GDC | March 21-25, 2022
San Francisco, CA

Application of AI Technology and Organizational Design to Improve Game Quality and Productivity

#GDC22

Speaker

Katsuhiko Sato(DeNA)
Business Development and Technical Director

e-mail : 67kanade@gmail.com

▼ Working at <u>DeNA's AI Promotion Division</u> from 2019.

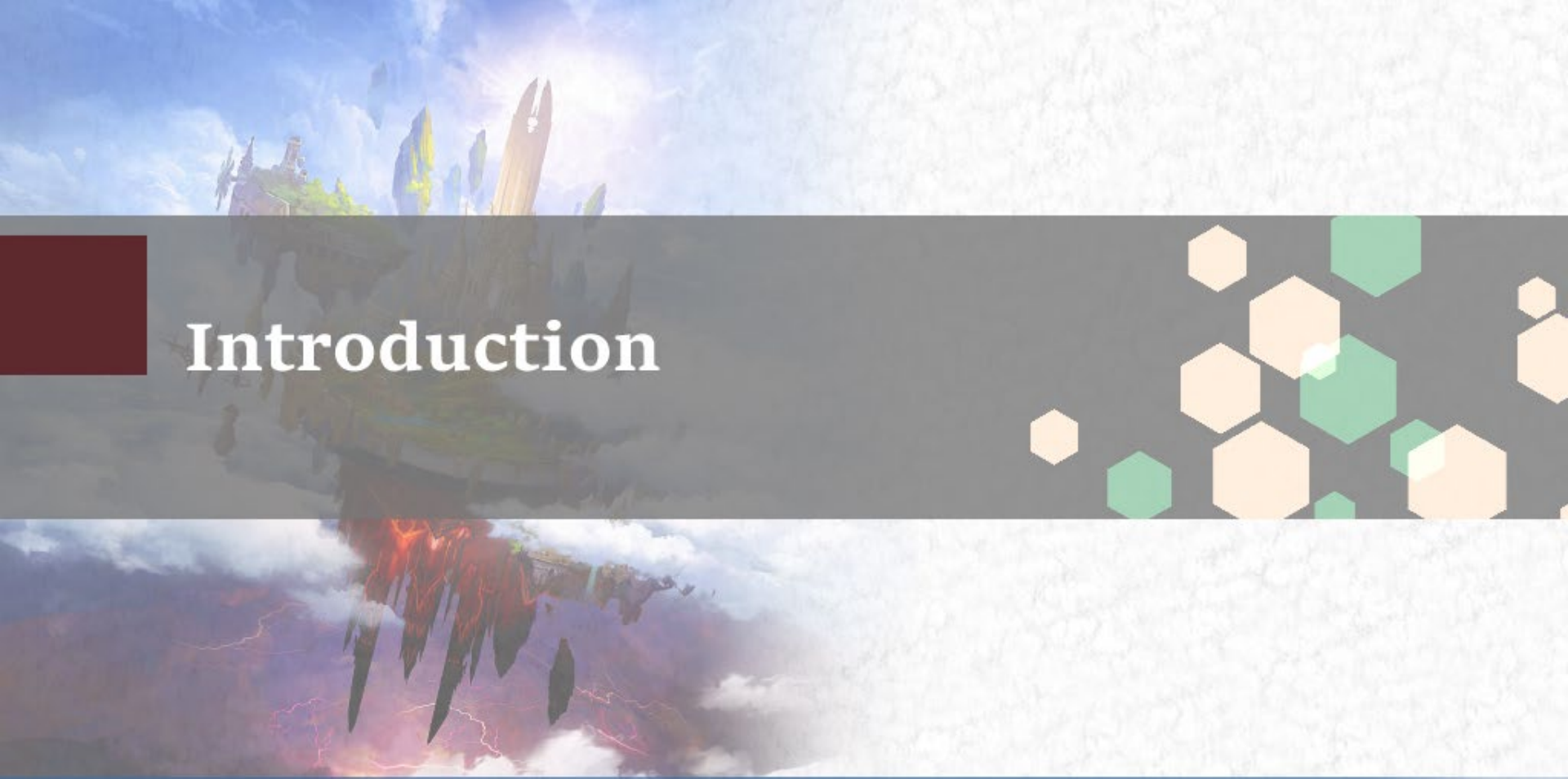
- promote the use and adoption of AI in game products and business.

▼ In charge of AI development such as

- DARK SOULS III（FromSoftware）
- Shadowverse(Cygames)

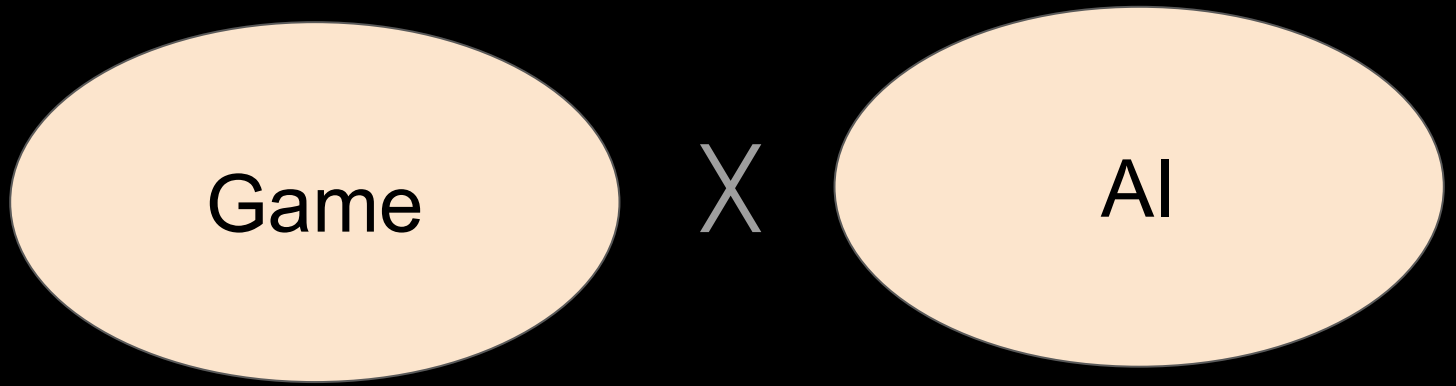
▼ Experience in various positions

- researcher/engineer to planner/project manager/director, assistant producer
- promoted AI Development across both content development teams and R&D sections



Introduction

How can we promote and scale them？



There is many pieces…

Business needs x AI Technology

Multiple Procjects

Game developments x R&D plans

Multiple areas of expertise

Mismatches can be tragic.

Our apploach

Business needs x AI Technology

Cross-Project System for matching & plannning

AI Promotion Division

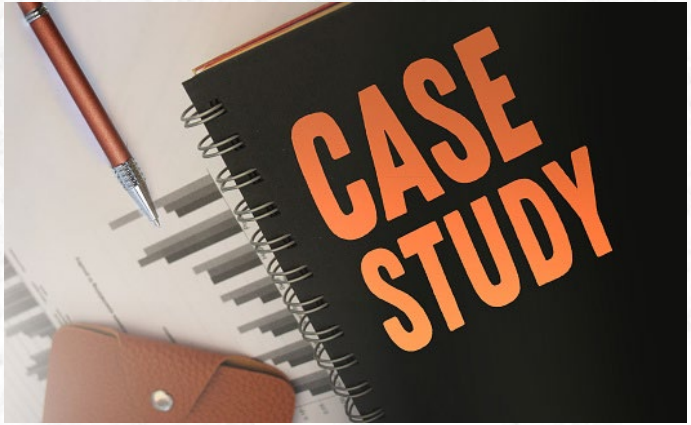
Multiple Procjects

Game developments x R&D plans

Multiple areas of expertise

You can take away…

- Benefits of **cross-project** system and plannning
- How to organize cross-project system
- Good and Bad theories in AI promoting and scaling



If you love AI and Game, this is for your session!!
Please enjoy!!

Agenda

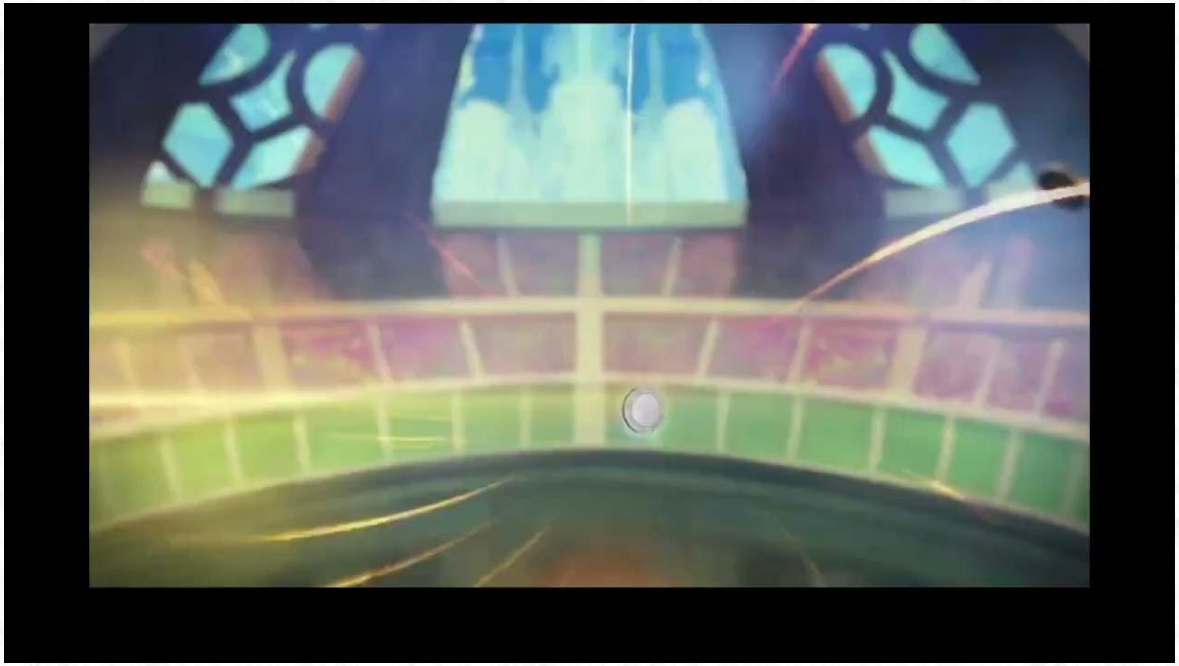
1. Background
2. Bad patterns
3. Role of the deivision
4. Planning
5. Use case expansion
6. Common infrastructre
7. Risk control

Background

GDC.2019
Applying AI in Games with DeNA(Presented by Google Cloud)

We discussed **the usage of machine learning technology** in **“Gyakuten Othellonia.”**

Othello/Reversi
x
TCG



Strategic app game

- Based on Board Game

  (Othello / Reversi)

- Variety of Characters / Skills

  4000 Characters, 2 x 10^44 Deck patterns

Released in 2016

30M downloads so far

Region: Japan / Taiwan

the usage of machine learning technology

Support beginners by two AI functions

Deck Recommendation

select appropriate characters for deck
(Association Analysis)

Othellonia Dojo (battle AI)

support human-level AI for practicing
(Supervised Learning w/ Deep Neural Network)

Use of AI in areas other than games

Virtual Security System

Route recommendations from demand forecast for taxis.

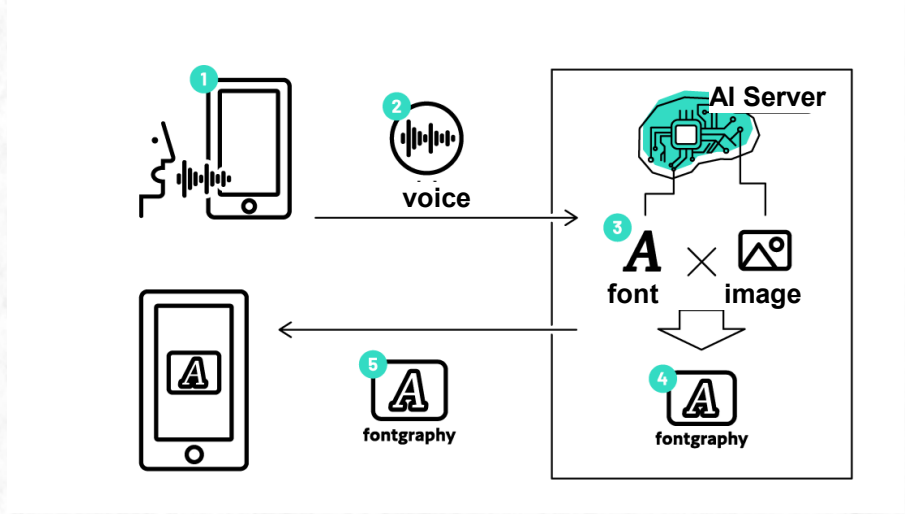
Analysis for services

Trials in animation production

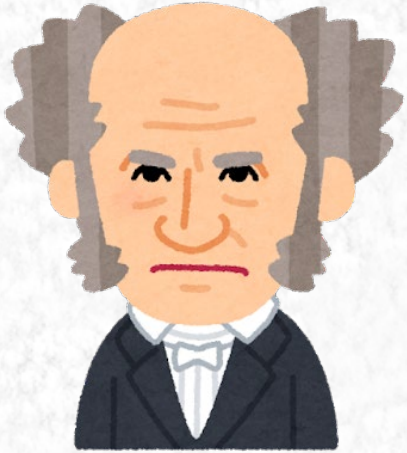
PSGAN(Progressive Structure-Conditional Generative Adversarial Networks)」

Full-body high-resolution Anime Generation from 2D illustlation.

