Computational Thinking

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Centre Learn

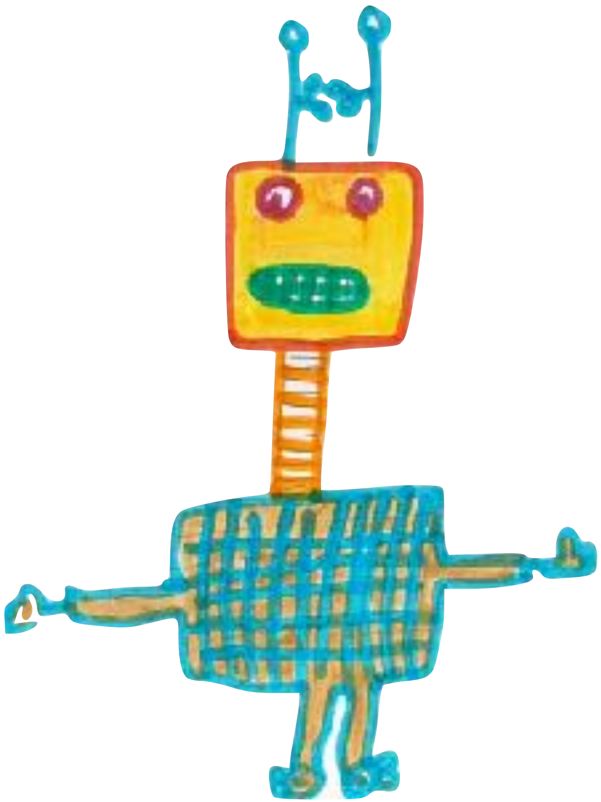
28 nov 2023

Agenda

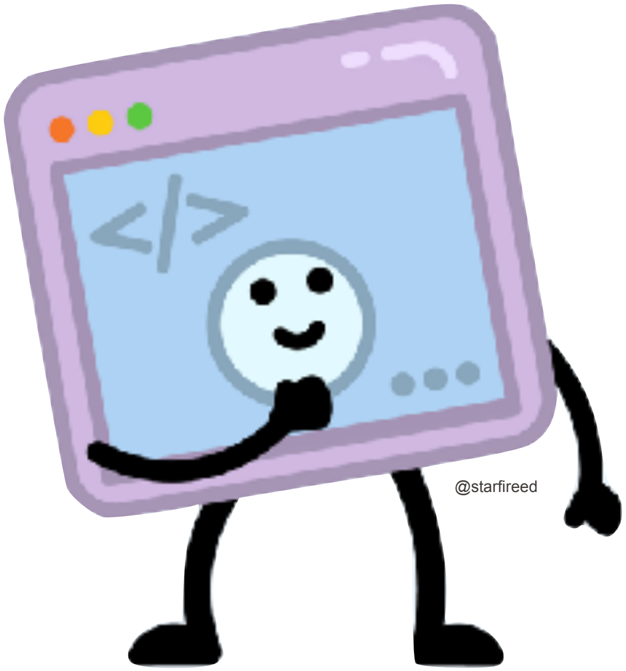
- 8:15 Computational Thinking : what and why
  - Définition
  - Integration
- 9:00 *Pause*
- 9:15 Teaching computational Thinking
  - Approach
  - Orchestration

Our path

- Primary school teacher
- Teacher trainers
- Edunum project coordination



- MSc in Computer Science
- Ph.D student at EPFL - ETH Joint Doctoral Program in Learning Sciences

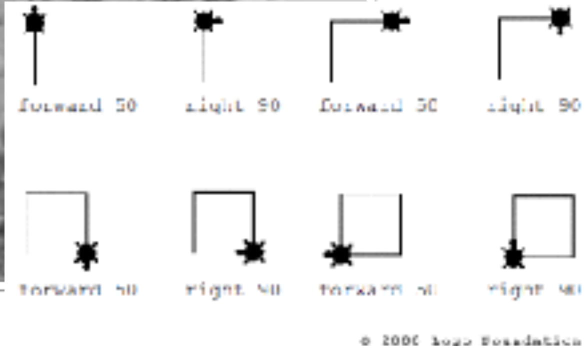


Define CT

Computational Thinking?

Saymour Papert - A statement

- The first to use the expression "*computational thinking*» in Mindstorm
- Inspired by Piaget's Constructivism theories, developed Constructionism
- Developed Logo



Computational Thinking?

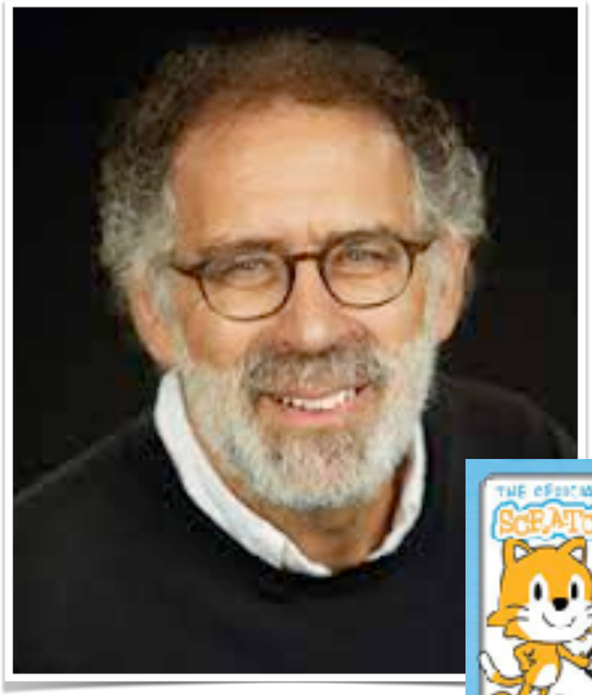
Jeannette Wing - A definition

- "The thought processes involved in **formulating** problems and their solutions, so that the solutions are **represented** in a form that can be effectively implemented by an information processing **agent**".

Computational Thinking

- https://www.cs.cmu.edu/~15110-s13/Wing06-ct.pdf

Computational Thinking?



M. Resnick - An observation

Presentation of a concrete framework including

- **concepts** (e.g. loop, variable),
- **practices** (e.g. debugging, iteration)
- **perspectives** (e.g. expression, questioning).

- https://www.sciencedirect.com/science/article/pii/S0360131522000021?via=ihub#bbib11

EPFL

Computational Thinking?

Micheal Lodi - An Implementation

General classification of elements :

- **Mental processes** (mental strategies useful for solving problems)
- **Methods** (operational approaches widely used by computer scientists)
- **Practices** (typically used in the implementation of solutions based on computing machines)
- **Cross-cutting skills** (general ways of seeing and operating in the world)

- https://ioinformatics.org/journal/v14_2020_113_132.pdf

CT's components

Méthode	Pratique	Processus mentaux	Compétences transversales
Automation	Experimenting	Algorithmic thinking	Design and Create
Data Collection	Iterating	Logical thinking	Communicate and collaborate
Analysis and Representation	Tinkering	Problem analysis	Reflect
Parallelization	Test and Debug	Problem decomposition	Learn
Modeling and Simulation	Reuse and Remix	Abstraction	Meta-reflect
Analysis and Evaluation		Pattern	Computational world
Programming		Generalization	Be tolerant for ambiguity
		Representation	Be persistent
		Representation	

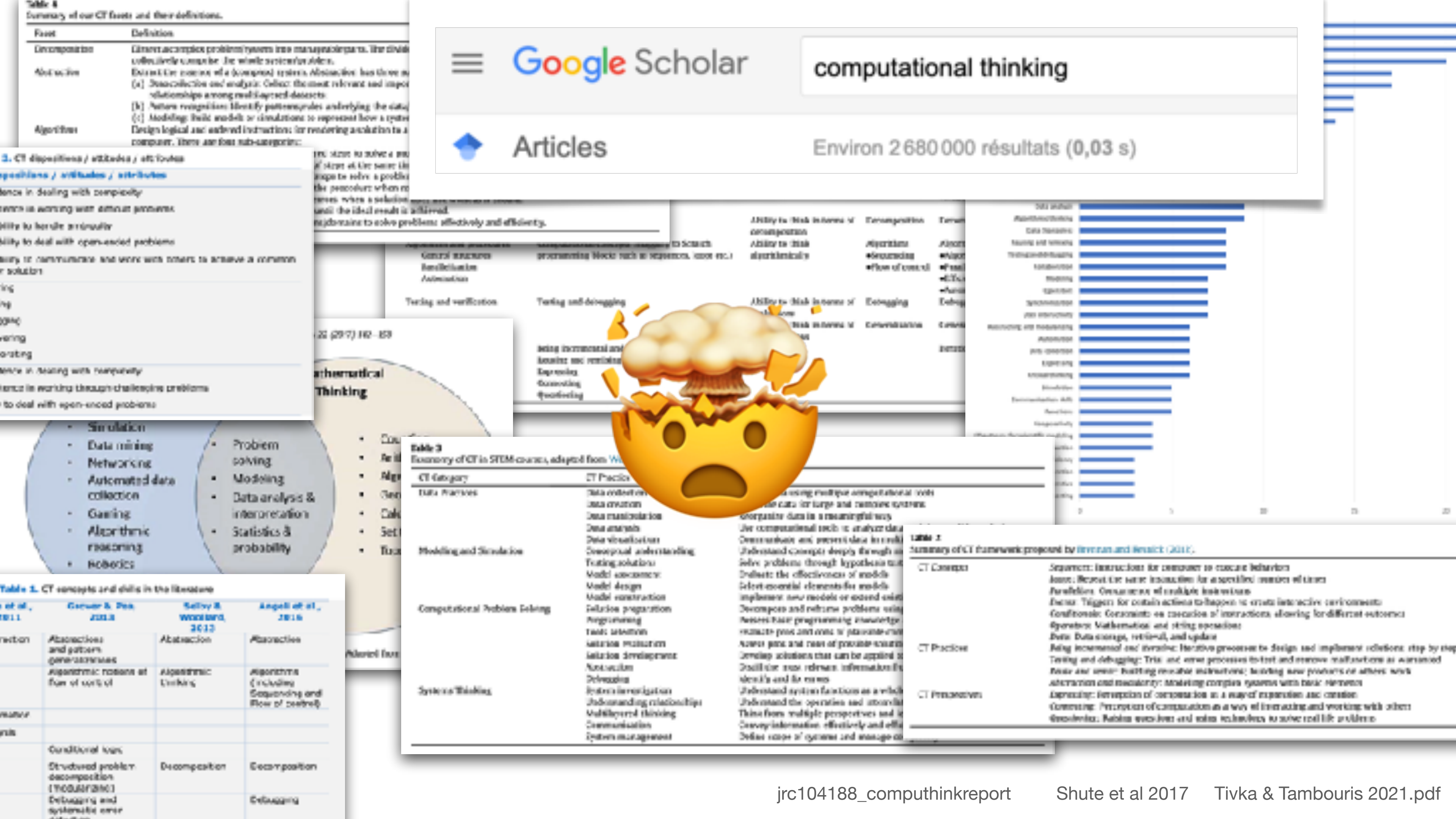
Lodi

Concept	Approche
Logic	Tinkering
Algorithm	Creativity
Decomposition	Debugg
Patterns	Perseverance
Evaluation	Collaboration
Abstraction	

