Connectivism and Artificial Intelligence in education

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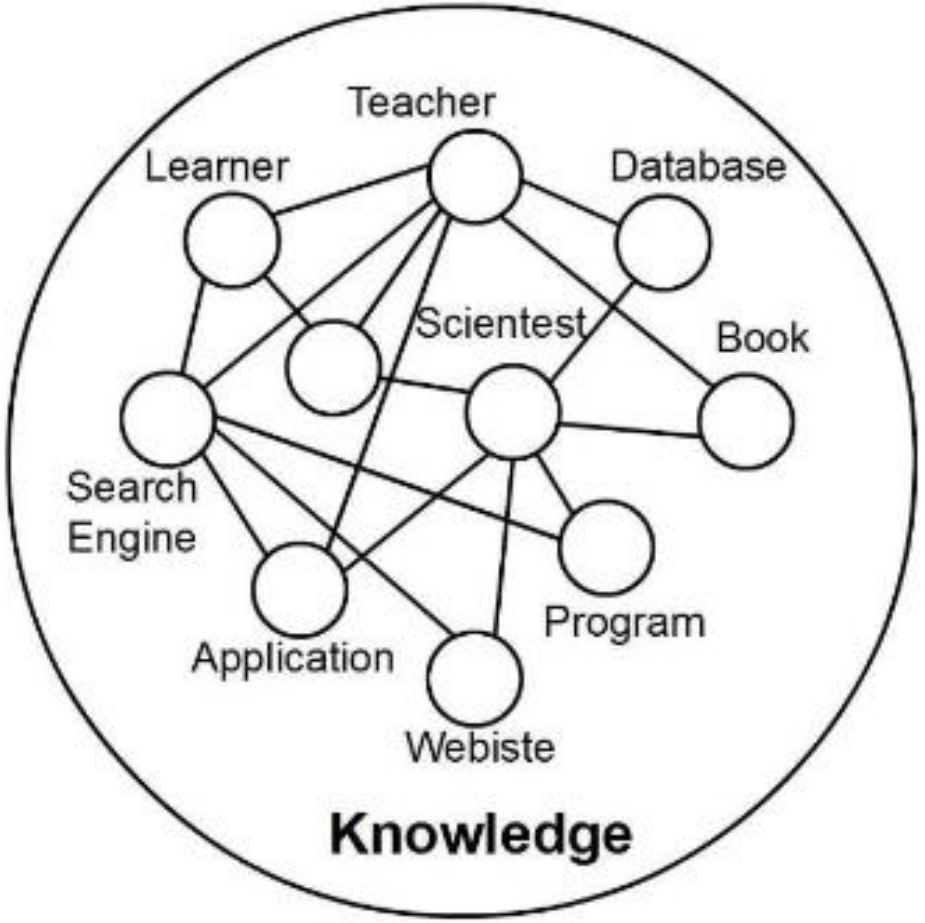
3rd International Virtual Congress on Research, Innovation, and Educational Technology in Pre-University and High School Education, Universidad Nacional Autónoma de México

May 16, 2025

What is the role of AI in education and its connection to Connectivist learning theories?



Connectivism
https://www.downes.ca/post/73314

Cover image:
https://www.mdpi.com/2227-7102/15/3/368

https://files.eric.ed.gov/fulltext/ED572896.pdf

The Robot Tutor

In which I discuss the idea of AI as delivering ‘personalized’ learning

- Knewton (2015) https://www.wired.com/2015/08/knewton-robot-tutor/
- Pearson (2016) https://eliterate.us/pearsonalized-learning/
- Robot Academy https://robotacademy.net.au/
- Khanmigo - https://www.khanmigo.ai/learners
- Professor tailored AI tutor to physics course (2024) https://news.harvard.edu/gazette/story/2024/09/professor-tailored-ai-tutor-to-physics-course-engagement-doubled/
- ProfBot (2025) https://www.downes.ca/post/77500/rd

The Robot Tutor

What AI *can* do (if imperfectly, for now)

- AI can write instructional materials
- AI can help you answer questions
- AI can evaluate your work
- AI can create adaptive instruction
- It can help administrate learning

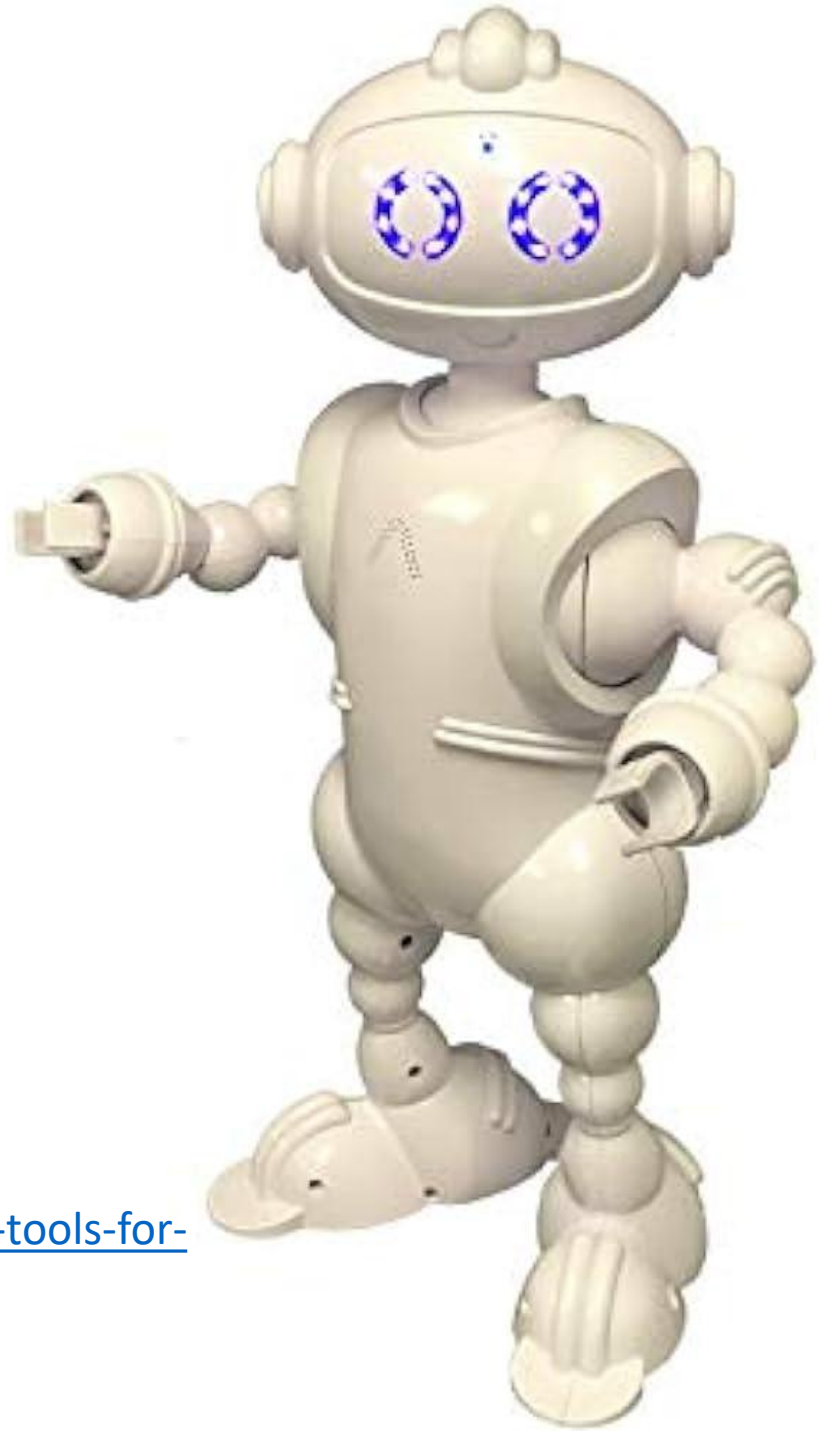
https://education.illinois.edu/about/news-events/news/article/2024/10/24/ai-in-schools--pros-and-cons

The Robot Tutor

What we're not using it for (right now)

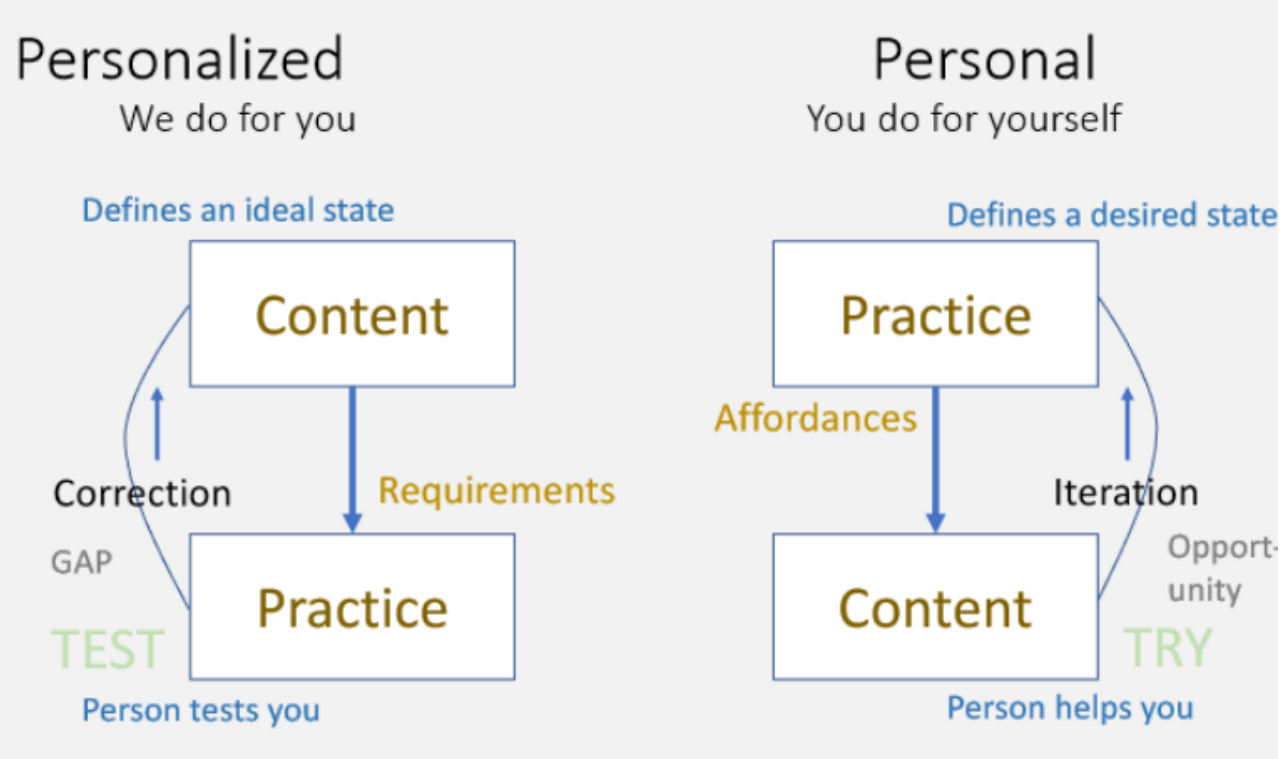
- Posing alternatives or raising questions
- Fostering critical thinking and personal reflection
- Stimulating or facilitating discussion
- Building community
- Generate student activities
- Work on the cognitive skills to be developed

https://www.tonybates.ca/2025/05/09/an-evaluation-of-contact-norths-ai-tools-for-teachers-instructors-learning-shorts/



