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

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*?

Introduction

Definitions

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

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

Example

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

Definitions

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.

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

What about **interpersonal relationships?**

Background

Myers-Briggs Type Indicator (MBTI)

Background

MBTI

EXTRAVERT INTROVERT	OBSERVANT INTUITIVE
THINKING FEELING	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"

INFP (-A/-T)

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

"PROTAGONIST"

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Charismatic and inspiring leaders, able to mesmerize their listeners.

"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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Flexible and charming artists, always ready to explore and experience something new.

"ENTREPRENEUR"

ESTP (-A/-T)

Smart, energetic and very perceptive people, who truly enjoy living on the edge.

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Image credit: https://www.16personalities.com

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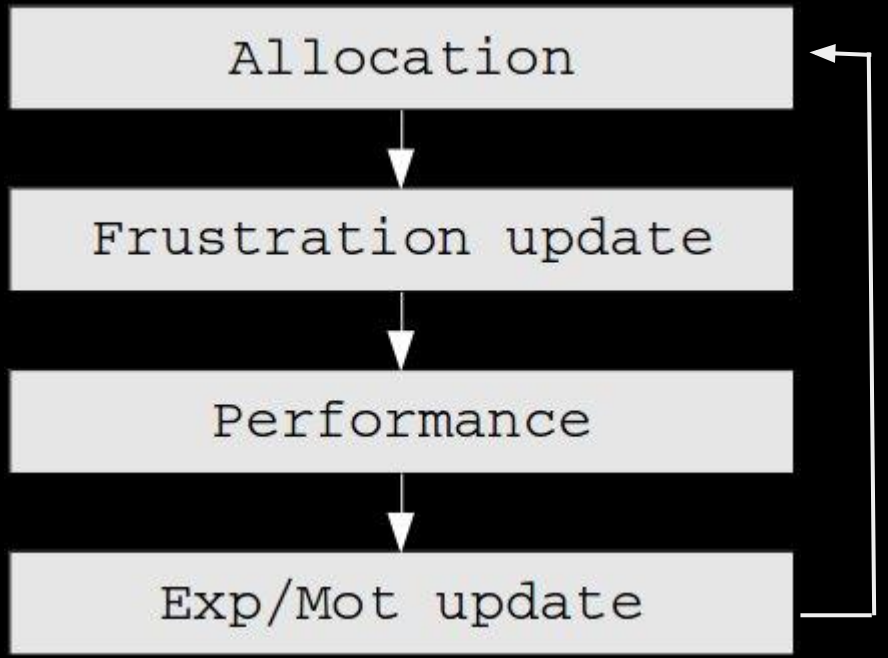
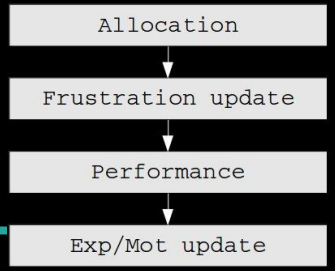
Main Contributions

(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

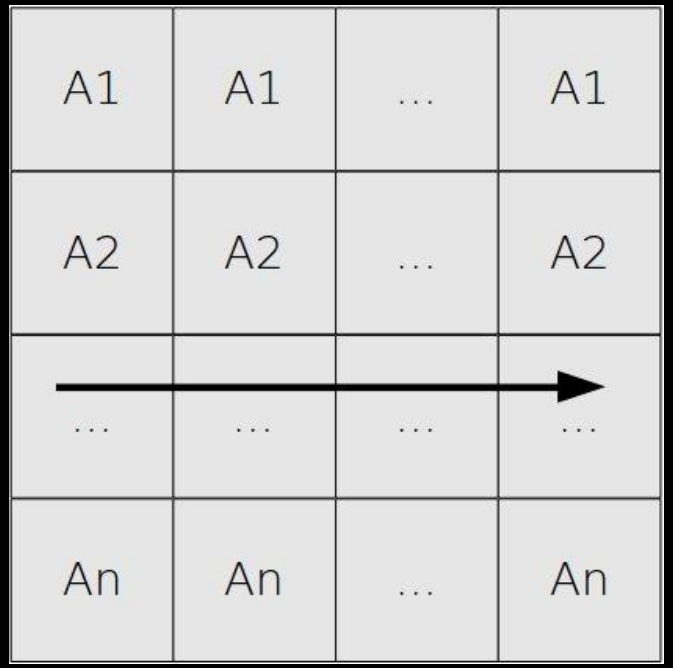
Model


Allocation
Frustration update
Performance
Exp/Mot update

Tasks

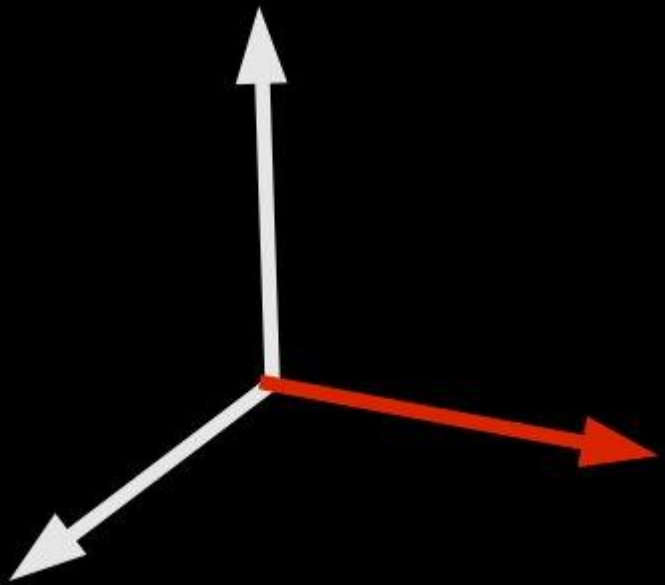


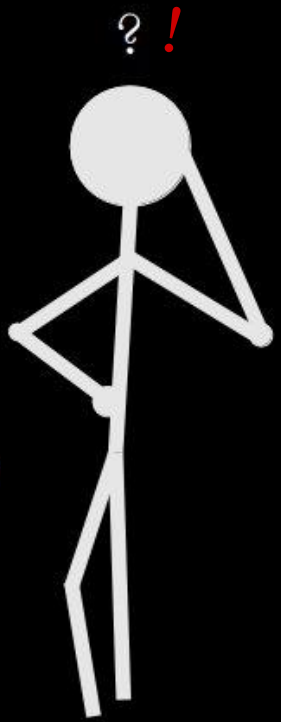
- Several cycles
- Several actions per cycle
- One skill per action