Barefoot

Perspectives	Pratique	Concept
Expressing	Being incremental	Sequences
Connecting	Testing and debugging	Loops
Questioning	Reusing and remixing	Events
	Abstracting	Parallelism
	Modularizating	Conditionals
	Tester	Operators
	Affinage itératif	Data
		Automatisation
		Generalisation

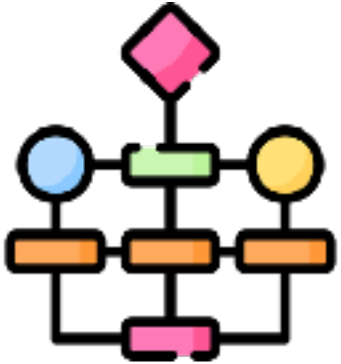
Resnick + Brennan



jrc104188_computhinkreport   Shute et al 2017   Tivka & Tambouris 2021.pdf

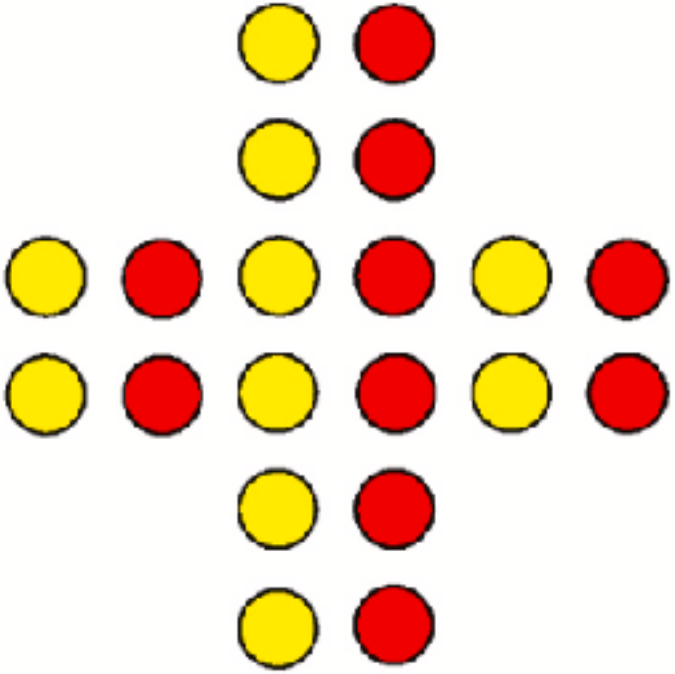
Defining a computational problem

Problem - Situation



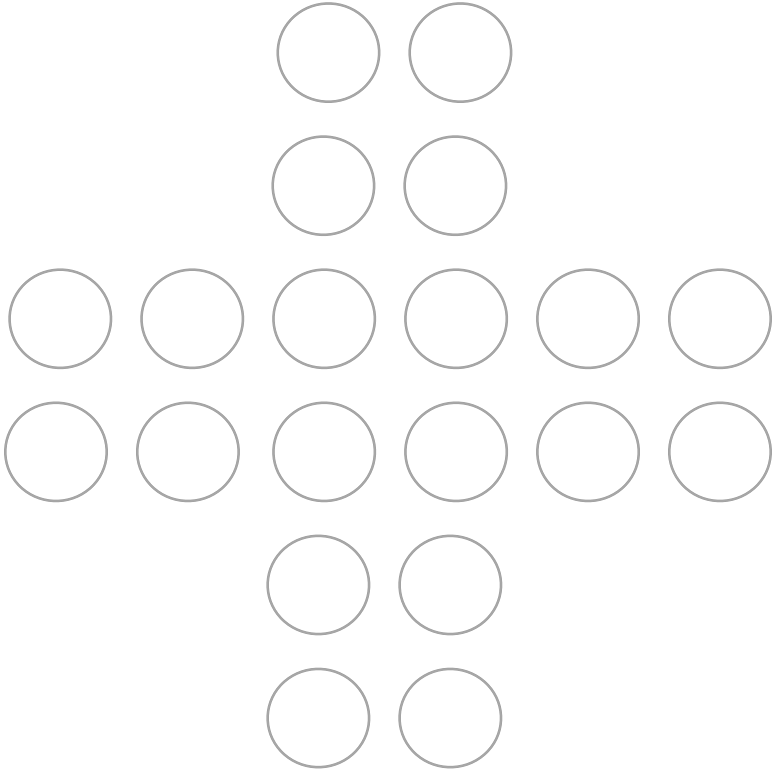
Algorithm

Agent

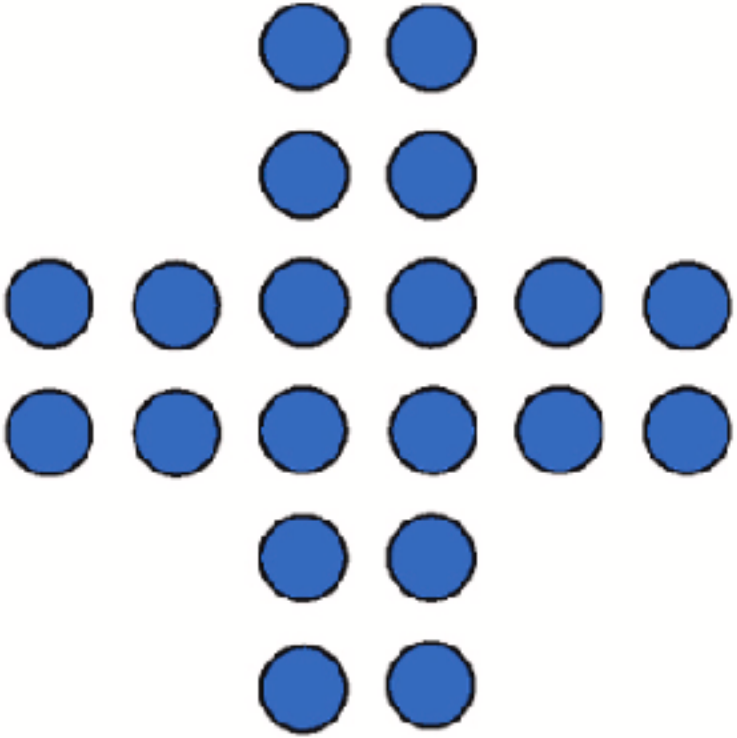


Identify CT

CT in Practice - Unplugged



CT in Practice - Unplugged



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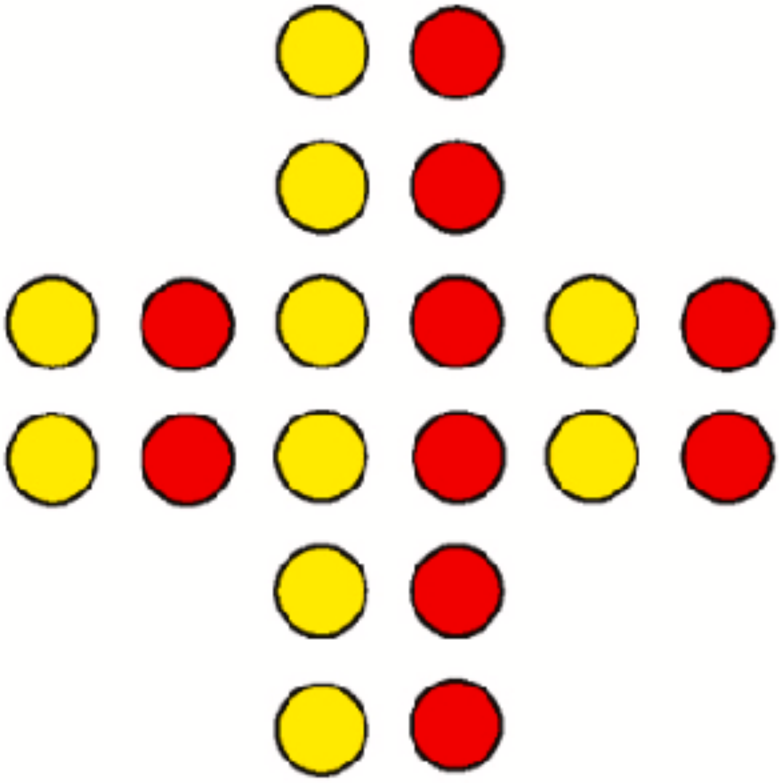

