

# Division of Labour & Group Performance in an Environment with Different Personalities

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**Modelling and Simulating Social Systems**

Fall 2018

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**IBERIA**

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How do  
**task variety**  
and  
**interpersonal relationships**  
influence *performance*?

A person with a red backpack is walking away from the camera on a narrow suspension bridge. The bridge is made of metal cables and a wooden plank floor, and it stretches across a deep, dense forest. In the background, there are rolling mountains under a hazy sky. The overall scene is serene and adventurous.

# Introduction

# Definitions

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A **workplace** is composed of **agents** which must perform a series of **tasks**.

Each **agent** possesses a **skillset**: here, their *expertise* and *motivation* for each **skill** is recorded.

Each **task** is composed of a series of **actions**.

Each **action** requires exactly one **skill**.

# Definitions

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**What is task variety?**

A measure for the **variety of the skills** associated with the collection of actions.

*High task variety* means that many actions will require the frequent activation of different sets of skills by the intervening agents (= a lot of context switching).

# Definitions

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## What is group performance?

Group performance is determined by two factors:

- the time taken by the agents to perform the tasks;
- the *coordination time*, i.e., the time taken by the agents to distribute tasks between themselves.

**Group performance depends on the designated tasks.**

# Definitions

## Example

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### Low task variety

- Pluck peaches
- Put them in a box
- Sell them

1

- Pluck peaches
- Put them in a box
- Ship them

2

### High task variety

- Pluck peaches
- Put them in a box
- Sell them

1

- Pluck peaches
- Buy other ingredients
- Make jam

2

How do  
**task variety**  
and  
**interpersonal relationships**  
influence *performance*?



What about **interpersonal relationships**?

# Background

Myers-Briggs Type Indicator (MBTI)

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# Background

MBTI

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EXTRAVERT

INTROVERT

THINKING

FEELING

OBSERVANT

INTUITIVE

JUDGING

PROSPECTING

# Background

## MBTI

### Analysts



**"ARCHITECT"**  
INTJ (-A/-T)

Imaginative and strategic thinkers, with a plan for everything.



**"LOGICIAN"**  
INTP (-A/-T)

Innovative inventors with an unquenchable thirst for knowledge.



**"COMMANDER"**  
ENTJ (-A/-T)

Bold, imaginative and strong-willed leaders, always finding a way - or making one.



**"DEBATER"**  
ENTP (-A/-T)

Smart and curious thinkers who cannot resist an intellectual challenge.

### Sentinels



**"LOGISTICIAN"**  
ISTJ (-A/-T)

Practical and fact-minded individuals, whose reliability cannot be doubted.



**"DEFENDER"**  
ISFJ (-A/-T)

Very dedicated and warm protectors, always ready to defend their loved ones.



**"EXECUTIVE"**  
ESTJ (-A/-T)

Excellent administrators, unsurpassed at managing things - or people.



**"CONSUL"**  
ESFJ (-A/-T)

Extraordinarily caring, social and popular people, always eager to help.

### Diplomats



**"ADVOCATE"**  
INFJ (-A/-T)

Quiet and mystical, yet very inspiring and tireless idealists.



**"MEDIATOR"**  
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Poetic, kind and altruistic people, always eager to help a good cause.



**"PROTAGONIST"**  
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**"CAMPAIGNER"**  
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Enthusiastic, creative and sociable free spirits, who can always find a reason to smile.

### Explorers



**"VIRTUOSO"**  
ISTP (-A/-T)

Bold and practical experimenters, masters of all kinds of tools.



**"ADVENTURER"**  
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# Main Contributions

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## (1) Resurrection of WORKMATE-I

- Delphi6 → Python3
- Object-oriented
- Incorporation of plotting libraries

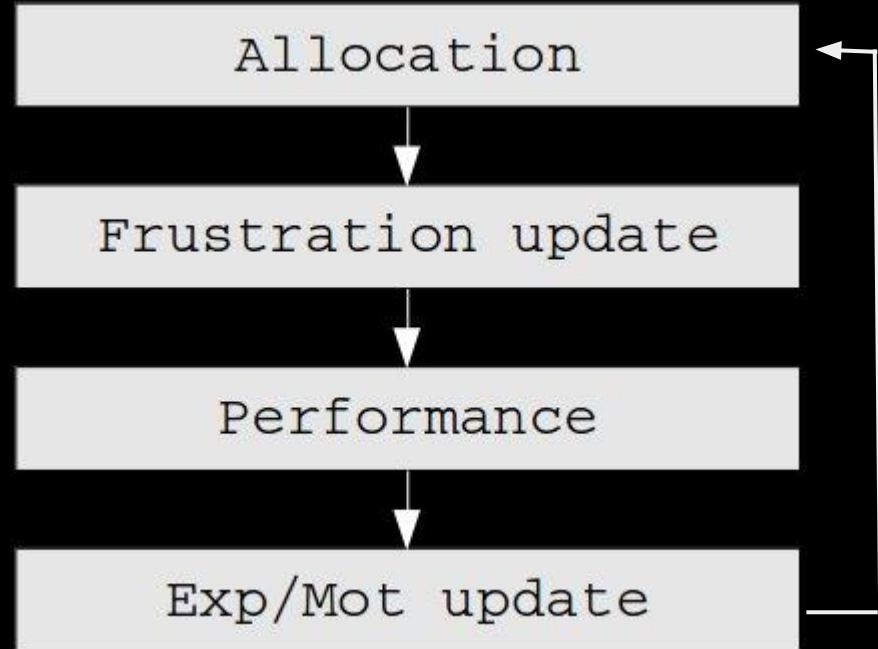
## (2) Modelling frustration/happiness related to work environment

## (3) Linking two areas of research

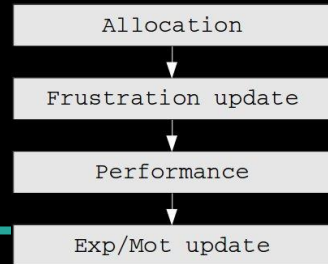
- Task allocation and group performance
- Personality models

