AI and Learning

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AI and Learning

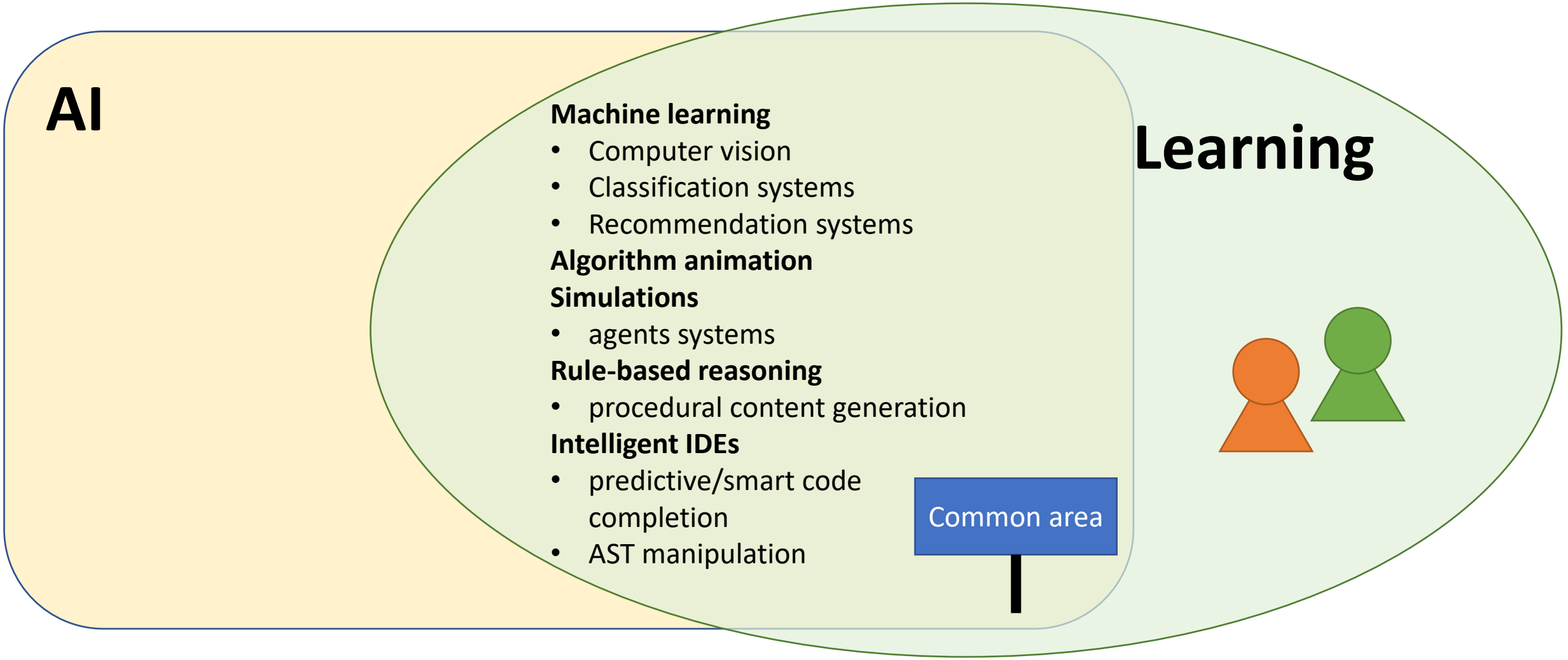
AI

Learning

CT

Programming

AI and Learning



AI and Learning – Defining the Field

AI the Next Big Thing waiting to revolutionise learning

- Luckin and Cukurova – 2019 - Increasing evidence showing that *AI works* when well-designed to support education - focus on contextual factors
- Advocating for inter-stakeholder interdisciplinary partnership between educators and developers

  Similar approach for e-learning It-Takes-Three (Marchetti and Valente 2016)
- Sciences - as interdisciplinary subject suitable to explore the role of AI in education – covering: natural sciences, computer science, psychology, sociology, education and cognition (Luckin and Cukurova 2019)
- Computational Thinking - a suitable interdisciplinary subject too (Tedre and Denning 2016, Wing 2006)

AI and Learning – which role(s)for AI?

Typical applications focus on:

- Anthropomorphism – Natural language processing - Simulating human behaviour - AI software or embedded in robotic artefacts
- Data and analytics – processing analytics and automatic content generation
- Ethics – AI as transformative force able to radically change education – implications and guidelines

AI and Learning – which role(s)for AI?

Anthropomorphism – AI in learning applications – recent proceedings from ACM Interaction Design for Children Conference:

- Tutor – Conversational history tutor for children (Mack et al 2019)
- Collaborator - *Human-in-the-loop* approach to an algorithm to enable pupils to solve the Rubik Cube to learn about algorithmic problem solving (Agostinelli et al 2020) – Alexa as a Conversational agent – to influence students on how they anthropomorphise the computer and to develop a theory of mind relating to Alexa as a buddy (Van Brummelz, Tabunshchyk and Heng 2021)
- Parasocial relationship – AI as a character – concept from celebrity and SoMe studies (Gray, Reardon and Kotler 2017)

AI and Learning – which role(s)for AI?

Data Science & Analytics – AI used in relation to learning applications

- Automatic and personalisation – Assessment and automatic generation of learning content (Siemens 2013)
- Learning Analytics – Multimodal analytics using speech and face recognition (Crscenzi Lanna 2020)
- Interactive Learning Environment – Envisioning the learners as individual interacting in a AI learning environment (Cope et al 2020)

AI and Learning – which role(s)for AI?

AI & Ethics in learning – AI seen as a transformative force with the potential of radically changing the learning landscape – AI versus teachers

- Interactive Learning Environment – Teachers – implications of anthropomorfism in learning - AI with the power of transforming learning, but will never replace teachers – make education more human not the opposite (Cope et al 2020)
- Ethical Guidelines – for the use and design of AI for learning (Jobin et al 2019, Hagendorff 2020, Borenstein and Howard 2021)
- AI to learn about AI – introducing critical perspectives on AI (Charisi et al 2020) through Co-design (Mack et al 2019, Buckingham Shum et al 2019)

AI and Learning – our perspective

Dominant approaches

- Litteral – approach to the affordances of the technology
- Limiting – towards exploring other possible roles and functions of AI

Is there more to it?