Personal vs Personalized Learning

Where do we want learning to go? https://www.downes.ca/presentation/497



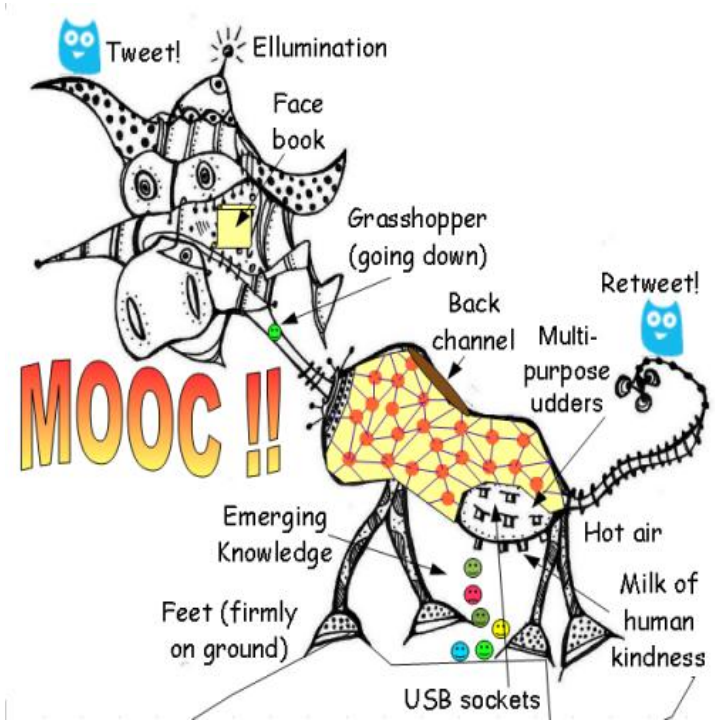
Personal vs Personalized Learning

The idea of personal learning:

- Based on learner projects, needs or interests
- Learning results from practice more than instruction
- Pedagogy of support rather than evaluation
- Tools designed to build capacity

Combine the idea of personal learning + online course to create the MOOC

The MOOC



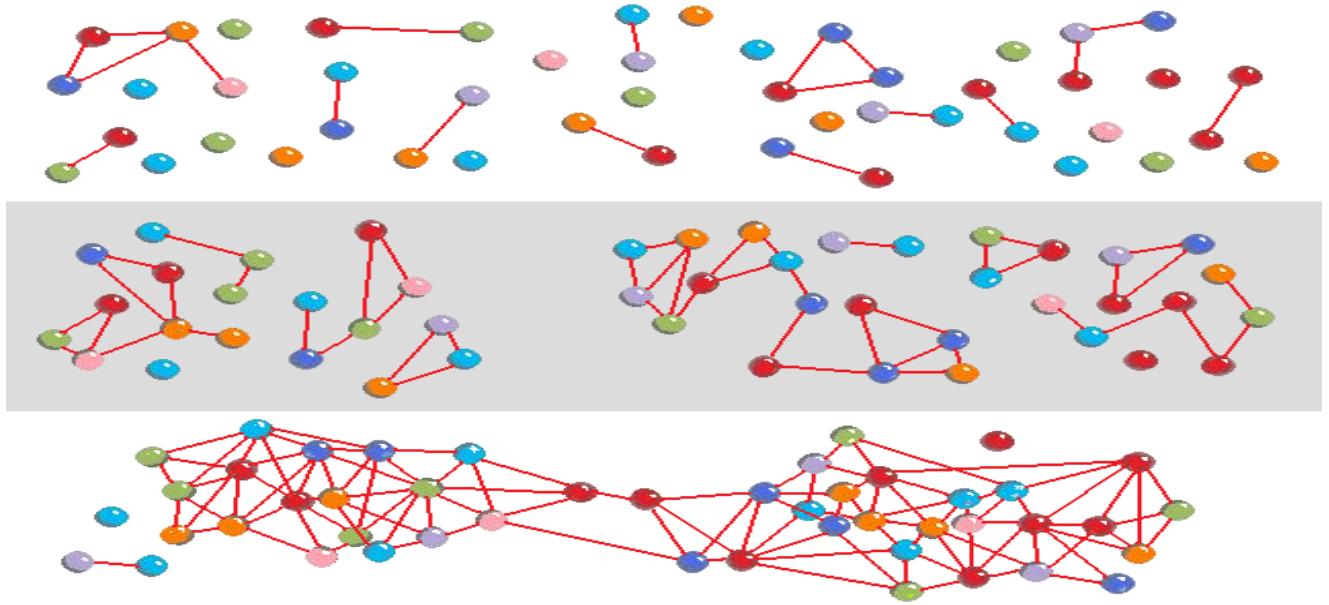
- Massive – by design
- Open – gratis and libre
- Online – not blended, not wrapped
- Courses – not communities, websites, video collections, etc

https://www.downes.ca/presentation/336

Image: Gordon Lockhart
http://gbl55.wordpress.com/2011/03/08/cck11-man-this-mooc-is-something-else/

The MOOC

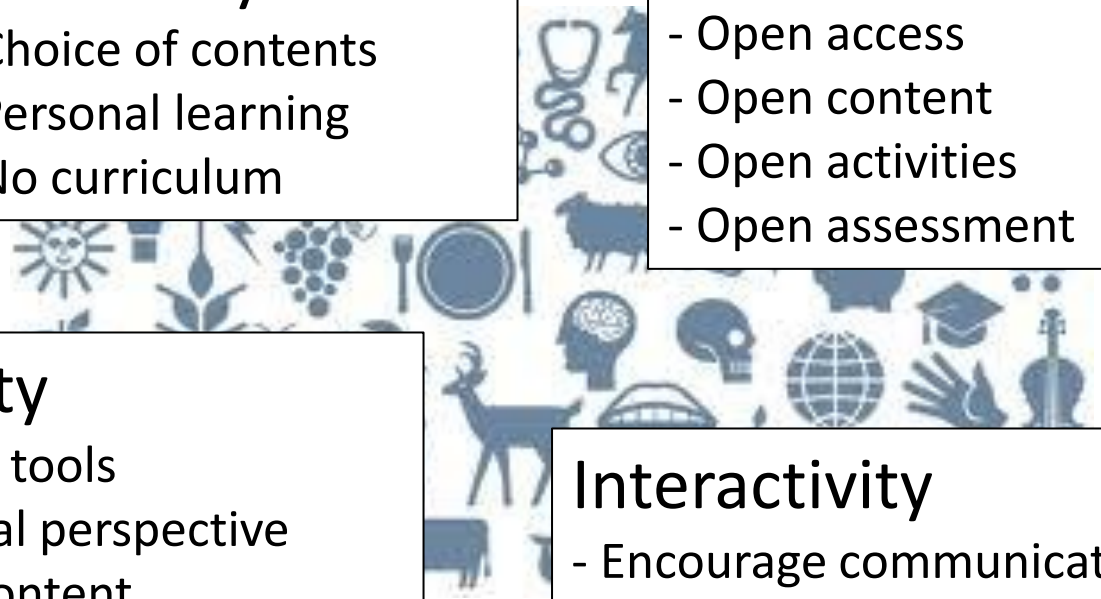
And the idea of learning as self-organizing learning communities



These are at once perceptual systems and reasoning systems

The MOOC

Design principles…



Autonomy
- Choice of contents
- Personal learning
- No curriculum

Openness
- Open access
- Open content
- Open activities
- Open assessment

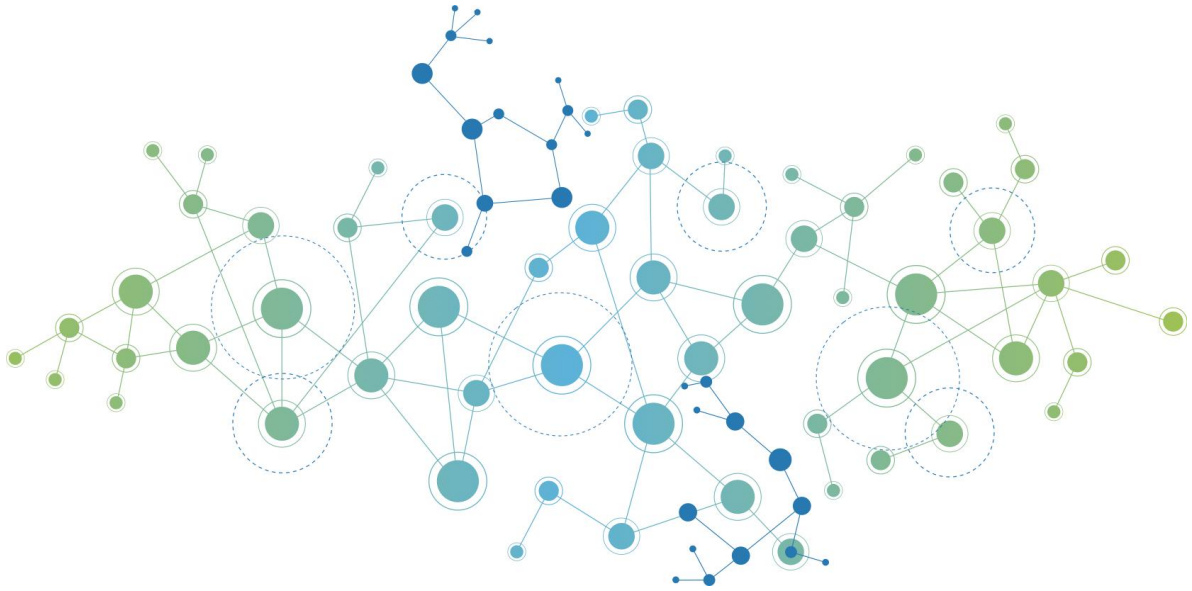
Diversity
- Multiple tools
- Individual perspective
- Varied content

Interactivity
- Encourage communication
- Cooperative learning
- Emergent knowledge

Connectivism

Connectivism is the thesis that… https://www.downes.ca/presentation/547

knowledge is distributed across a network of connections, and therefore that learning consists of the ability to construct and traverse those networks.