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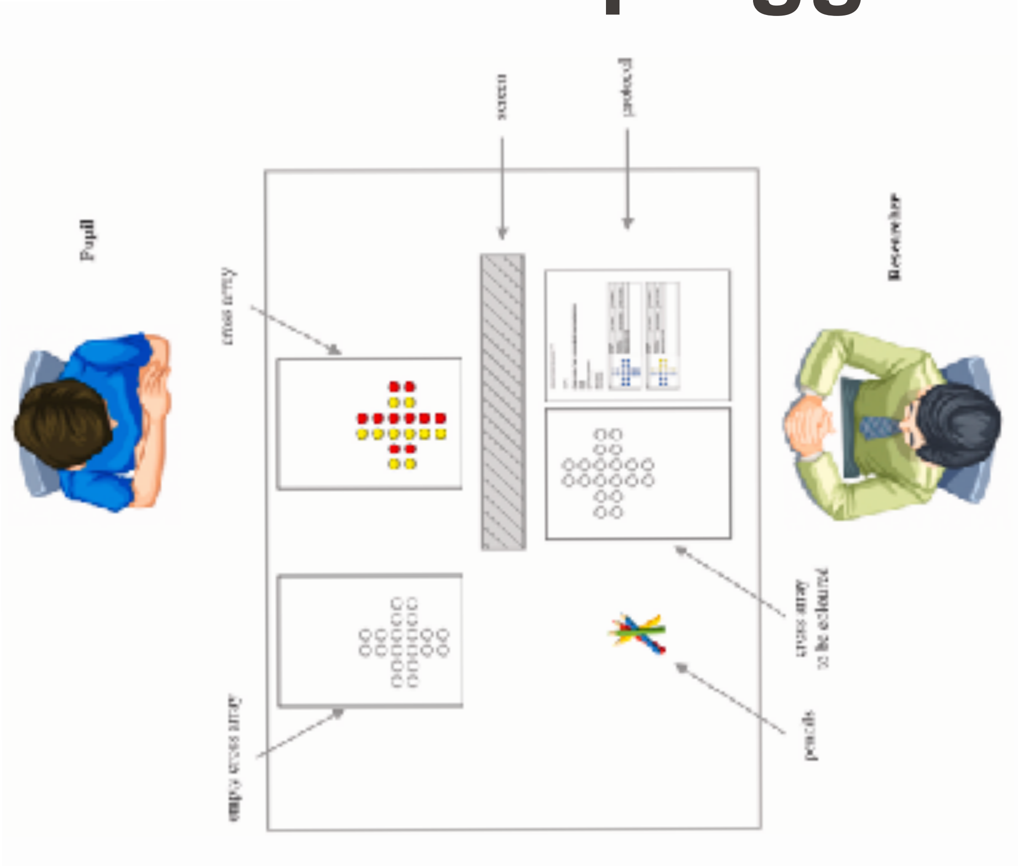
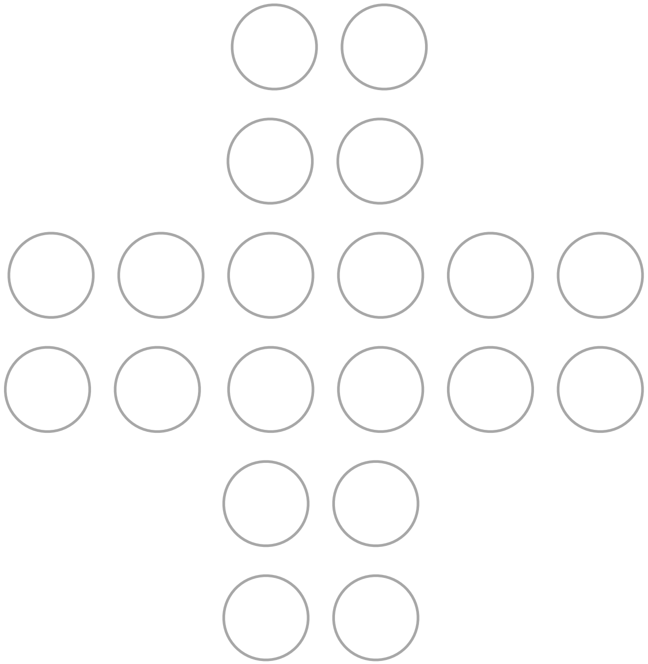


Experimental setting of the CAT

CT in Practice - Unplugged (by team)



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Resnick + Brennan

CT in Practice - Unplugged

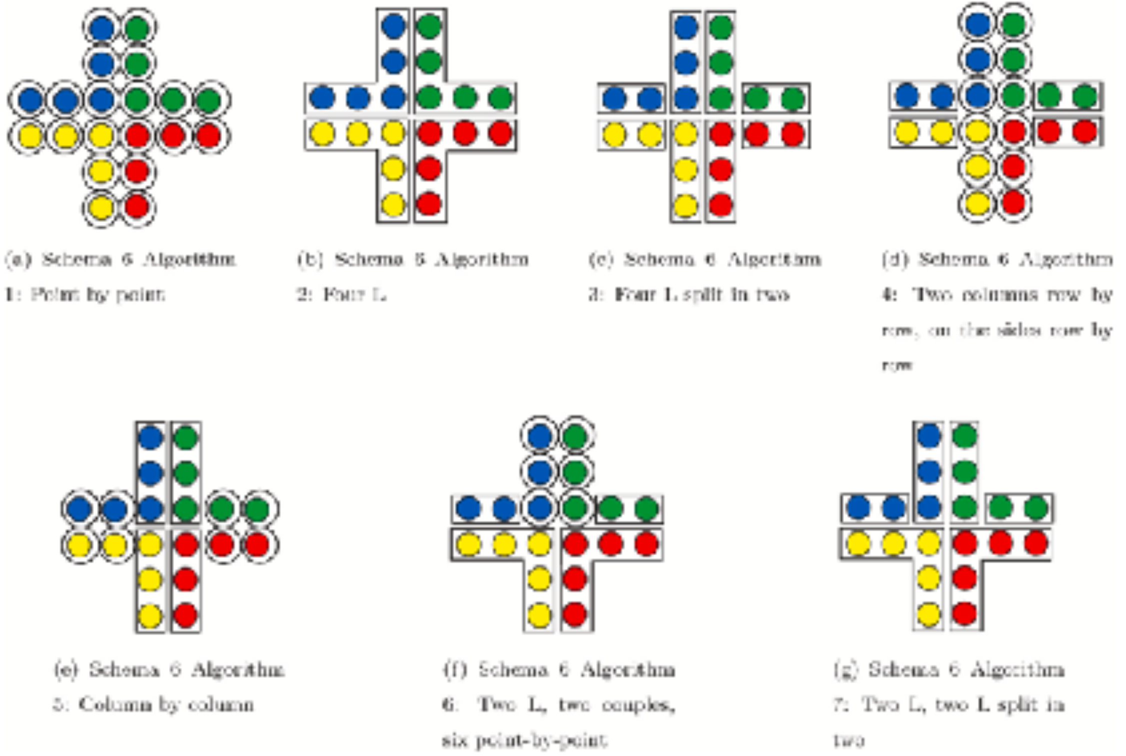

Fig. A.22. Algorithms that have been observed at least once for schema S6.

- In *The CT-cube: A framework for the design and the assessment of* computational thinking activities

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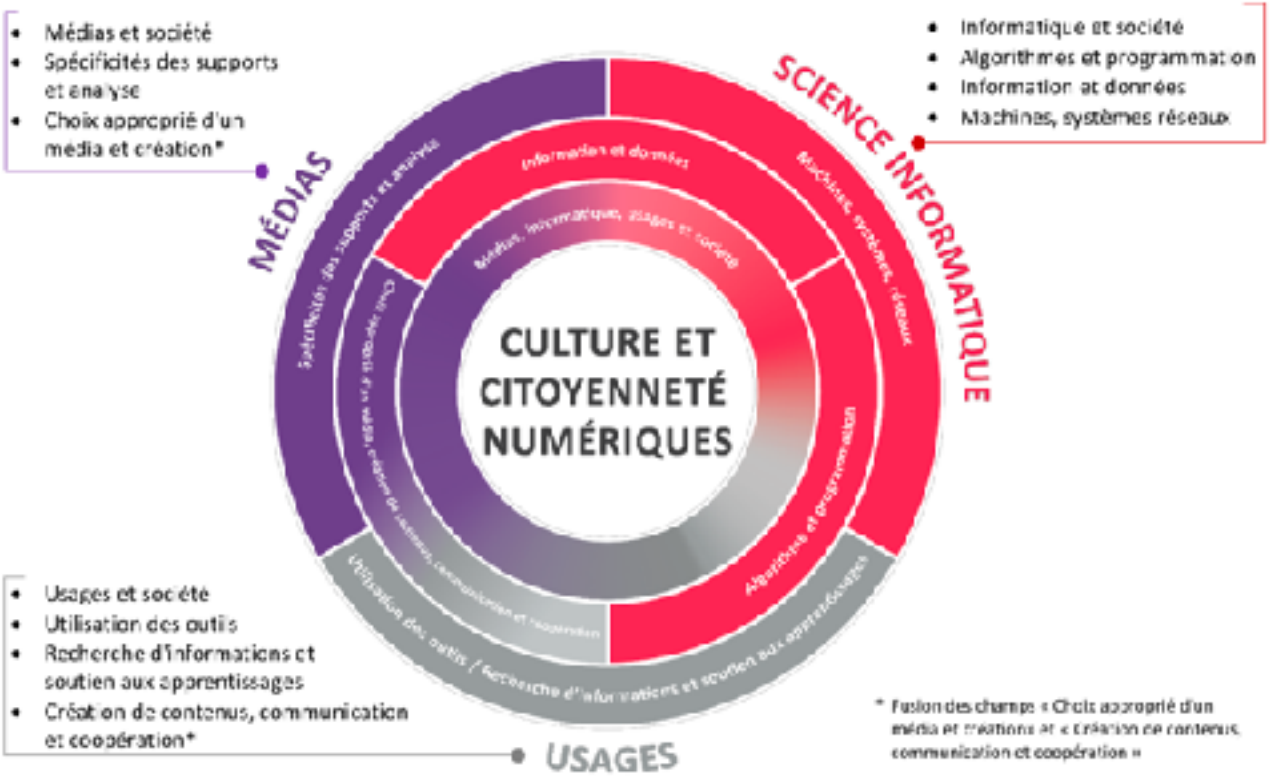
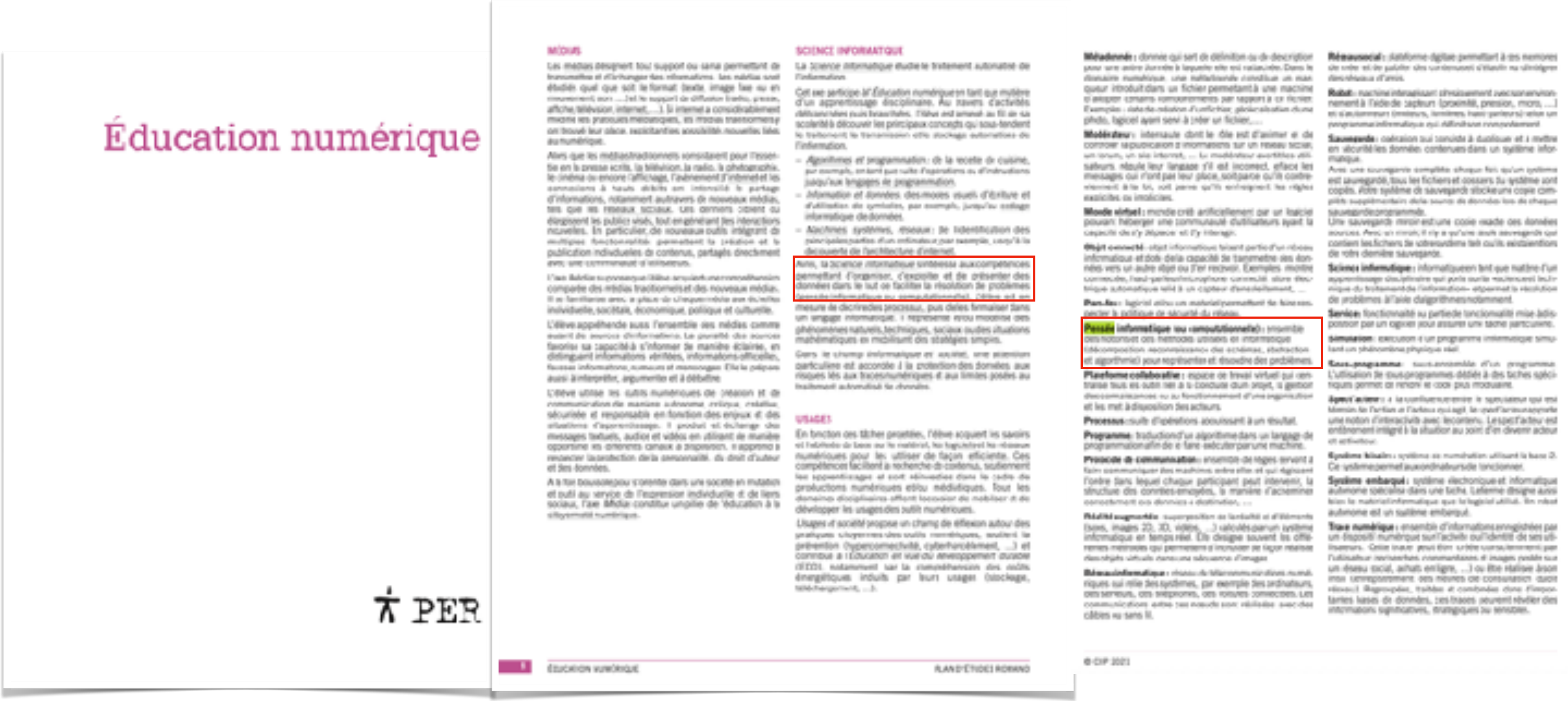
Resnick + Brennan