- AI as a rich laboratory-simulation tool – magnifier-translator of meaning:
- Mediational mean-translator – tools - Latour 2005
- AI for simulation - reproducing systems and phenomena – Simon 1968
- Hermeneutic Mean – Tomkins and Etough 2018

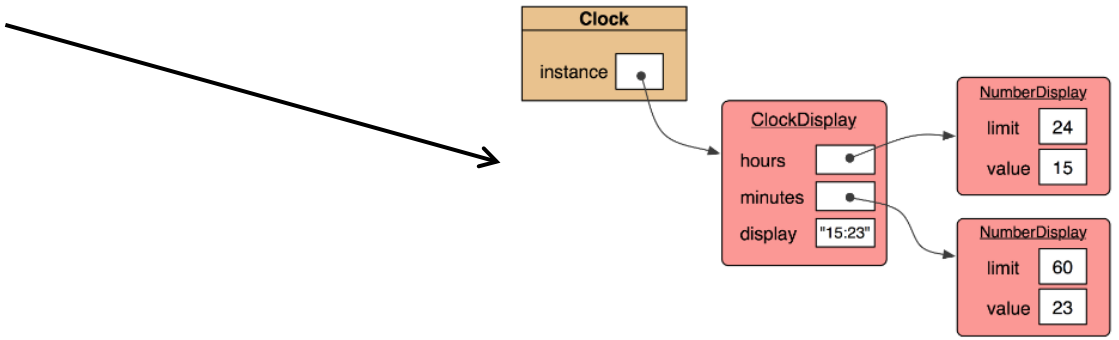
AI and Learning – Three care studies

Exemples of our approach through 3 case studies

- Medialib – AI applied to a tool for CT
- MicroCulture – AI applied to learning of history in museums
- Storymatching – AI applied to learning of screen writing

AI support for **students** and **teachers**, in CT

1. How can AI assist/support NOMs for learning CT and programming, in editors?
   - "notional machine" is an **abstract computer** *(or rules)* for executing programs **(Sorva)**
   - AI could assist generation/customization of **NOM-based visualization** of code execution **(*)**
     The Notional Machine here visualizes objects



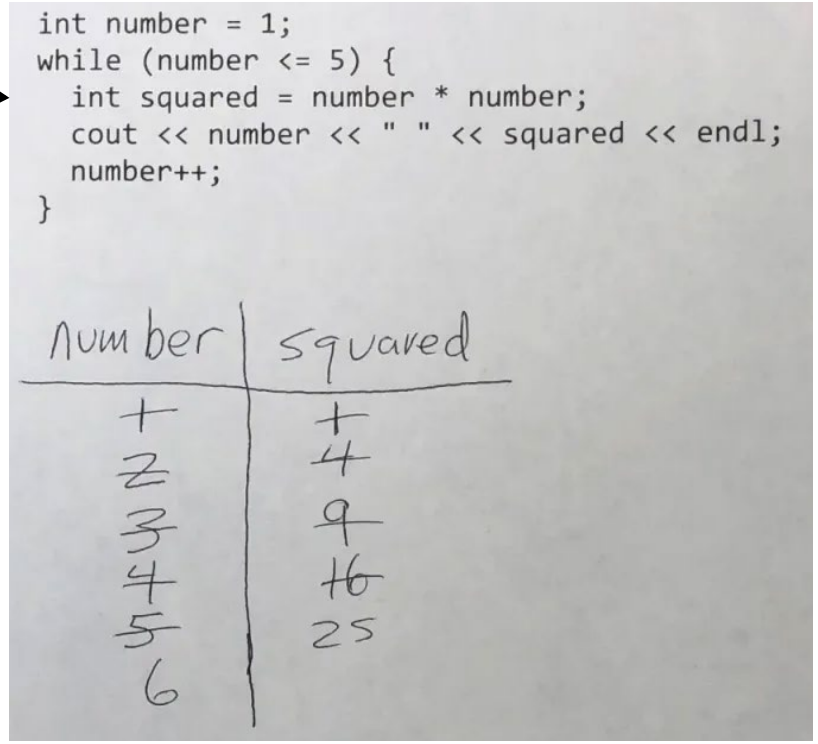
   - Domain: Algorithm visualization/animation
   - Existing examples: **Jeliot** http://cs.joensuu.fi/jeliot/files/jeliotSimple.avi and **Bluej** (for Java), **Python tutor** for JS https://pythontutor.com/live.html#mode=edit
     -> **limits:** hardcoded AKA not easy to change, bad scaling to more complex programs, no support for new commands/libraries

(*) BlueJ and NoMs - https://www.researchgate.net/profile/Michael-Koelling-2/publication/266657026_The_state_of_play_A_notional_machine_for_learning_programming/links/548f1a200cf214269f263619/The-state-of-play-A-notional-machine-for-learning-programming.pdf

AI support for **students** and **teachers**, in CT

2. AI to assist generation or variation of programming exercises of similar "level of complexity"

Classic example: "given a few lines of code in C, the student has to evaluate what is the final value of the variables in the code" …
AKA tracing a program's execution



Surprisingly:

- more research on math exercises than on programming exercises
- easier to find papers about "procedurally generated" contents than papers about AI helping teachers to create variations from pool of exercises

How to define **that** and what could the **interplay** be between teacher(s) and AI?

- **Possible scenario:** teacher defines a programming task using or declaring some categories that are present in a programming exercise, then the AI generates variations (perhaps using refactoring-like methods)
- For example, the AI could produce mutations to a given **AST**, attempting to minimize a certain cost or distance functions

Abstract Syntax Tree (short)

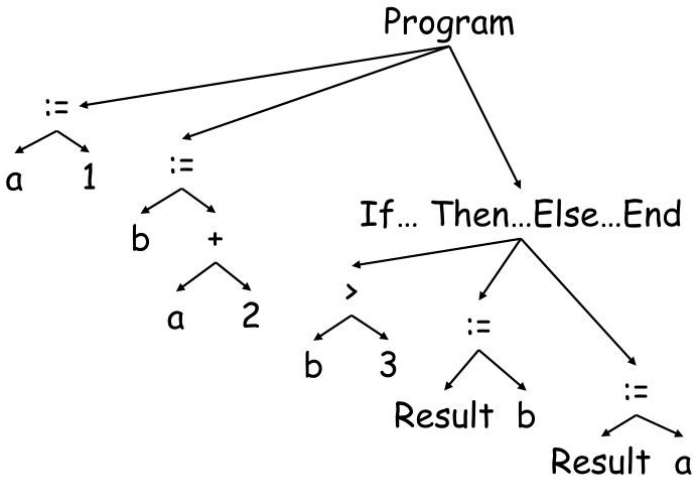
DEF: a **tree** representation of the **abstract syntactic structure** of code.
Each node of the tree denotes a construct of the code