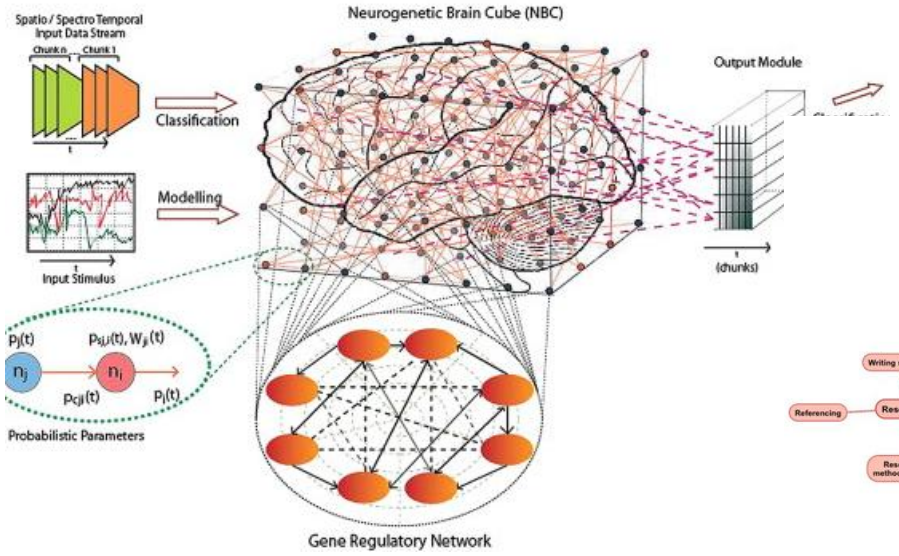


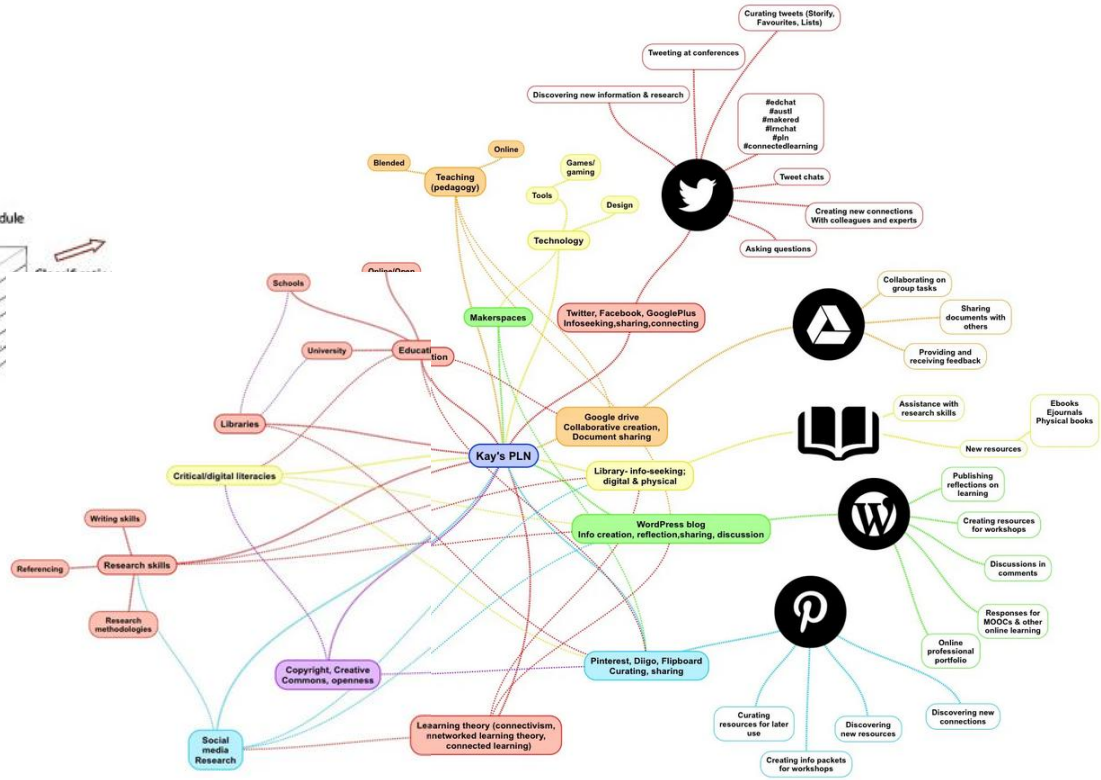
To *know* something is to be organized in a certain way

To *learn* is to become organized in that way

Connectivism

Things that learn





Personal Learning (Polanyi)

Social Learning (Wittgenstein)

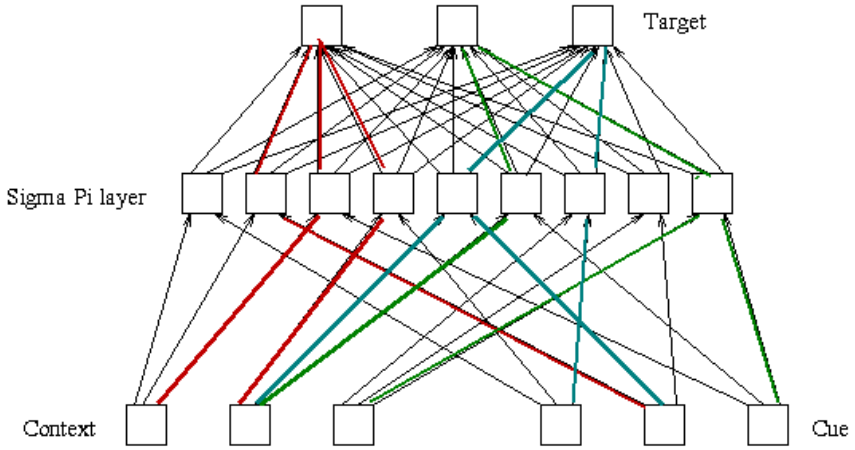
Connectivism

How we learn…

Hebbian rules - 'what fires together wires together'
Contiguity - neurons that are located near each other connect
Back Propagation - signals sent in reverse direction through a network, aka 'feedback', modify connections created by forward propagated signals
Boltzmann - networks seek to attain the lowest level of kinetic energy
The actual *physical* descriptions of these theories vary from network to network.

Distributed Representation

Concepts in a network https://www.downes.ca/presentation/144



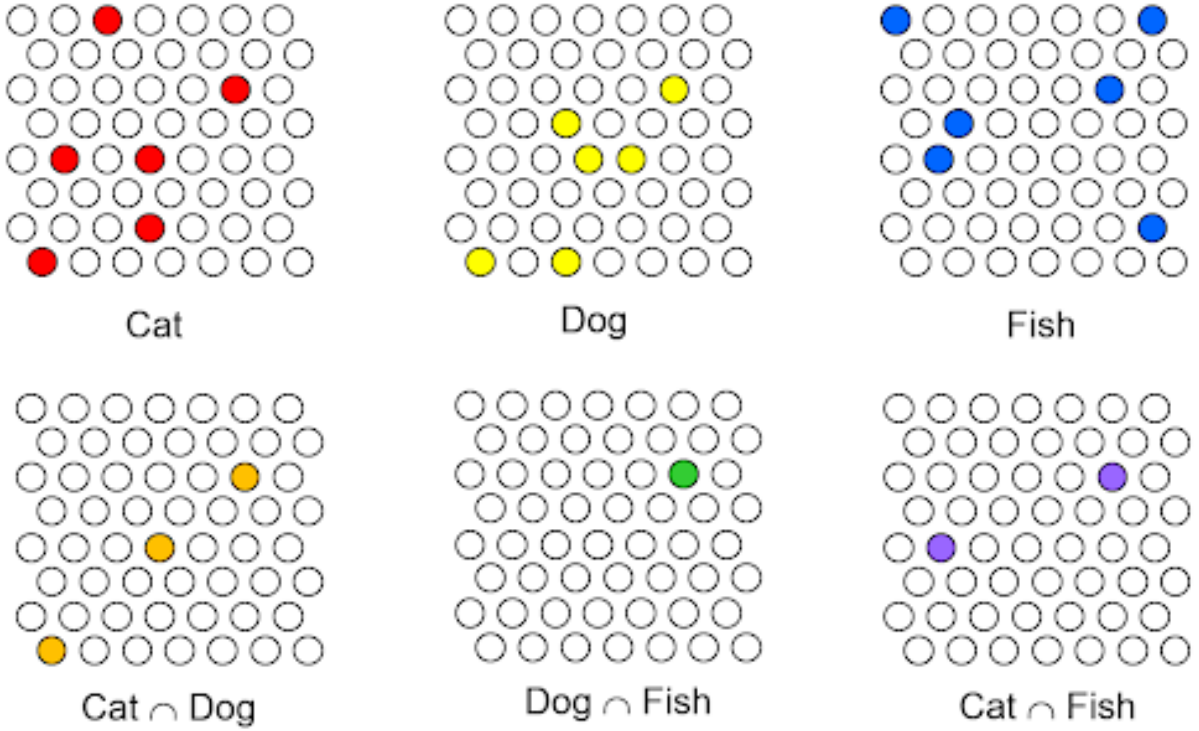
Distributed Representation
= a pattern of connectivity

stands for?

Or is caused by?