L’éducation numérique :
programme scolaire Suisse romande



Curriculum



MÉDIAS

Les médias désignent tout support ou canal permettant de transmettre et d'échanger des informations. Les médias sont étudiés quel que soit le format (texte, image fixe ou en mouvement, son, ...) et le support de diffusion (radio, presse, affiche, télévision, internet, ...). Si internet a considérablement modifié les pratiques médiatiques, les médias traditionnels y ont trouvé leur place, exploitant les possibilités nouvelles liées au numérique.

Alors que les médias traditionnels consistaient pour l'essentiel en la presse écrite, la télévision, la radio, la photographie, le cinéma ou encore l'affichage, l'avènement d'internet et les connexions à hauts débits ont intensifié le partage d'informations, notamment au travers de nouveaux médias, tels que les réseaux sociaux. Ces derniers ciblent ou élargissent les publics visés, tout en générant des interactions nouvelles. En particulier, de nouveaux outils intégrant de multiples fonctionnalités permettent la création et la publication individuelles de contenus, partagés directement avec une communauté d'utilisateurs.

L'axe *Médias* suppose que l'élève acquiert une compréhension comparée des médias traditionnels et des nouveaux médias. Il se familiarise avec la place de chaque média aux échelles individuelle, sociétale, économique, politique et culturelle.

L'élève appréhende aussi l'ensemble des médias comme autant de sources d'informations. La pluralité des sources favorise sa capacité à s'informer de manière éclairée, en distinguant informations vérifiées, informations officielles, fausses informations, rumeurs et mensonges. Elle le prépare aussi à interpréter, argumenter et à débattre.

L'élève utilise les outils numériques de création et de communication de manière autonome, critique, créative

SCIENCE INFORMATIQUE

La *Science Informatique* étudie le traitement automatisé de l'information.

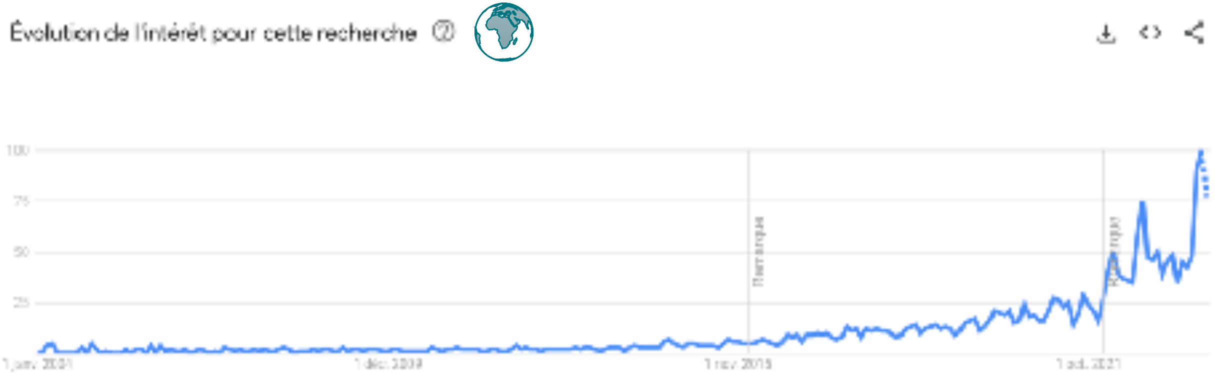
Cet axe participe à l'*Éducation numérique* en tant que matière d'un apprentissage disciplinaire. Au travers d'activités débranchées puis branchées, l'élève est amené au fil de sa scolarité à découvrir les principaux concepts qui sous-tendent le traitement, la transmission et le stockage automatisés de l'information.

- *Algorithmes et programmation :* de la recette de cuisine, par exemple, en tant que suite d'opérations ou d'instructions jusqu'aux langages de programmation.
- *Information et données :* des modes usuels d'écriture et d'utilisation de symboles, par exemple, jusqu'au codage informatique de données.
- *Machines, systèmes, réseaux :* de l'identification des principales parties d'un ordinateur, par exemple, jusqu'à la découverte de l'architecture d'internet.

Ainsi, la *Science Informatique* s'intéresse aux compétences permettant d'organiser, d'exploiter et de présenter des données dans le but de faciliter la résolution de problèmes (pensée informatique ou computationnelle). L'élève est en mesure de décrire des processus, puis de les formaliser dans un langage informatique. Il représente et/ou modélise des phénomènes naturels, techniques, sociaux ou des situations mathématiques en mobilisant des stratégies simples.

Dans le champ *Informatique et société*, une attention particulière est accordée à la protection des données, aux risques liés aux traces numériques et aux limites posées au traitement automatisé de données.

Trend of CT


Évolution de l'intérêt pour cette recherche
100
75
50
25
Remarque
1 déc. 2009
1 nov. 2015
1 oct. 2021


Évolution de l'intérêt pour cette recherche
100
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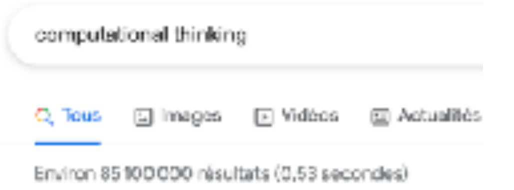
Remarque
1 oct. 2021


computational thinking
Tous
Images
Vidéos
Actualités
Environ 85 100 000 résultats (0,53 secondes)