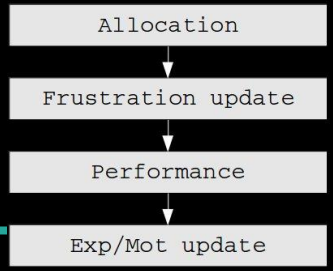


Agents: dimensions

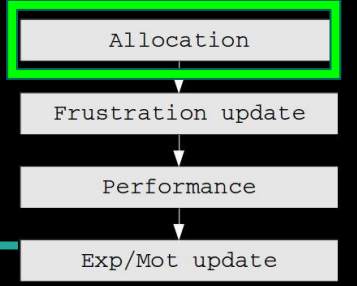
- Per skill
  - Expertise
  - Motivation
- Per agent
  - Frustration
    - MBTI







Agents: interactions



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

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

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

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

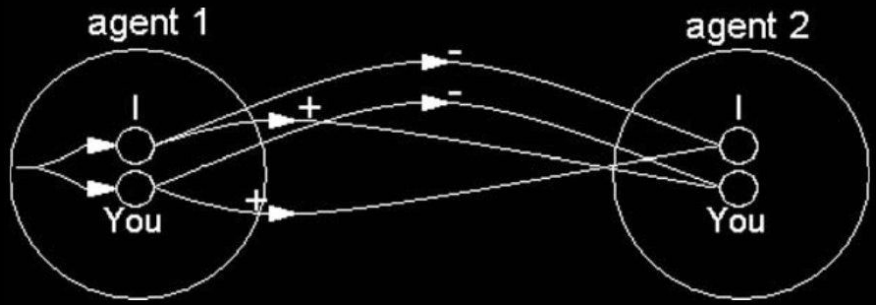
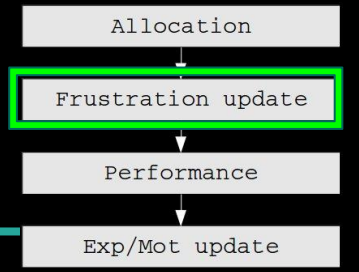


Image: Kees Zoethout, et al. “Formalizing self-organizing processes of task allocation”

Agents: mood



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

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

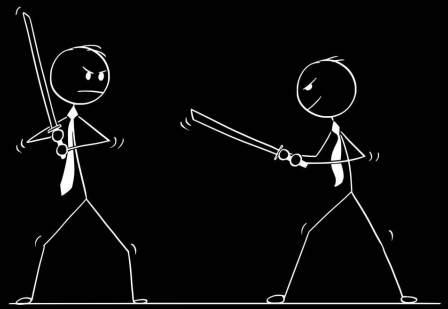
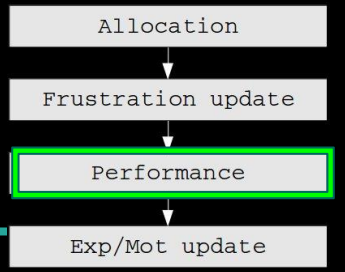


Image: vectorstock.com

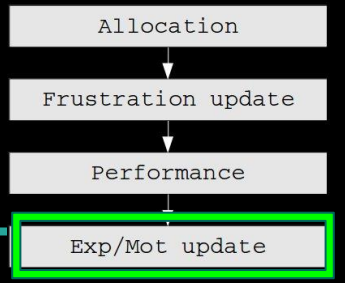
Agents: performance



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

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

Agents: expertise & motivation



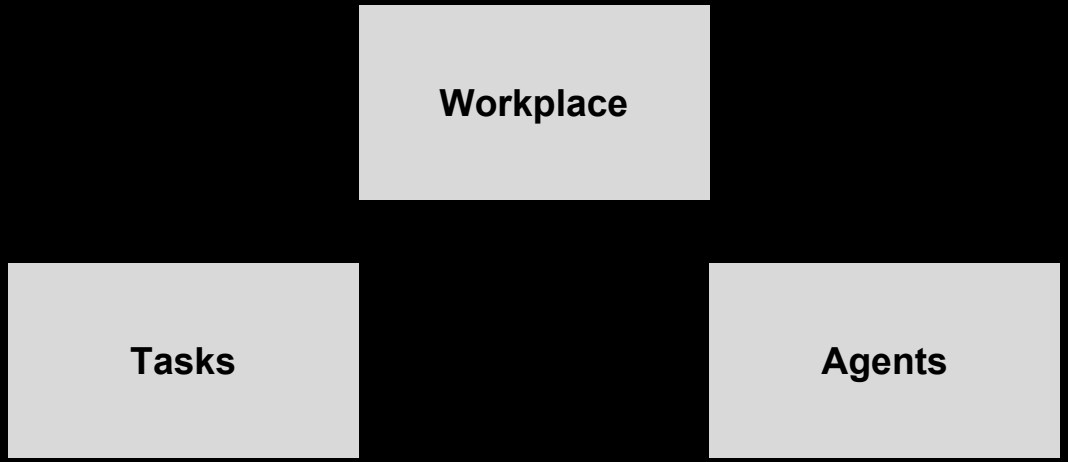
$$p_{t+1} = p_t + \lambda_p \frac{p_{max} - p_t}{p_{max}}$$