Graphics generation from user voice

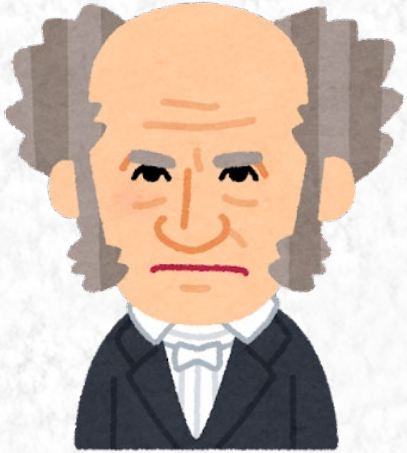


fontography(2019/9-2020/7)



OK.
Through these trials,
we have found AI to be a useful tool.

What should we do **next for the game business?**



Expanding use cases

Improve development quality
and respond to diversifying user needs

Establishment of reproducibility and scaling

Improve production and development efficiency

- The scale of development is steadily expanding
  as the performance of terminals improves and user needs to diversify.

- The number of titles in operation is increasing every year,
  and there is an urgent need to improve development production efficiency.

Gaming in DeNA

Inhouse

Gyakuten Othellonia

Megido 72

Bandit Nation

Alliance

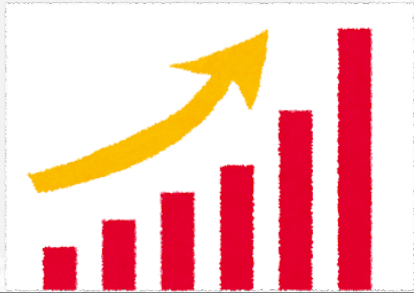
- Final Fantasy Record Keeper
- Uta Macross
- Touhou Danmaku Kagura

Nintendo Alliance Titles

- Super Mario Run
- Fire Emblem Heroes
- Animal Crossing: Pocket Camp

3rd Party

- Granblue Fantasy



But…

we have encountered
many failures and obstacles.

What’s the problem？

Bad patterns

Causes of trouble

Sporadic Efforts

Misperception of the goal

Elite Four

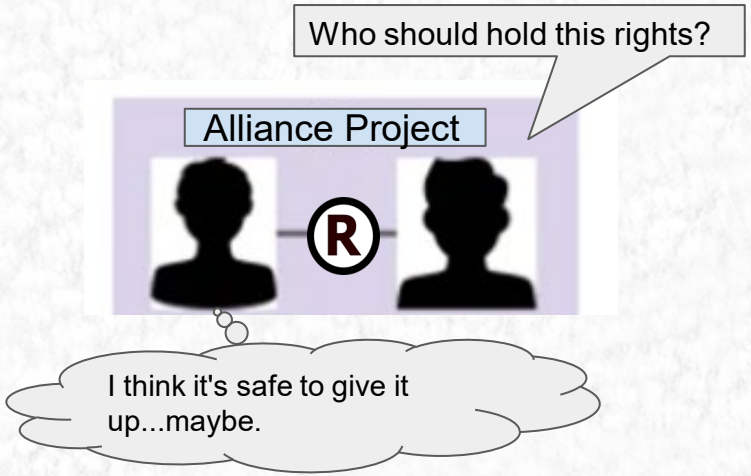
Too late introduction

Risk control
in long-term R&D

Sporadic Efforts

Individual…Guerrilla development…
Only bottom-up...
Uncontrolled many communication paths...

Problems with intellectual property(1)



Training Data？

AI Model？

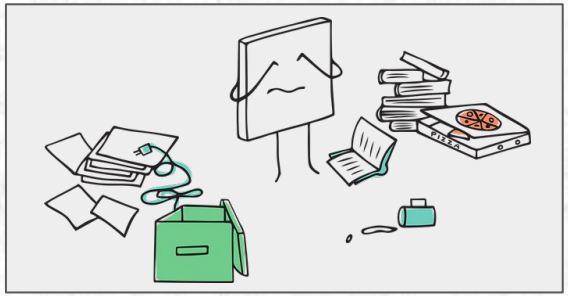
Service？

Technology license?

Generated assets?

Problems with intellectual property(2)

Dissipation of know-how



Reinventing the wheel

Inappropriate resource allocation

Lost opportunities
to make cross-sectional strategic decisions

Project1

Is the value of the challenge really being judged from multiple perspectives?

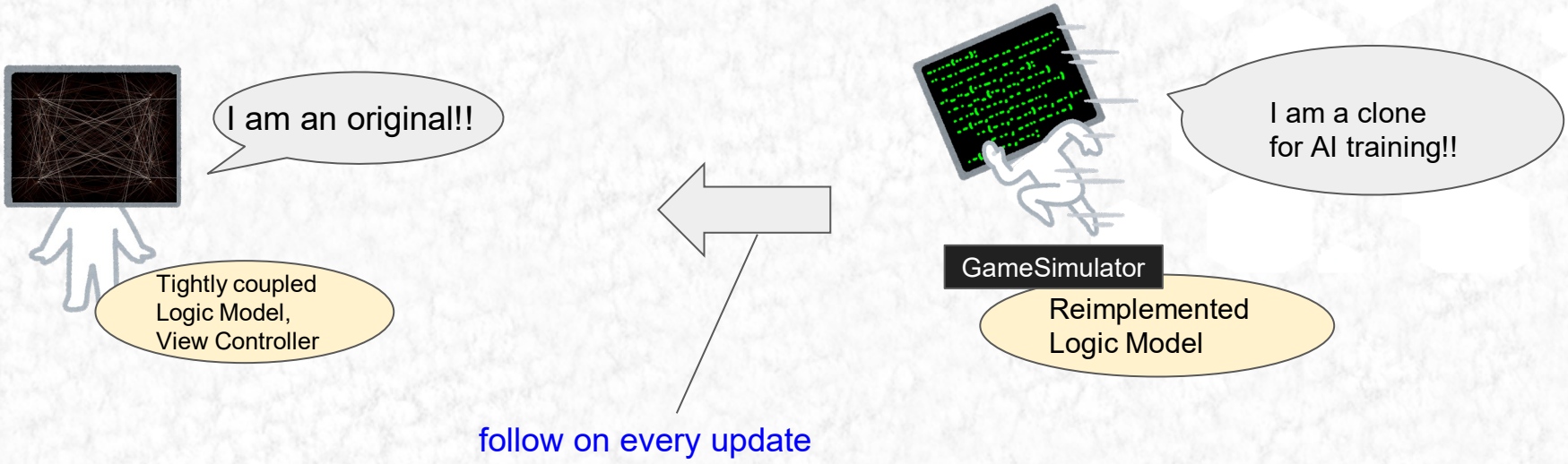
Project2

Why no help?

Potential value

Too late introduction

In “Gyakuten Othellonia”, it was difficult to modify the game engine after the release.
So, we created for AI training…



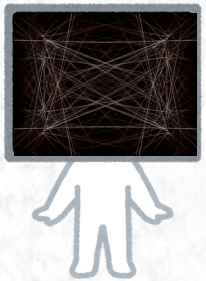
Double cost of development and maintenance

Trouble caused by leaking follow-up

Decreased options and feasible measures.

Hi!! we have trouble on balance designs.

We need the power of AI learning agents immediately!!



lack of the requirements for appropriate simulation

No preparation of training data

No R&D Time

In realizing AI measures, it is very important to have a dialogue early in the game development process, with an eye to future demand.

Risk control in long-term R&D

Producer

We want to provide AI-based PvE
as a **core feature of the game upon release.**

Oh, No!!😠

R&D Team

Sorry Boss, we did not get sufficient learning accuracy.
At this rate, we will **not be able to release it in time.**

- If you want to incorporate R&D into your plan
  always need to consider the possibility of experimental failure.

Project conflagration

We want to allocate resources for the AI function to other functions.

Change of trends

R&D is progressing well!!

Oh, No!!😣

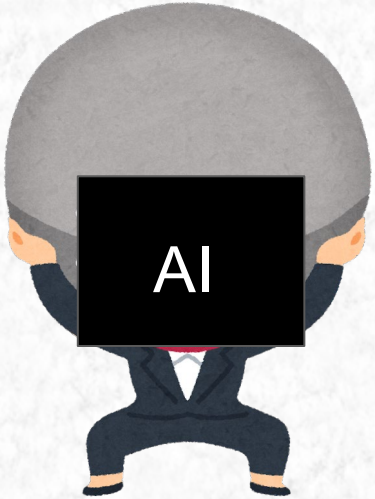
- When incorporating long-term R&D into planning, development status and changes in the environment need to be taken into account.

Misperception of the goal

Development team requirements

input : the strength of a new character on a scale of 10
output : suggested adjustments

Subjective and ambiguous indicators



Too heavy an AI scope of responsibility

Differences in domain knowledge
often lead to incorrect goal setting and planning.

Why do you want the tool?

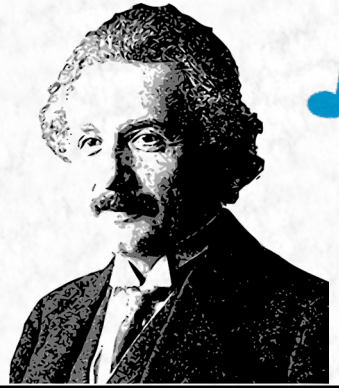
- We don't want to release a character with a different strength than expected.
- I wish to eliminate the dependency on personal skill and ensure mobility of personnel between projects.

essential needs

Is this goal feasible?

- Calculate the win rate between deck archetypes as an objective measure by playing against the AI.
- Game designers compare the expected win rate to see if there are any deviations.

Objective indicators



Lack of a bird's eye view is a tragedy.

So what should we do?

Role of the division

Our apploach

Business needs x AI Technology

Cross-Project System for matching & plannning

AI Promotion Division

Multiple Procjects

Game developments x R&D plans

Multiple areas of expertise

Division members

Various experts who act as intermediaries in each area.

product manager

game planner

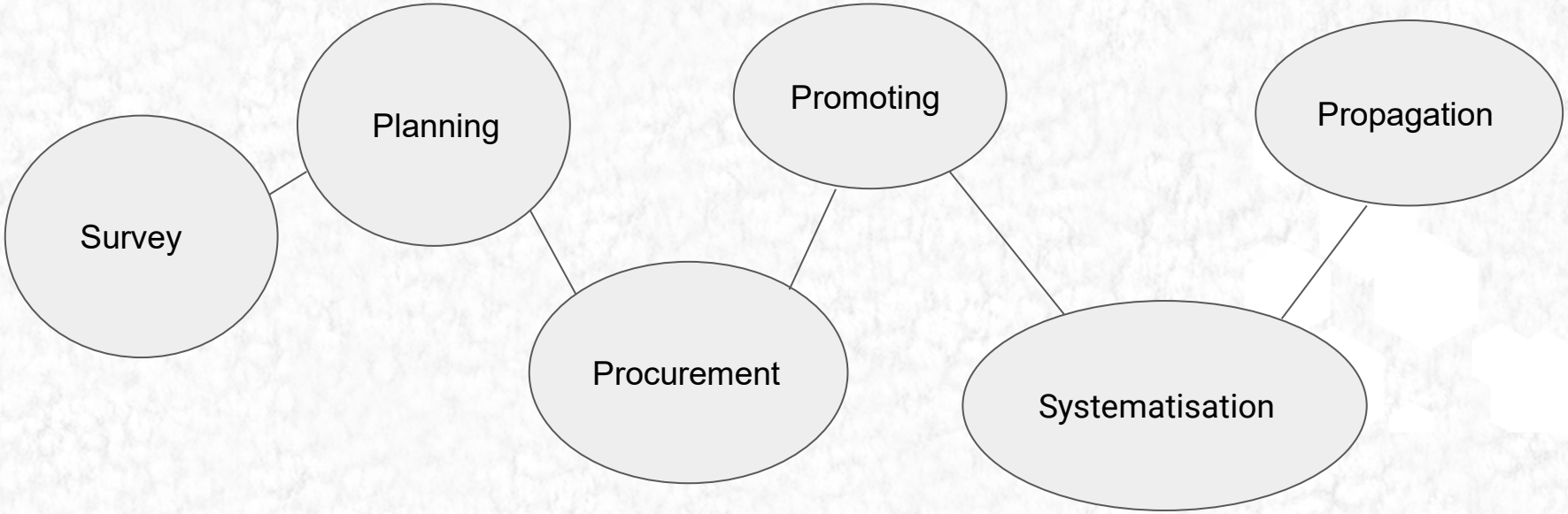
analyst

project manager

server client

We have domain knowledge
in both operational game development and AI.