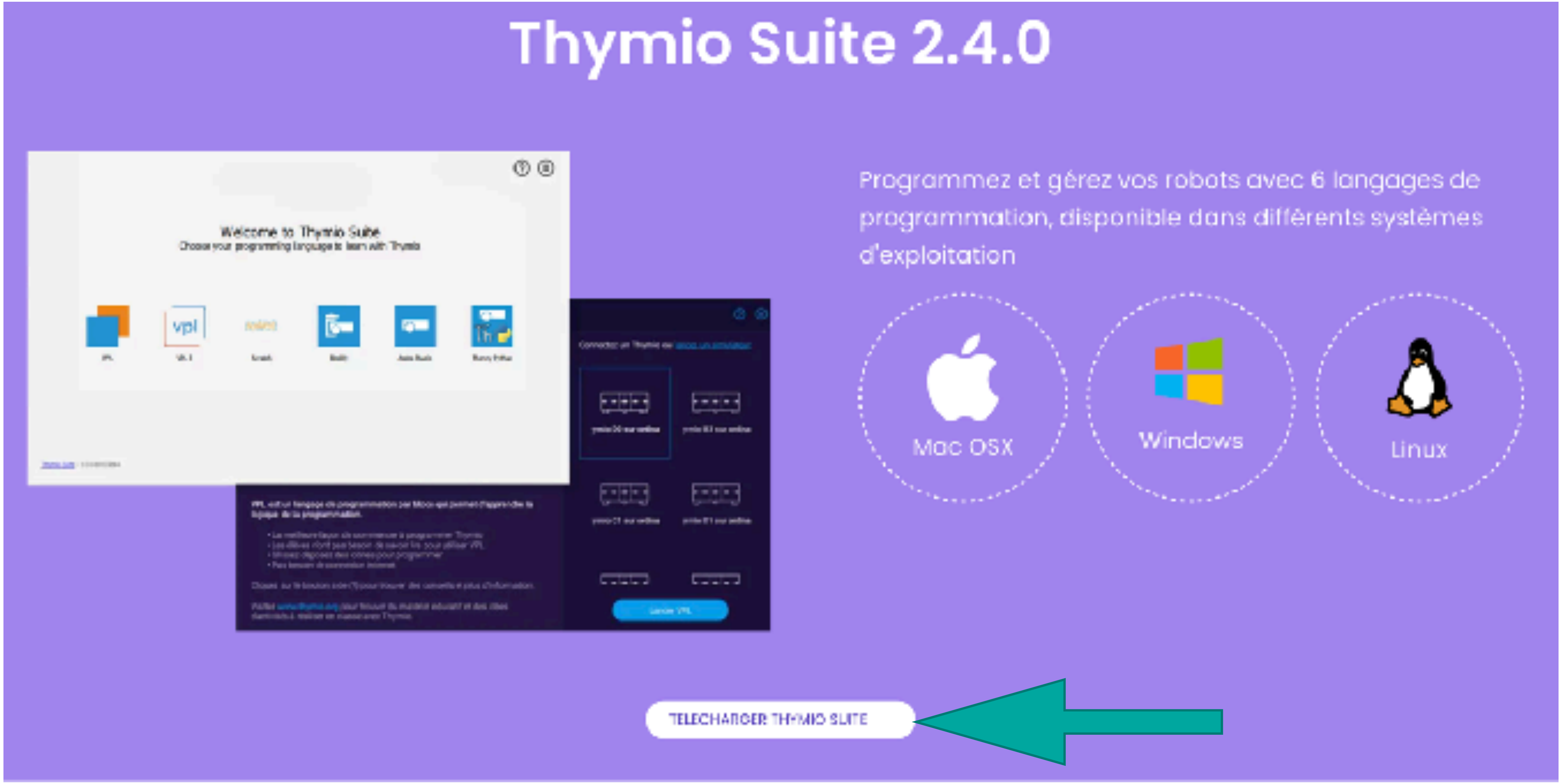

critical Thinking
Tous
Images
Actualités
Environ 679 000 000 résultats (0,61 secondes)

Why CT ?

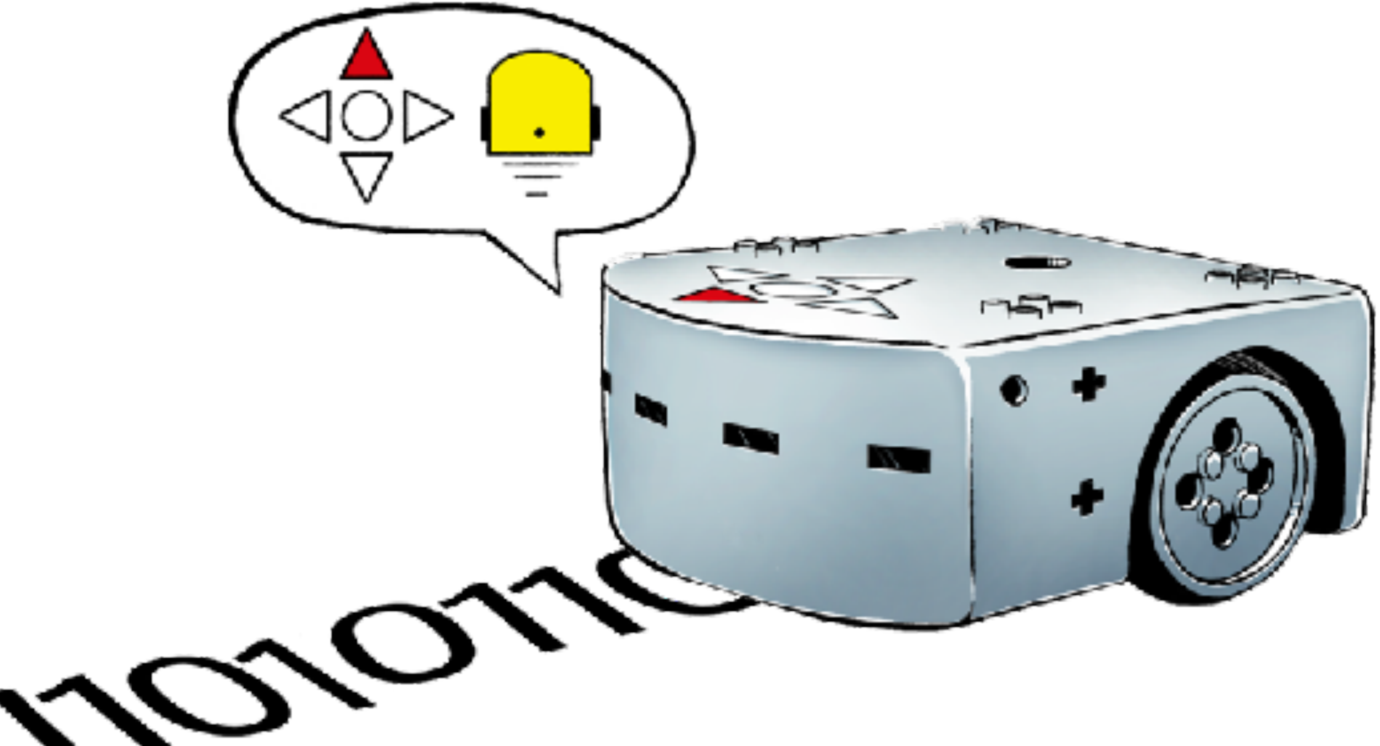
Teaching computational thinking, is to teach them how to think like an economist, a physicist, an artist, and to understand how to use computation to solve their problems, to create, and to discover new questions that can fruitfully be explored.

- Hemmendinger, David. "A plea for modesty." Acm Inroads 1.2 (2010): 4-7. https://dl.acm.org/doi/abs/10.1145/1805724.1805725

Installer Thymio : https://dgxy.link/CS411

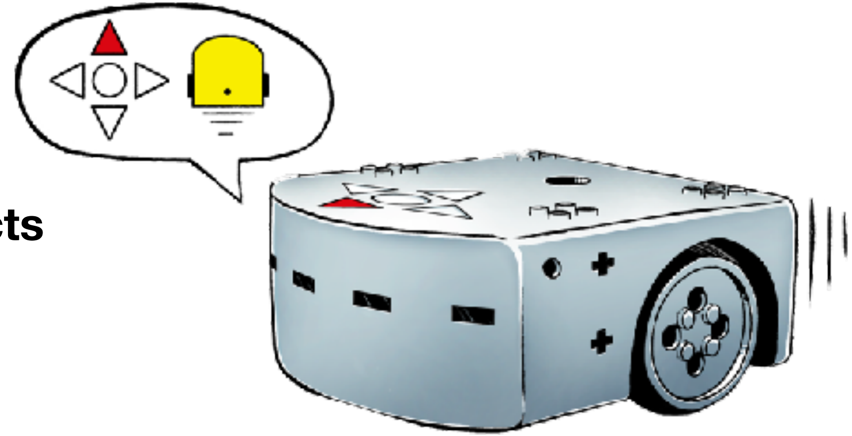


DISCOVER THYMIO THE ROBOT



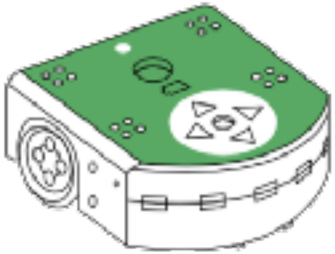
DISCOVER THYMIO THE ROBOT

- A **robot** for **educational purposes**
- Designed in Switzerland
- **Learn programming** as well as how to approach the **scientific process**
- Morphologically neutral, non-gendered
- Better **understanding of technological objects surrounding us**
- Always a **great interest** from students...and teachers!!