Distributed Representation

What we learn

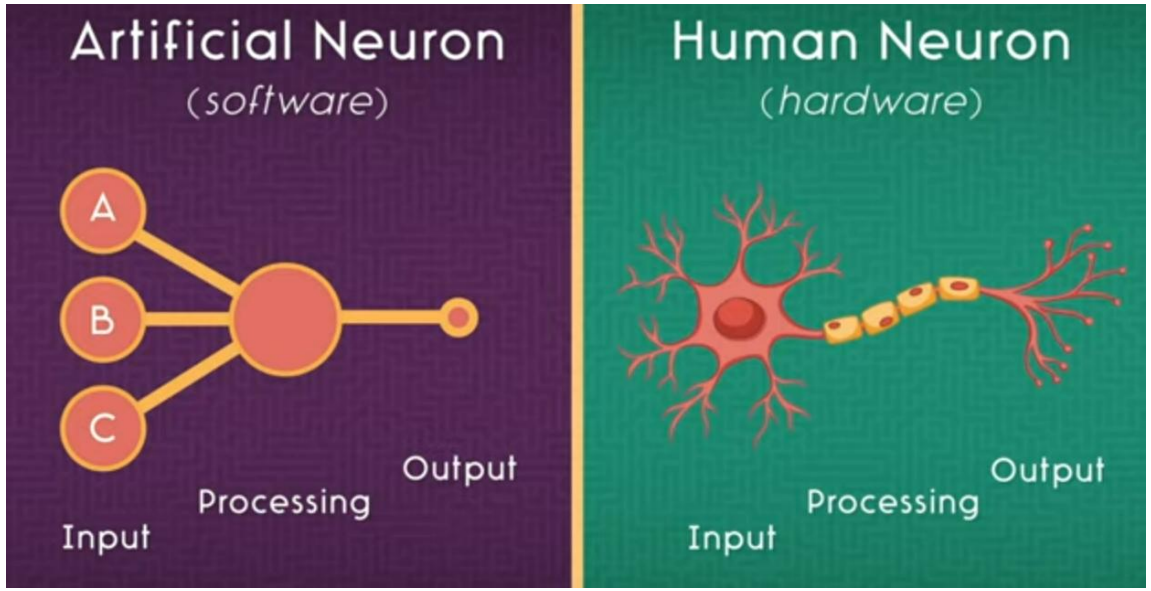


The Classical Realization of Quantum Parallelism
http://brainworkshow.sparsey.com/tag/sparse-distributed-representations/

Connectionism

Neural networks and artificial neural networks

https://ethics.mooc.ca/cgi-bin/page.cgi?presentation=59



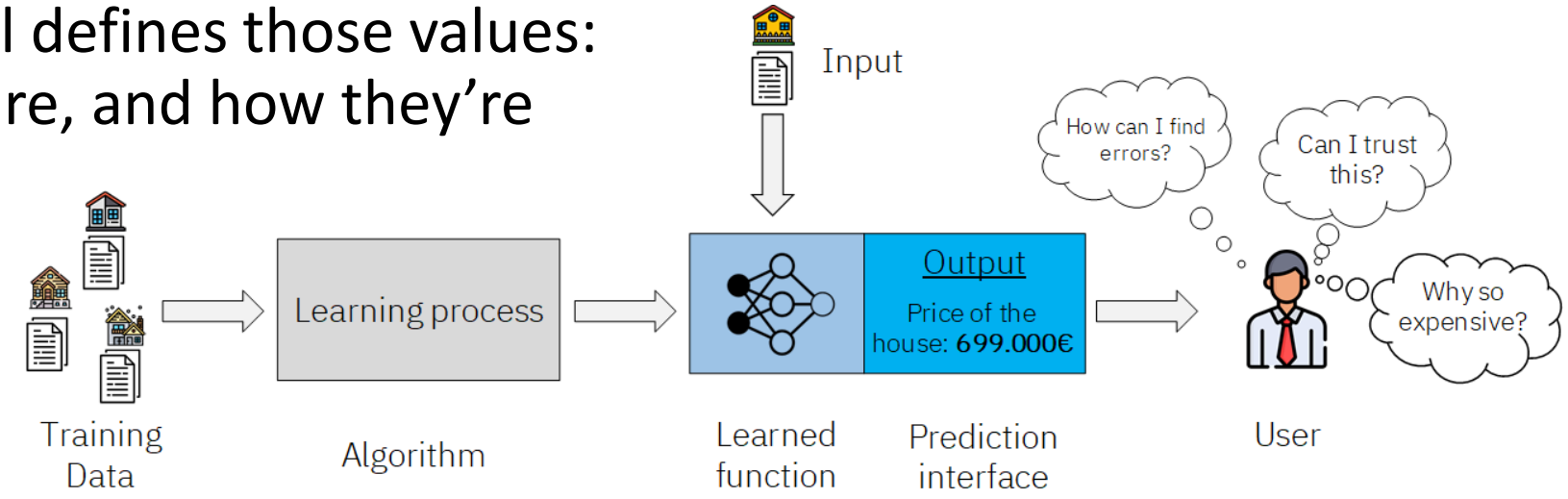
https://www.youtube.com/watch?v=JrXazCEACVo

Connectionism

What does AI actually do?

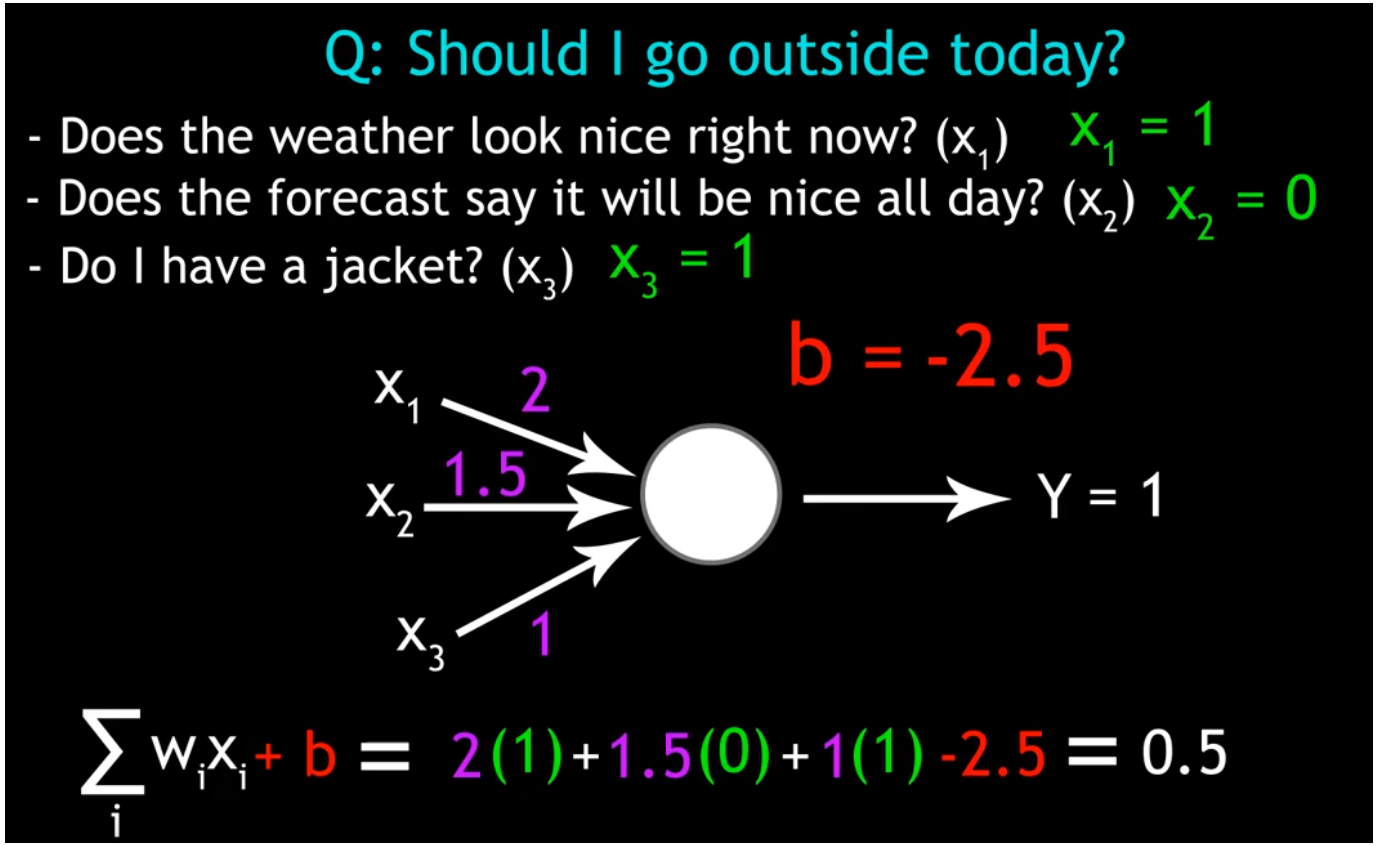
- A neural network is ultimately a statistical function, but one that manages tens of thousands of input variables
- An AI model defines those values: what they are, and how they're determined

- Regression
- Feature detection
- Clustering
- Prediction



Connectionism

Weights, values and biases

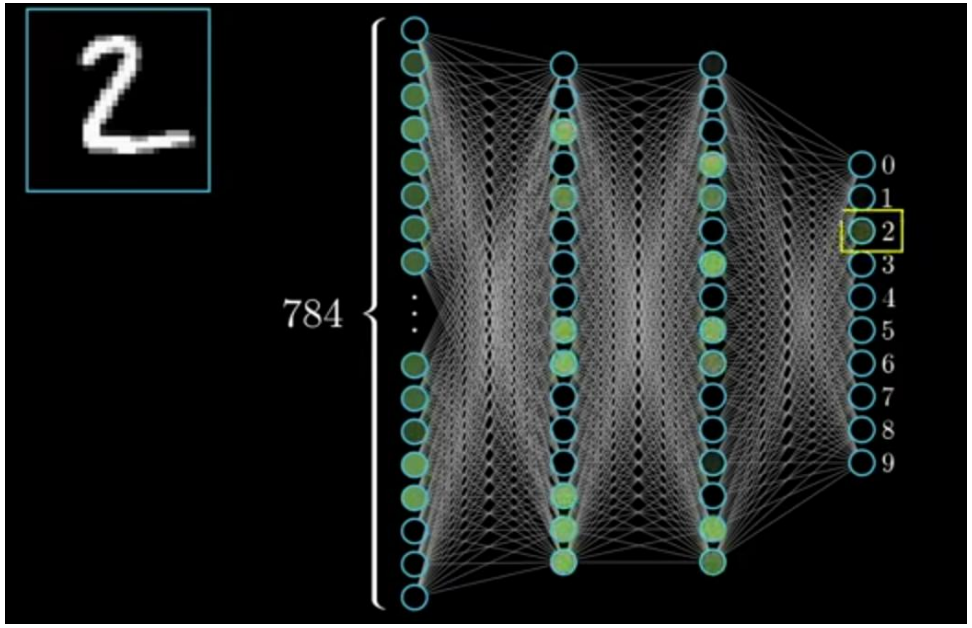


One node in a larger network

Pattern Recognition

What does it mean to say ‘knowledge is the set of connections…’?