- "Abstract"? -> it represents the relations among constructs, not their concrete syntax
- **Advantage:** programs written in different languages, or styles, could have the same AST
- "Clever" changes to parts of an AST can easily result in a new AST, i.e. new working program, with certain relation to the original program
  -> a kind of *distance* between programs

code

```
a := 1
b := a + 2
if (b > 3) then
        Result := b
else
        Result := a
end
```

AST



Can **we** make **AI** simpler/easier for novice programmers?

How to **empower** learners (beginners) to write **interesting/stimulating programs** with little and simple code?

- We did it in the Medialib project:
  - using media programming to support learning of programming
  - define an imperative, sequential **fragment** of Python then **extend** it with synchronous media commands -> **supporting a minimal NoM, for beginners**

- Partners – SDU, University of Kyushu in Fukuoka, Durham University in England
  - deployed in “intro to programming” courses in JP and UK,
  - digital media course in DK
  - tested since 2018 on multiple platforms (PC, Mac and Jupyter notebooks)

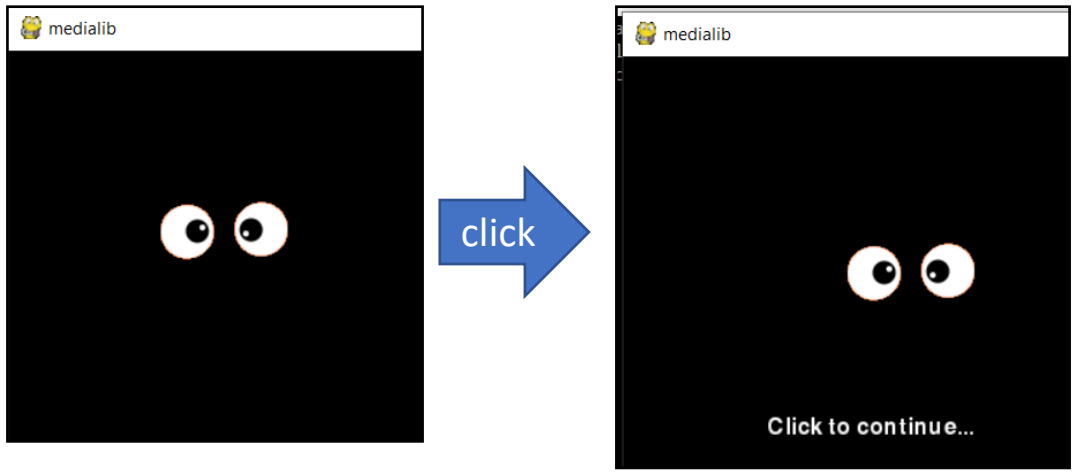
Medialib example code

```
## the following line is just MAGIC ##########################
## we need it to be able to draw images on the screen ########
from medialib import *
############################################################

draw("eye.png",100,100)
draw("eye2.png",150,100)
print("Click the left button on the mouse to continue...")
wait_mouse_press()

clear()
draw("eye.png",100+50,100+25)
draw("eye2.png",150+50,100+25)
text("Click to continue...",100,250,16)
wait_mouse_press()
print("done")

all_done() # always the last instruction of the program
```

Our approach with the Medialib is related also to **Task-Specific programming languages** (TSPL)

Bonnie A. Nardi – "A Small Matter of Programming" in Perspectives on End User Computing-The MIT Press (1993)

Behavior



Same approach… to learn AI

<<Learn **about** AI>>

- In a recent paper we suggested that the same approach can be used to:
  - create a NoM for AI: support understanding in AI/programming beginners
  - and then a library that simplifies AI for beginners
- A possible **application domains** might be
  - procedural generation of text (probability- and rule-based)
  - generation of text from examples (perhaps via neural nets)
  - or generation of other contents like pictures, game maps, or audio/music
  - classification systems

Can **AI** make **things** simpler/easier for novice programmers?

<<Learn **with** AI>>

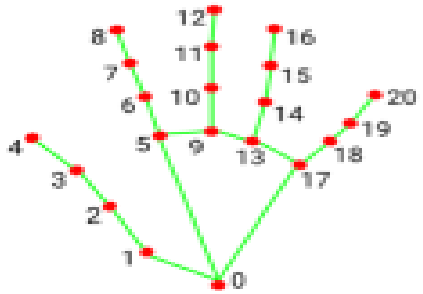
- **Back to our questions:**
  How to **empower** learners (beginners) to write **interesting/stimulating programs** with little and simple code?

- **Use existing AI/Machine learning tools:** take advantage of them when learning programming
  - simpleCV/openCV -> computer vision made simple
  - simpleAI -> AI made simple! (*classifiers* mostly)
  - **Google's MediaPipe library** (instead of hw, like a Kinect!) -> demo **next page**
  - machine learning library for p5.js: *ml5.js* https://thecodingtrain.com/learning/ml5/

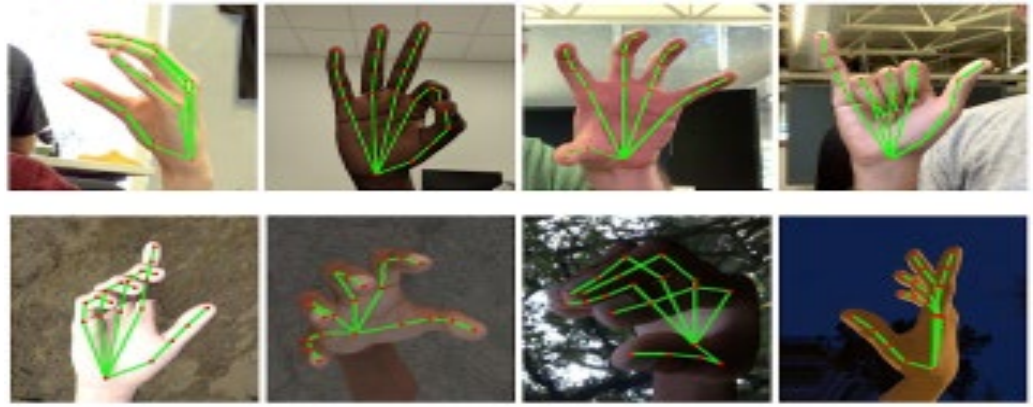
Google's "MediaPipe"

- https://google.github.io/mediapipe/solutions/hands
- How?