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

Implementation

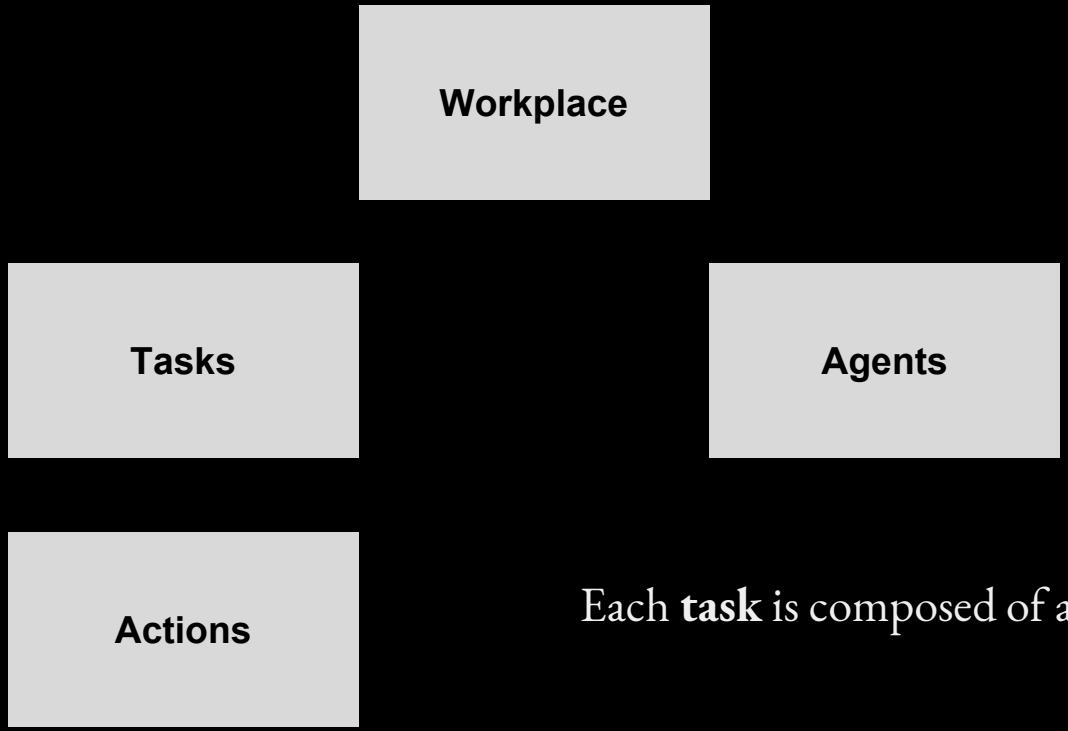
Simulator as a ‘Black Box’

Class Diagram



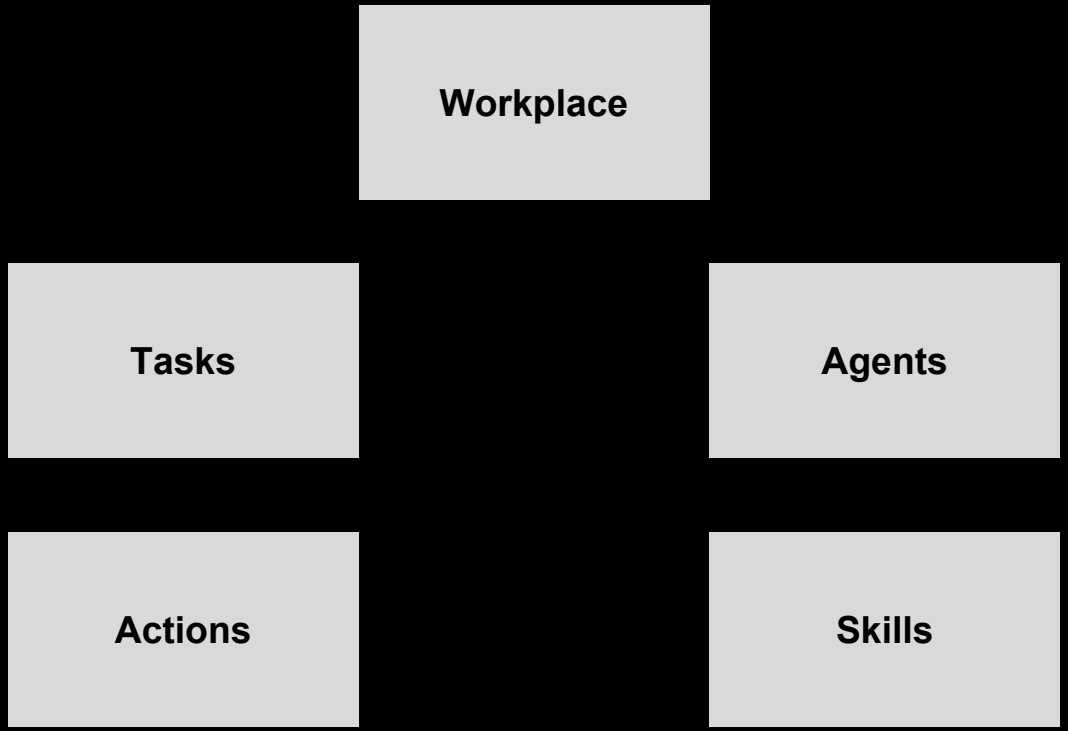
A **workplace** is composed of **agents** which must perform a series of **tasks**.

Class Diagram



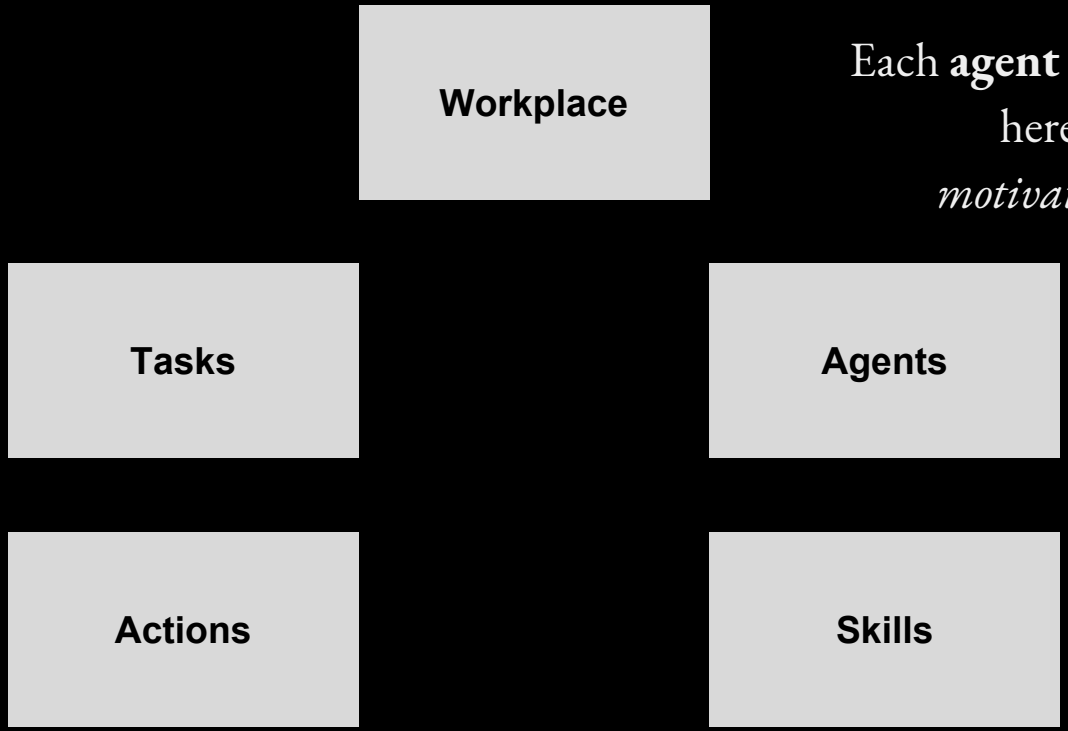
Each **task** is composed of a series of **actions.**