Role



Simple six step!!
Cross-project execution is most important.

Survey

CaseStudy
internal & external

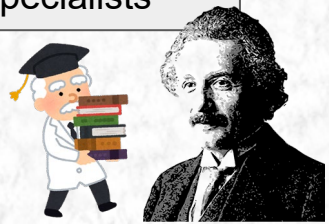
use case
service

issues
potential needs

technology
skill

Game Projects

Specialists



Planning

CaseStudy
internal & external

use case
service

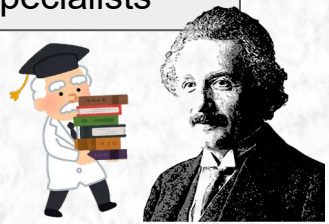
Matching!!

issues
potential needs

technology
skill

Game Projects

Specialists

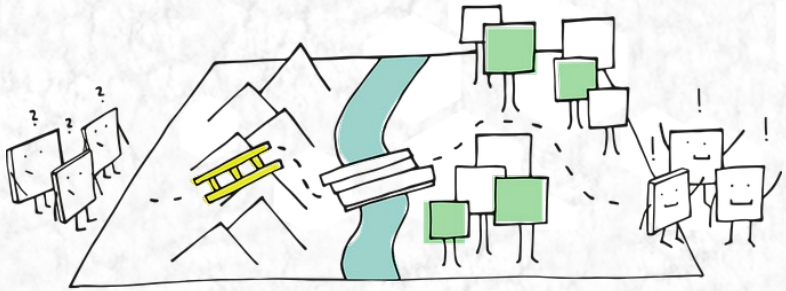


Matching!!

Define the requirements and use cases

Evaluate and provide decision-making tools for the implementation of measures.

Provide direction and develop an action plan across projects and sections



What's the decision making tool？

Tools for dialogue

Where should we go?

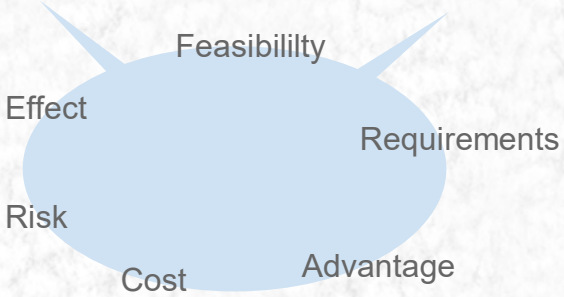
How can we achieve this?

Technology r

Usecase catalog

Overview of the means

overview of measures, design concepts and operational assumptions for each use case.



Procurement

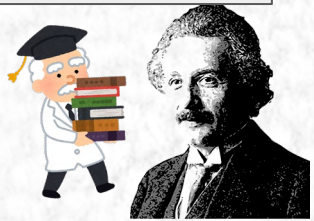
Member

Action Plan

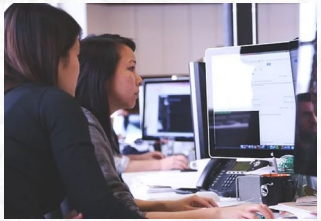
Funds

problem-solving skills

Specialists



Environment



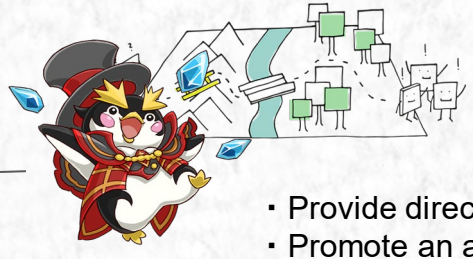
We reserve funds for PoC.
Why？

Separeted

- Lighten the footprint of technical trials.
- Determine whether to introduce it into the title after improving the accuracy of the feasibility estimates.
- Patented materials will be validated during the PoC phase to limit the risk ofsitting on a game budget dependency.

Promoting

Change of circumstances

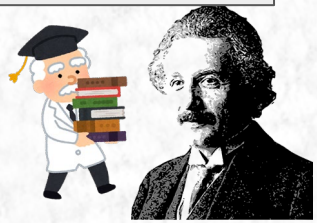


- Provide direction and project management.
- Promote an action plan.
- Prepare for changing circumstances and control risks.
- Negotiating with stakeholders.

Game Development

Bridging the gap

R&D



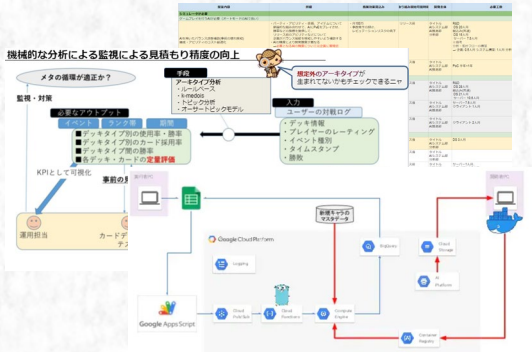
Systematisation

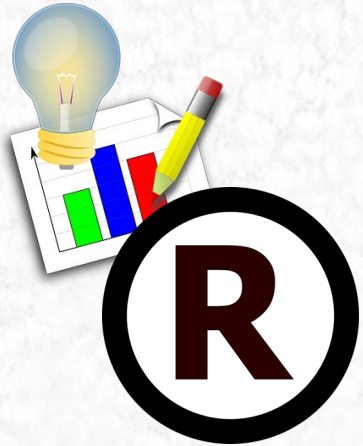
- Evaluation of the results
- Accumulate and generalize of Know-how

- Obtain a patent

- Building a common infrastructure

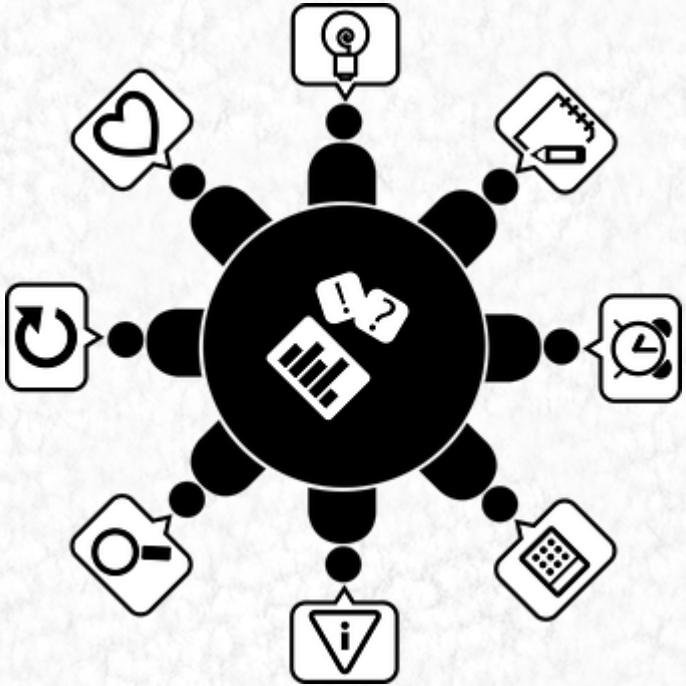
Documentation and organisation





HANDY RL

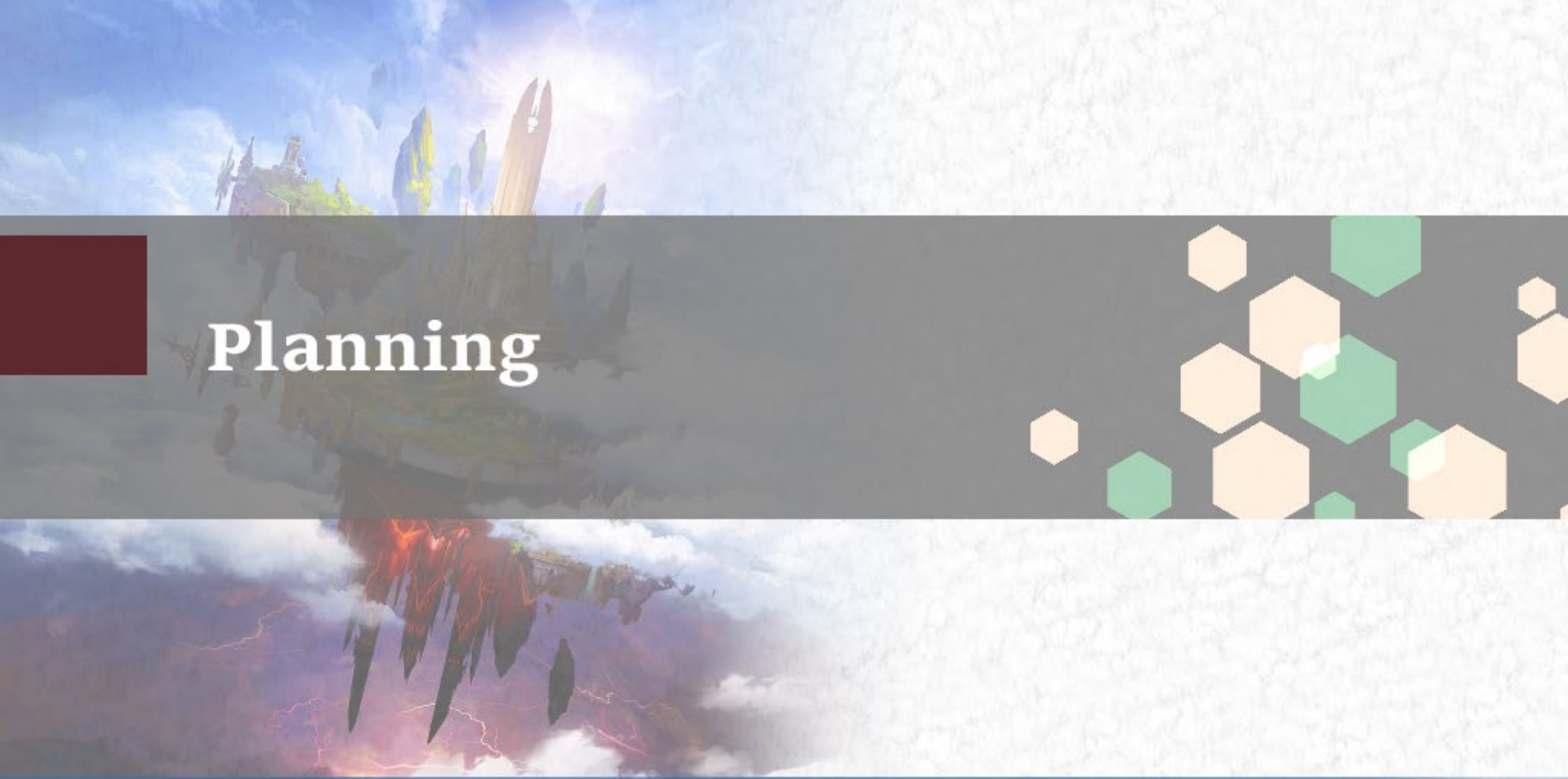
Propagation



- Disseminate internally and externally

such as this session,wow!!

Let's follow the case study
and see how it works in practice!



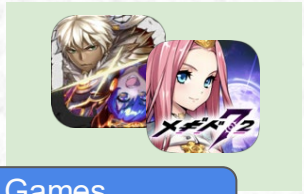
Planning

Where is the issue?

Survey from both top-down and bottom-up perspectives.

Alliance

- Reputational risk and damage caused by post-release problems.
- Quantitative indicators for dialogue.
  ex) about balance design deliverables



Games in Operation

- The cost of balance design and QC increasing year by year.
- The fluidity of personnel between projects.

New Games in Develop

- Enhance the launch immediately after release.
- Increase the inflow and retention of casual users.

Evaluate each technical area

balance design and PvE

Metagame economic design optimization

Network Analysis

focus on

in scope feasibility

Analysis and automation of QC

impact

Sales forecast

risk

Matcihng optimization

advantage

Asset Generation

Auto-adjust banners

Verify feasibility and risk

Evaluate each technical area

balance design and PvE

Metagame economic design optimization

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in scope

focus on

Analysis and automation of QC

Sales forecast

Matcihng optimization

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Verify feasibility and risk

Auto-adjust banners

More depth for each area

Examples by QC

Ingame QC

▼Difficult to solve with outside services

- Large differences in specifications between games, making it difficult to categorize and optimize test cases.
- The level of understanding of the game required for test design is also high.

▼Test cases become bloated as operations become longer.

(※Such as Character and skill combinations)

Outgame QC

▼High accuracy of testing by outsourcing.

- Fewer differences in specifications among titles, making it easier to categorize and optimize test cases.

▼Foreign services are expected to enter the market.