It uses "*machine learning (ML) to infer 21 3D landmarks of a hand from just a single frame*"



0. WRIST
1. THUMB_CMC
2. THUMB_MCP
3. THUMB_IP
4. THUMB_TIP
5. INDEX_FINGER_MCP
6. INDEX_FINGER_PIP
7. INDEX_FINGER_DIP
8. INDEX_FINGER_TIP
9. MIDDLE_FINGER_MCP
10. MIDDLE_FINGER_PIP
11. MIDDLE_FINGER_DIP
12. MIDDLE_FINGER_TIP
13. RING_FINGER_MCP
14. RING_FINGER_PIP
15. RING_FINGER_DIP
16. RING_FINGER_TIP
17. PINKY_MCP
18. PINKY_PIP
19. PINKY_DIP
20. PINKY_TIP



- In JS… on your phone?!
- Demo: https://codepen.io/andrea270872/pen/QWGJyEp
  offline: burstBubbleFingerTip.html

Agent systems: MicroCulture

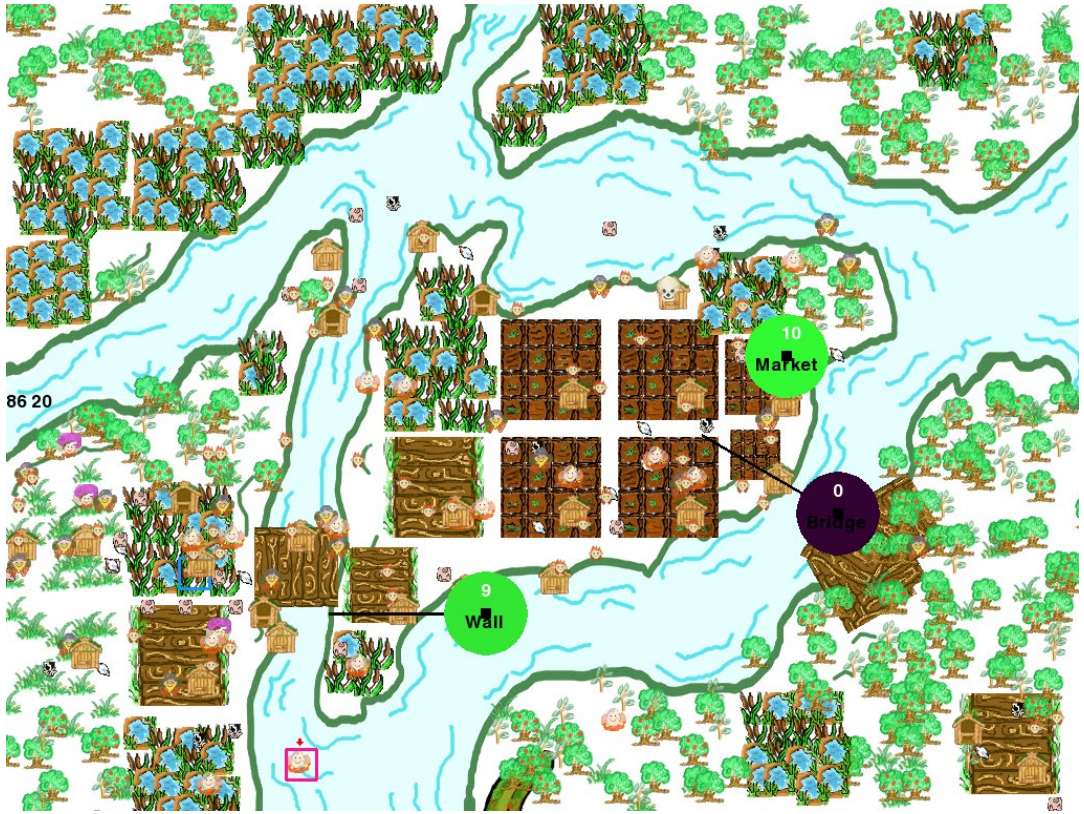
- AI as amplification of cause-effect in rule-based reasoning
- History as a target subject – urban development at the time of Harald Bluetooth in Denmark – Ribe
- Goal – to enrich children's experience of guided tours
- Co-design process with 25 children 8 to 10 years old from Oksbøl and 2 guides from Ribes Vikinger

Agent systems - MicroCulture

Table-top interactive simulation of the foundation of Ribe

Reactivision - markers tracking system – each marker represented an infrastructure from Harald Bluetooth's time:

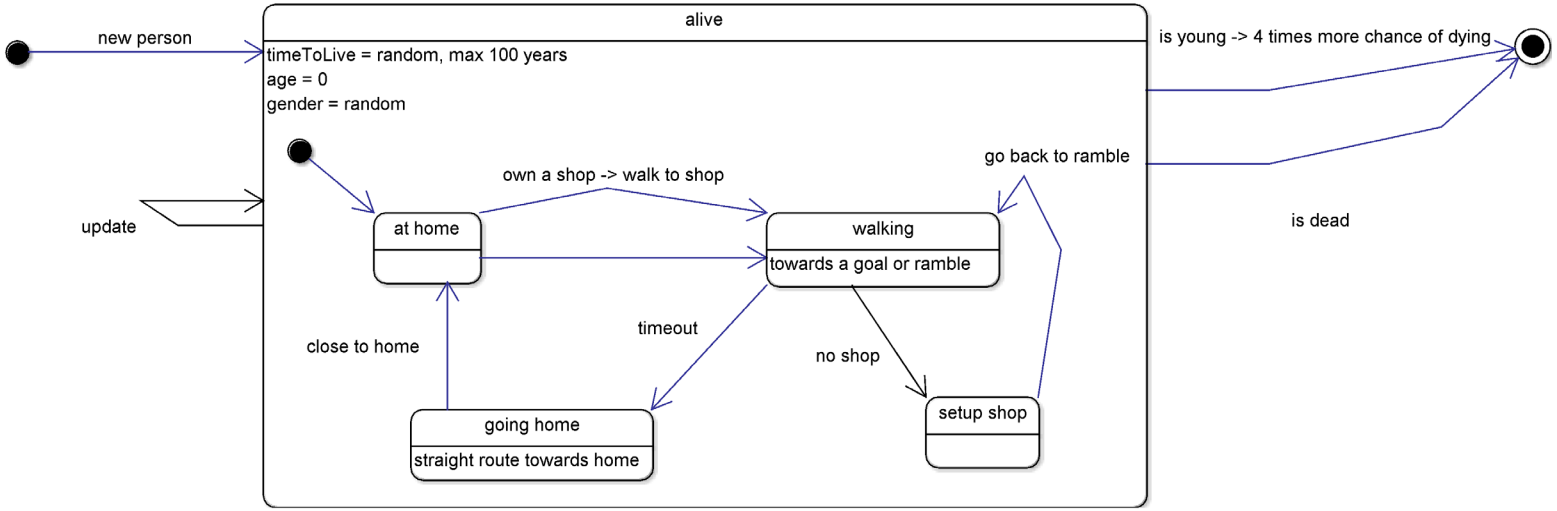
- Section of round rampart,
- Wooden paved street,
- Wooden bridges,
- Market partition for merchants



Agent systems: MicroCulture

Agent-based simulated population

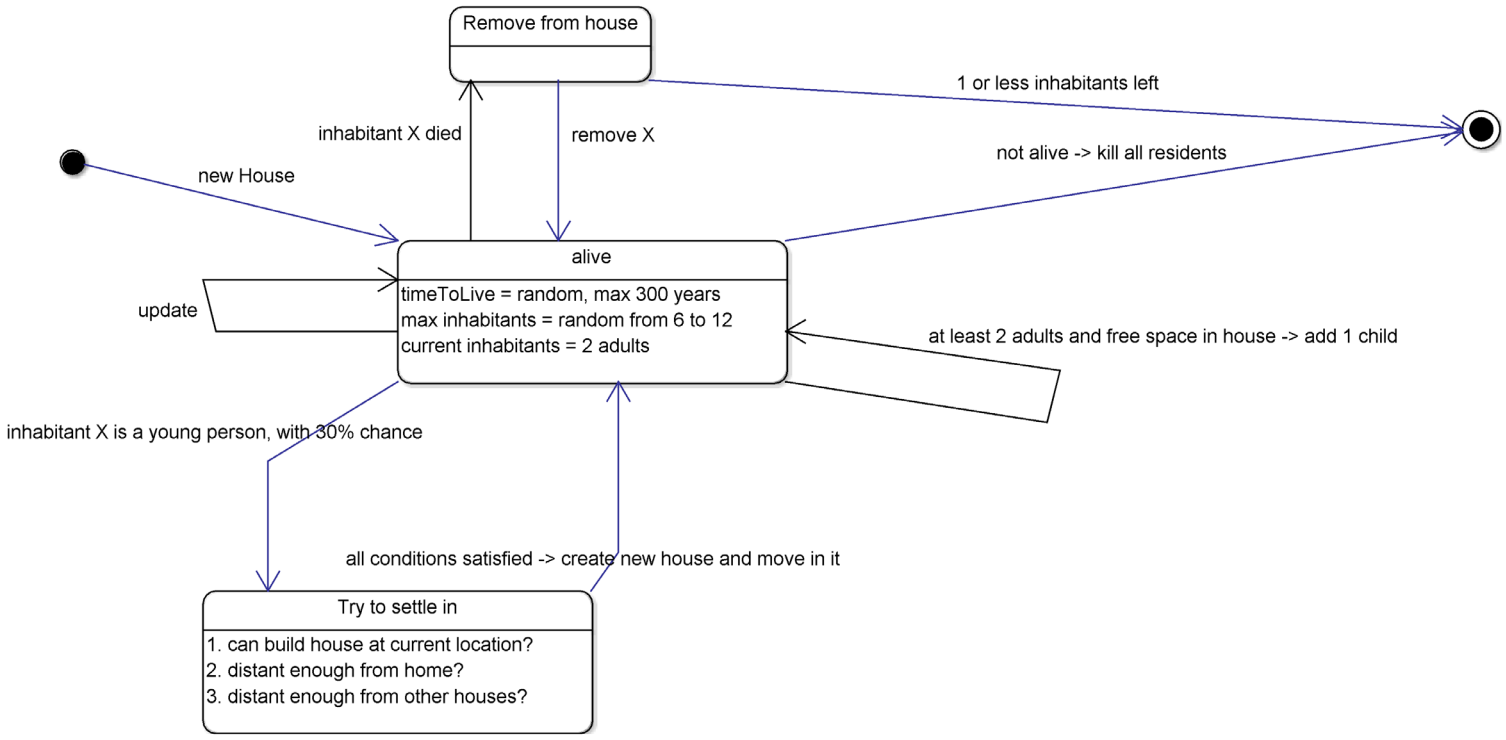
- Generated random – gender and age
- Living cycle – birth, adulthood, old age, dead
- Children can normally see the head of the character – metaphor for kings - peasants power relationship
- When they place infrastructures the farmers lift their head at look at the players – metaphor for territorial dialogue between kings and peasants



Agent systems and history: MicroCulture

AI in MicroCulture - Agent-based simulated population:

- Impact of infrastructures placement from the king to the peasants
- The more infrastructures the more inhabitants would build their houses
- Simulation of Jutland Wandering Villages (Stouman 1980, Marchetti 2004) – adults tended to build their houses a bit away from their parents' house



