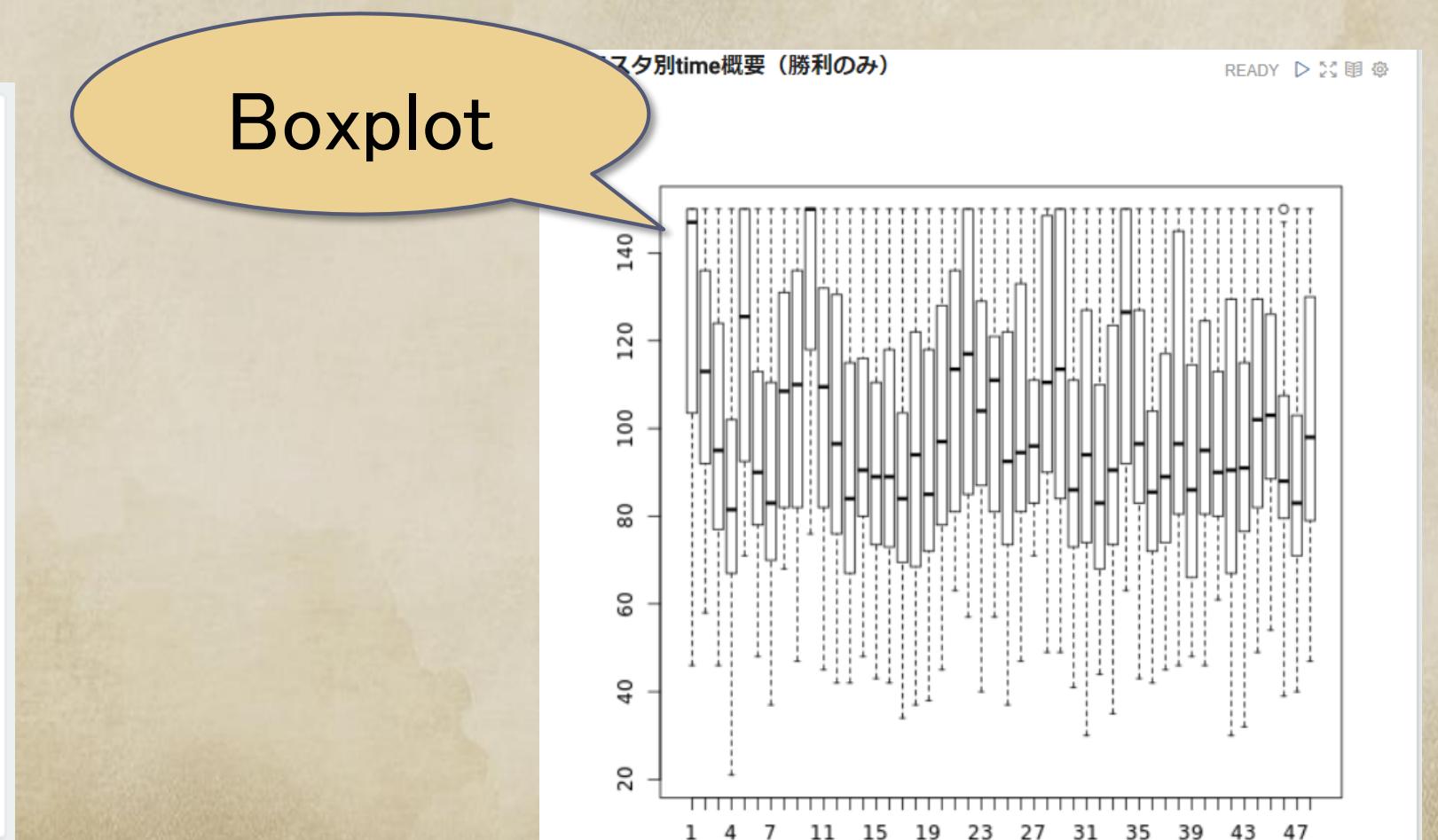
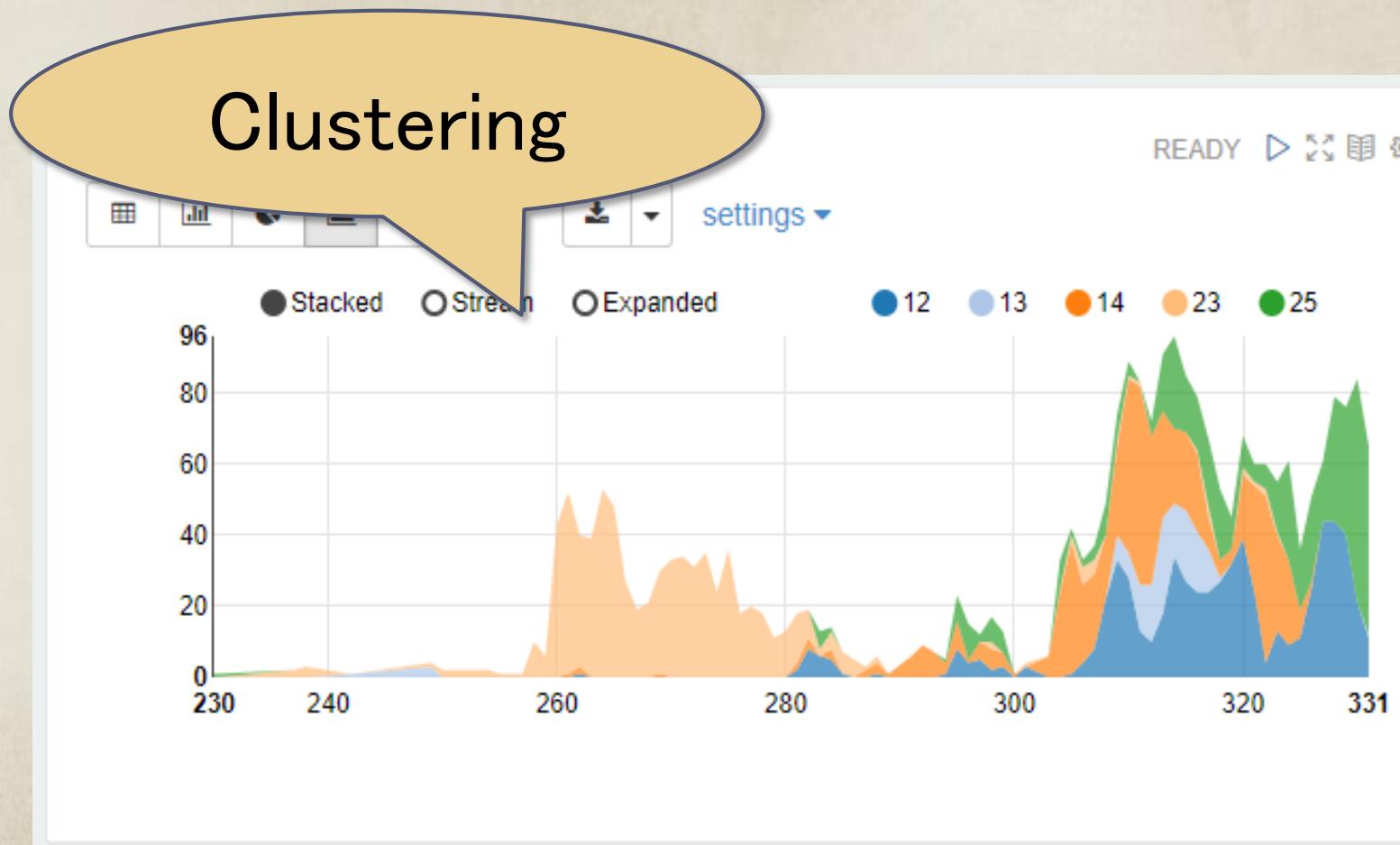
► Confirm the cyclic balance

Ideal correlation



What could we do next?

- Method for observing growth as a group
 - Clustering of the abstracted party compositions
 - Use boxplot to visualize the potential on a group basis



Takeaways

- ▶ Finding strong agent saves you from the nightmare
 - ▶ For example, by Genetic Algorithm
 - ▶ Data visualization and analysis are essential
 - ▶ Auto-play environment should be accurate and updated automatically
- ▶ You should prepare in the early development

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Questions?

Slowly, simply, please!
(Seriously)