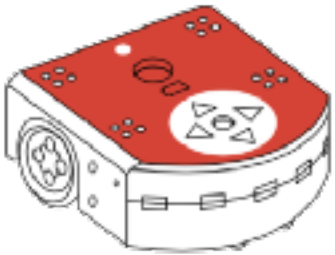
PRE-PROGRAMMED BEHAVIORS

Thymio green



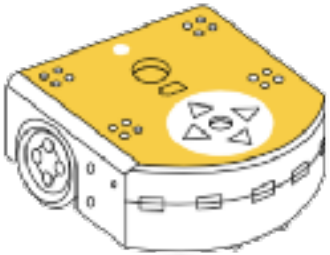
The follower

Thymio red



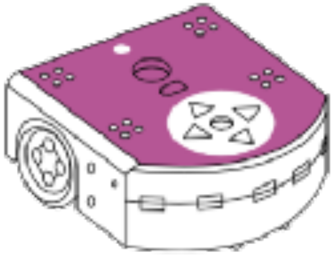
The fearful

Thymio yellow



The curious

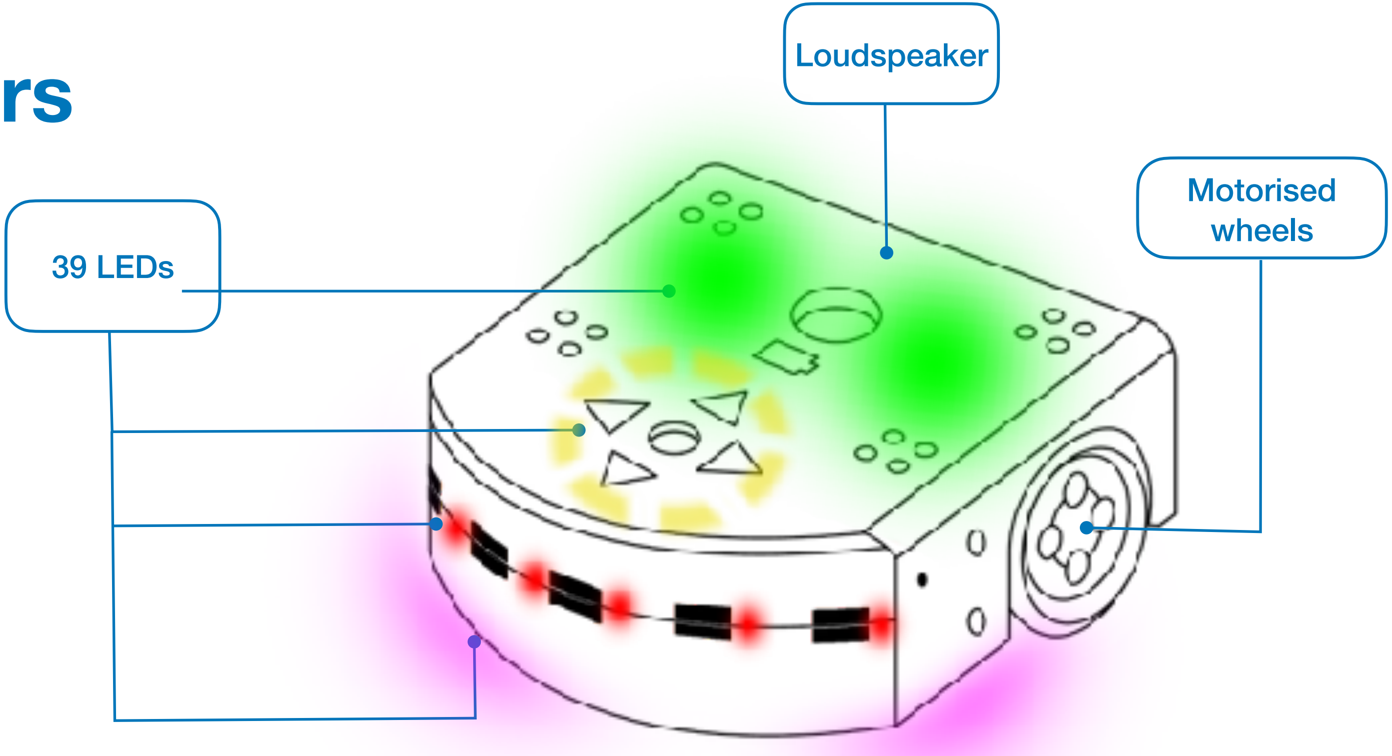
Thymio magenta



The obedient

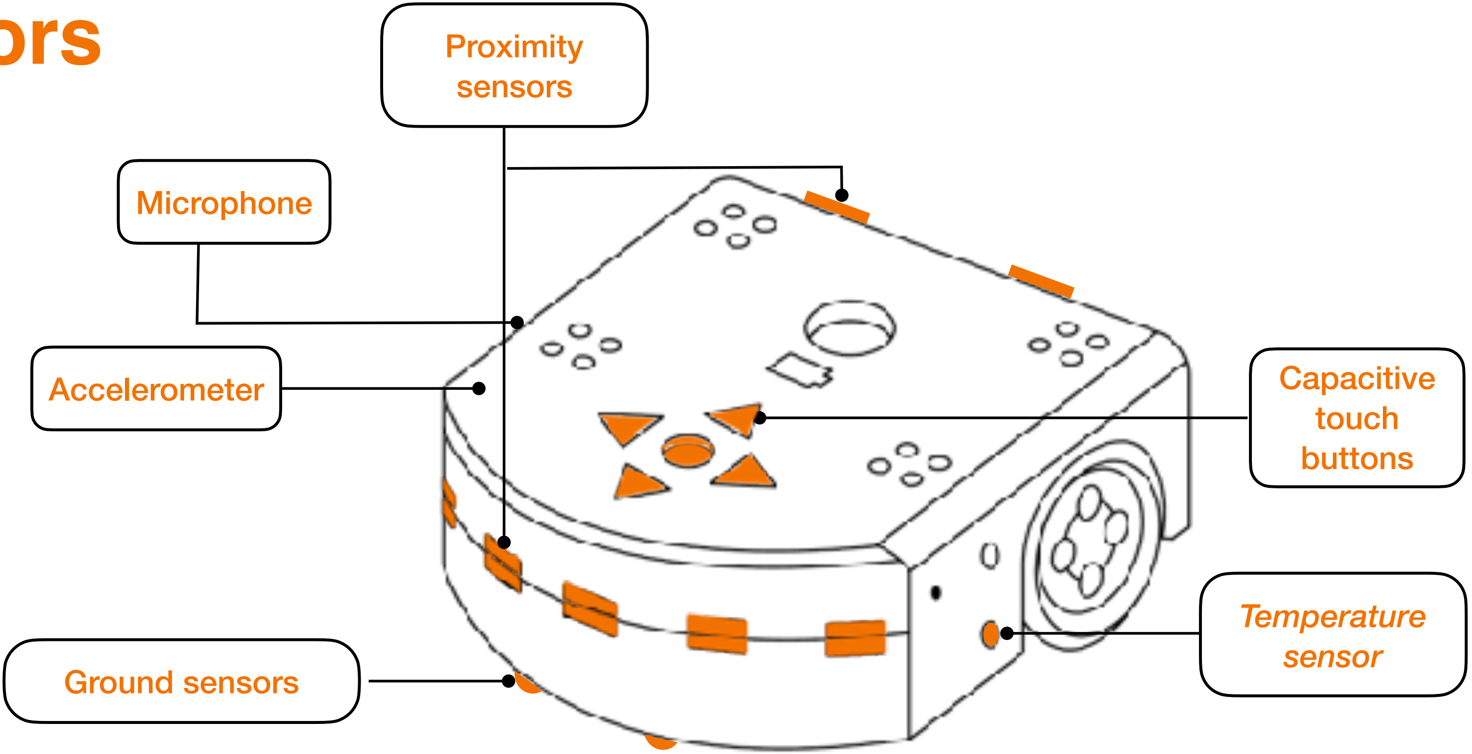
THE COMPONENTS

The actuators

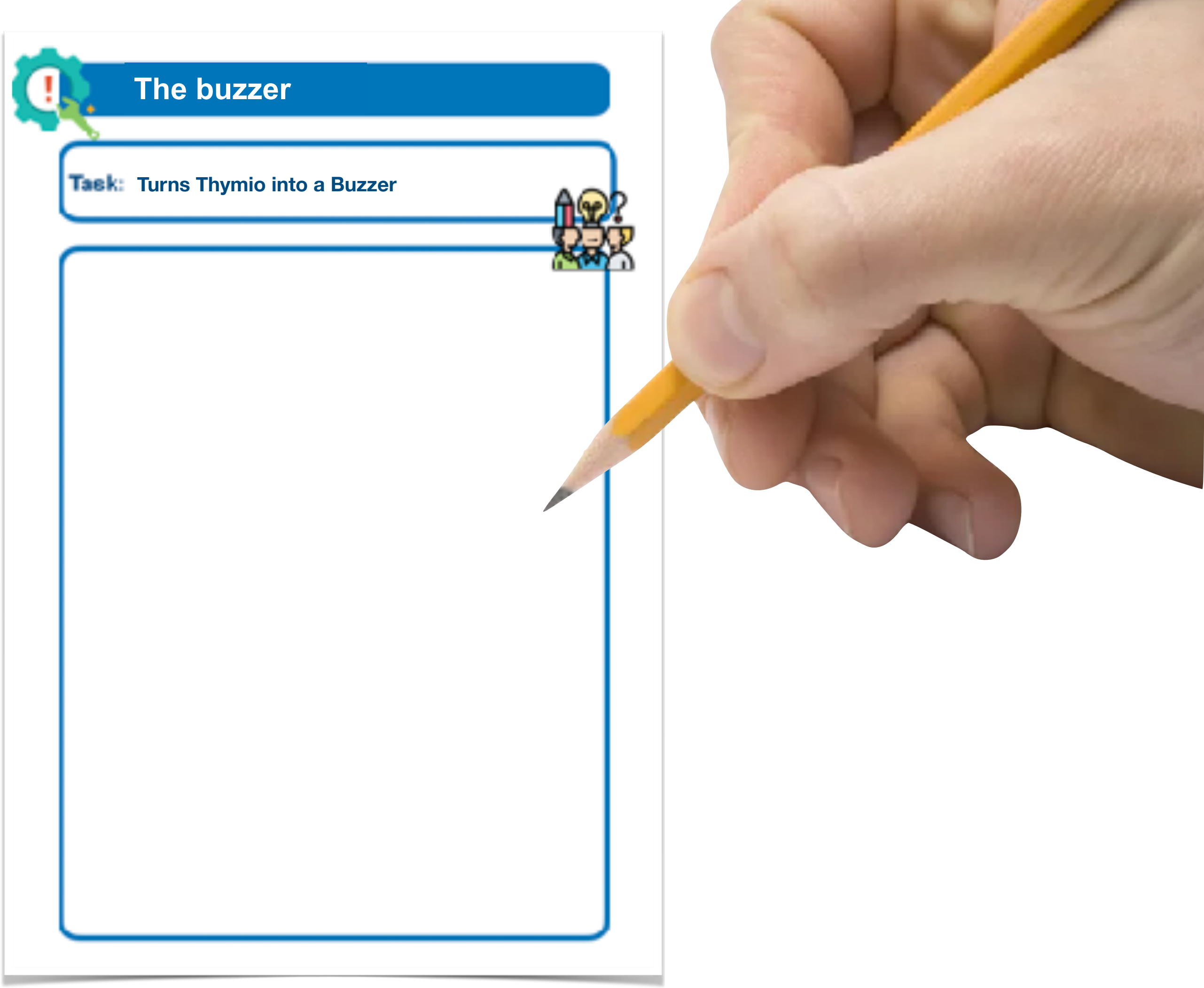


THE COMPONENTS

The sensors

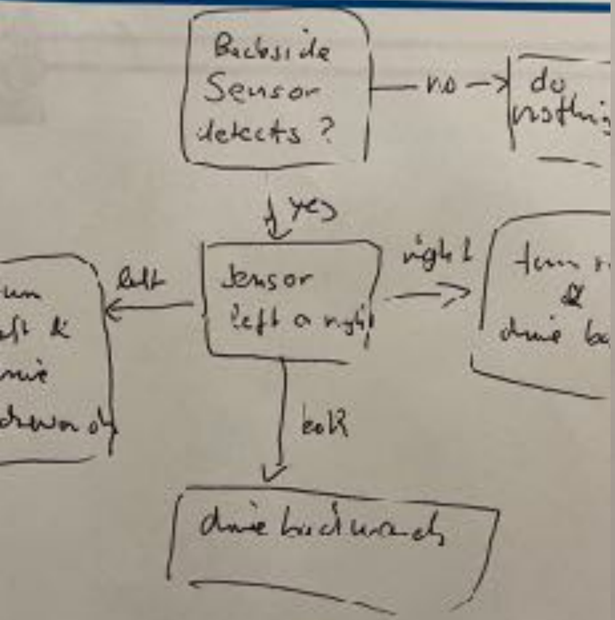


THE BUZZER…


The buzzer