※ex.Conversion of QC framework for web services

More depth for each area

Examples by QC

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focus on

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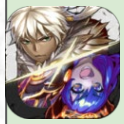
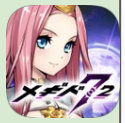
Core strategy in focus area to reproducibility through scaling

Inhouse & In Operation





R&D and patent acquisition for new use cases

BalanceDesign&QC, Network Analysis

Common infrastructure for AI

Link to functional development in non-AI areas

Early diffusion

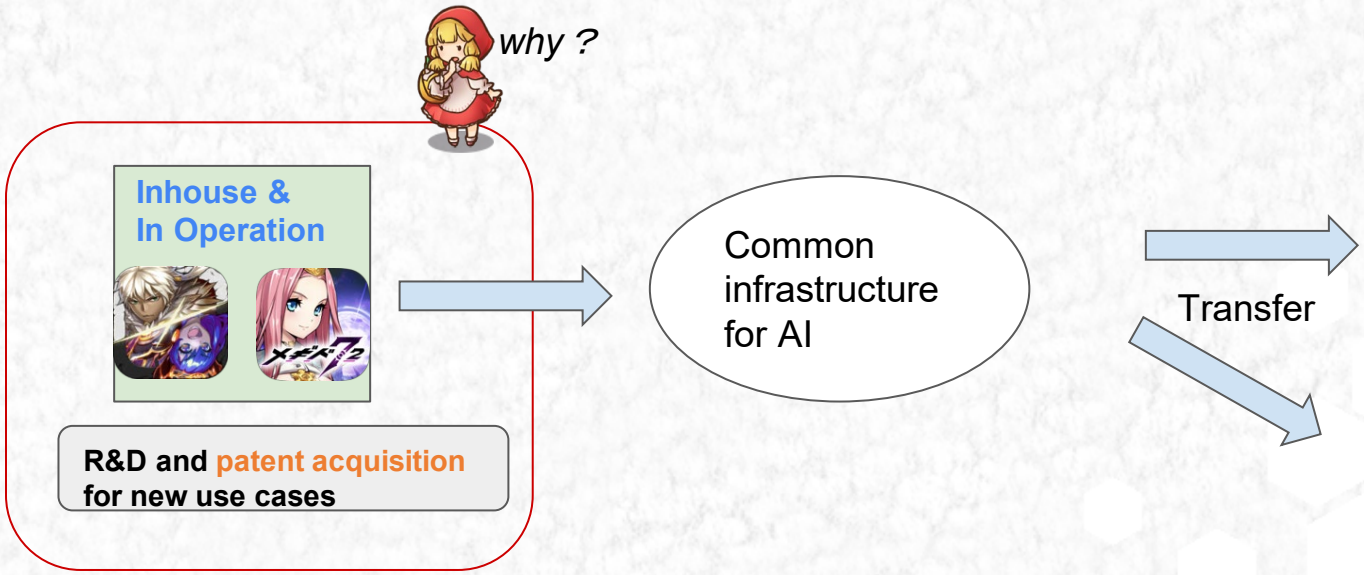
Transfer

Alliance Project

New Project

Parallel development of PvE agents using simulation & utility-based AI and reinforcement learning

Risk control & Feature delivery on release



- By acquiring patents in advance for internally produced titles, the risk of alliance in intellectual property will be controlled.
- Conduct R&D on in-operation titles with mature learning data for AI and game environments and transfer them to titles under development can reduce R&D time and Improving feasibility.
- Cost and development time are compressed with scaling.

Sub strategy in Asset Generation

In terms of feasibility and risk

Make the **smallest attempt** and verify both at **marketing measures** that are **not affected by the development status of the game.**

※*From the standpoint of growing in-house technological capabilities, it may compete with other companies' middleware. But we judged that the comprehensive know-how related to the content application is worth keeping in check.*

Nanakoe Nina
2021.5.7 - 2022/3/31
Free voice conversion service with promotional character

Under development in “Gyakuten Othellonia”
Marketing measures using characters created by image generation

Sub strategy in Asset Generation

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Nanakoe Nina
2021.5.7 - 2022/3/31

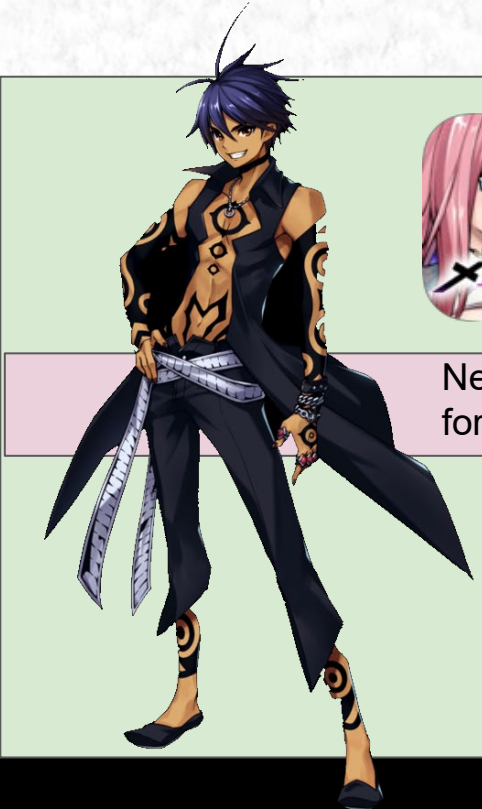
Free voice conversion service with promotional character

By consolidating issues and looking at them from a bird's eye view,

you can design goals, assign roles, and allocate resources
with the expectation of synergy between projects.

Use case expansion

In this chapter,
we show two samples!!



Network analysis
for viral marketing

AI Agent
for balance design

Network analysis for viral marketing

What is 『Megiddo72』？

Japan Game Awards : 2019
日本ゲーム大賞

- **Japan Game Awards 2019**
  first runner-up

- **RPG App Game**
  turn based rpg with an emphasis on strategy

- **Released in 2017**
  region: Japan

Where is the issue?

- Enhance the launch immediately after release.
- Increase the inflow and retention of casual users.

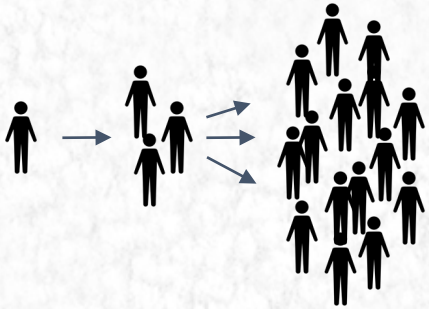
Can advertising be the solution?

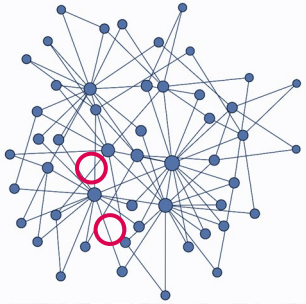
- Numerous titles in the market
- Return on investment for paid advertising is generally deteriorating.
- It is difficult to resonate with the game management's message alone.

Counter Measure

- through Community Analysis,
  Identifying Influencers who will spread the information
  that the game wants to convey to the people around them.

- Solve Portfolio Optimization for Influence Spread on the internal network
  to formulate how to distribute ads and improve the efficiency of viral spread.





Benefits of viral marketing

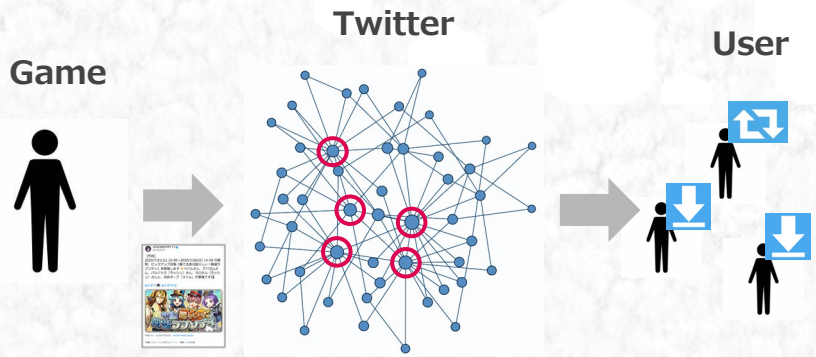
- Information from people the customer likes and trusts is more likely to resonate.
  - Recommendations from people at the center of the community, people you can trust.

- Leverage network analysis to inform not only famous influencers,
  but also diverse customers and communities.

Means used for advertising

promo tweet

- Ad delivery allows advertisers to reach and deliver information to a variety of Twitter users.
- The goal is to expand awareness and acquire new users.
- Displayed on the timeline and search screen just like a normal tweet
- Various delivery settings are available to deliver to specific users.



Experimental setup

- **Data used**
  - Twitter data of game titles to be distributed（four months）
  - Twitter data for IPs with high affinity（10 types）

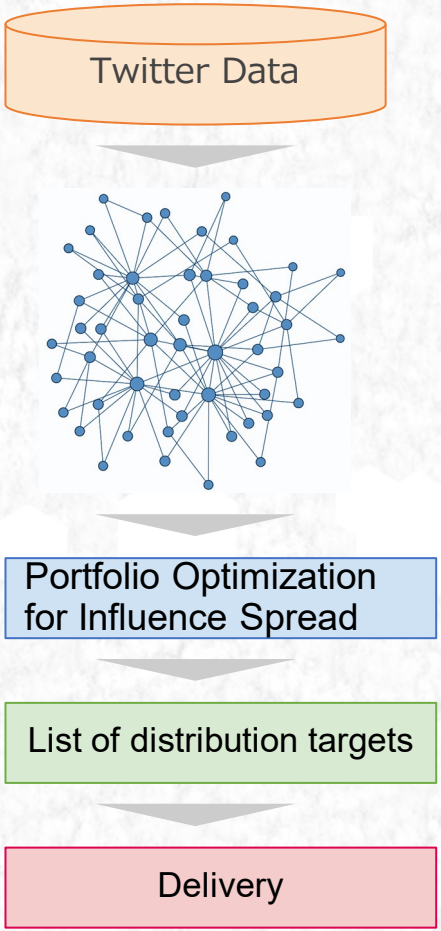
    Calculate the probability that B is also muttered when A is muttered,
    and the IP with the higher value is considered as the IP with high affinity.

- **Network**
  - Node: users（100K）
  - Edge: retweet、mention、reply（600K）
  - Propagation Probability: Percentage of past retweets, mentions, and replies

- **Portfolio Optimization for Influence Spread**
  - Independent. Cascade＋greedy
  - Number of users extracted: 300

    ※Targeting the extracted users and their surroundings (people they follow) in the distribution

- **Evaluation index(Comparison with an average of existing methods)**
  - Number of impressions
  - Cost per impression



Results

Number of impressions

existing methods

Cost per impression

existing methods

- Delivering information to more users.
- Results can be fully utilized as one of the delivery methods.

- Costs are on a slight downward trend
  - Distribution to niche but diffuse user groups
- Why didn't it go down significantly?
  - Active users are more difficult to acquire.
  - Characteristics of distribution auctions with competing titles

It has been transferred to almost all development and operation titles.
It is also being used for pre-release advertising initiatives.

Transfer

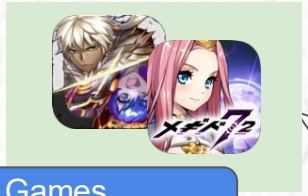
Other Games

Pococha
a social live application

The lowest CPI and the highest growth
in distribution volume compared to existing methods.

AI Agent for balance design

Where is the issue?



Games
in Operation

- The cost of balance design
- Reliance on individual skills and reduced mobility of personnel

Alliance

- Reputation risk due to post-release problems
- Lack of means to check the quality
  of the collaborator's balance design deliverables

Counter-Measure

- Calculate the **win rate between deck archetypes** as an objective measure by playing against the AI Agent.
- Game designers compare the expected win rate to see if there are any deviations.

win rate between deck archetypes

Workflow

Problem

Game designer's calculation of win rate by round-robin

It takes time &
There is a limit to the amount of work.

Workflow

Problem

Game designer's calculation of win rate by round-robin

It takes time &
There is a limit to the amount of work.

Support

Try

Mechanical brute force by AI

That can handle a large number of matches by scaling.

Workflow

Problem

Game designer's calculation of win rate by round-robin

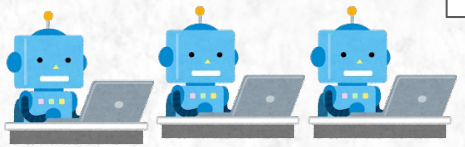
It takes time &
There is a limit to the amount of work.