# Model

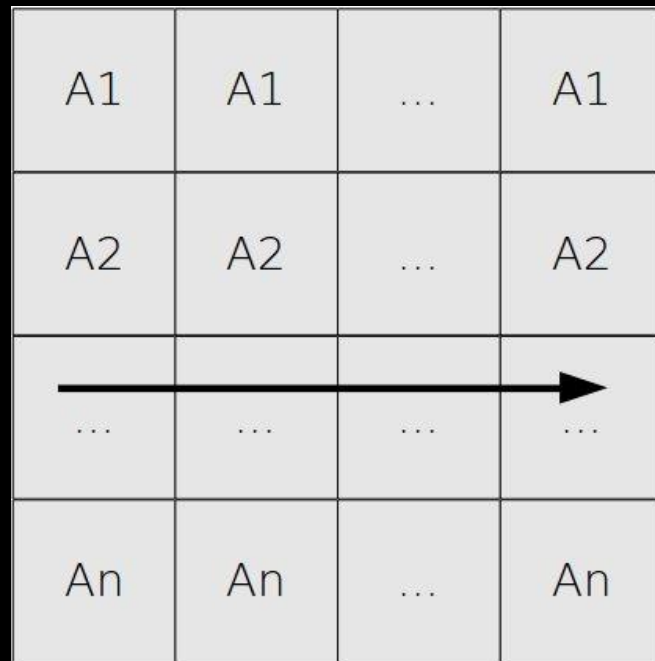
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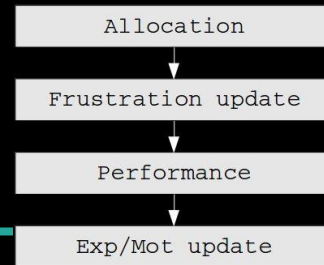
# Tasks



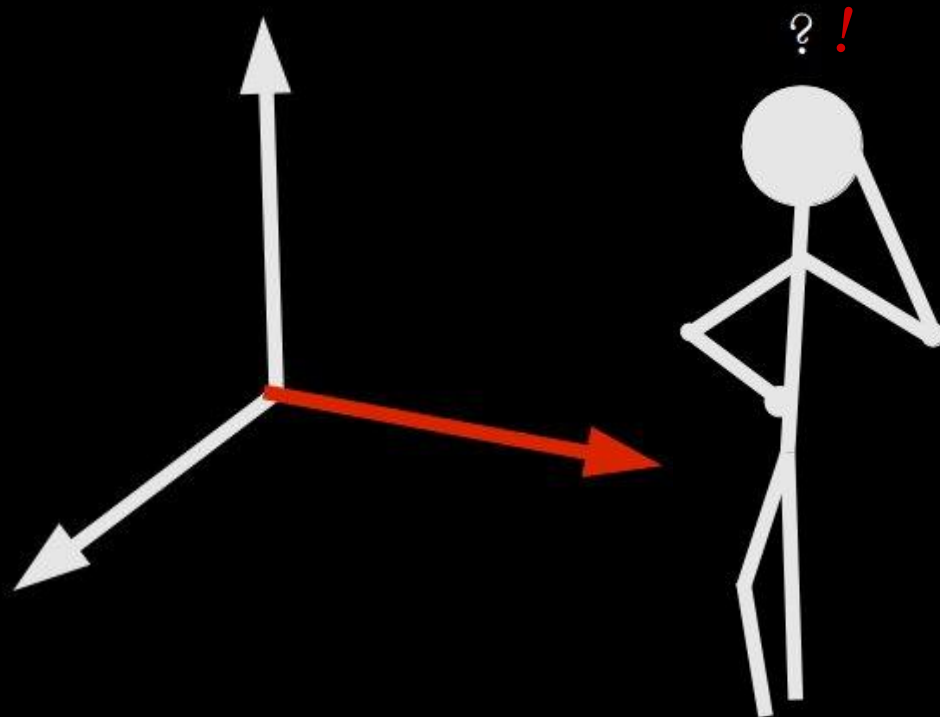
- Several cycles
- Several actions per cycle
- One skill per action



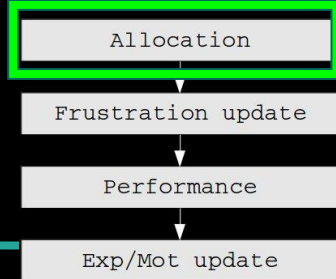
# Agents: dimensions



- Per skill
  - Expertise
  - Motivation
- Per agent
  - **Frustration**
    - MBTI



# Agents: interactions

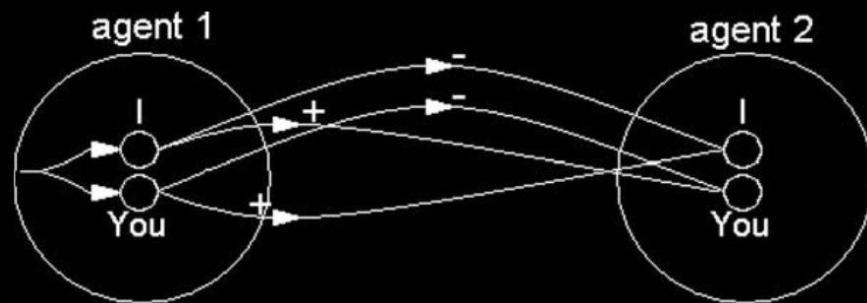


$$I_2 := I_2 - i \cdot I_1 I_2 | I_1 - I_2 |$$

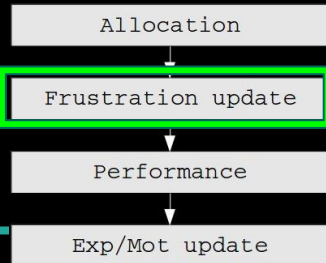
$$Y_2 := Y_2 - i \cdot Y_1 Y_2 | Y_1 - Y_2 |$$

$$Y_2 := Y_2 + \varepsilon \cdot (1 - Y_2) I_1 | I_1 - I_2 |$$

$$I_2 := I_2 + \varepsilon \cdot (1 - I_2) Y_1 | Y_1 - Y_2 |$$

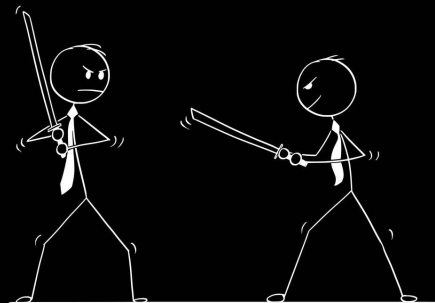


# Agents: mood

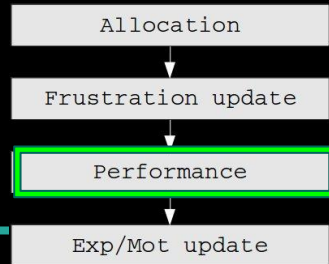


$$f_{t+1} := 0.8f_t + 0.2I(T, r_{ij})$$

$$I(T, r_{ij}) = I_{max} \left( 1 - e^{-\beta \frac{1-r_{ij}}{r_{ij}} \frac{\mathfrak{T} / \mathfrak{T}_{max}}{1 - \mathfrak{T} / \mathfrak{T}_{max}}} \right)$$