Class Diagram



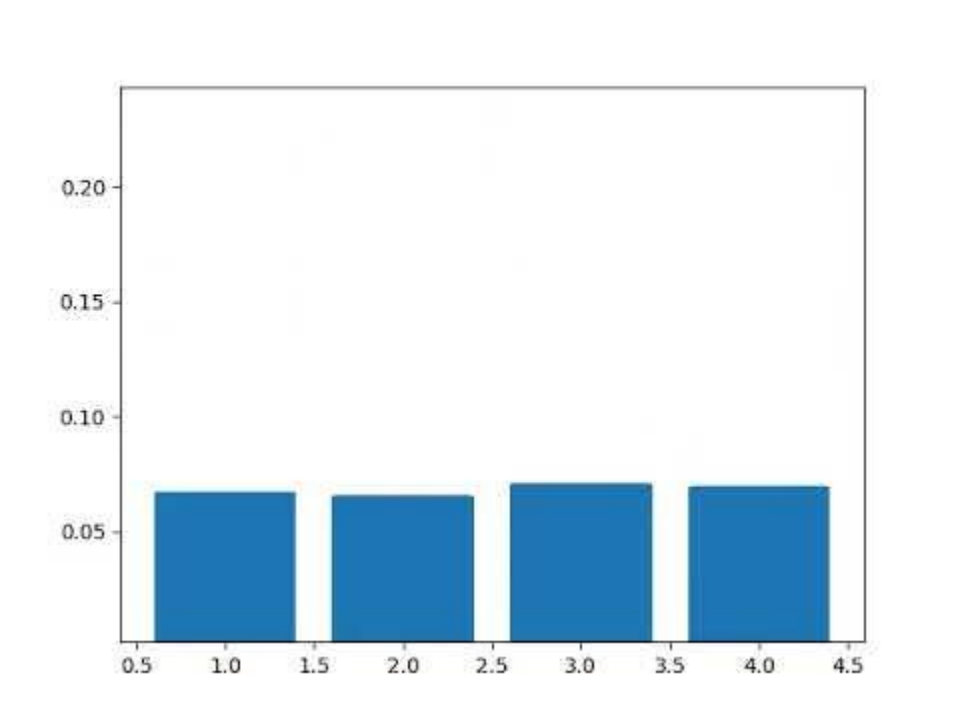
Each **action** requires exactly one **skill**.