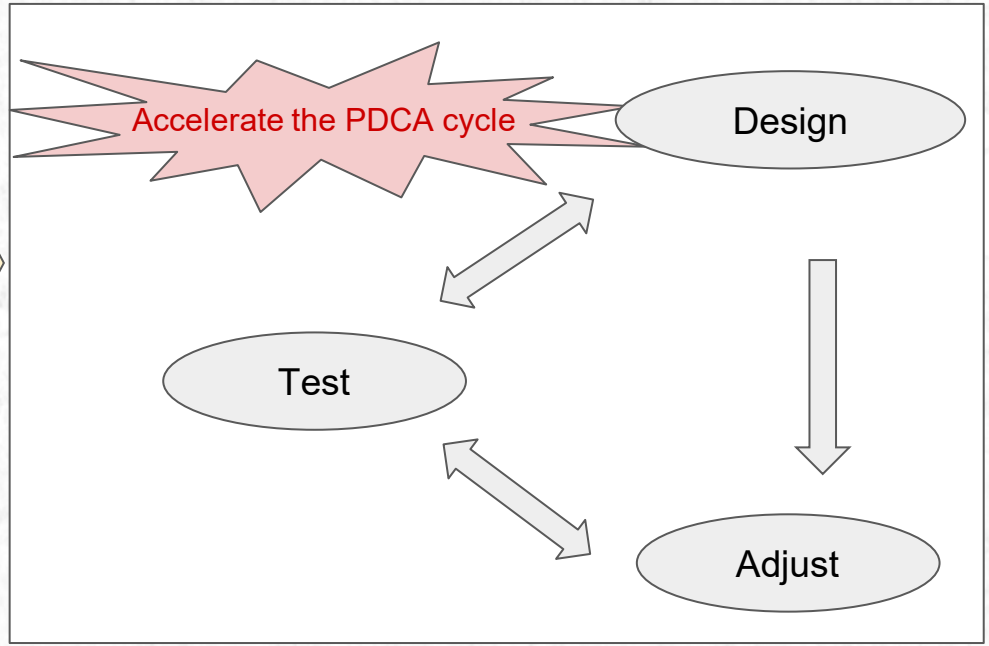
Support

Try

Mechanical brute force by AI

That can handle a large number of matches by scaling.

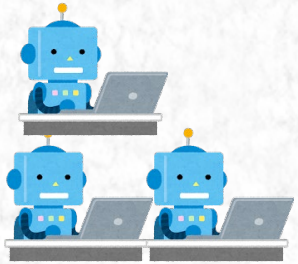


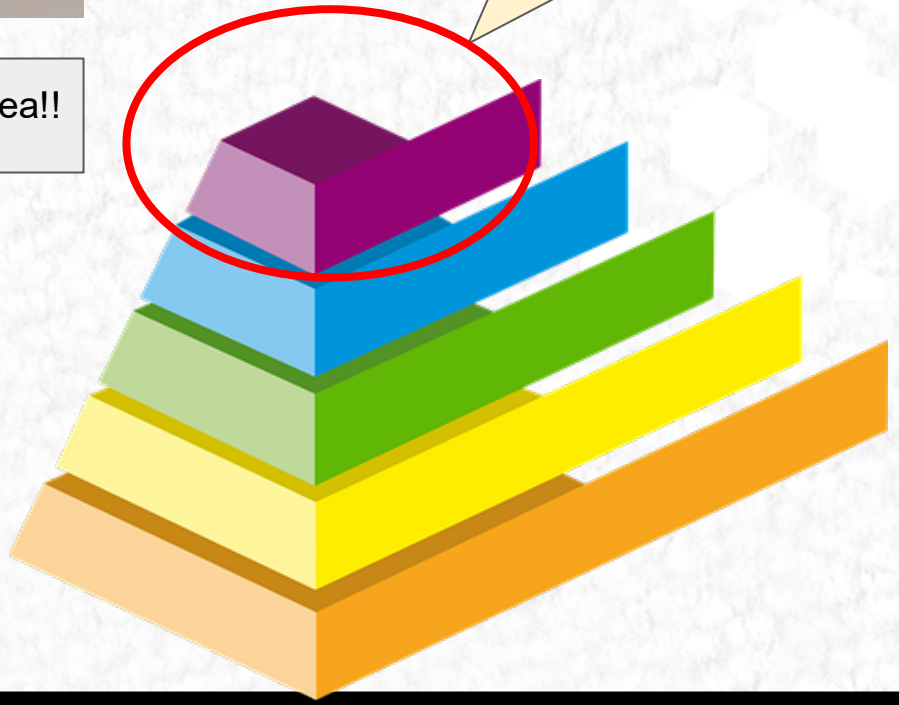


Where should I verify?

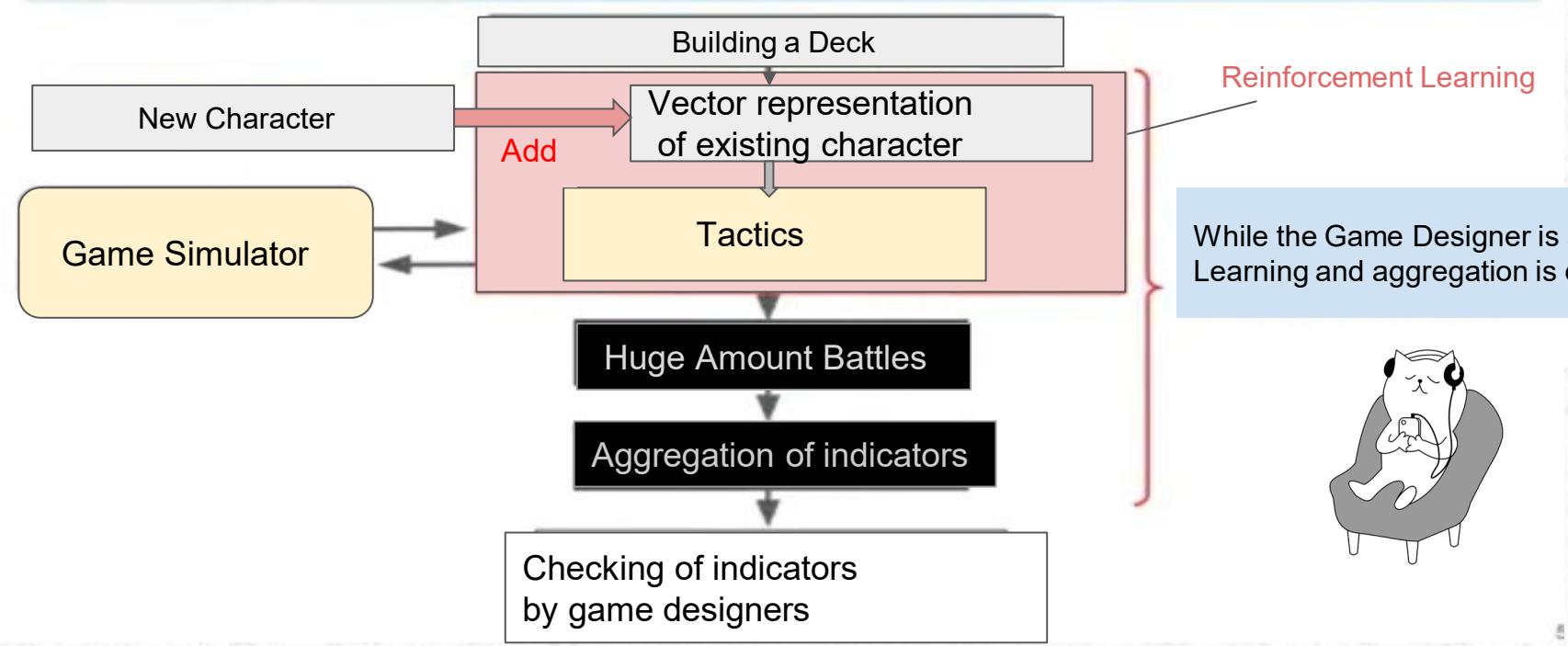
Human resources can be focused on high-priority coordination like top-tier decks.

We can be used to quickly get a rough idea!!

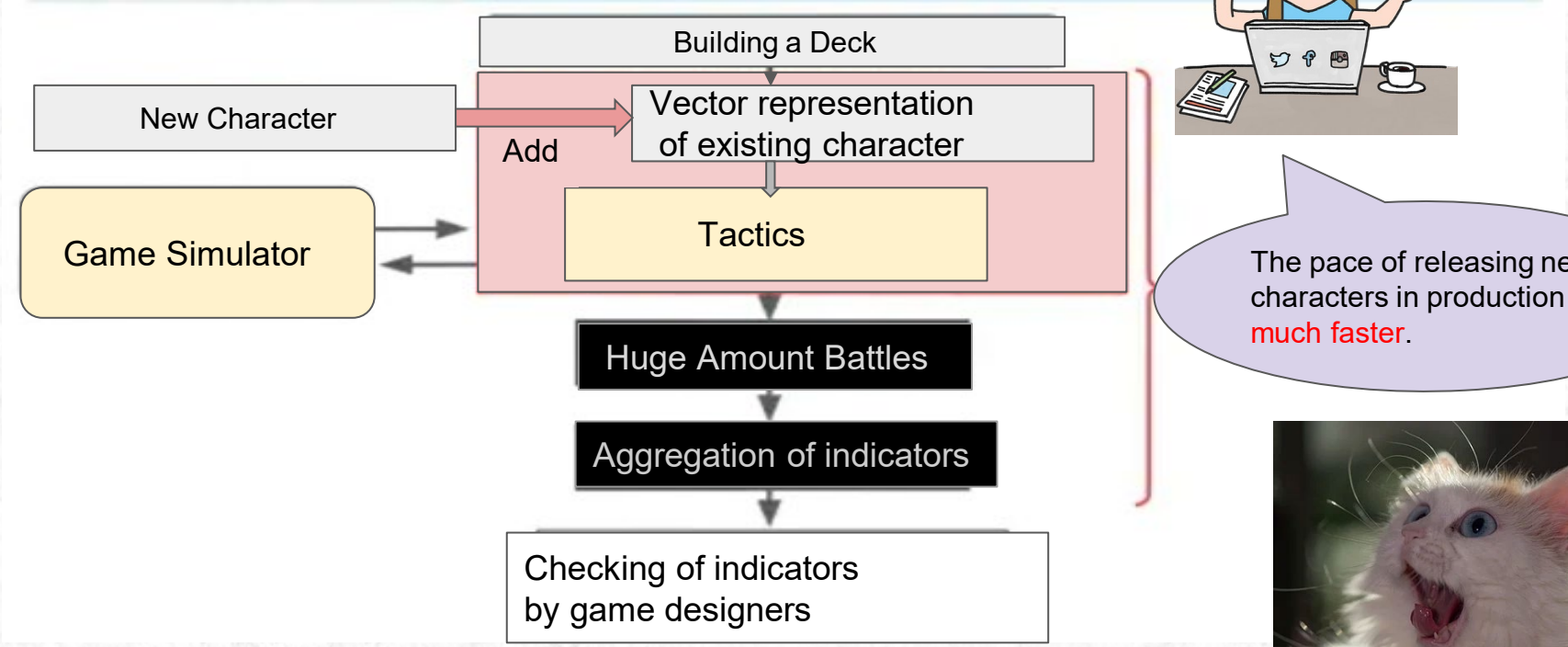




Tool image at the beginning of development

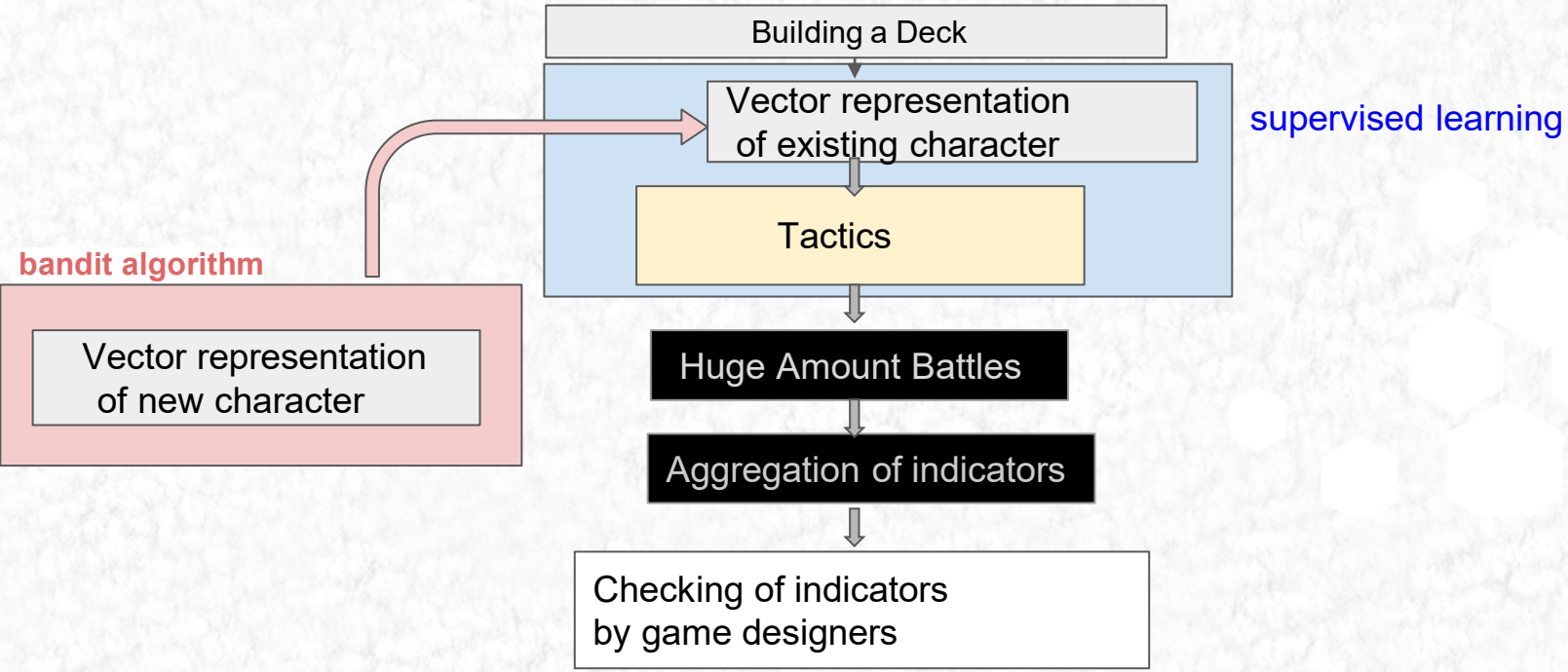


But…



The pace of releasing new characters in production is much faster.