- When presented with phenomena, *this* pattern, rather than *that* pattern, is activated



Pattern Recognition

To know is to recognize

- To 'know' that 'A is B' is to 'recognize' that 'A is B', that is, when presented with 'A', one reacts as though being presented with a 'B'. Recognition lies at the core of communication, as it allows (for example) a symbol 'tiger' to suggest a phenomenon (a tiger).
- What is important to understand here is that the recognition is something the *recipient* brings to the table. It is not inherent in the presentation of the phenomenon, and may not even be intended by the presenter (indeed, as likely as not, the presenter had something different in mind).

https://www.downes.ca/post/57746

Projection Game

What word comes next?

Bacon and _____

Projection Game

What word comes next?

Bacon and _*eggs*_

Wayne _____

Projection Game

What word comes next?

Bacon and _*eggs*_

Wayne _*Gretzky*_

American _____

Projection Game

What word comes next?

Bacon and _*eggs*_

Wayne _*Gretzky*_

American _*Idol*_

Justin _____

Projection Game

What word comes next?

Bacon and _*eggs*_

Wayne _*Gretzky*_

American _*Idol*_

Justin _*Trudeau*_

Tried and _____

Projection Game

What word comes next?

Bacon and _*eggs*_

Wayne _*Gretzky*_

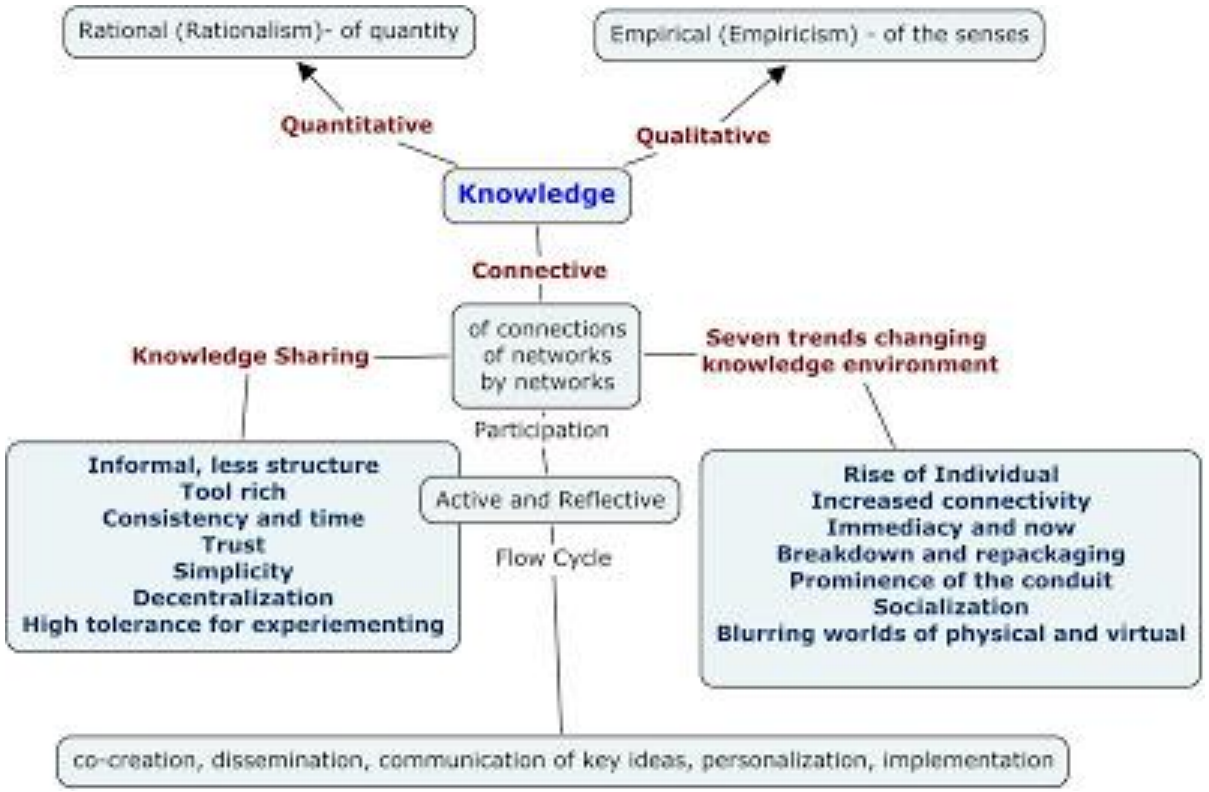
American _*Idol*_

Justin _*Trudeau*_

Tried and _*true*_

Knowledge

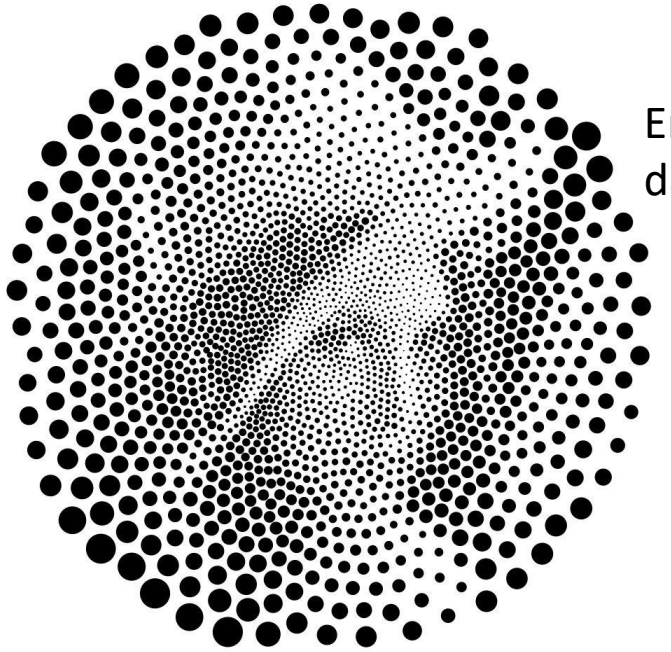
Three kinds of knowledge



http://teachweb2.blogspot.com/2008/09/cck08-knowledge-concept-map.html

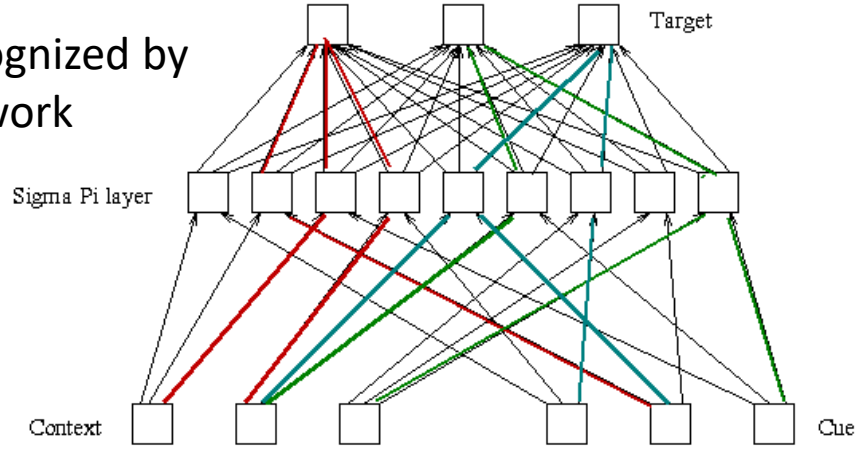
Knowledge

Connective knowledge is emergent



Emerges from data…

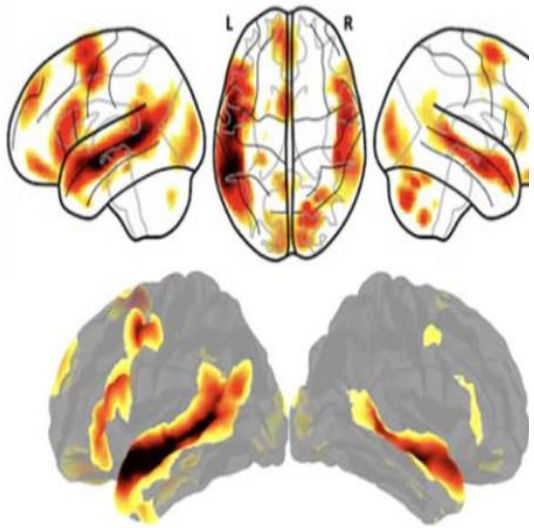
Recognized by network

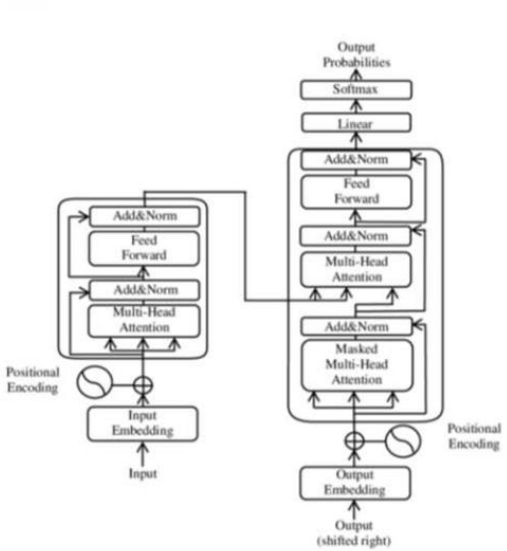


Based on previous experiences shaping the network

Knowledge

Our detailed understanding of development in LLMs can allow us to probe specific questions about human development.