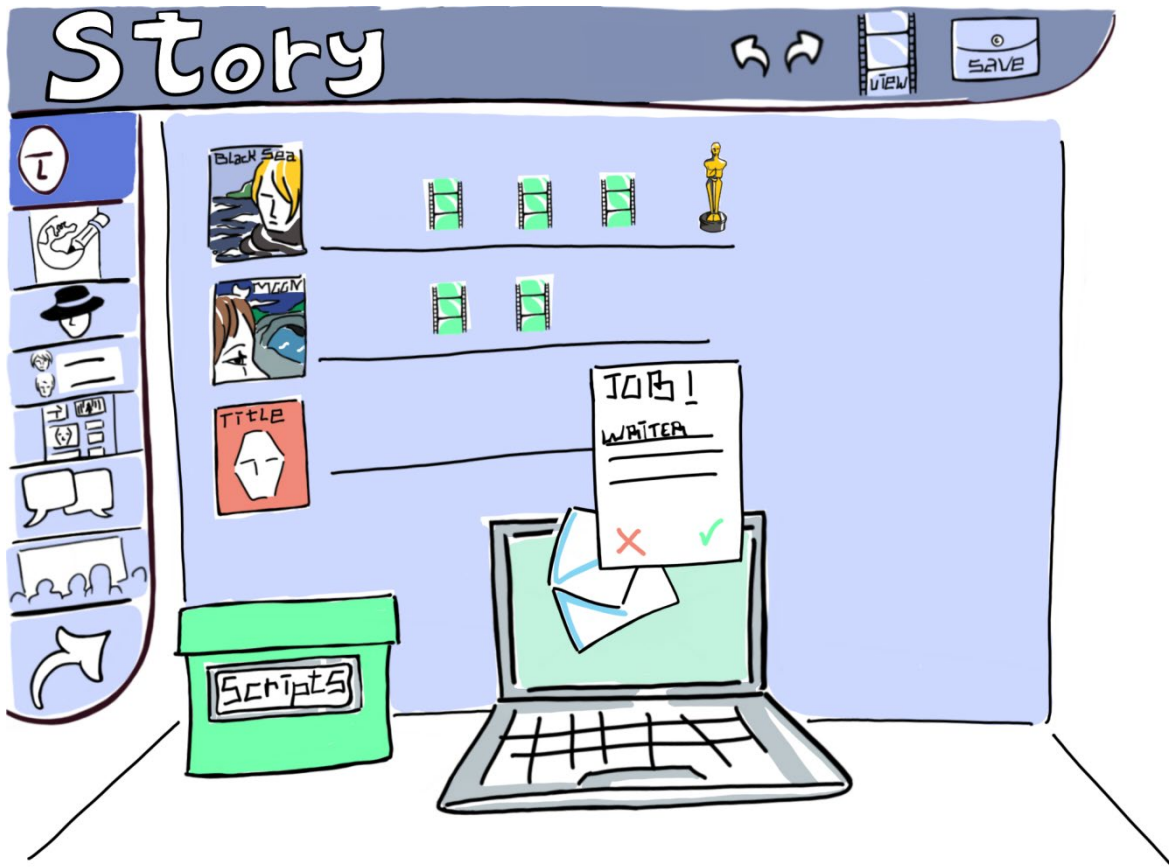
AI and Creativity – The Storymatching case

AI as creative tool – early-stage project, focus on screen writing students ad young writers

Goal - to support students and newly graduates to gater a scripts portfolio, supporting the creative methodology they learn during their education

Partners – SDU, Høgskole i Innlandet (Lillehammer), University College Lillebælt, Media City Odense

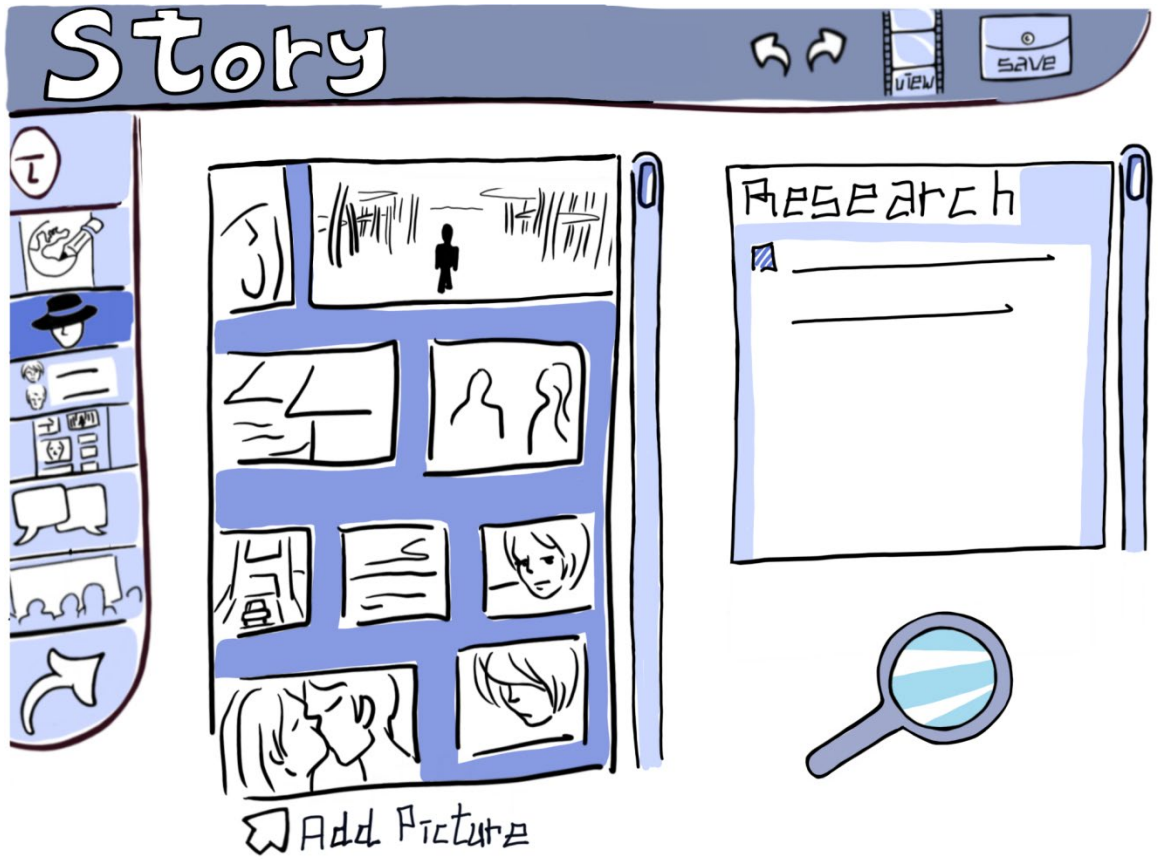
Principal investigator - Associate Professor Heidi Philipsen from Media Studies