Class Diagram



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

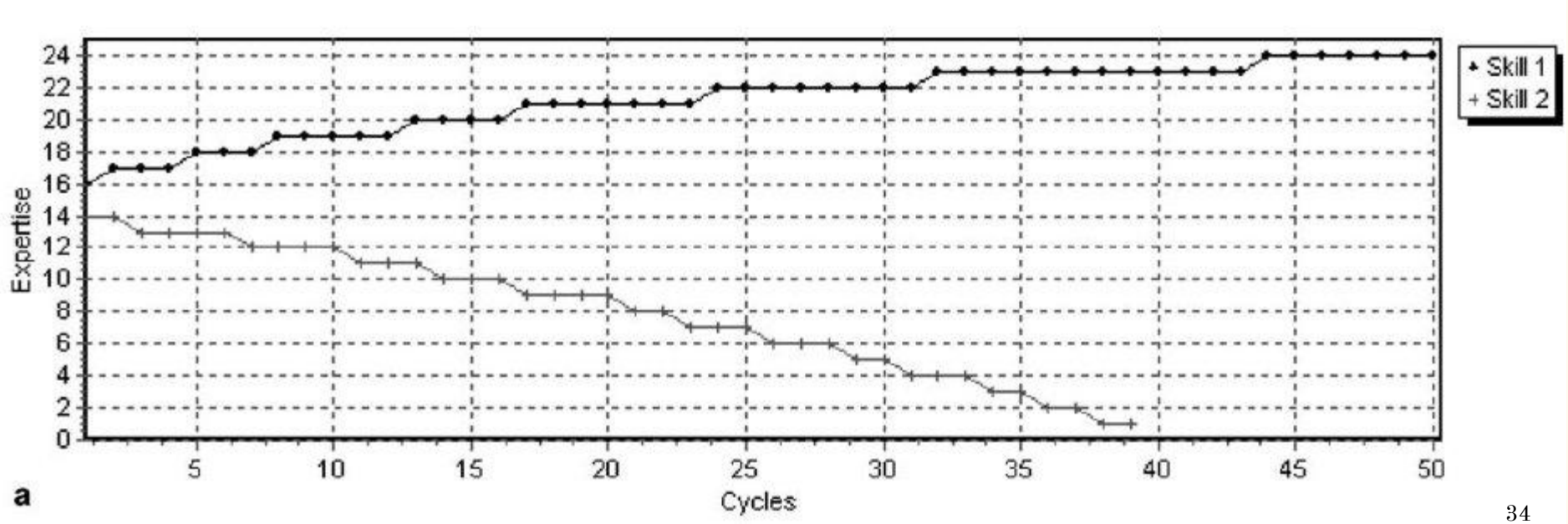
Dynamic plots



Results

0.1 Replicating the results

Expertise over time



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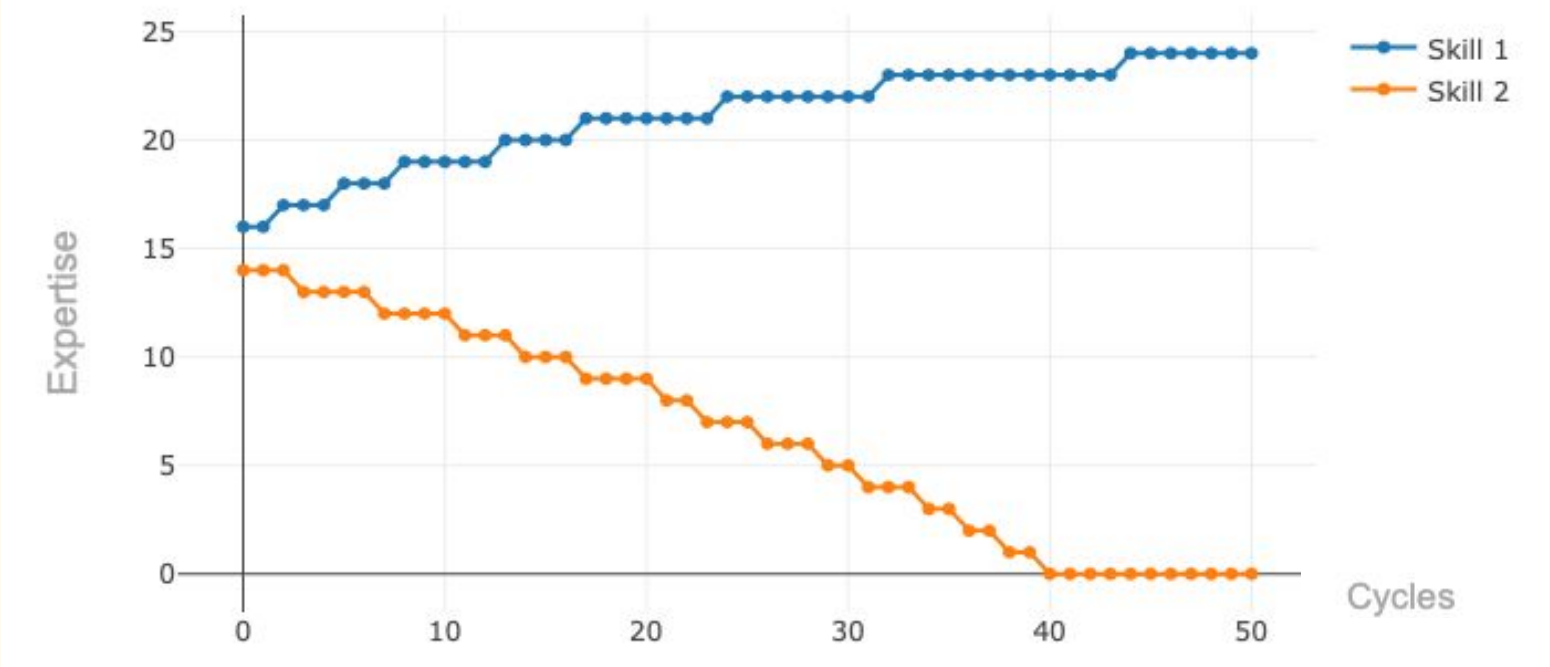
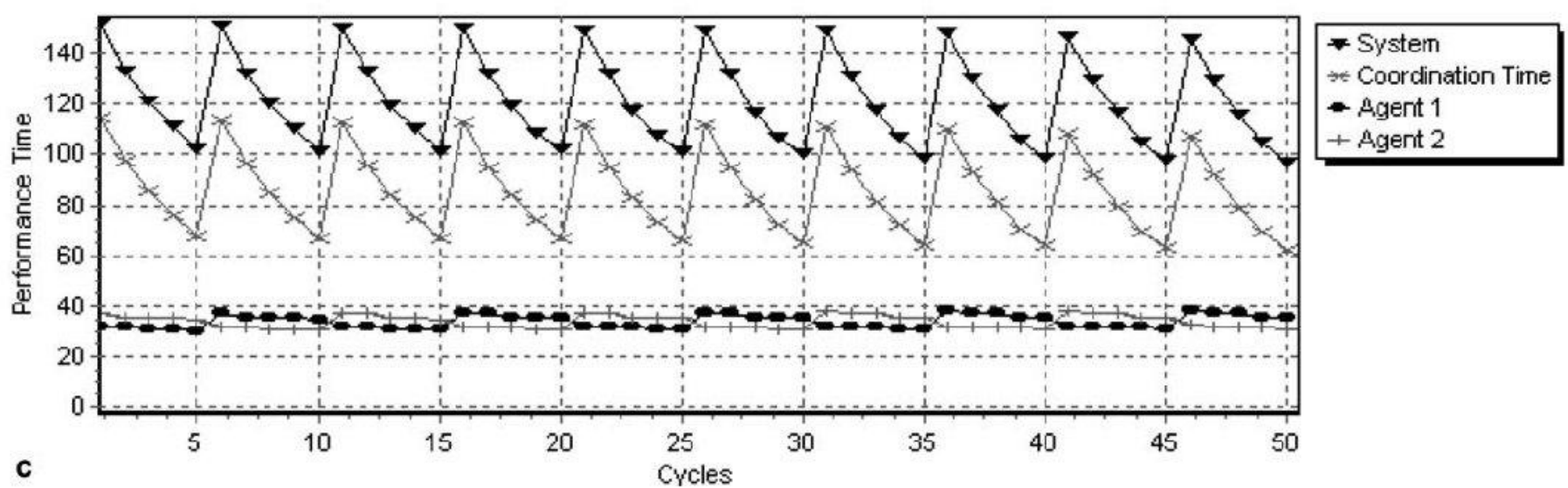
Expertise over time