# Agents: performance



$$t_{perf\_a} = \sum_{i=1}^{N_{actions}} \frac{t_{action\_i}}{\alpha_e \frac{e_i}{e_{max}} + \alpha_m \frac{m_i}{m_{max}} + \alpha_f \frac{1-f}{f_{max}}}$$

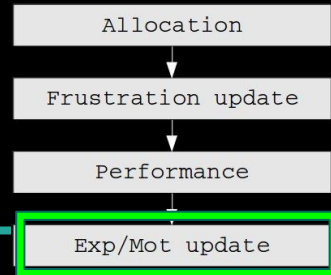
$$T_{perf} = \max\{t_{perf_1}, \dots, t_{perf_n}\} + T_{coordination}$$





# Agents: expertise & motivation

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$$p_{t+1} = p_t + \lambda_p \frac{p_{max} - p_t}{p_{max}}$$

$$p_{t+1} = \frac{(p_t - \mu_p)p_{max}}{p_{max} - \mu_p}$$

# Implementation

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# Simulator as a 'Black Box'

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# Class Diagram

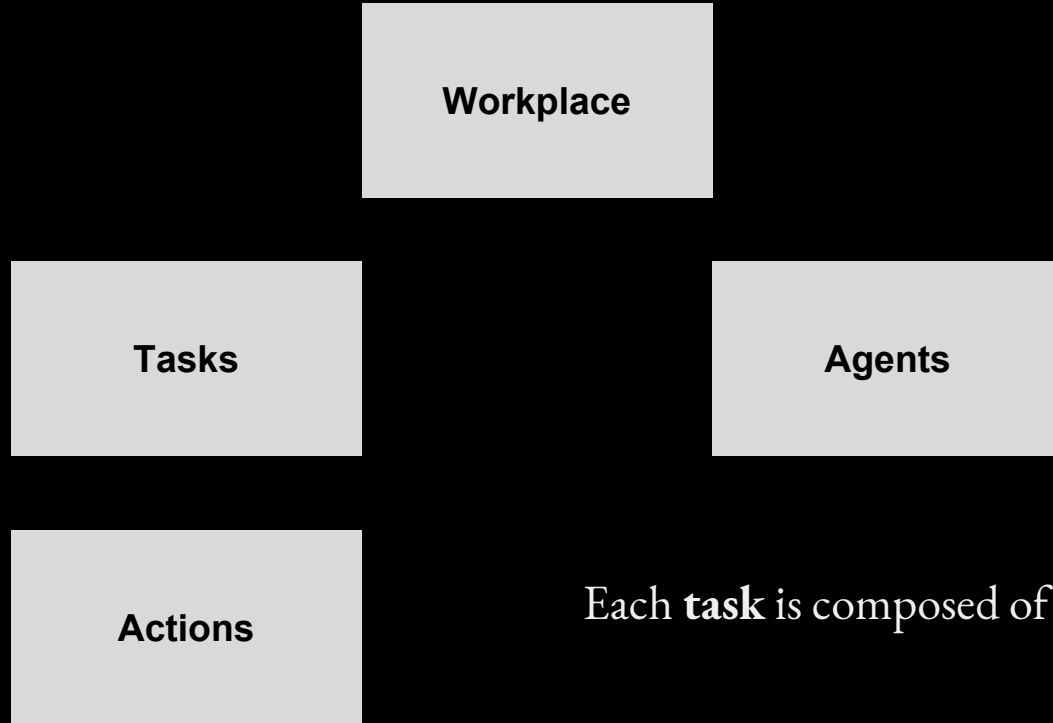
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A **workplace** is composed of **agents** which must perform a series of **tasks**.

# Class Diagram

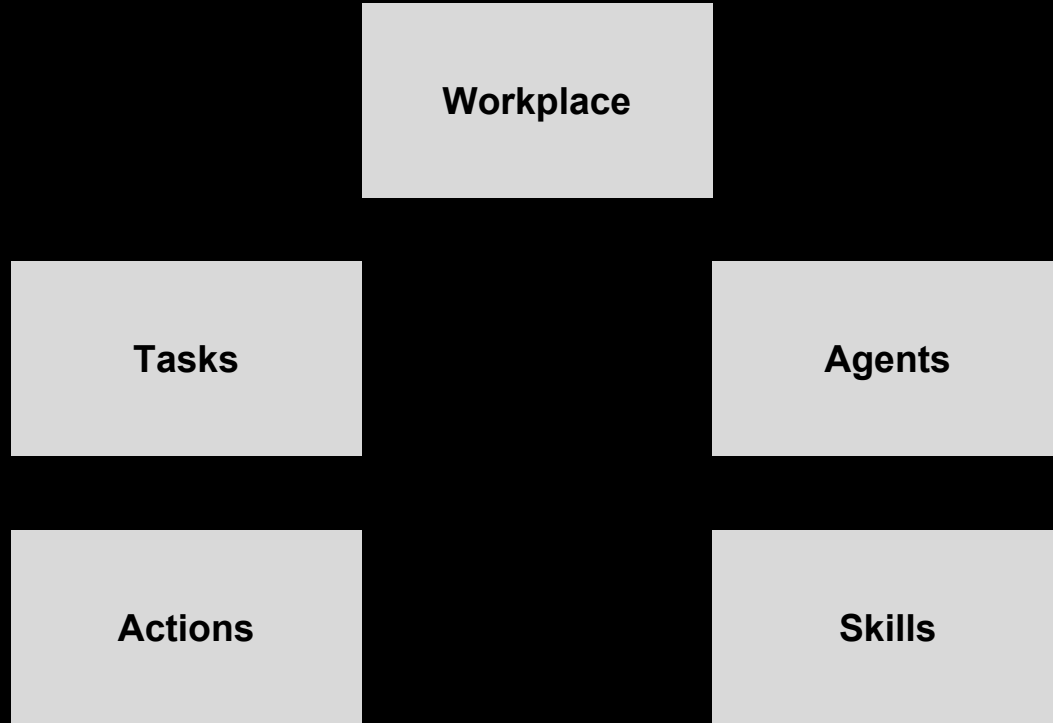
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Each **task** is composed of a series of **actions**.