"The distinction between meaning itself, and representations of meaning encoded in language, is a crucial element of over a century of work in semiotics. This work argues that meaning is derived from the interpretation of mappings between signs (forms) and signifiers (e.g., Peirce, 1977; Saussure, 1983; similar to Bender & Koller's definition of meaning). Signifiers are things in the world that we are familiar with through embodied experience. LLMs do not have access to signifiers; they only have access to written linguistic forms"

https://direct.mit.edu/opmi/article/doi/10.1162/opmi_a_00160/124234/The-Limitations-of-Large-Language-Models-for

Knowledge

Learning from experience

Learning as an active process	•Learning is continuous and iterative •Engage dynamically with real-world challenges not passively absorbing
Experience-based engagement	•Knowledge is acquired through hands-on participation in practical activities •Activities such as simulations, fieldwork, and case studies immerse students in authentic learning experiences
Reflection and Critical Thinking	•Structured reflection, analyze experiences and extract insights •Critical thinking, assess situations, adapt, and make informed decisions
Application and Experimentation	•Knowledge is tested and refined through active experimentation •Students apply theoretical concepts to practical contexts, reinforcing understanding through trial and revision

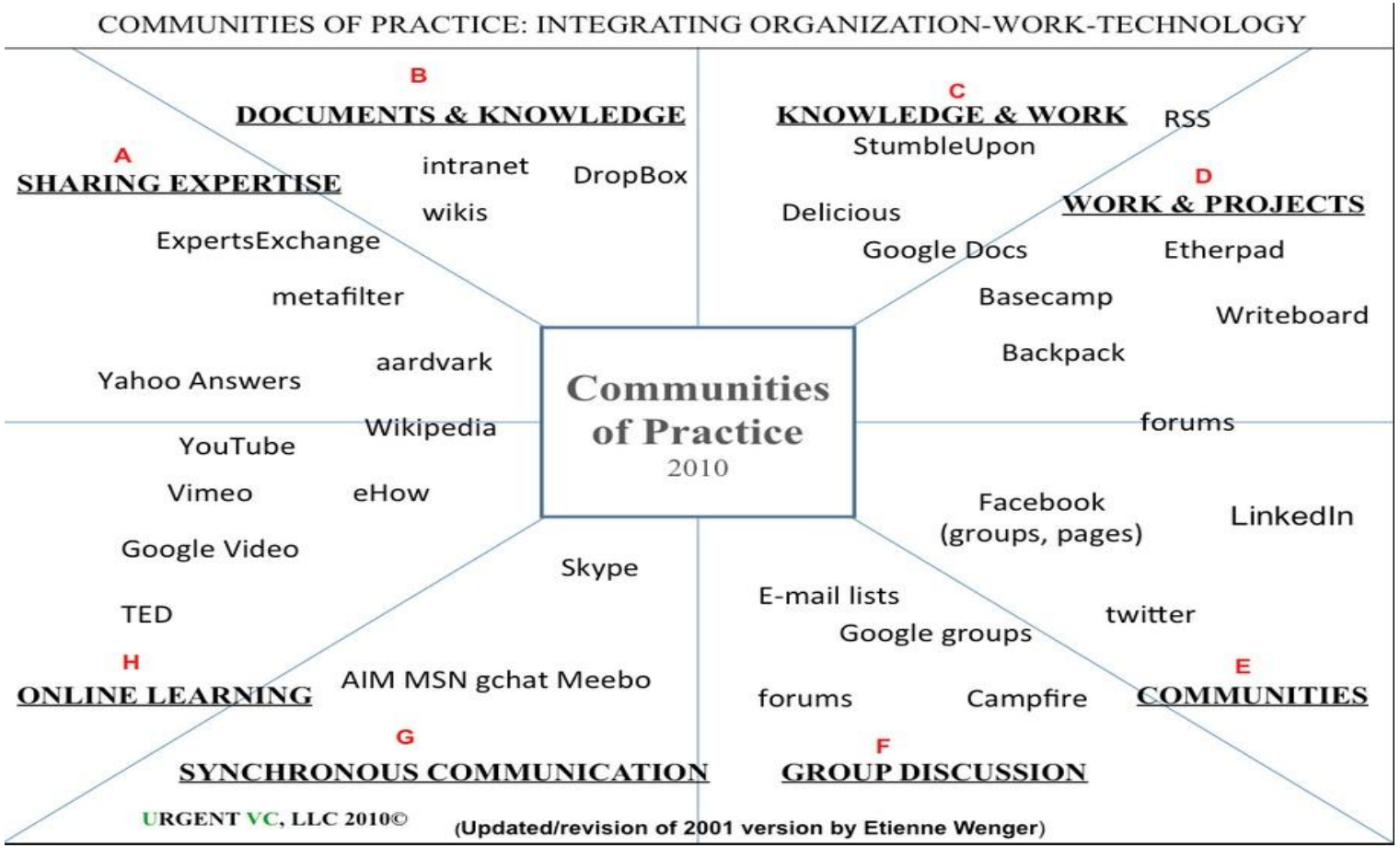
Kolb's Experiential Learning Theory (1984)

https://feedbackfruits.com/blog/bridging-theory-and-practice-with-experiential-learning

Learning Communities

- Learning as a part of a community
- Being part of a community that learns
- Wenger: domain, community, practice
- (aspects of CoP here – finding, connecting, creating)
  - engaging in activities of mutual interest (finding),
  - building relationships through shared activity (connecting)
  - creating common resources https://doi.org/10.1002/bmb.20548
- Compare with how we train an AI

Learning Communities

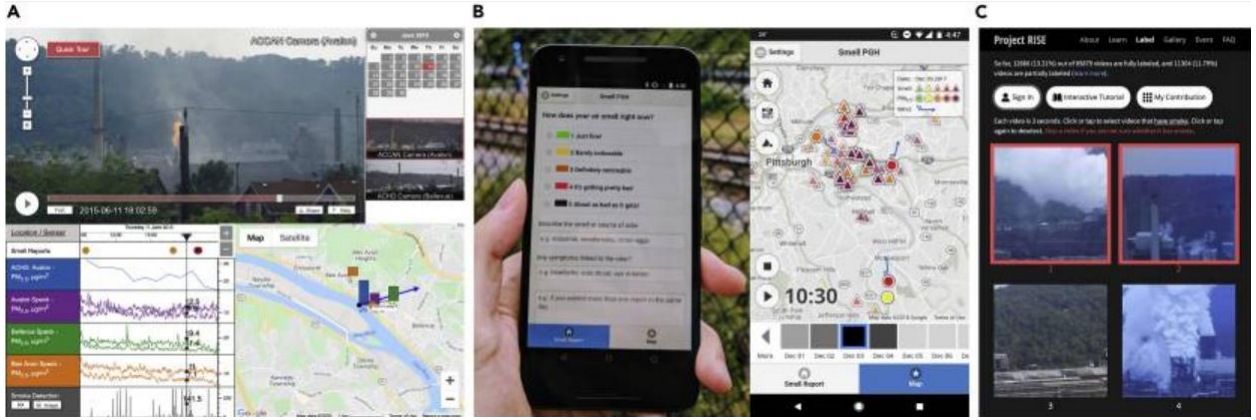


https://www.tonybates.ca/2014/10/01/the-role-of-communities-of-practice-in-a-digital-age/
https://opentextbc.ca/teachinginadigitalage/chapter/6-7-experiential-learning/

Learning Communities

Empowering communities using artificial intelligence

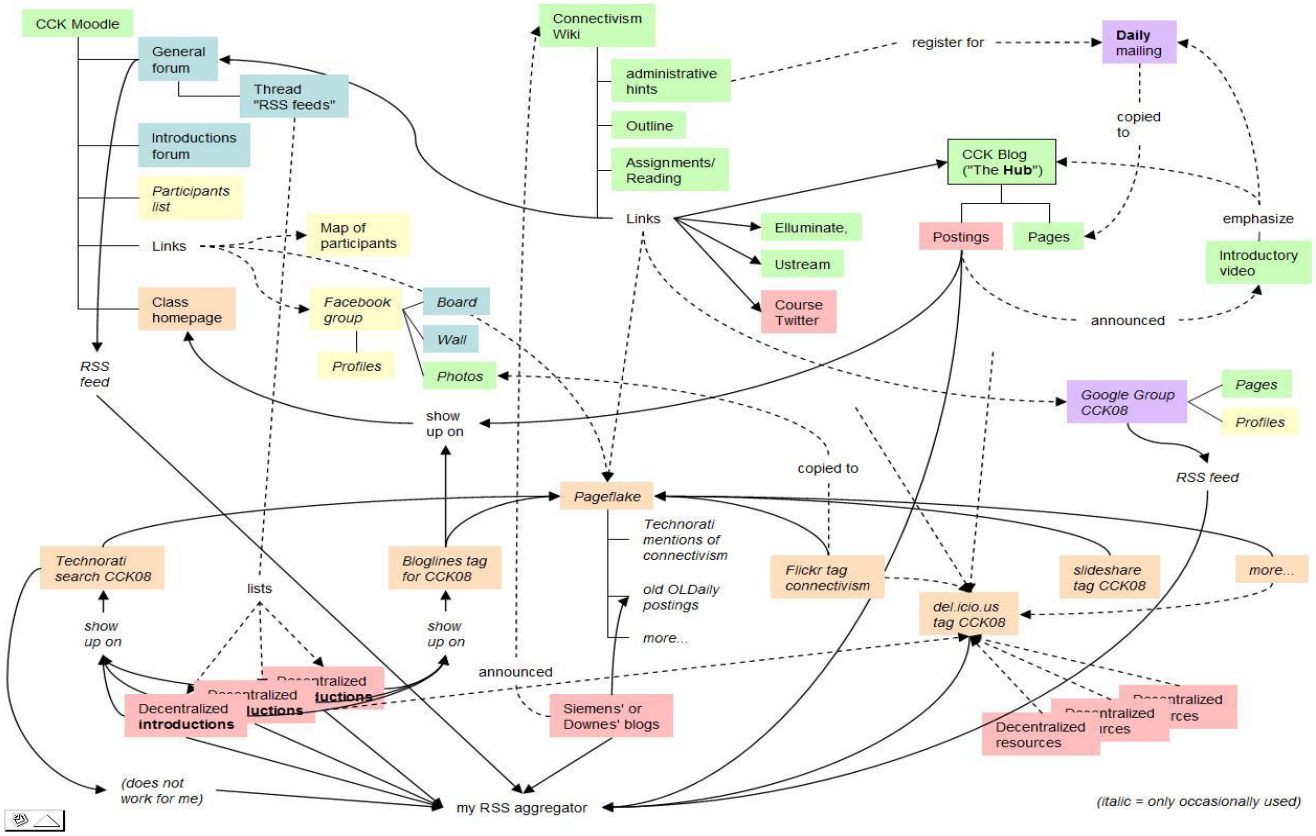
- Co-designing AI systems with local communities
- Collecting and explaining community data using AI
- Adapting AI systems to long-term social changes