Task: Turns Thymio into a Buzzer

Algorithm Turns Thymio into a Buzzer

lgorithm



Algorithm

```
θ: min distance
b1 }
b2 } sensors
while .
    if b1 < θ && b2 < θ
        M1 = M2 = 1
    elif b1 < θ
        m1 = 2
        m2 = 0
    elif b2 < θ
        M1 = 0
        M2 = 2
    else
        M1 = M2 = 0
```

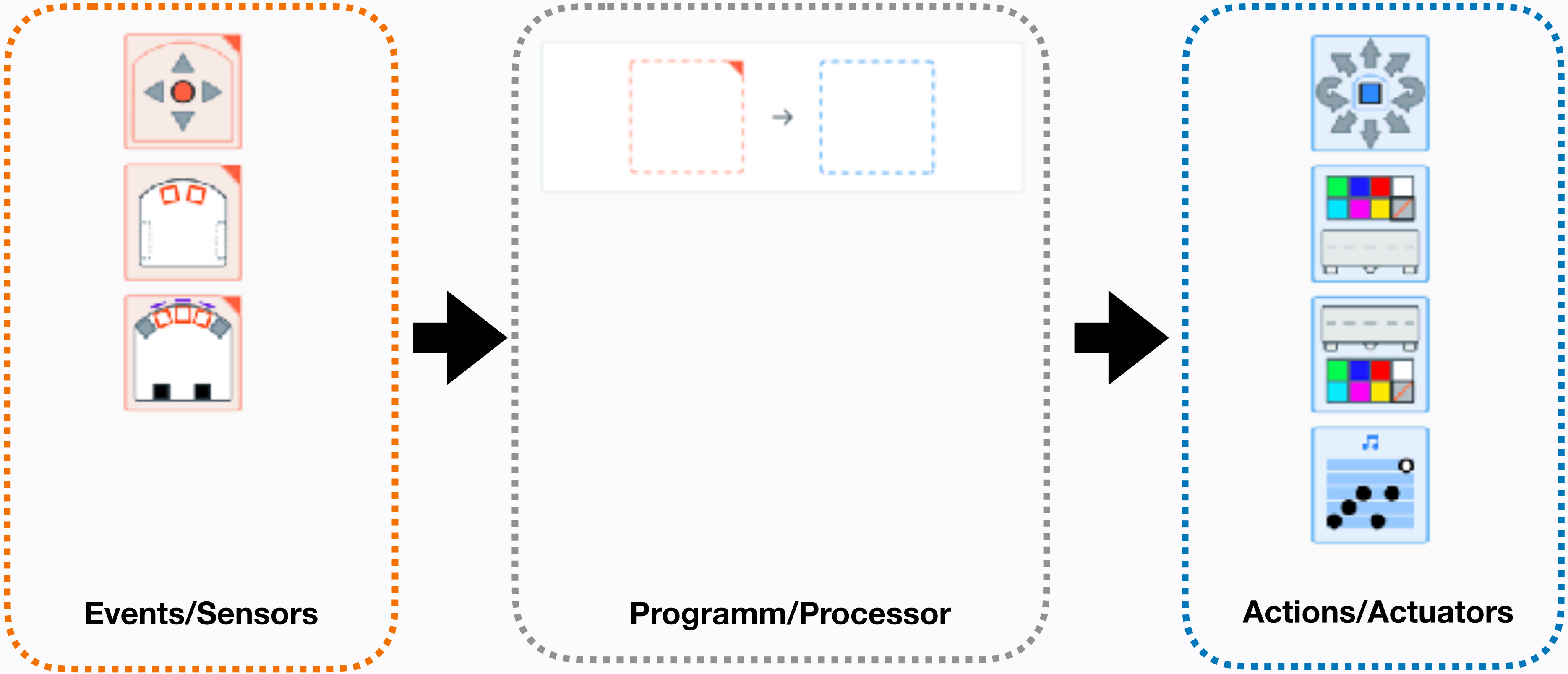
Algorithm

```
When hl = near
    right motor back(50)
else
    right motor speed(0)

when hr = near
    left motor back(50)
else
    left motor speed(0)
```