Revise the trajectory based on the actual operational flow



By using supervised learning in combination and limiting the target of reinforcement learning to new character representations, we were able to achieve a practical learning speed.

Estimate new character stance based on vector similarity with existing character representations..

Exploring Deck Construction

Building a Deck

Vector representation of existing character

Tactics

supervised learning

bandit algorithm

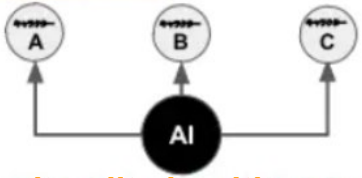
Vector representation of new character

Deck construction including new characters

Hug

Checking by game

What to replace the new characters with to make them stronger?



Similarly, the bandit algorithm was used for both data sampling and search.

Results

Improving the coverage of test plays

- A large number of matches in a short time
  - 200,000 matches per 8 hours
  - Coverage of major deck archetypes

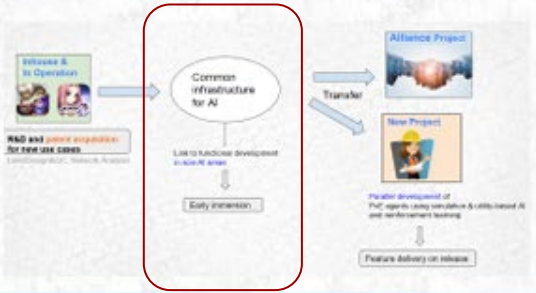
Reduce reliance on individual skills

- The level of evaluation indicators is sufficient.
  - Small margin of error from actual win rate after character release.

The deliverables and the know-how of creating AI agents
by reinforcement learning obtained in the process of development
are being used in new development titles.

Transfer

Common Infrastructure



In this chapter,
we show two topics!!

Common infrastructure for AI

1st Topic

HandyRL

A open source library
for distributed reinforcement learning

2nd Topic

Message-driven
game engine

It can reproduce game records for Simulation.

Server system
for game record
management

Link to functional development in non-AI areas

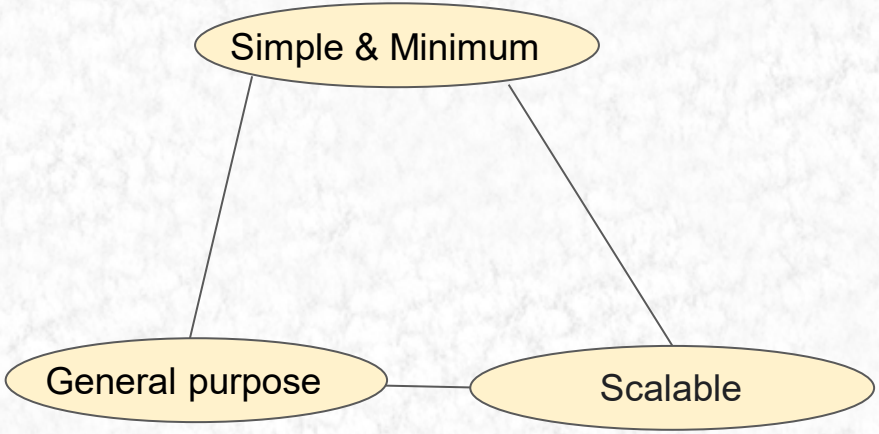
Early diffusion

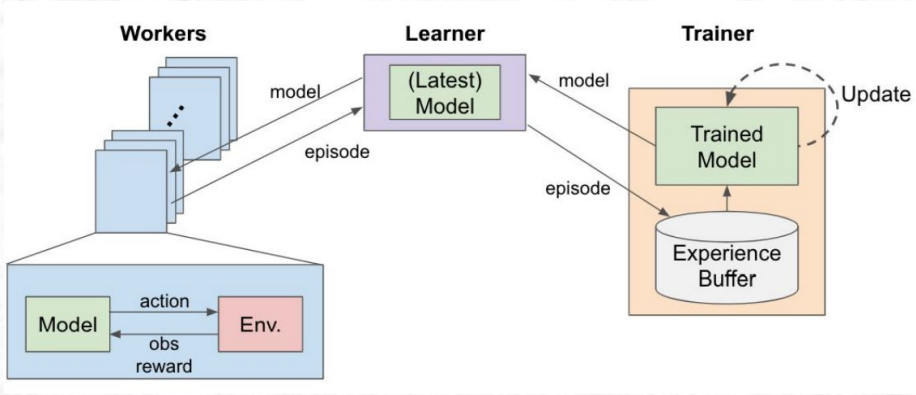
Handy RL

What's Handy RL ?

An open source library
for distributed reinforcement learning created by DeNA.

https://github.com/DeNA/HandyRL





Feature

Simple & Minimum

- Focus on ease of use.

Generic Use

- Extensible implementation allows for greater customization and uses in a variety of games.
- It can be used not only for two-player games but also for multiplayer games.
- Ensure **loosely coupled implementation with game engines.**

Scalable

- Can be prepared to scale according to CPU and GPU resources
- Able to handle large scale utilization of computing resources

Performance evaluation

▼Scale according to CPU and GPU resources

small experiment
worker: 96-core CPU
learner/trainer: 24-core CPU + 1 GPU

⟺

large experiment
worker: 96-core CPU x8
learner/trainer: 96-core CPU + 4 GPU

※Standard configuration currently used for learning in in-house game development.

Performance evaluation

Won in Kaggle's competition for multi-agent development in games.

▼Hungry Geese
2021/1/25~7/26
Torus Snake game for 4 players

Monthly Awards(2021/2)： 1st
Using “Handy RL”, we were able to achieve reinforcement learning in a short period of less than one month

Final Awards(2021/8)：1st

▼Google Research Football with Manchester City F.C.
2020/9/29~11/30
soccer game like FIFA

Final Awards：5th

Library Development Team

Ikki Tanaka
Data Scientist(Kaggle Master)

Katsuki Oto
AI Spectialist

Why did we create it in open source?

Many ready-made libraries are for research purposes and are not easy to use.
Handy RL is very lightweight and easy to handle.

The number of applications of reinforcement learning in games is still small…
and so we expect to expand the use cases and mutual penetration of know-how
through the use of the library!!

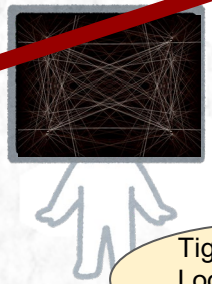
Designed for early penetration

Where is an issue？

In the training of AI agents, it is important to
realize a fast simulator of game behavior with a low maintenance burden.

GameSimulator

Reimplemented
Logic Model

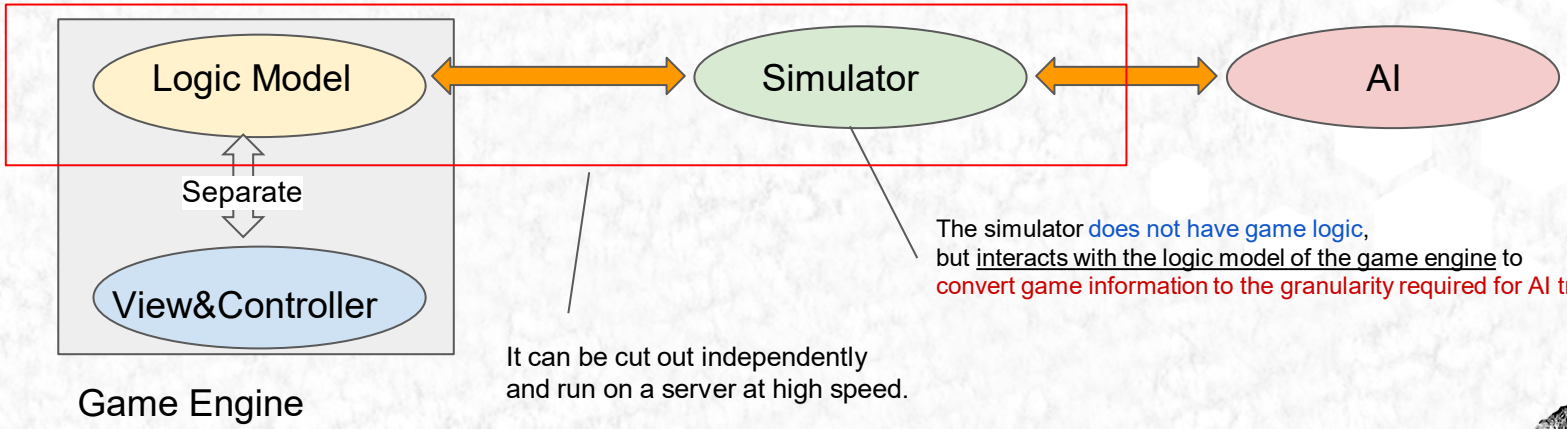


I am an original!!

Tightly coupled
Logic Model,
View Controller

How should it be?

Since game specifications and code change daily, it is desirable that
the behavior of the simulator always **follows automatically** as the game engine is updated.

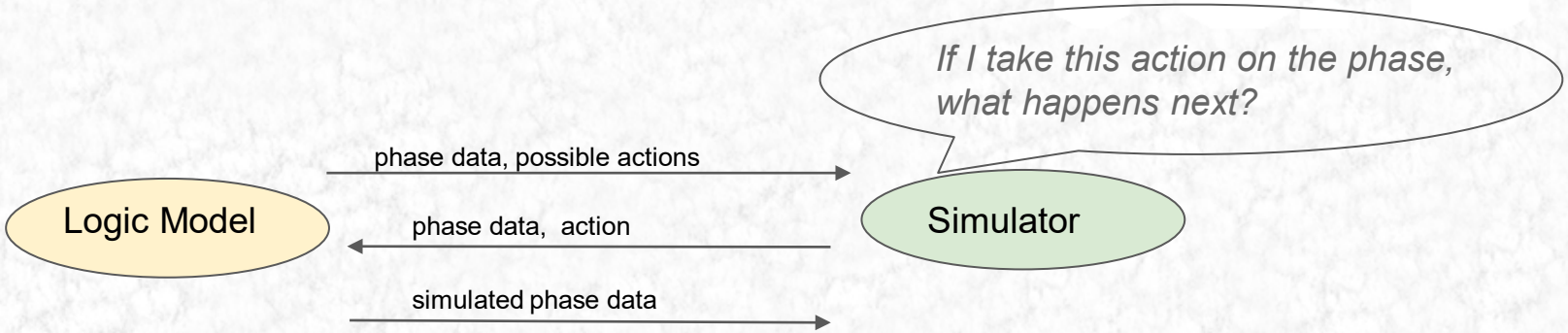


What are the requirements for a game engine?

- MVC Separation
- Models can be executed independently and in parallel on a server.

- The game situation can be reproduced from the game log.