https://pmc.ncbi.nlm.nih.gov/articles/PMC9058901/

Personal Learning Environments

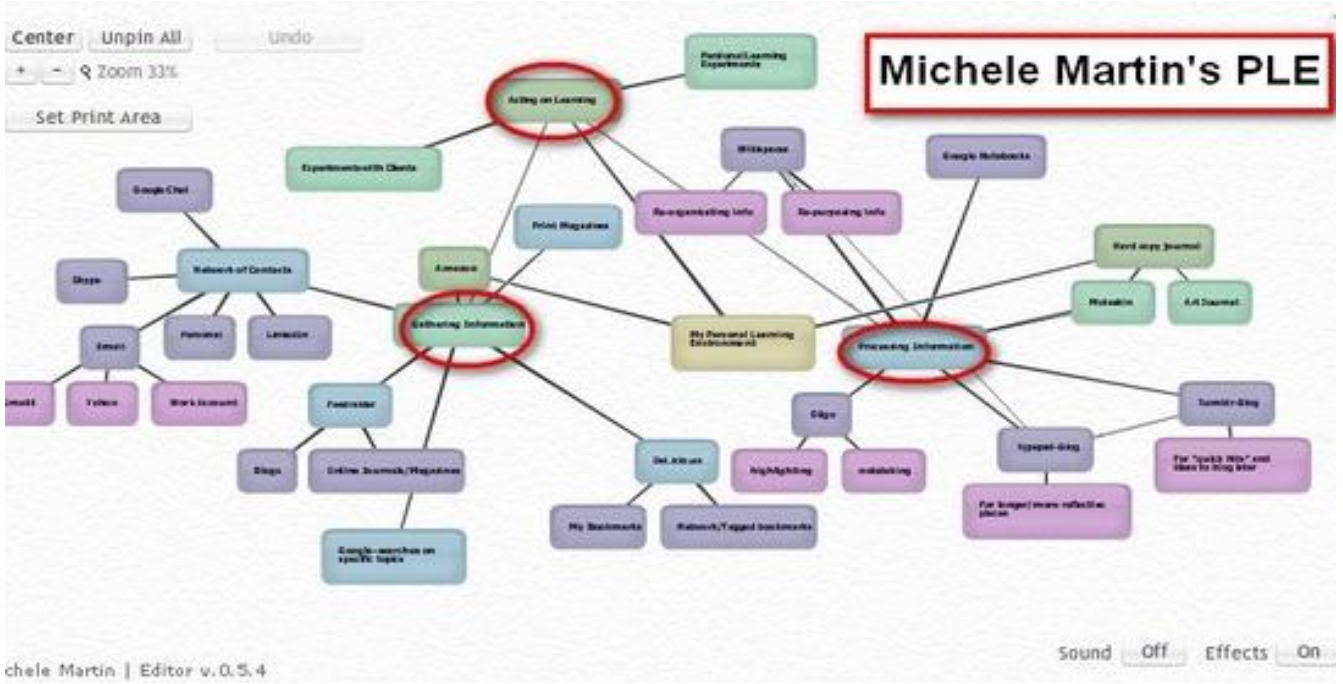
A network of personal learning environments creates a ‘borderless MOOC’