# Class Diagram

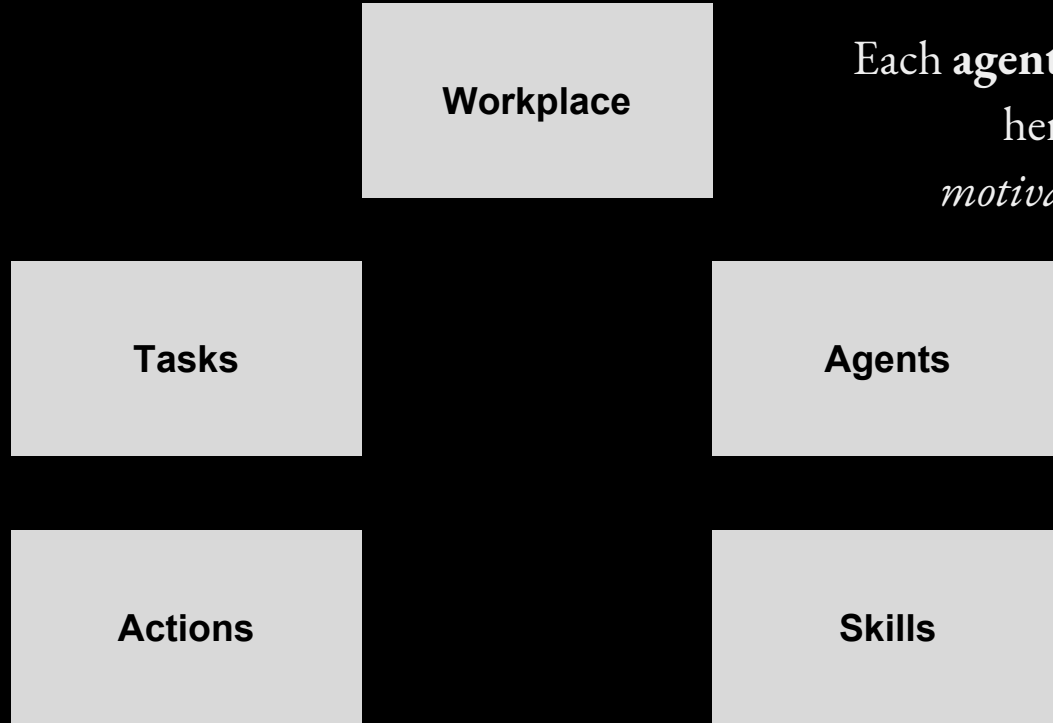
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Each **action**  
requires exactly  
one **skill**.

# Class Diagram

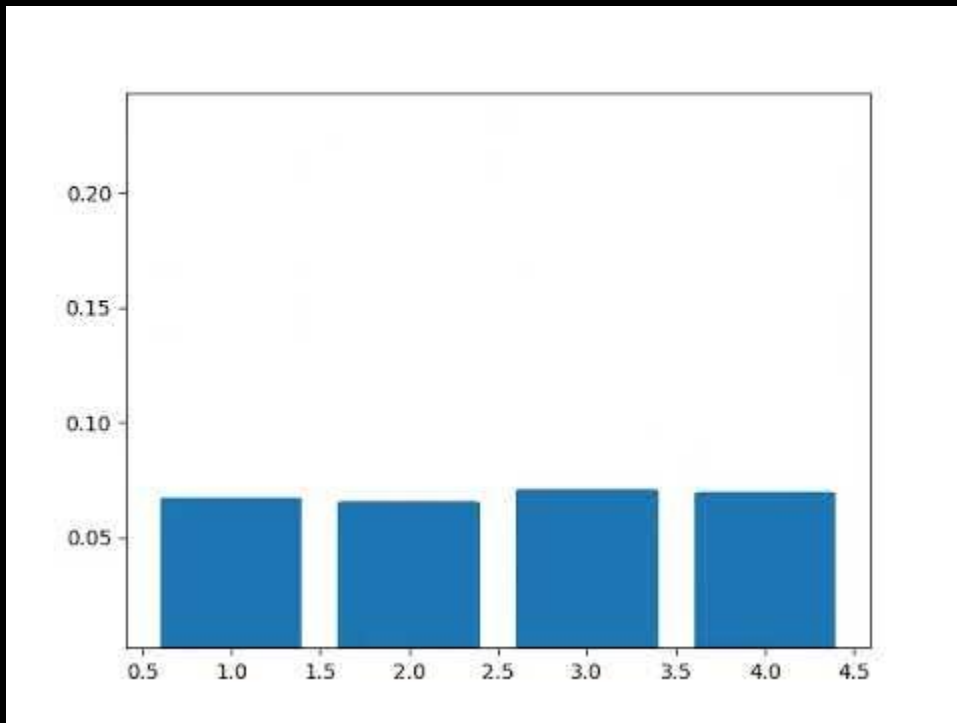
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Each **agent** possesses a **skillset**:  
here, their *expertise* and  
*motivation* for each **skill** is  
recorded.