0.2 Replicating the results

Group performance over time



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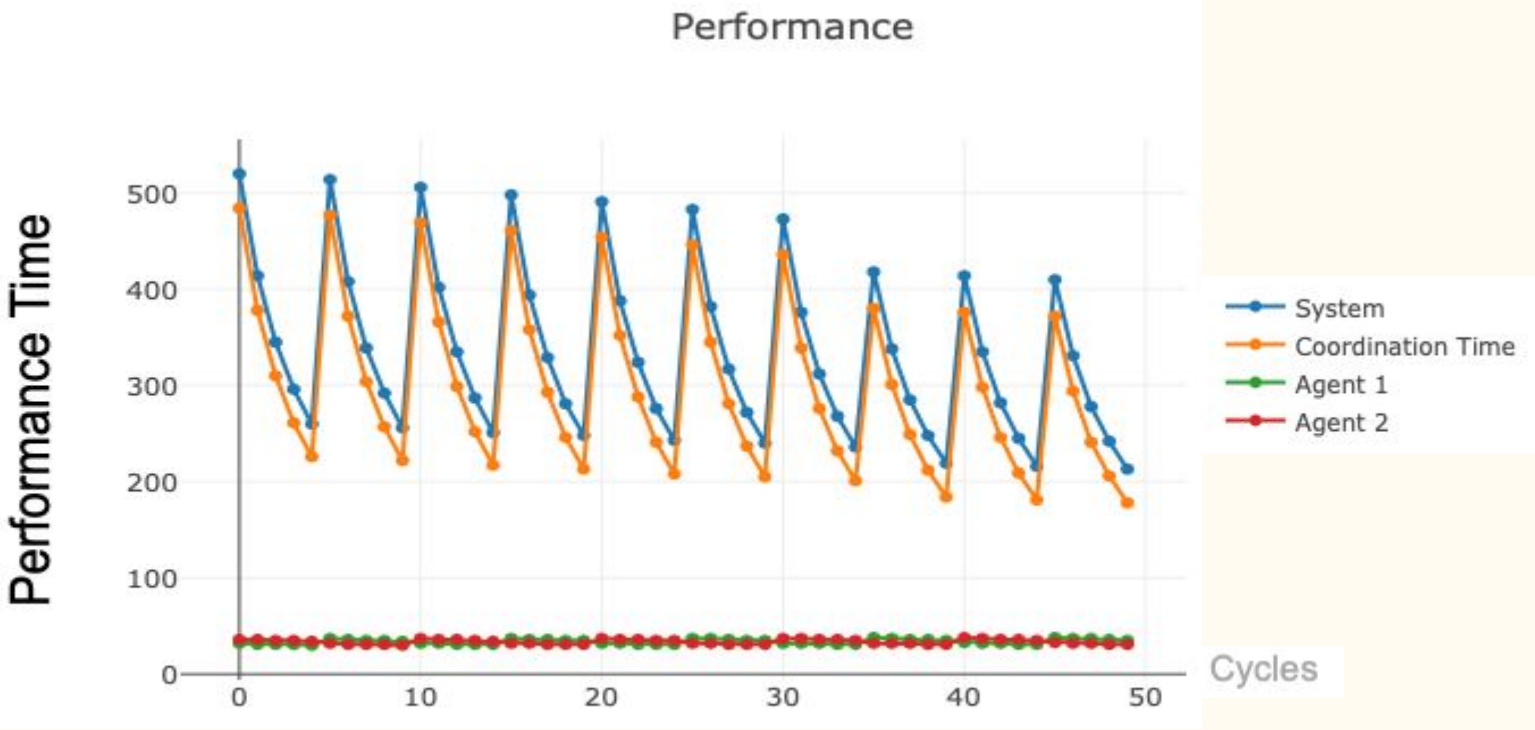
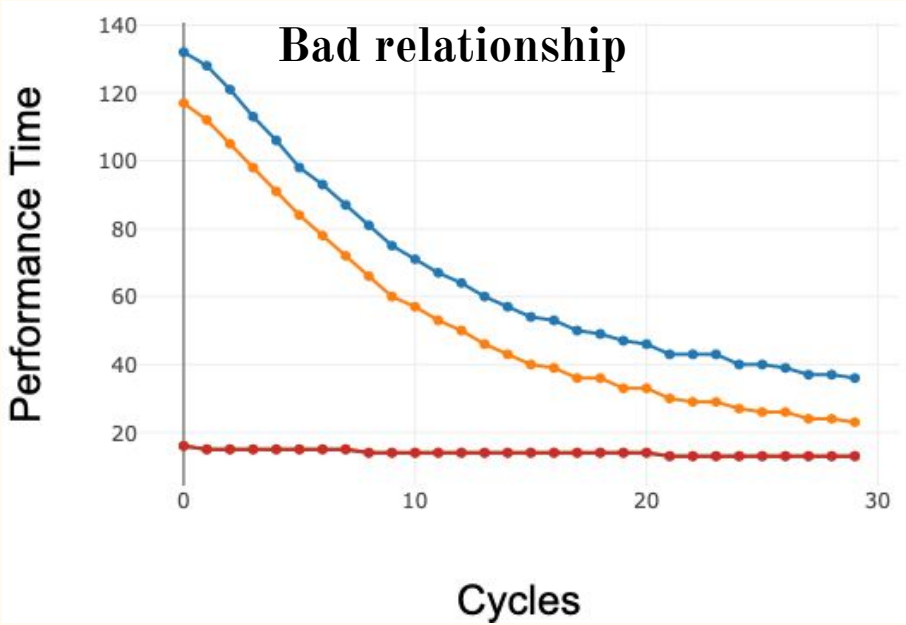
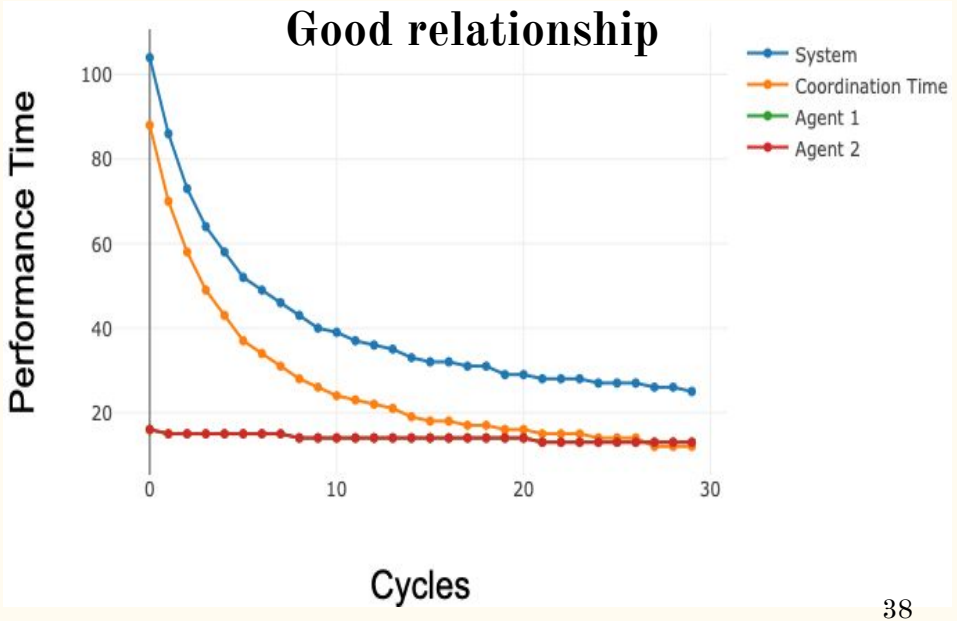
Group performance over time