AI and Creativity – The Storymatching case

Supporting students to going through the early stages of their methodology:

1. Finding visual materials and making moodboards
2. World building
3. Character building
4. Storyboarding
5. Scenes and Dialogues



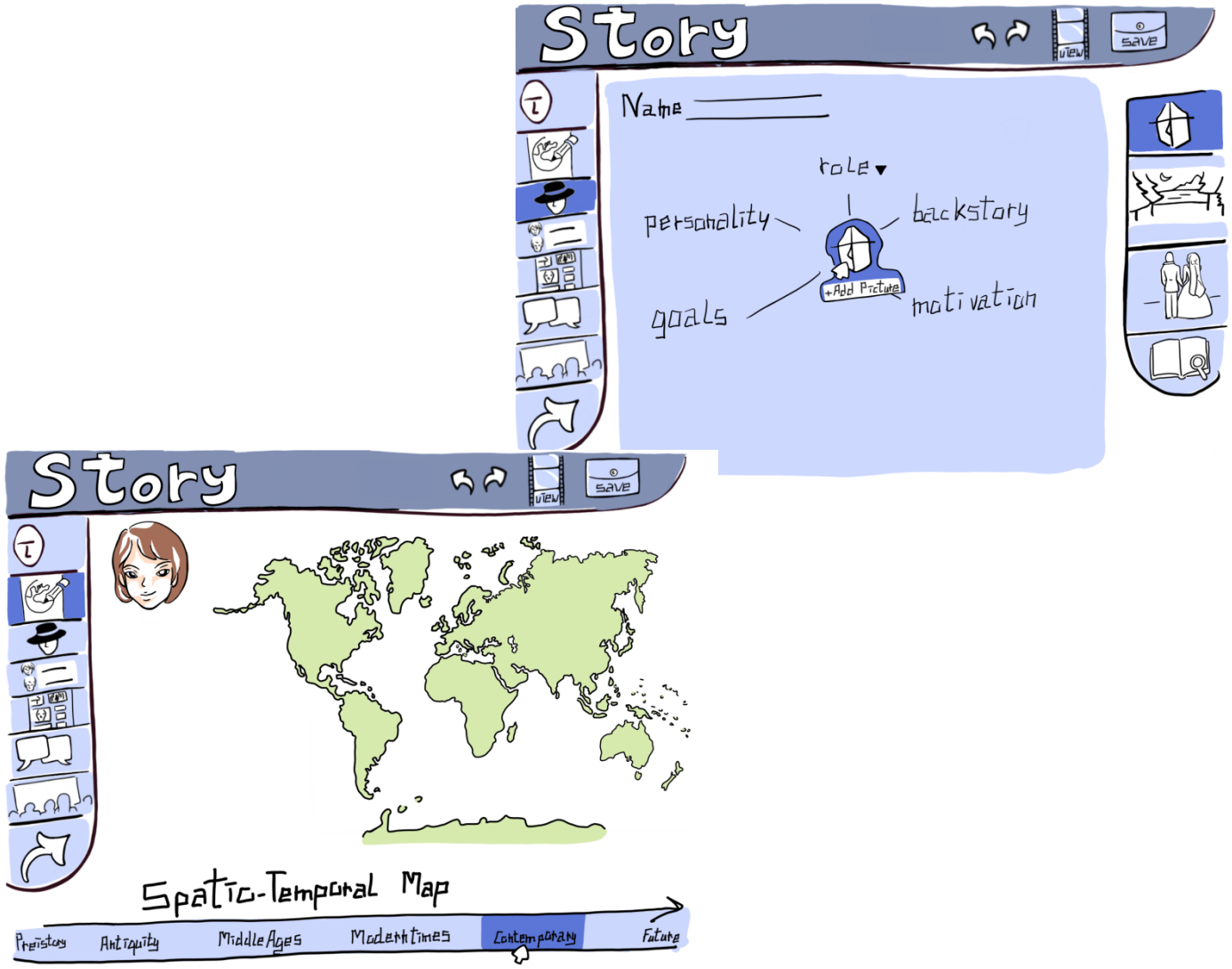
Storymatching aims at supporting - management of visual material, while focusing on their writing and following their methodology

Forgiving approach – the writers decide the level of details

AI and Creativity – The Storymatching case

AI role in Storymatching – introducing iterative prototyping in screenplay writing