# Dynamic plots

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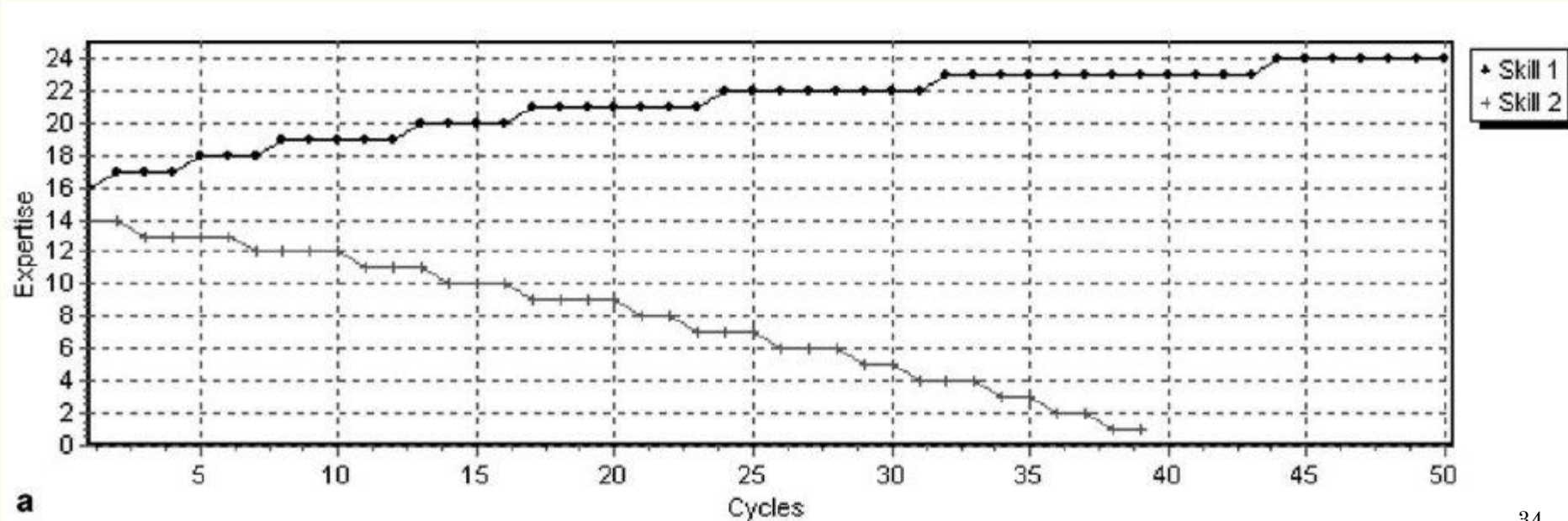


# Results

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# 0.1 Replicating the results