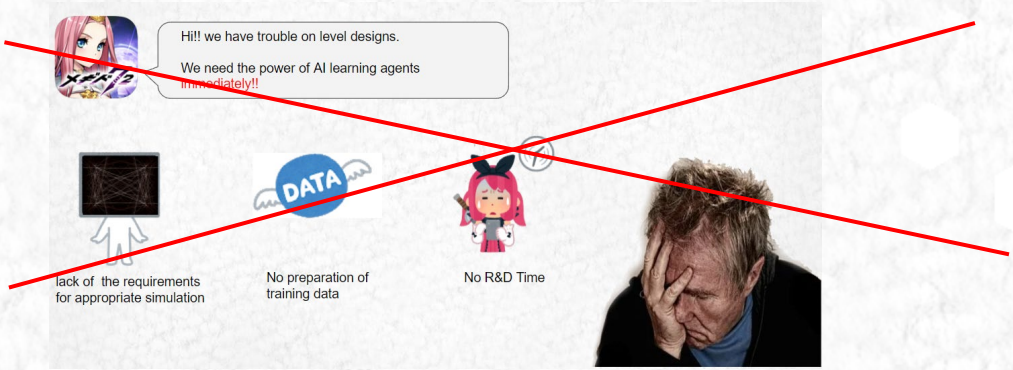
- Responsiveness to simulate specific situations



Difficulty of fulfilling requirements

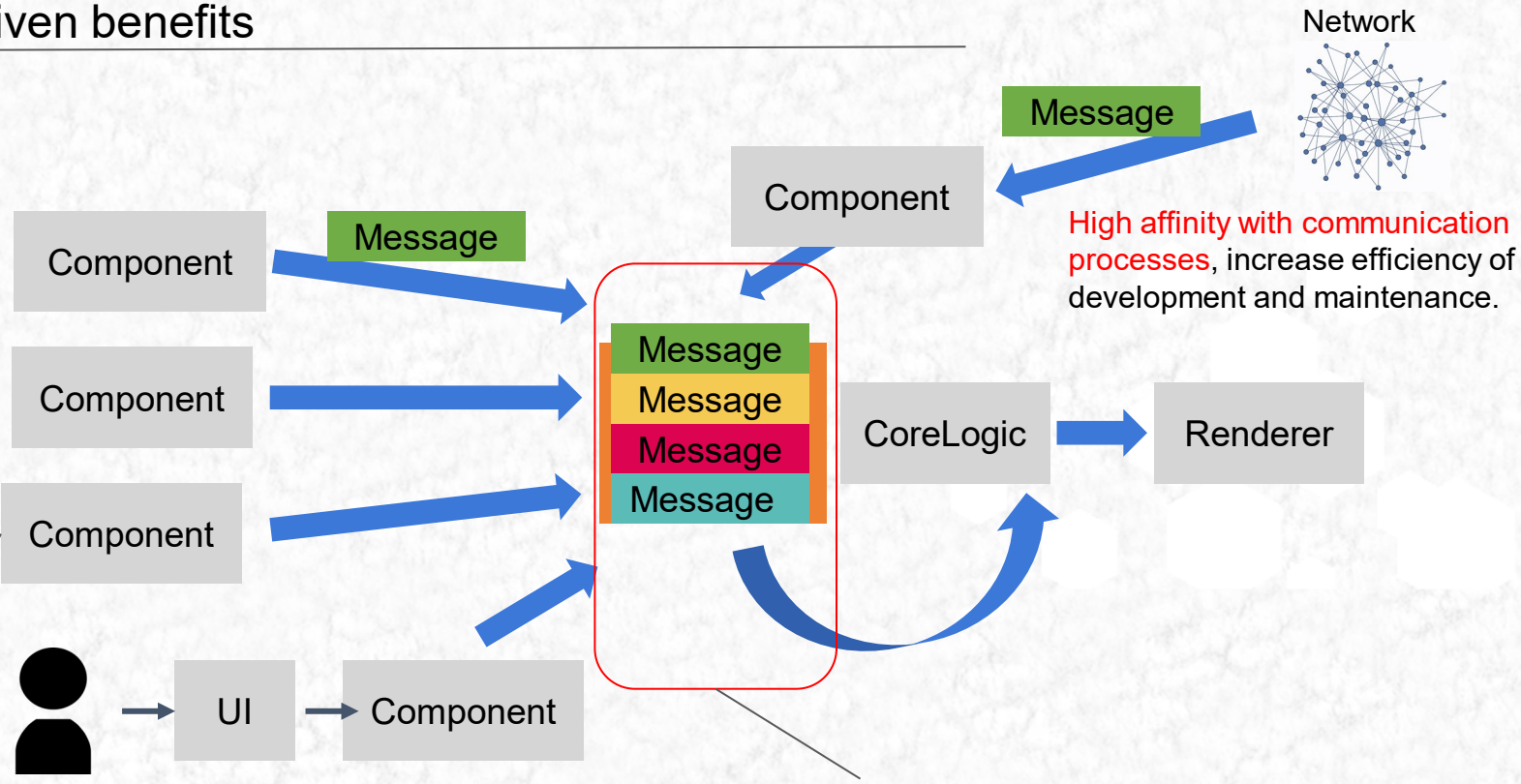
Easy : **In the early stages of game engine design.**

Difficult : Refactoring after the game engine is completed.



In realizing AI measures, it is very important to have a dialogue early in the game development process, with an eye to future demand.

Message-driven benefits



Components remain loosely coupled
increase maintenance efficiency

Easier central monitoring and logging of game status.
It is also easy to recreate game situations from game logs.

Benefits of the replay mechanism

easy to recreate game situations from game logs

Link to functional development in non-AI areas

- recovery processing when communication is cut off
- cheat detection
- a game spectator function
- reproduction of the situation and bugs for QC
- Automation of regression testing

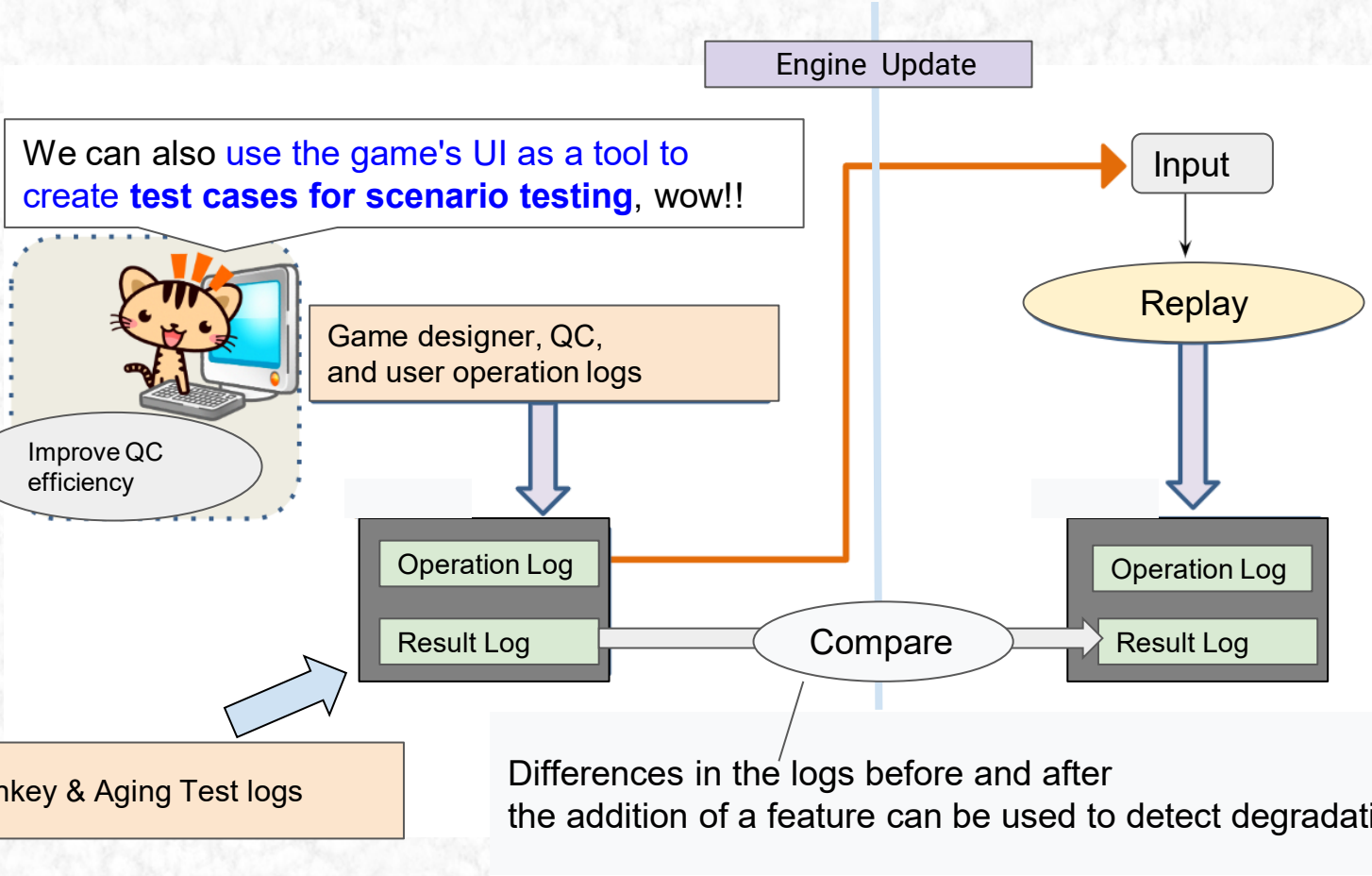
Benefits of the replay mechanism

easy to recreate game situations from game logs

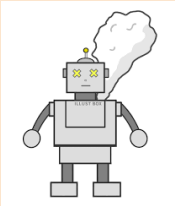
Link to functional development in non-AI

We can reduce the cost and psychological hurdles
by increasing surrounding understanding and total development
of the overall benefits of the infrastructure, including non-AI areas.

Automation of regression testing



AI Agent is not behaving properly…



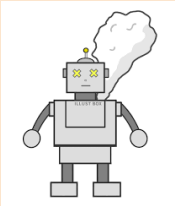
Which is the cause?

Game Engine

AI Model

It is difficult to distinguish
whether the anomaly is due to the AI implementation or the game engine…

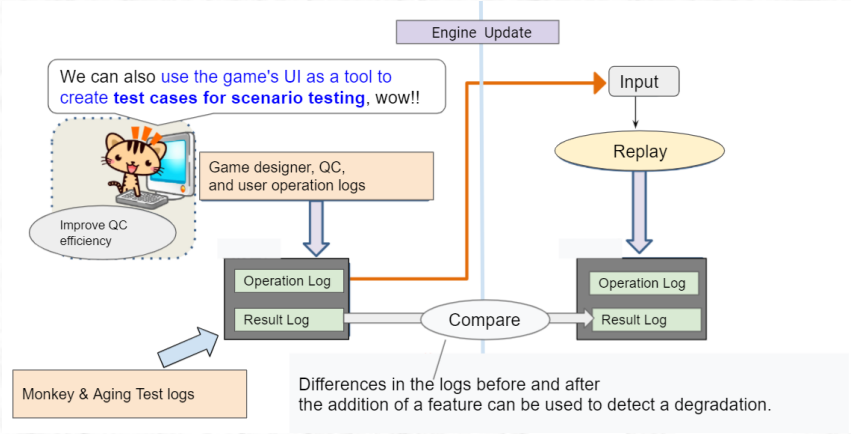
AI Agent is not behaving properly…



Which is the cause?

Game Engine

AI Model



Check for differences in AI behavior under the same conditions and isolate the range of influence.

Early implementation of the regression testing mechanism will also help AI development!!

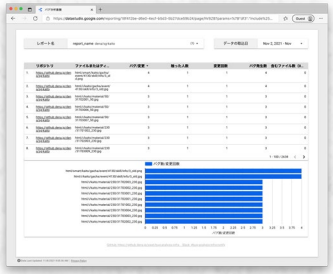
Bug analysis using test logs

Establish a **company-wide QC flow**
to record changes to bug tickets
when bugs are handled.

Git update history
statistics

Bug analysis using test logs

A model to **predict the bug rate for each file using LightGBM**.



Git update history statistics

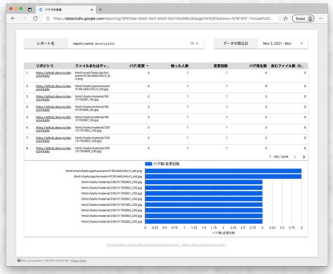
Provided as a metric
for engineers to improve development

※Conduct experiments with titles in operation,
and then offer them to newly developed titles.

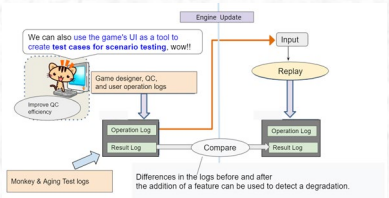
Bug analysis using test logs

Git update history
statistics

A model
to predict the bug rate
for each file using LightGBM.



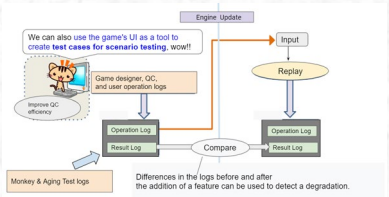
manual trace



auto trace

Collecting test cases and
file association data from stack traces
during QC test case execution

Bug analysis using test logs



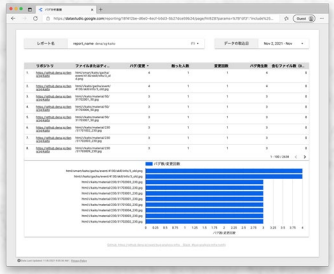
A model to predict the bug rate **for each file**.

manual trace

auto trace

Collecting test cases and file association data from stack traces during QC test case execution

Git update history statistics

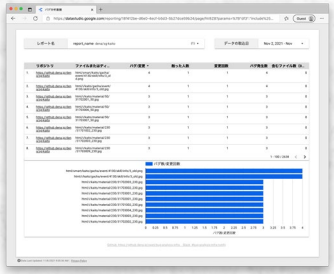


A model to predict the bug rate **for each test case**

Bug analysis using test logs

Git update history statistics

A model to **predict the bug rate for each file using LightGBM**.