http://x28newblog.blog.uni-heidelberg.de/2008/09/06/cck08-first-impressions/

Personal Learning Environments

Creating our own data and learning networks

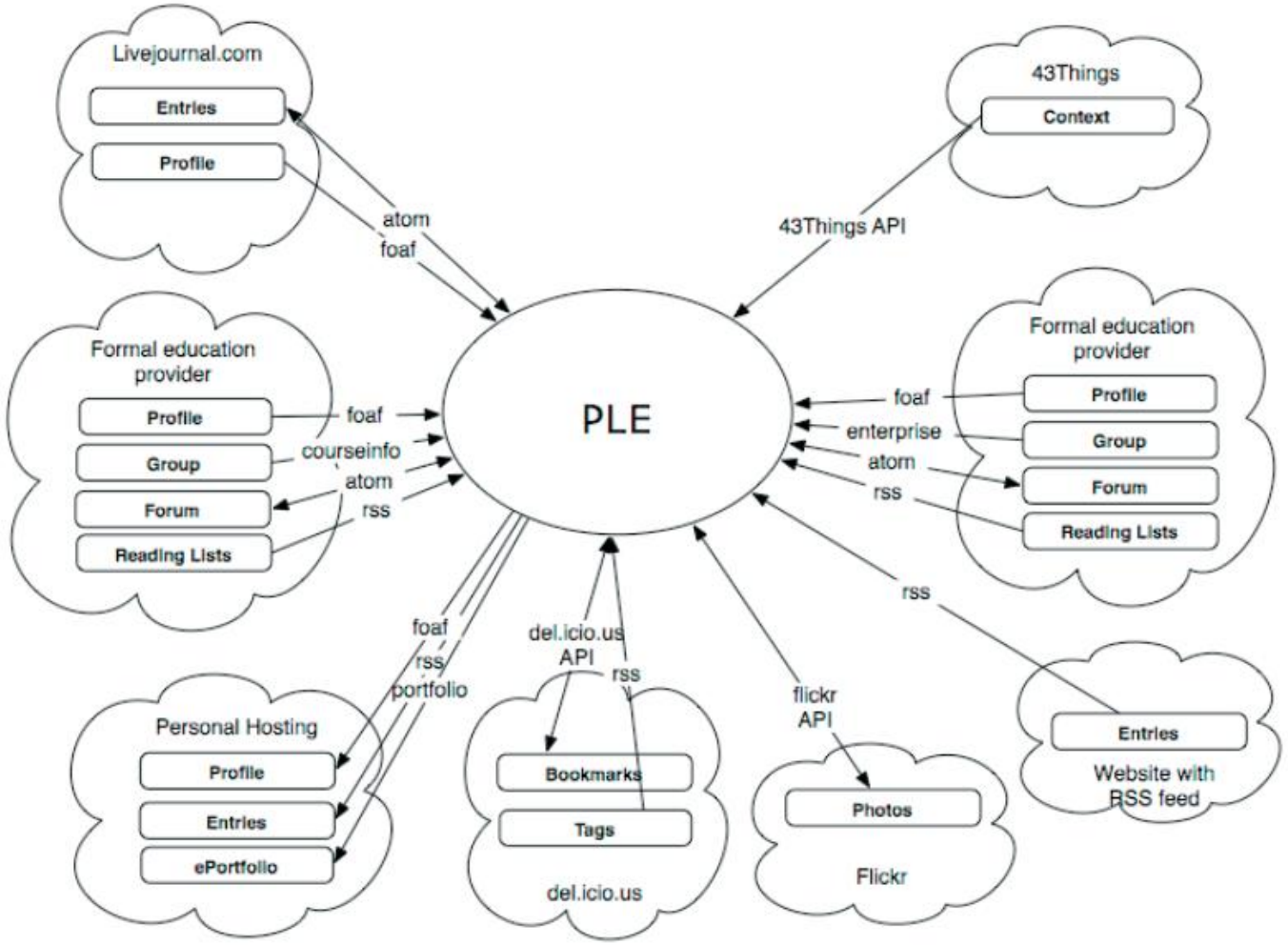


http://www.downes.ca/post/58150

http://dmlcentral.net/blog/howard-rheingold/diy-u-interview-anya-kamenetz

Personal Learning Environments

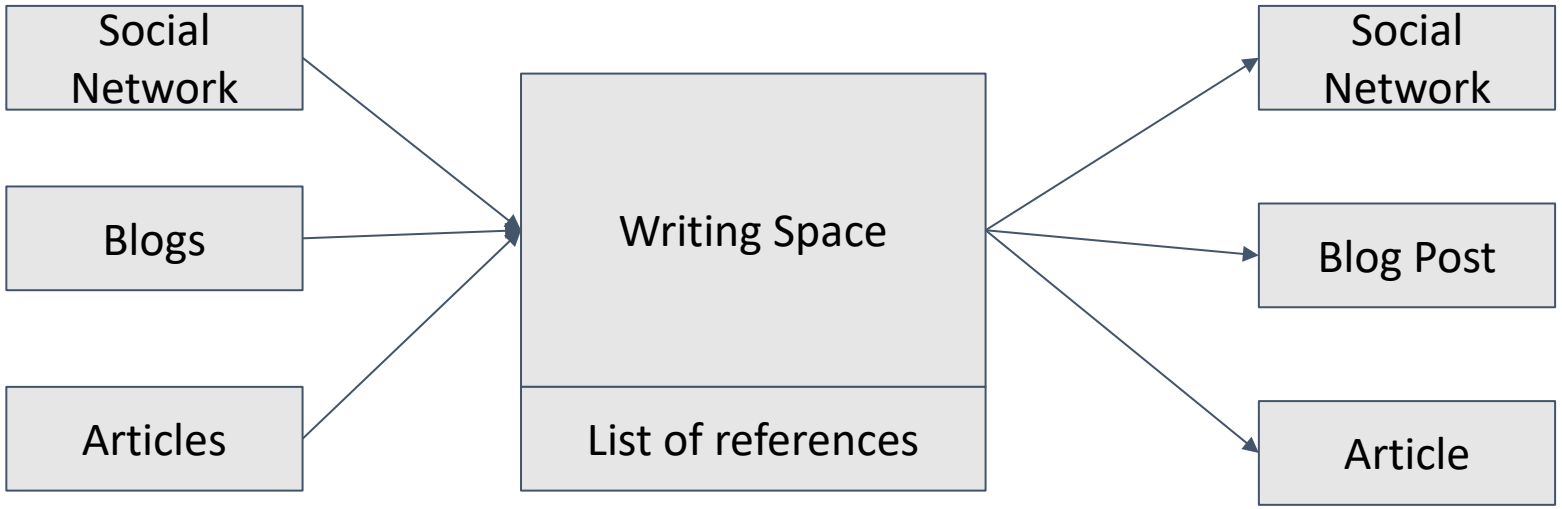
The prototypical model



https://www.je-lks.org/ojs/index.php/Je-LKS_EN/article/view/29

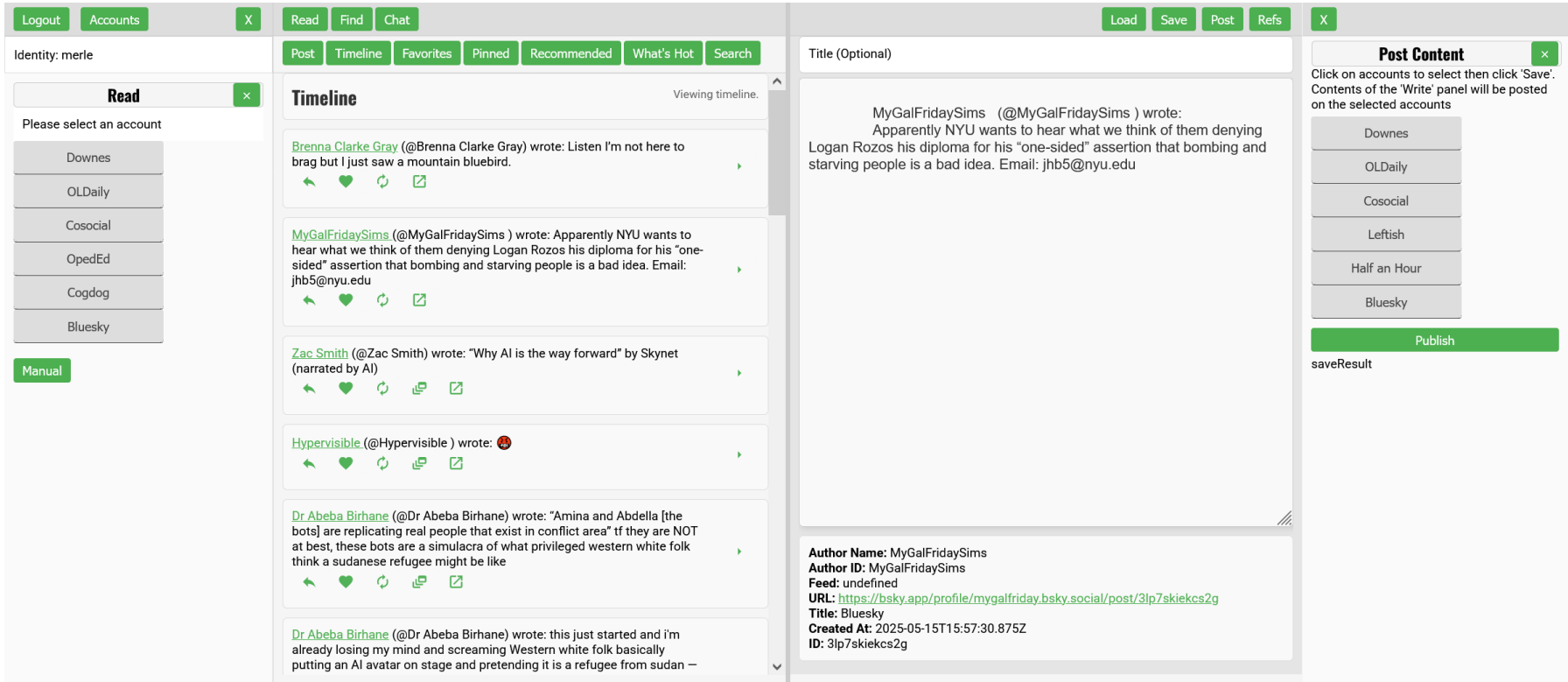
Personal Learning Environments

My approach



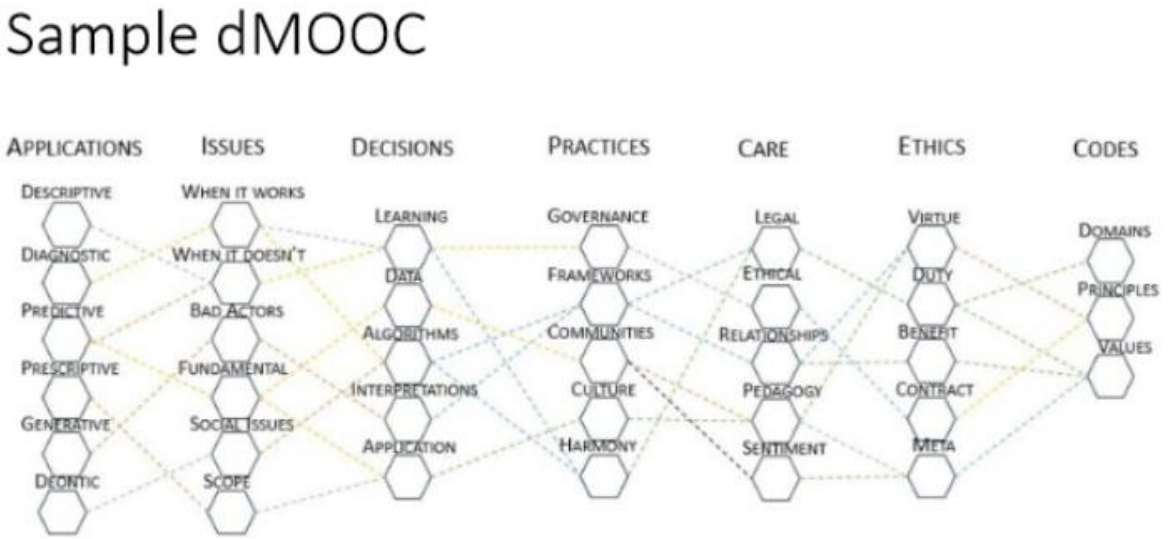
Personal Learning Environments

Clist – https://ple.mooc.ca



Core Skills

Data/AI literacy models



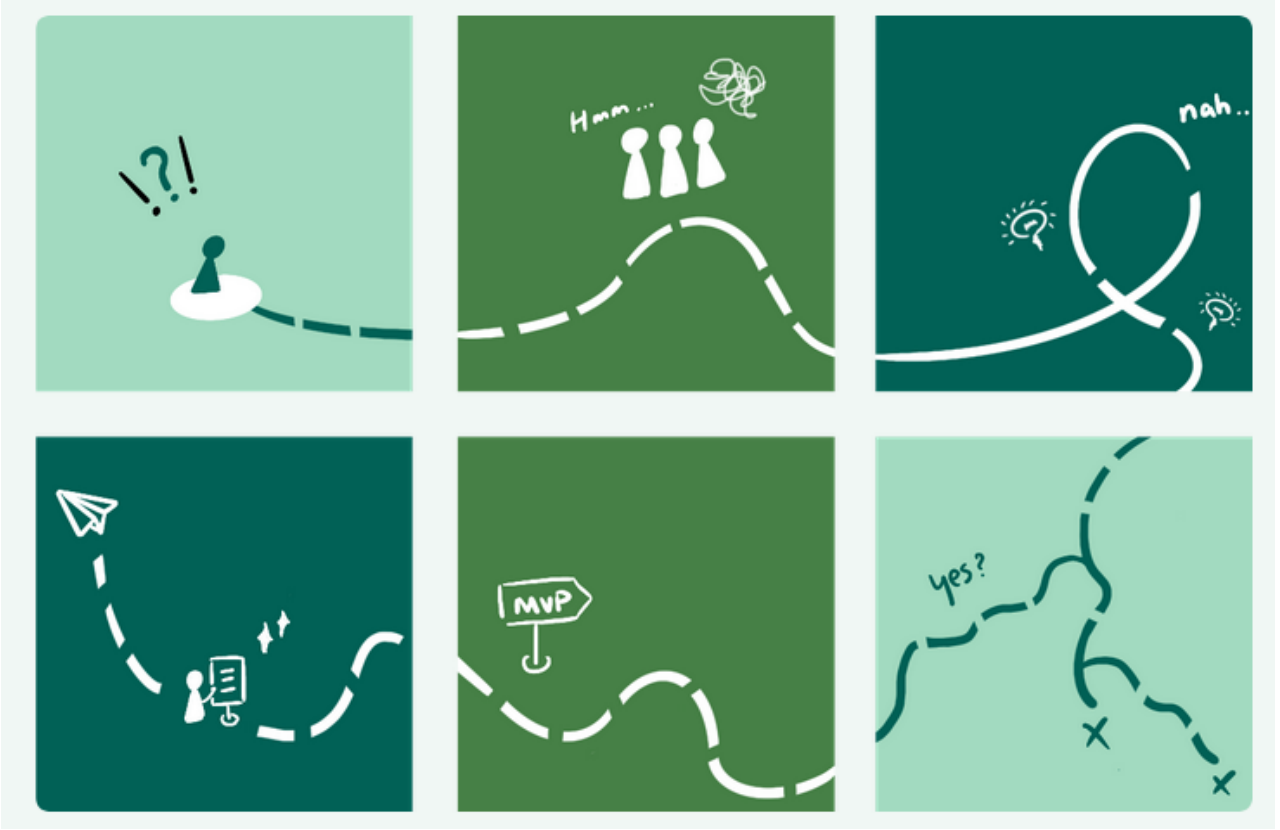
- Data stewardship model
- Analysis and decision-making model
- Information literacy model
- Science and research data literacy model
- Social engagement model

https://www.downes.ca/cgi-bin/page.cgi?presentation=574

Core Skills

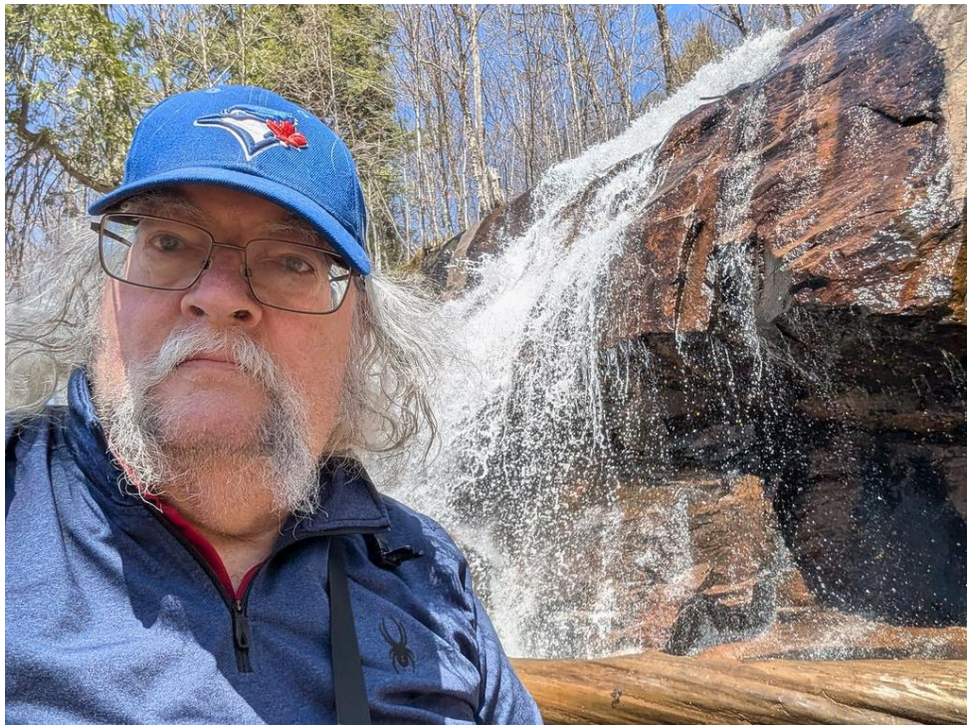
Activities and inspiration

- Consider the broader implications & thoughtful use
- Preserve learning and authentic voice
- Embrace play and experimentation
- Practice strategic iteration



https://creativecomputing.gse.harvard.edu/genai/

Thank you



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https://www.downes.ca