Experiment 1.1: performance

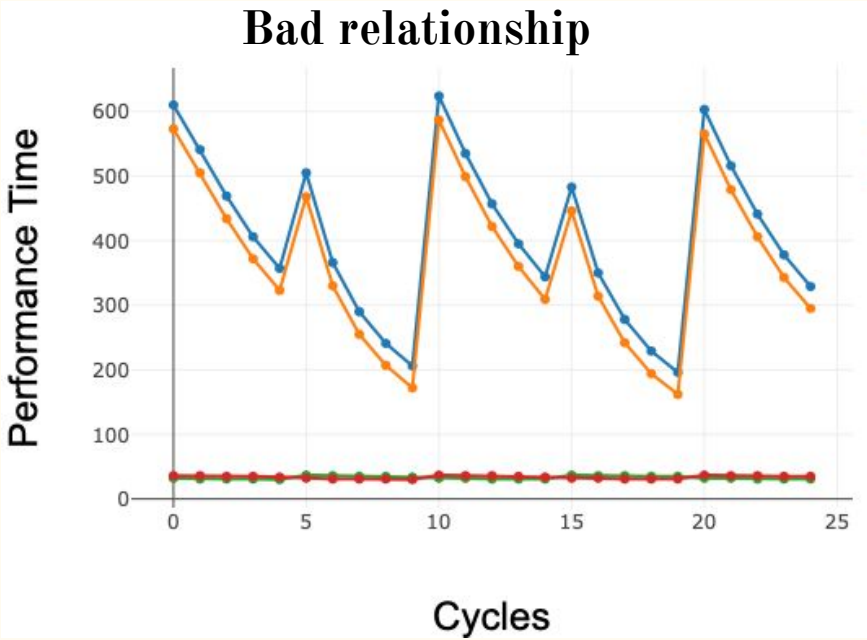
Low task variety

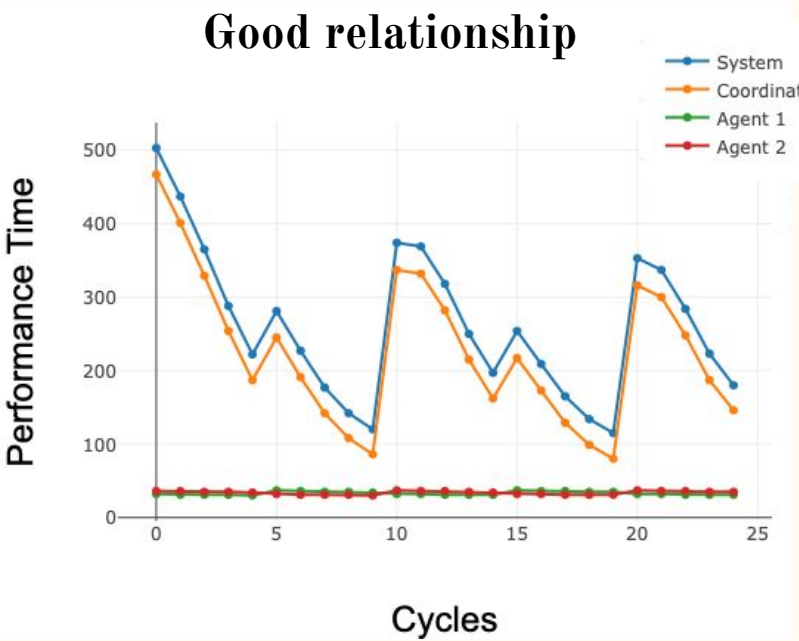




Experiment 1.2: performance

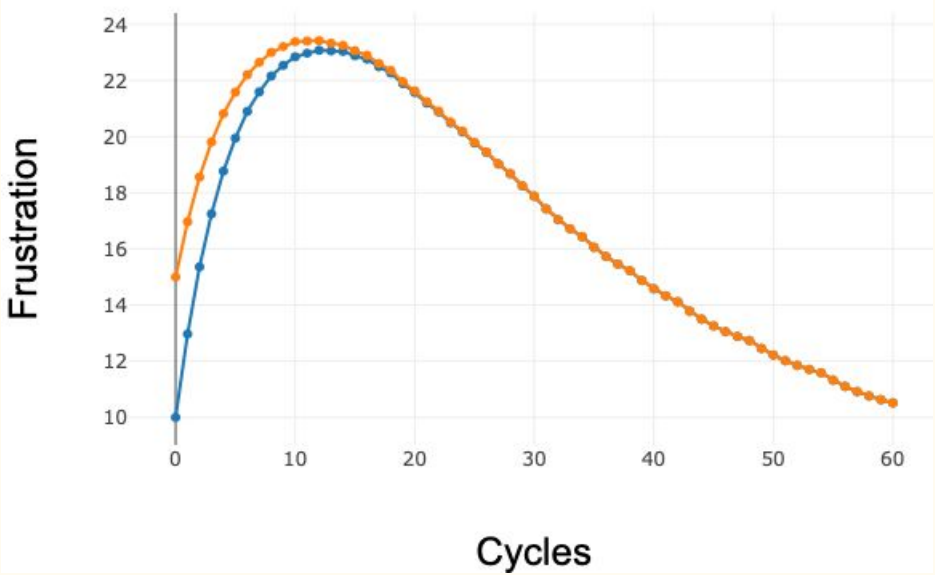
High task variety



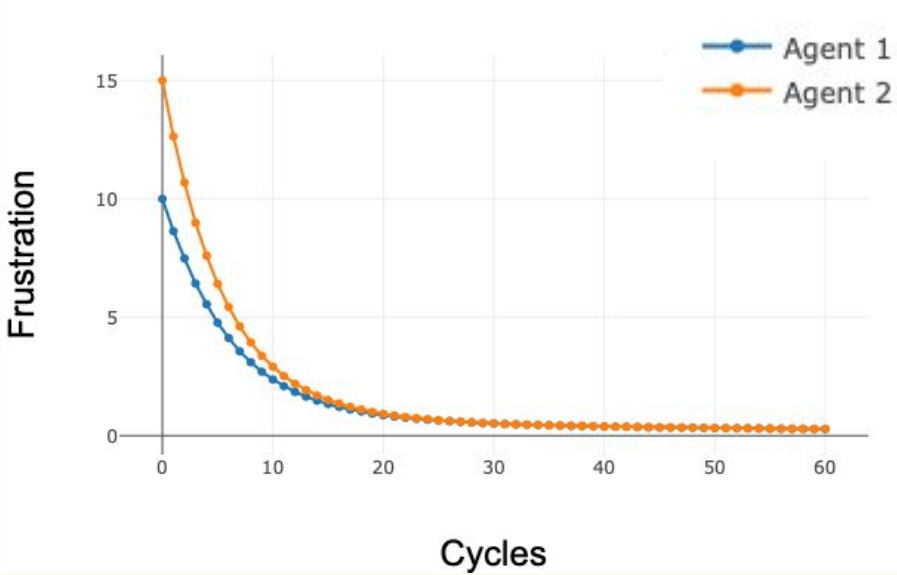


Experiment 2: frustration

Bad relationship



Good relationship



Specialization smooths out conflicts...

Specialization smooths out conflicts...

... if there is a ‘routine’