A model to predict the bug rate **for each test case**

metric for optimizing the allocation of human resources for each test case

※Undergoing trials to verify the efficacy

Bug analysis using test logs

Establish a **company-wide QC flow** to record changes to bug tickets when bugs are handled.

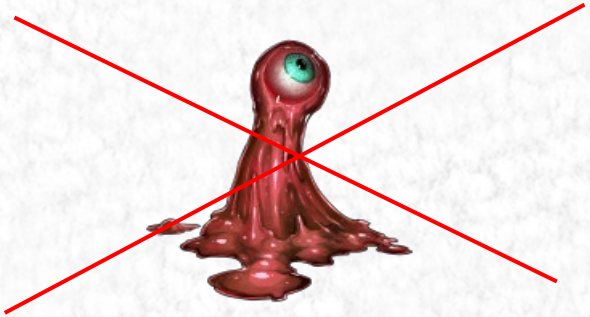
Git update history statistics

Cross-project planning enables cross-cutting efforts to **share and collect learning data.**

Approaches in infrastructure diffusion

- Conducted dialogue on AI measures and infrastructure implementation from the early stages of planning and development of new games.

- Reduce the cost and psychological hurdles to implementation by increasing surroundings understanding and total development of the overall benefits of the infrastructure, including non-AI areas.

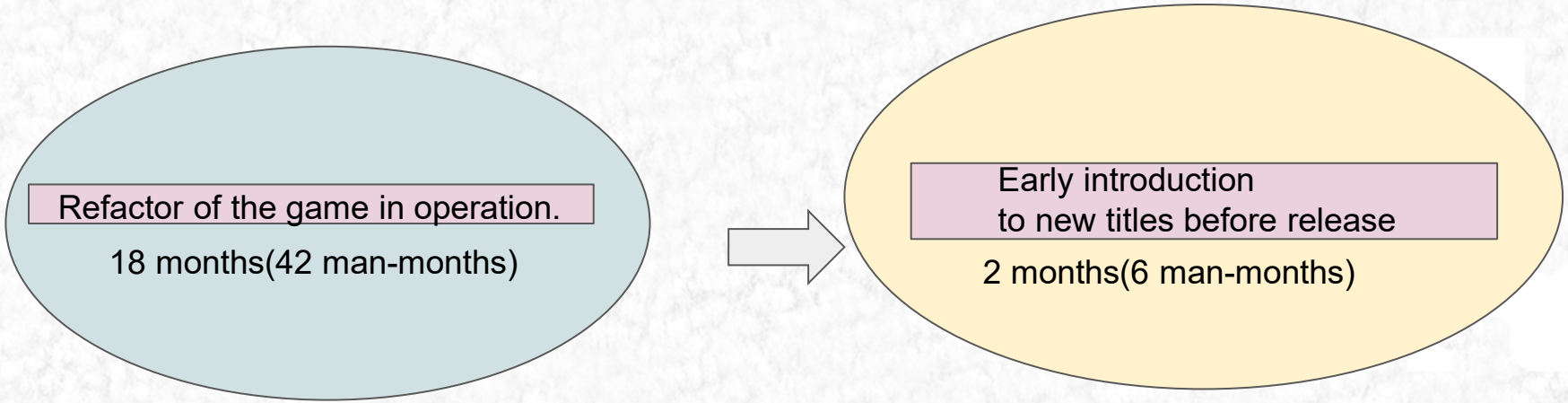


Common infrastructure for AI

Link to functional development in non-AI areas

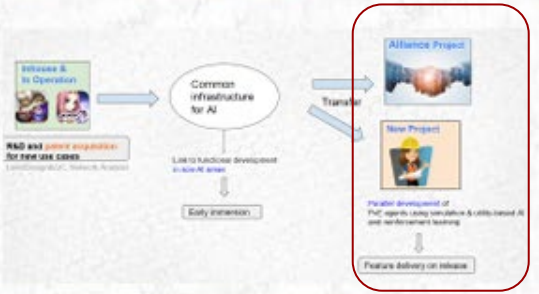
Results

The time it took to realize the simulator



- Succeeded in significantly reducing implementation costs and time required.
- The timing for learning has been accelerated,
  and we can now consider providing agents at the time of game release.

Risk control



Where is an issue？

- Enhance the launch immediately after release.
- Expand the number of incoming users by supporting casual users.

Dig deeper based on the game concept

- They are games with complex strategy, e-sports, and collection elements.

casual user

The more the operation progress,
the more complex the rules become.

New rules, new skills, and new characters…

- It's no fun if they can't win.
- Asset gap with advanced users.
- Fear about playing against other people.

Counter Measure

AI advice on user’s next move

Examples of how to fight through PvE

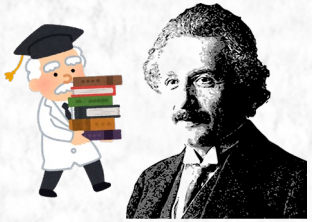
※AI that can realize strategies and tactics for each deck archetype

Dynamic taming in PvE
to ensure users' initial success experience

※Evaluate the shape of the board and adjust player’s moves

PvE that can continue to be played as end content

※AI with capabilities comparable to those of top-class users



R&D needs a long time.

We want them immediately after release..

OK. We will try **simultaneously developing the game and conducting R&D**.

Hedging risk through the use of sub-plans and step-by-step goals

Since PvE is a core feature that is mandatory at release time,
it is necessary to prepare for the risk if the learning accuracy does not meet the expected value.

Common infrastructure for AI
(Simulator)

R&D

simulation base
& utility base AI

Hedging risk by combining implementation with methods that do not require R&D and are highly compatible with learning agents

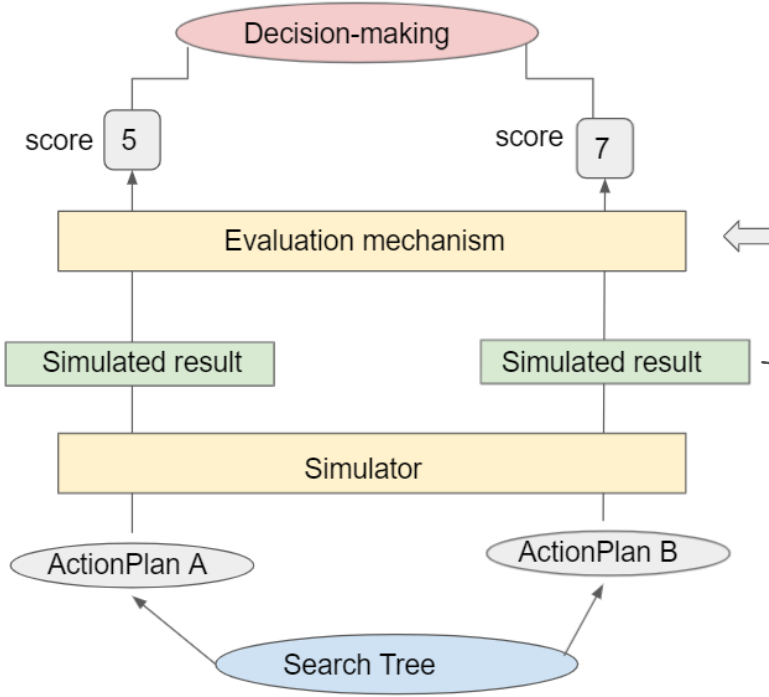
Validation of AI agents
using reinforcement learning

Game Release

Verify the use of
supervised learning together

Design goals so that results can be delivered in stages as R&D progresses.

Simulation base & utility base AI



The game designer can control the AI's behavioral tendencies through the medium of evaluation coefficients.

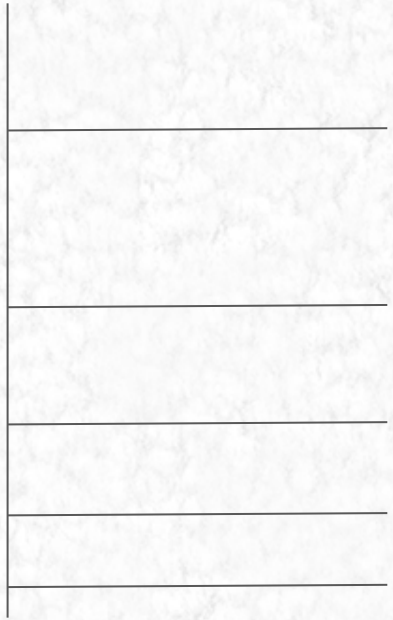
Data used as evaluation indicators

Game Designer

Since decisions are made based on simulation results, there is no need to modify the mechanism when the game is updated, making it more maintainable than rule-based systems.

- Goes well with data-driven, low-cost mass production of AI with diverse personalities.
- Balancing maintenance efficiency and usability by game designers.
- High affinity with learning AI and similar usage infrastructure, making it easy to migrate and use together.

Simulation & Utility Base AI



PvE for Initial user retention & guidance

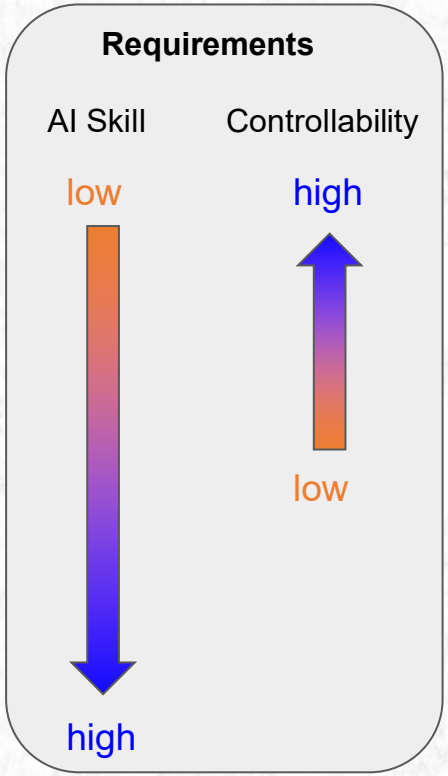
AI advice on user's next move

PvE for middle user

PvE for end contents

Support for balance design

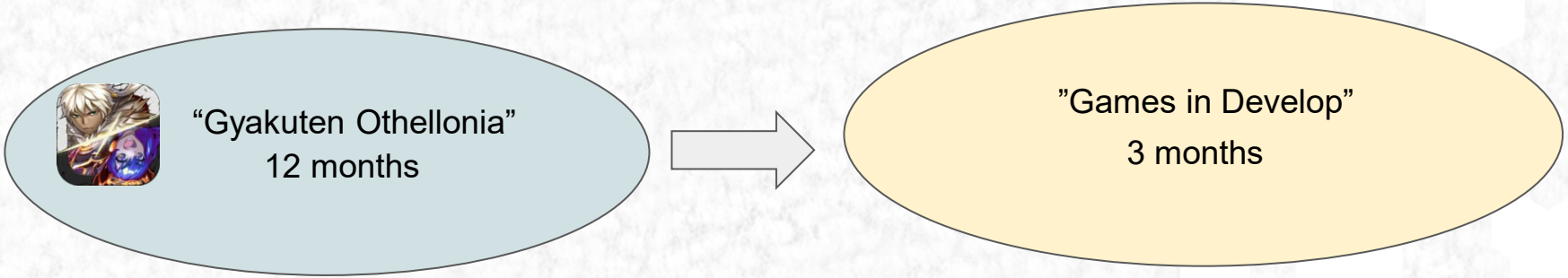
Reinforcement learning & Supervised Learning AI



- Design goals so that results can be delivered in stages as R&D progresses.
- Visualization of intermediate deliverables facilitates project progress and reduces the risk of interruptions.

Result

Costs & time required for AI agents to reach practical accuracy through reinforcement learning.



- Achieve better win rates than game designers and Simulation base & utility base AI.
- By analyzing the battle logs of reinforcement learning agents using time-series search trees, we visualized of winning strategies for each deck archetype.
  We confirmed that the AI was learning how to stand based on the characteristics of the deck.

Summary

- It is necessary to set appropriate goals based on an understanding of both the essential needs in game operation and the characteristics of the AI technology.

- By consolidating issues and looking at them from a bird's eye view, you can design goals, assign roles, and allocate resources with the expectation of synergy between projects.

- In realizing AI measures, it is very important to have a dialogue early in the game development process, with an eye to future demand.

- When simultaneously conducting game development and AI R&D, it is important to hedge risks by designing goals in stages and using subplans.

e-mail : 67kanade@gmail.com

Thank you for viewing! !