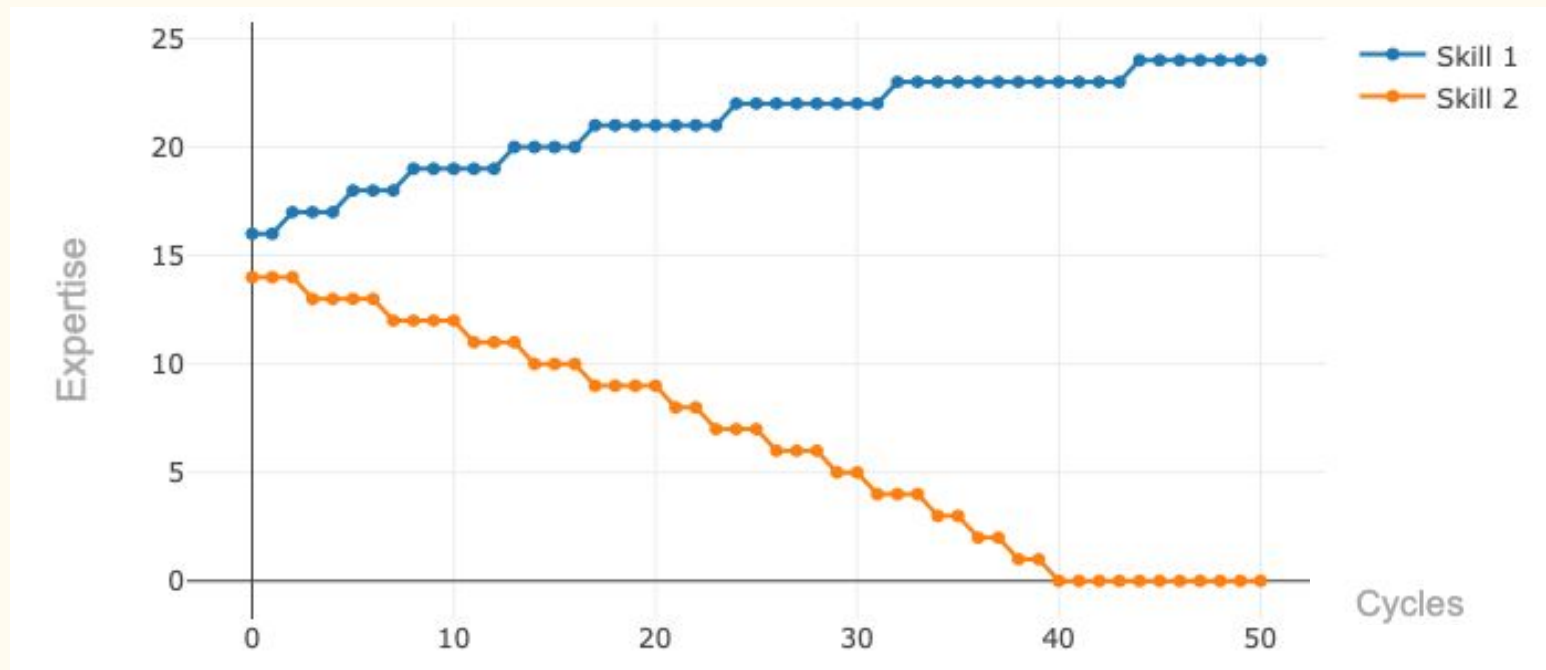
## Expertise over time



# 0.1 Replicating the results

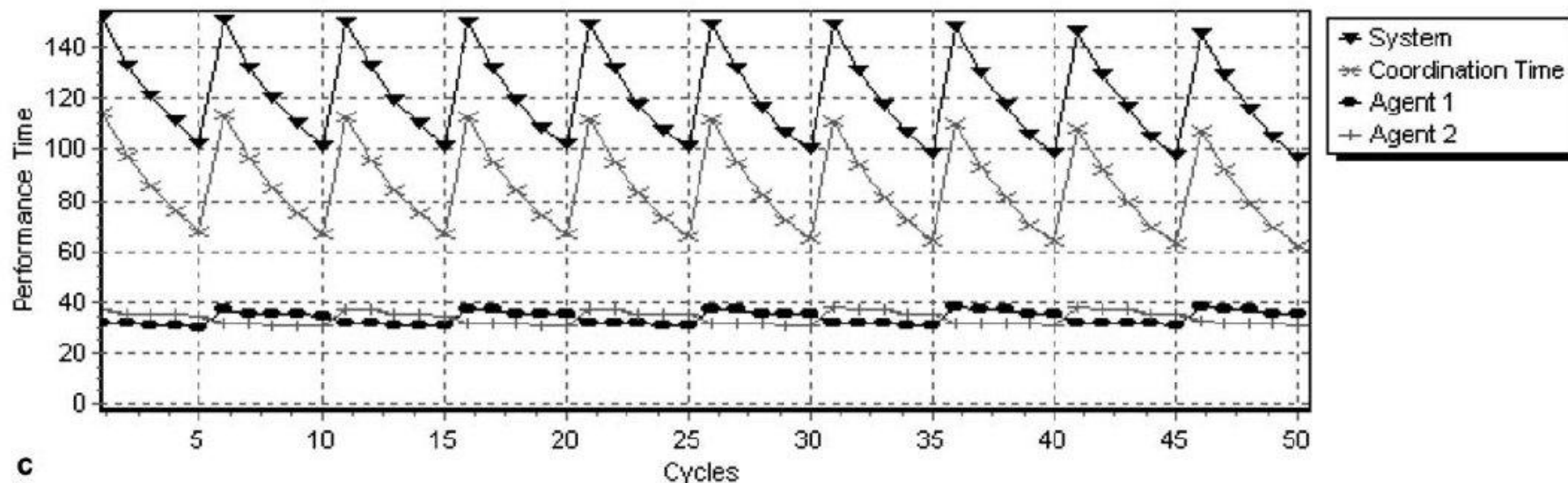
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## Expertise over time