Conclusions

Conclusions

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

Absence of randomness

No data to tune parameters

No complex tasks and dependencies

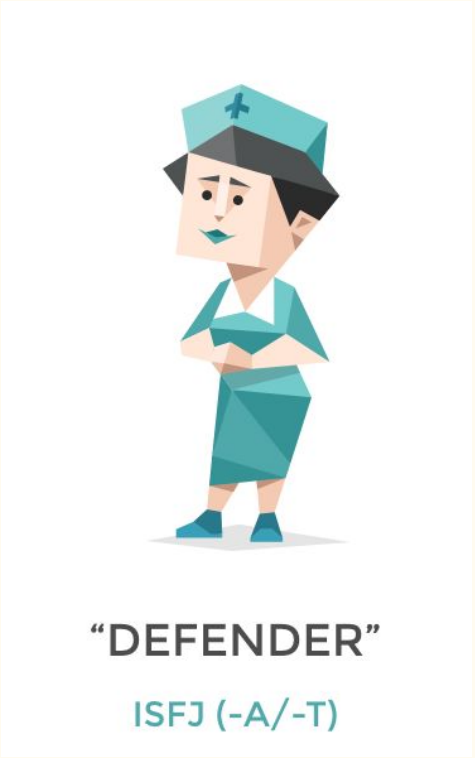
Future Work

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

Thank you.



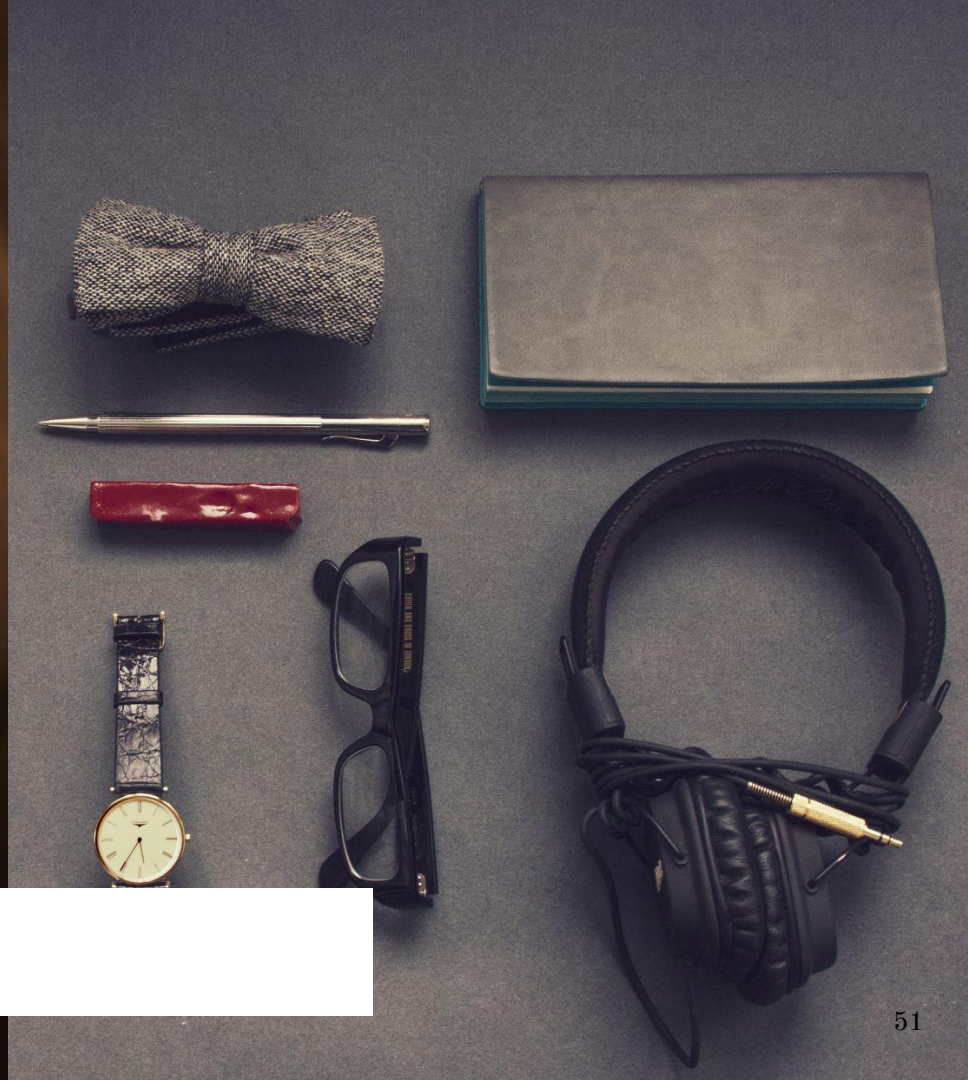
0.67

Material

Lo tienes todo en casa

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

P



Experiment