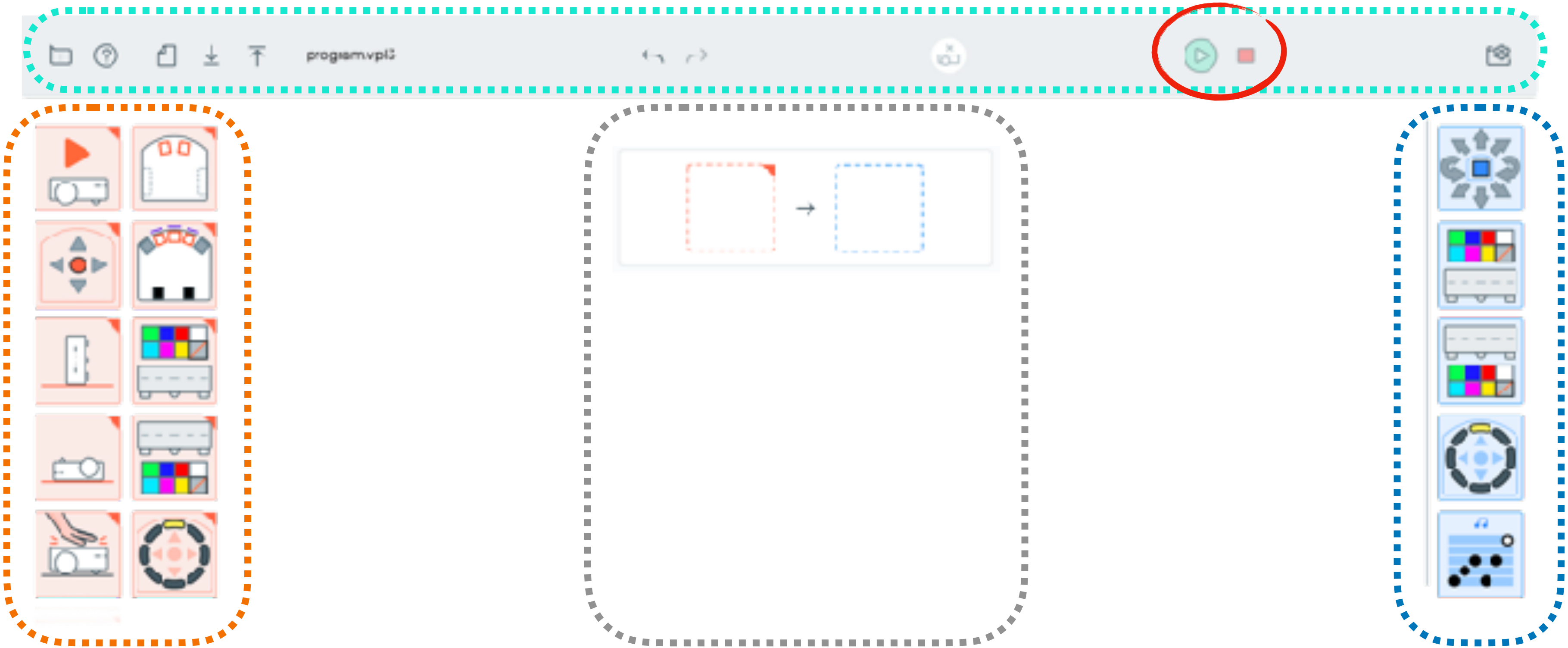
VPL3 : INTRODUCTION

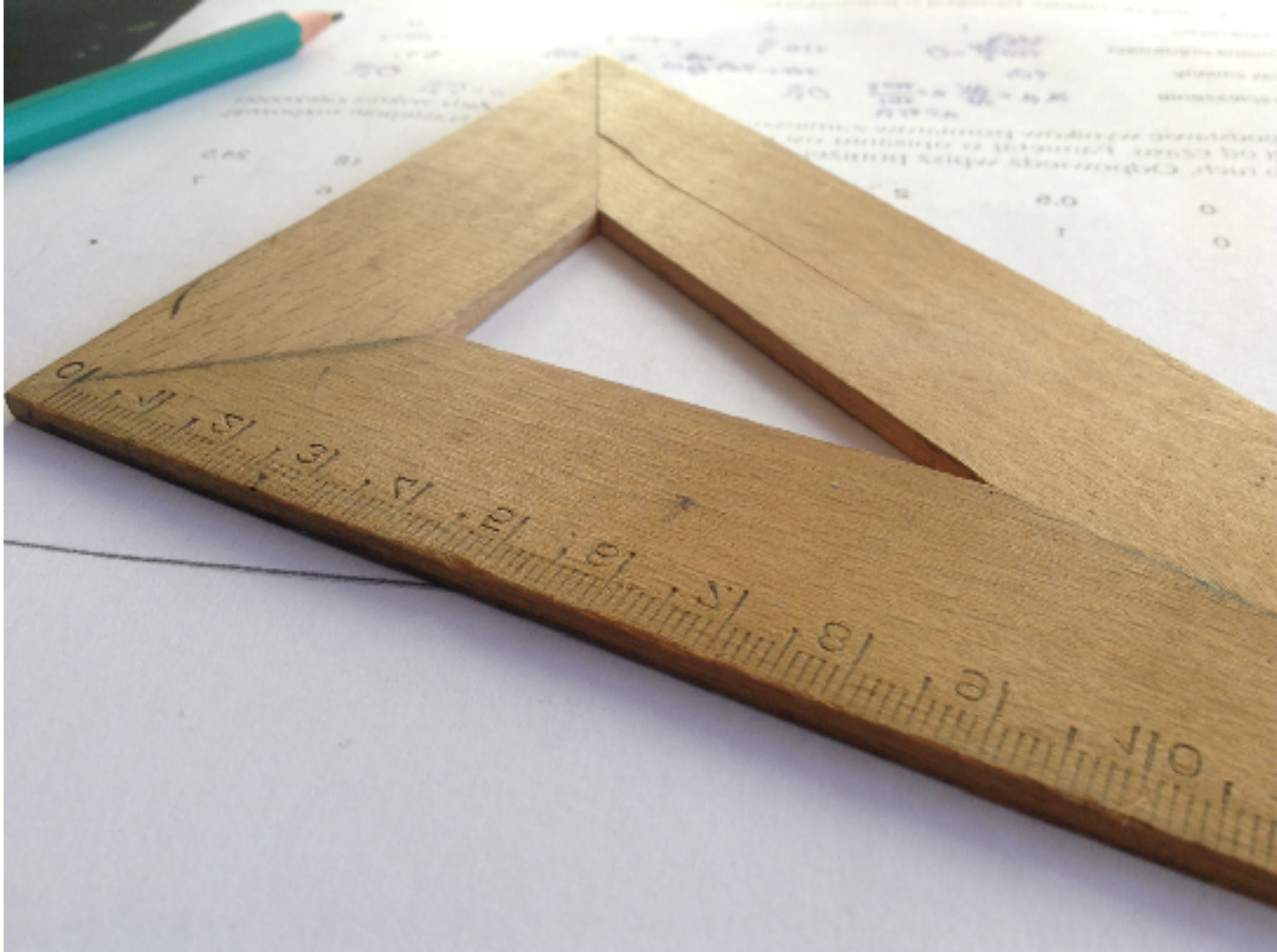
A VISUAL PROGRAMMING LANGUAGE



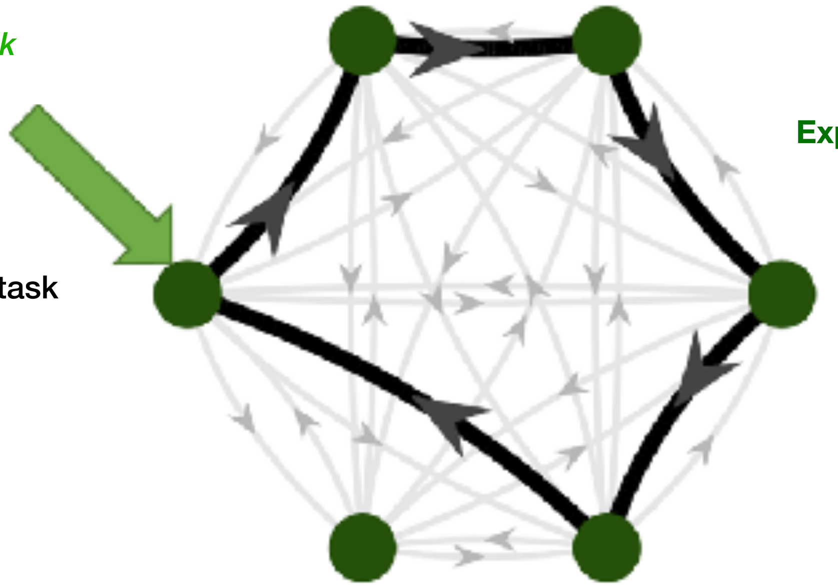
VPL3 : INTRODUCTION

A VISUAL PROGRAMMING LANGUAGE





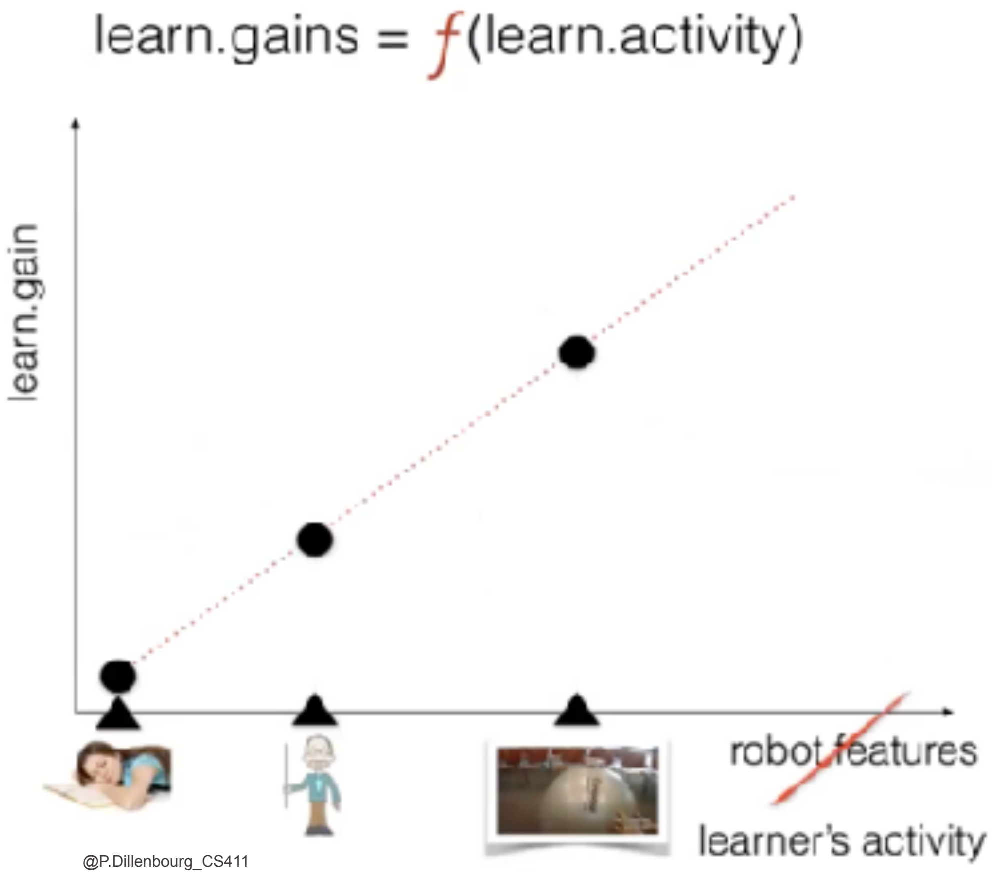
ORCHESTRATION



The six phases of the Creative Computationnal Problem Solving Model (Chevalier & Giang et al., 2020).

ORCHESTRATION

- **Unplugged /plugged**
- **Representations (explain, draw, write)**
- **Explicitation to the pair, to the teacher, to the group**
- **Compare propositions and approaches**

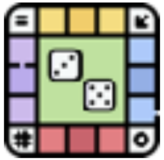


@P.Dillenbourg_CS411

ORCHESTRATION

Encouraging interaction

Real-life situations



Gamification

Project launch

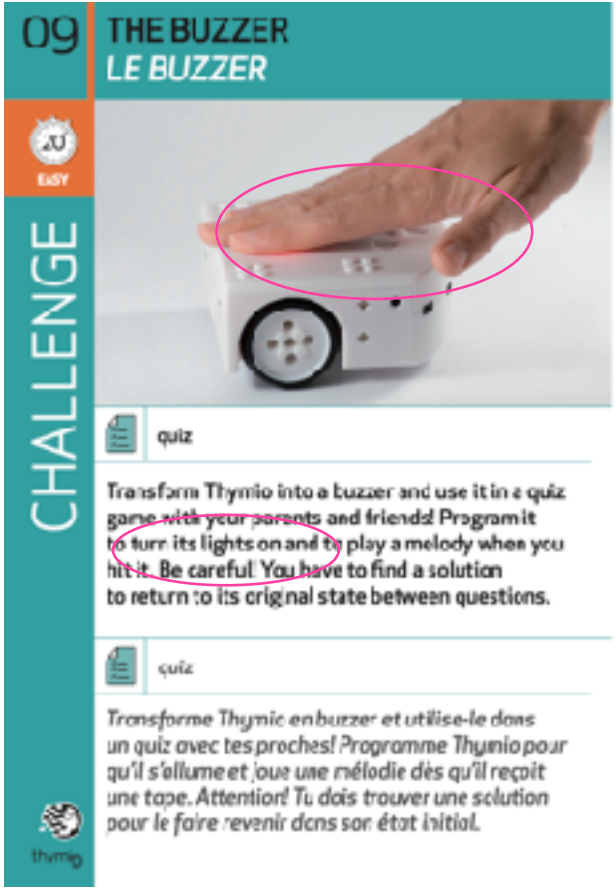
Increase student motivation

Teacher guidance and feedback

ORCHESTRATION

Guidance :

- Formulating the problem
- Keep your hands behind your back
- Question the pupils
- Break down the task
- Synchronous demonstration
- Provide external resources
- Tutoring between students



Bibliography

- The CT-cube: A framework for the design and the assessment of computational thinking activities, 2022, Alberto Piatti, Giorgia Adorni, Laila El-Hamamsy, Lucio Negrini, Dorit Assaf, Luca Gambardella, Francesco Mondada (https://www.sciencedirect.com/science/article/pii/S2451958821001147)
- The role of feedback and guidance as intervention methods to foster computational thinking in educational robotics learning activities for primary school, January 2022. Morgane Chevalier, Christian Giang, Laila El-Hamamsy, 10.1016/j.compedu.2022.104431
- New frameworks for studying and assessing the development of computational thinking, 2012, K. Brennan, M. Resnick https://www.sciencedirect.com/science/article/pii/S0360131522000021?via=ihub#bbib11
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