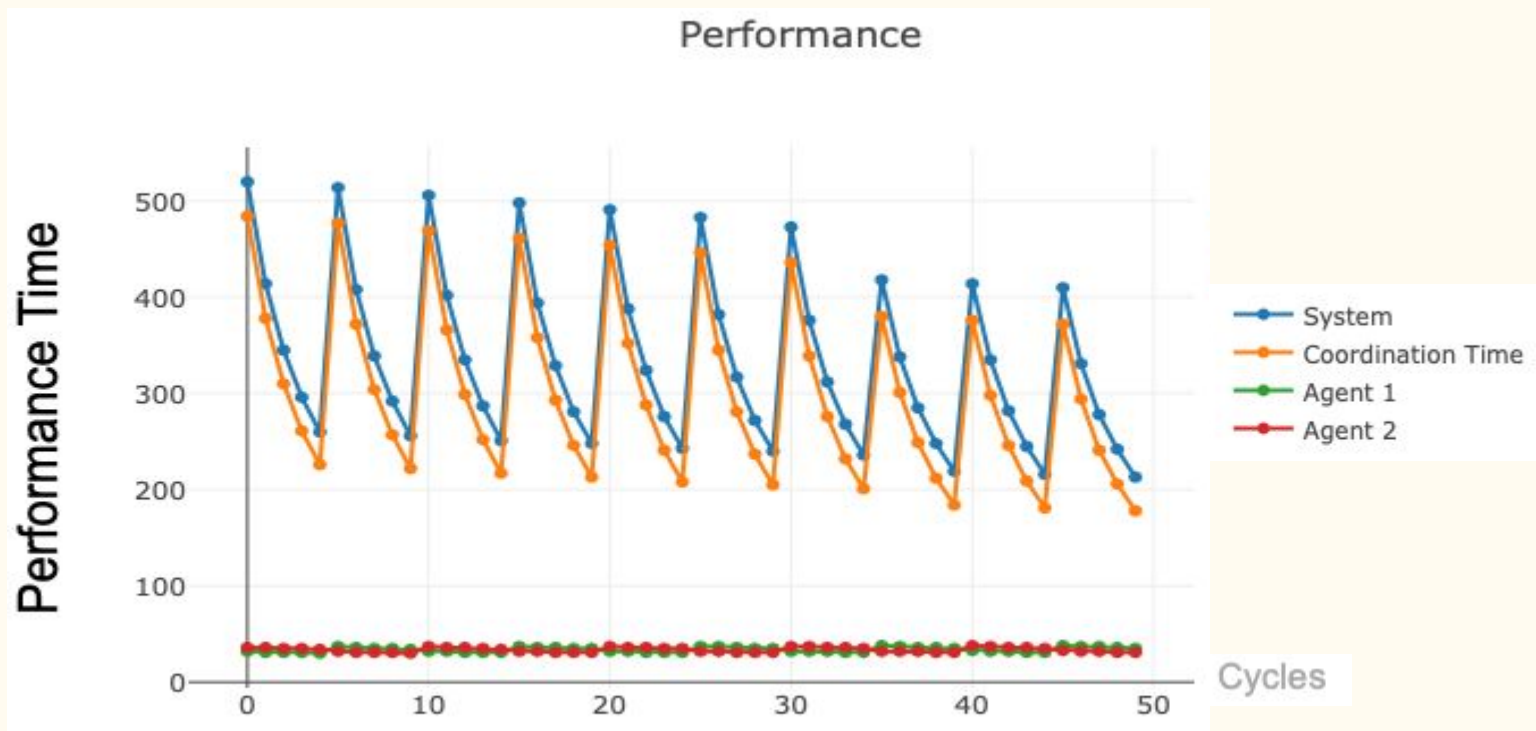
# 0.2 Replicating the results

## Group performance over time



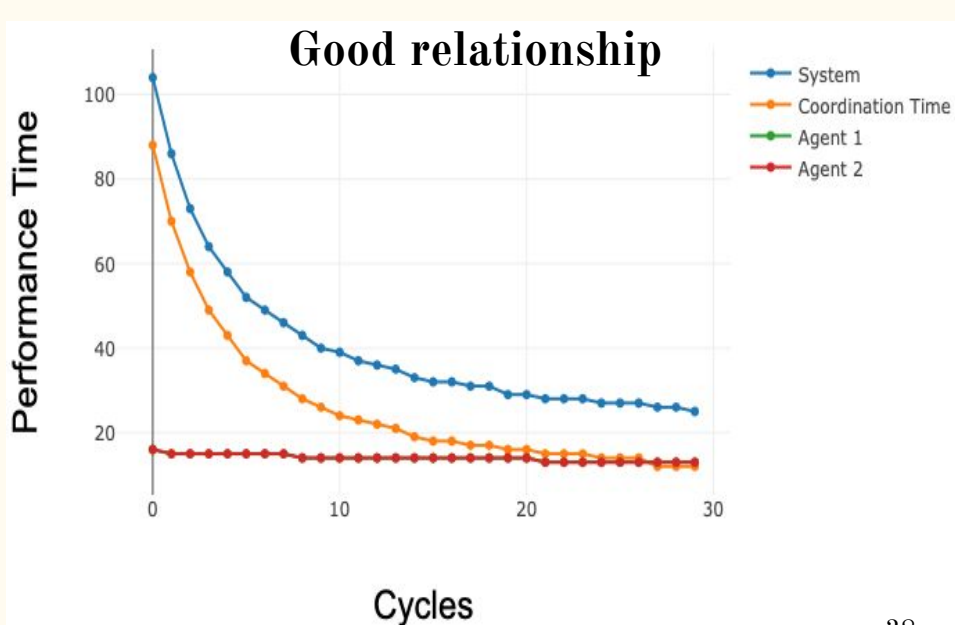
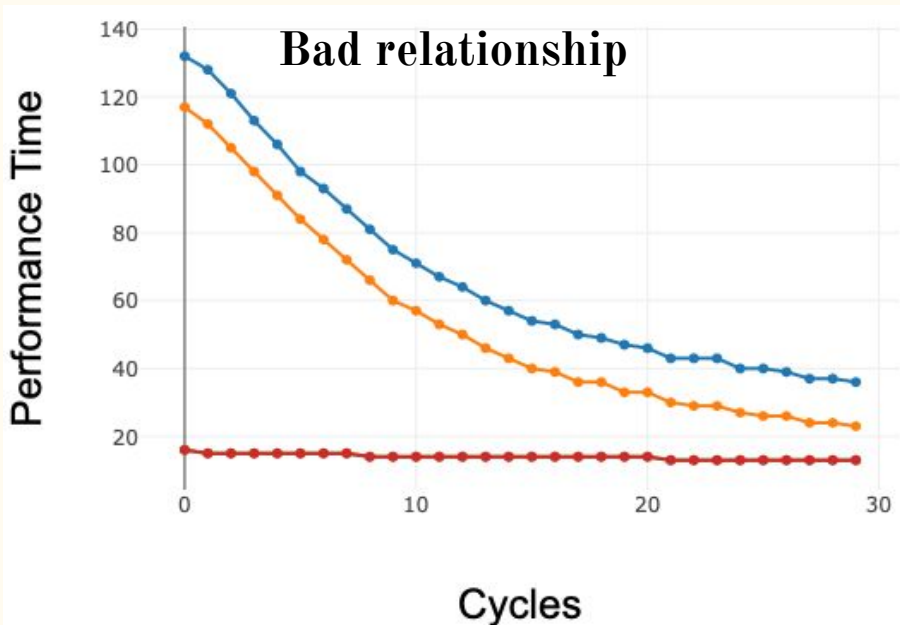
# 0.2 Replicating the results