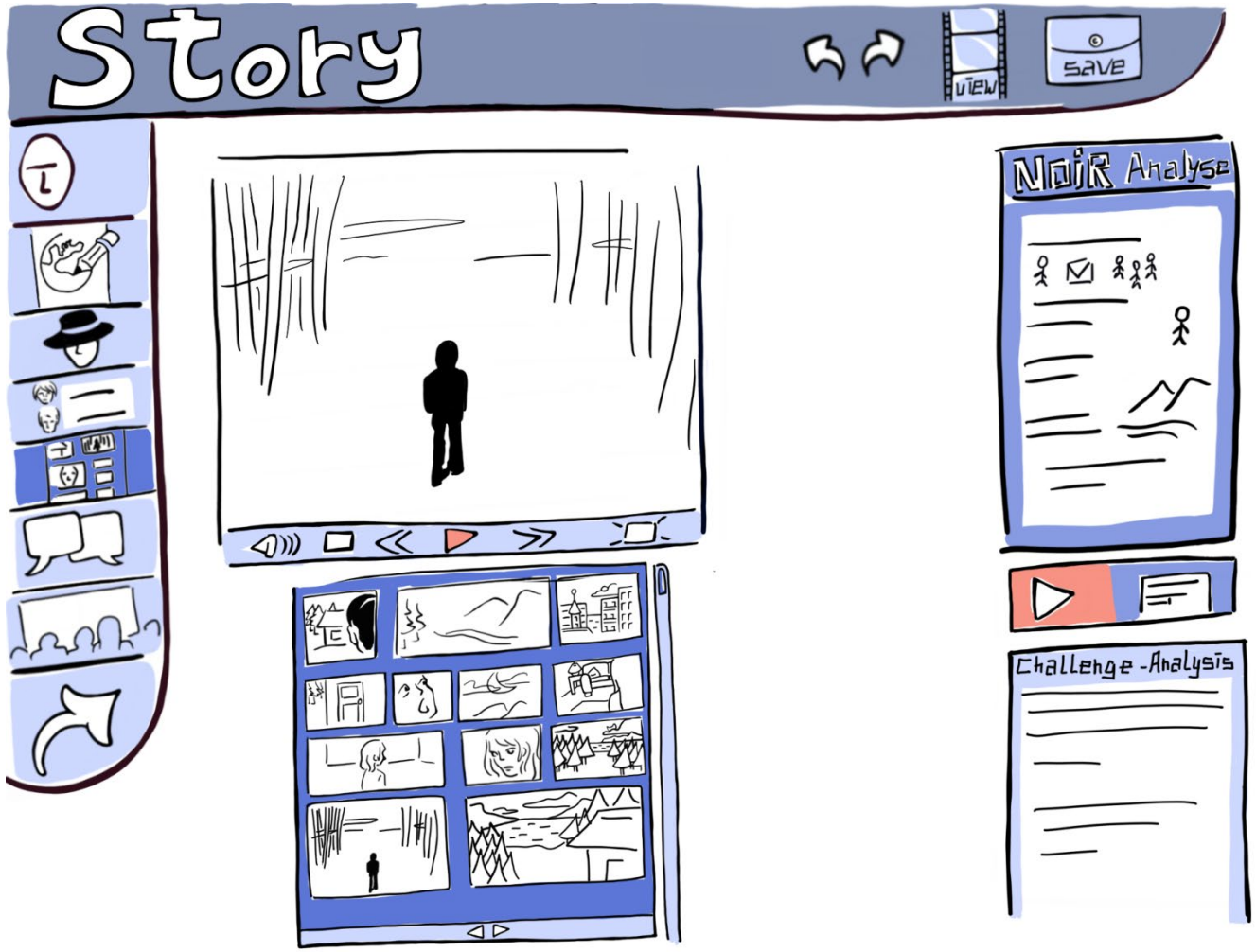
- Generation of an interactive Storyboard through algorithms re-assembling
  - The visual material gathered by the writers
  - The Worldbuilding
  - The definition of the characters
- The interactive storyboarding could be edited with re-uploading and editing the assembled material, eventually directly
- Generation of a possible draft – synopsis that can be freely edited



AI and Creativity – The Storymatching case

- AI as simulative-creative tool – helping writers to visualise and concretely reflect on their concept through a film simulation – Simon 1968

- A film mockup - that could contribute to the writers' portfolio and could communicate more effectively the writers' vision to potential collaborators or sponsors
  (as we did in **F4BL3S** http://www.andval.net/f4bl3s_v0_4_4/index.html)



Summary & conclusion

Framing the role of AI in learning

What is the role of AI in learning?

Embedding AI in learning system = framing a role to AI in our practice

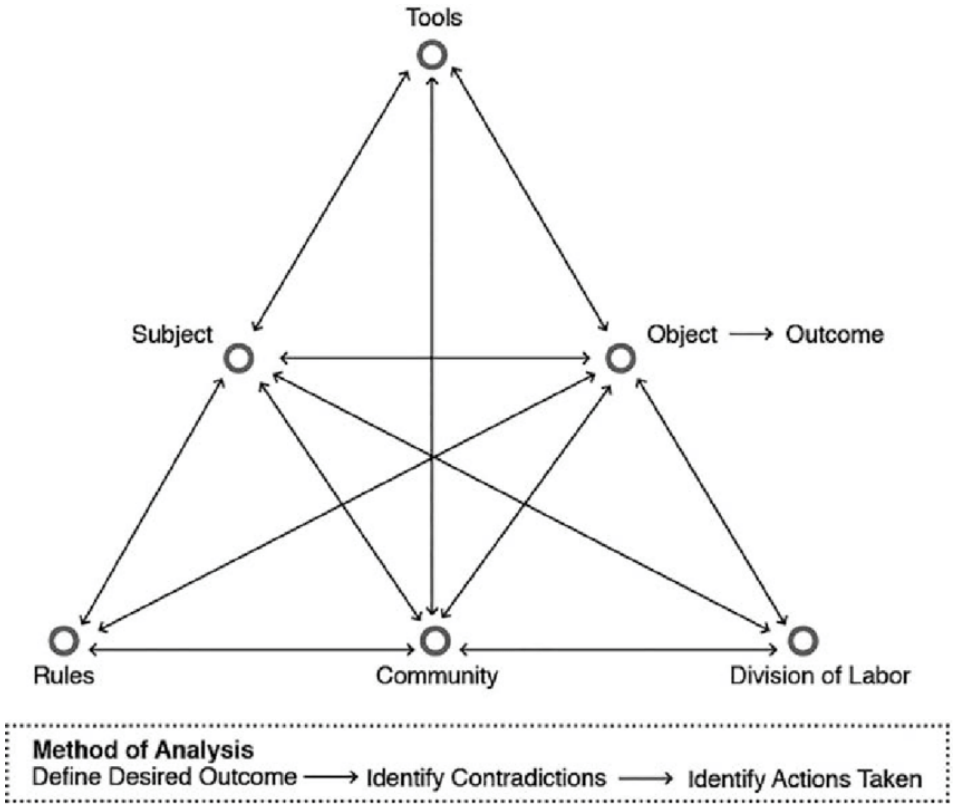
AI as a tool towards a goal

AI as Assistant and not competitor

- Support overview and reflection processes – as in Simon's (1968) approach to simulations – Medialib
  - Support critical experiments with algorithm and seeing the results
- Automatic generation of content based on users' input previous action
  - Storymatching script students upload visual material for inspiration and the system should
  - Teachers ganing new exercises for students

Framing the role of AI in learning

- AI should work on a different level than the users – enabling the users to focus on the part that requires their expertise – activity theory (Leontjev 1978, Engenström 1987)
- Imagine when you write and your orthographic corrector introduces more mistakes ;)
- Storymatching & MicroCulture – AI showing results of users' actions
  - AI reassemble students' material to generate a film mockup
  - AI shows results of territorial actions of kings on peasants
- AI acts not at the same time and not at the same task as the users – further investigation



Framing the role of AI in learning

Methodological implications - Participatory Design and User Centred Design

Luckin and Cukurova2019 - Starting from context and users Identifying opportunities for the users while gaining an understanding about which part of the practice matters for the users and where AI could provide assistance

Madsen 2017 – reaching balance between technology and professional intuition