## Group performance over time



# Experiment 1.1: performance

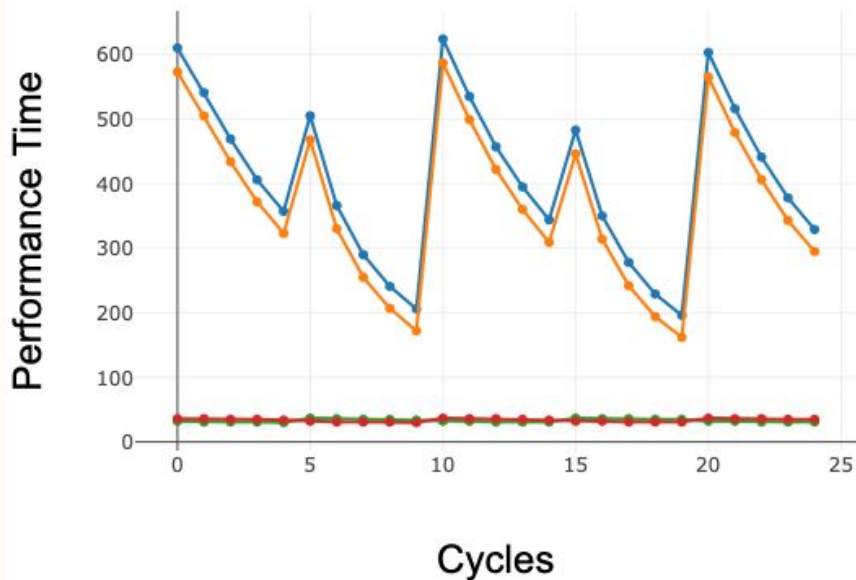
## Low task variety



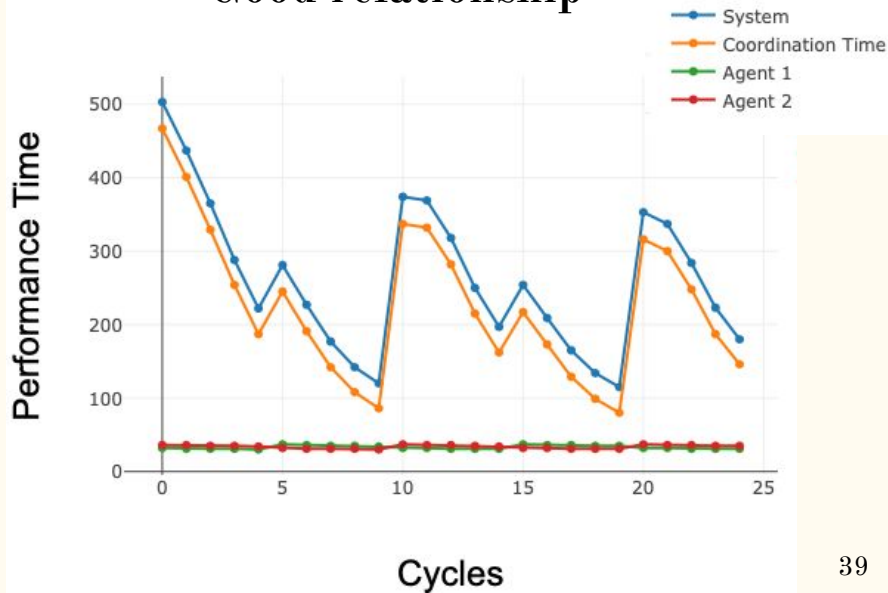
# Experiment 1.2: performance

High task variety

Bad relationship

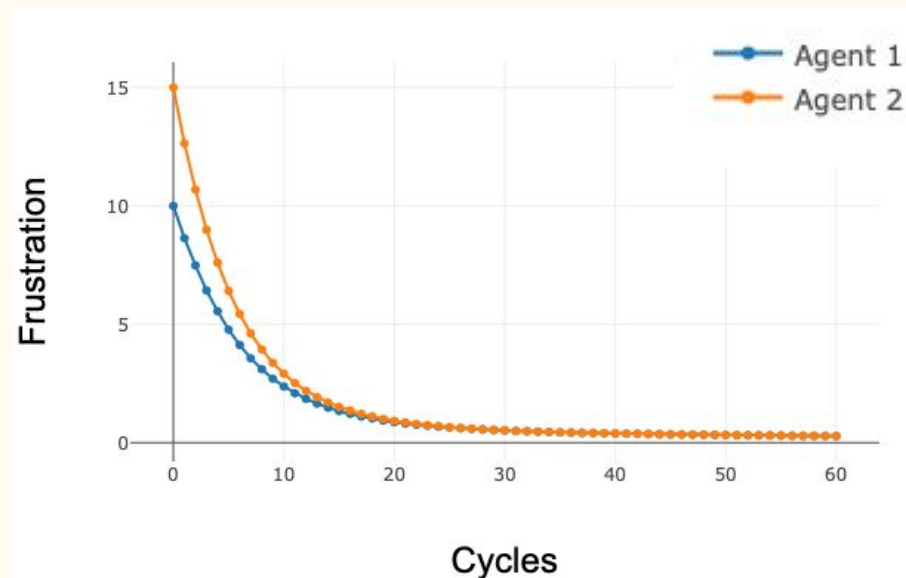
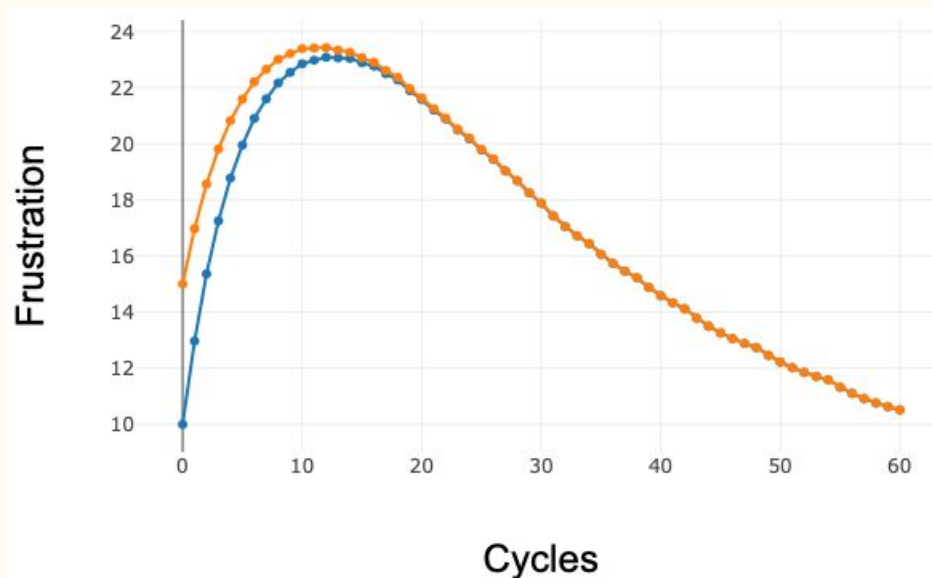


Good relationship



# Experiment 2: frustration

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Specialization smooths  
out conflicts...

Specialization smooths  
out conflicts...

... if there is a ‘routine’

# Conclusions

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# Conclusions

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Replicated results from bibliography in a modern and adaptable form.

Expanded the model to include a measure of frustration in agents.

Incorporated the nuanced nature of interpersonal relationships in the model.

# Limitations

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**Absence of randomness**

**No data to tune parameters**

**No complex tasks and dependencies**

# Future Work

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Several agents

Analyze group formation - looking for stable agent config if they are allowed to leave

Different psychological categories: Belbin Team Roles? → more work-oriented



**“ARCHITECT”**

INTJ (-A/-T)

Thank you.



**“DEFENDER”**

ISFJ (-A/-T)

**0.67**



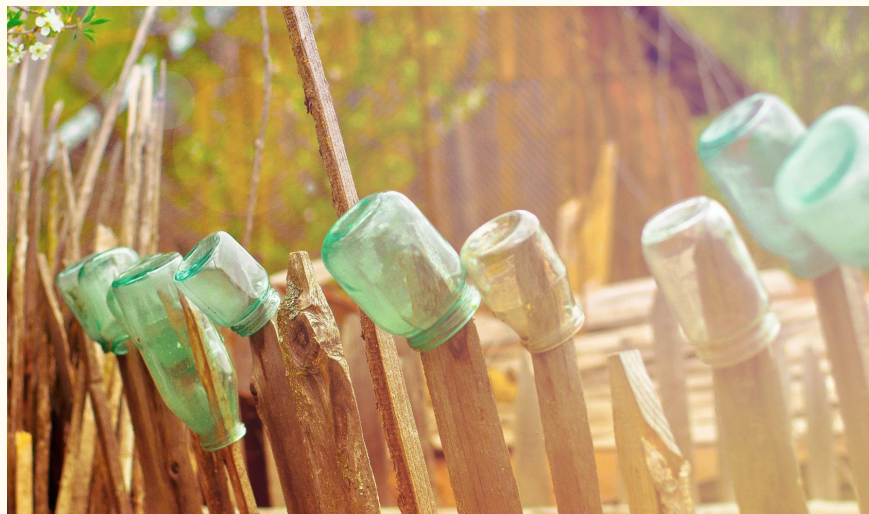
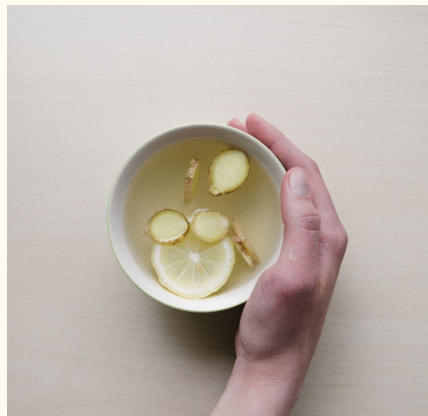


# Material

Lo tienes todo en casa

- 2 vasos
  - Sal de mesa
  - 2 huevos
  - Agua
-

P





# Experiment

