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April 27, 2021

Connectivism

https://www.downes.ca/presentation/547

Outline

1. What is connectivism?
2. How Does Learning Occur?
3. Interpreting Connectivism

1. What is Connectivism?

What is Learning?

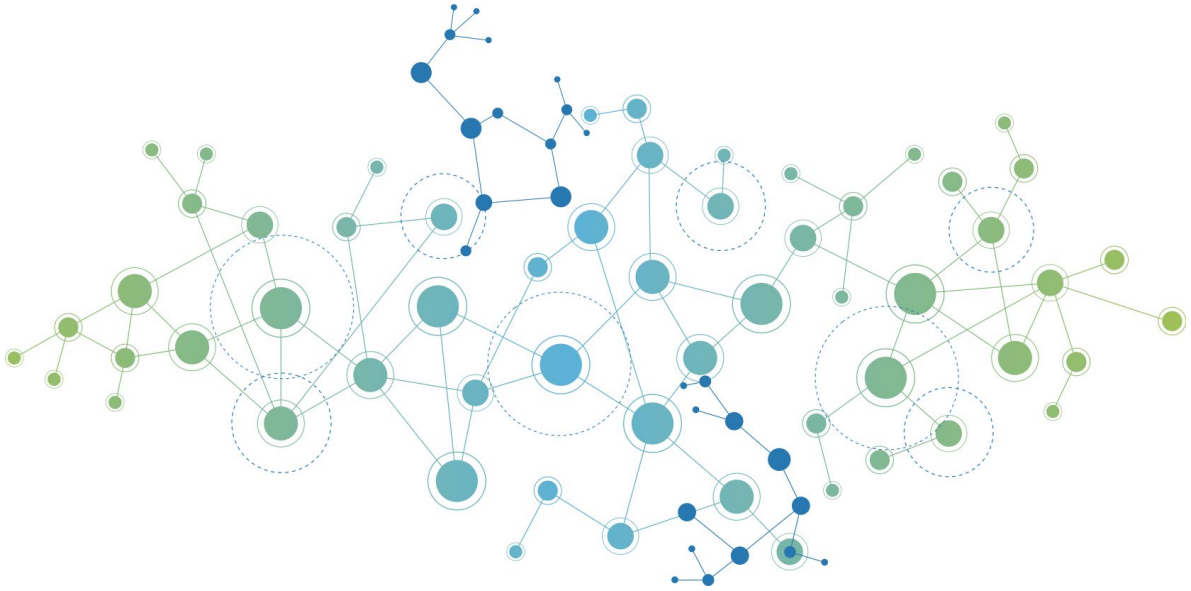
- A change in **human disposition** or capability (Gagne)
- A change in a **person's knowledge** or behavior due to experience (Mayer)
- A transformative process of **taking in information** (Bingham & Conner)
- The **acquisition and mastery** of what is already known about something (Smith)
- **Acquiring knowledge** and skills and having them readily available (Brown, et.al.)

Black Box Theories

- Connectivism seeks to look inside the black box to see *exactly* what is happening
- It seeks to describe the physical (chemical and biological) processes that underlie learning

What Is Connectivism?

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



Connectivist Account of Learning

- When I say of connectivism that 'learning is the formation of connections in a network' I mean this quite literally.
- The sort of connections I refer to are between *entities* (or, more formally, 'nodes').
- I define a connection as follows (other accounts may vary): "A connection exists between two entities when a change of state in one entity can cause or result in a change of state in the second entity.“

What is It To Learn?

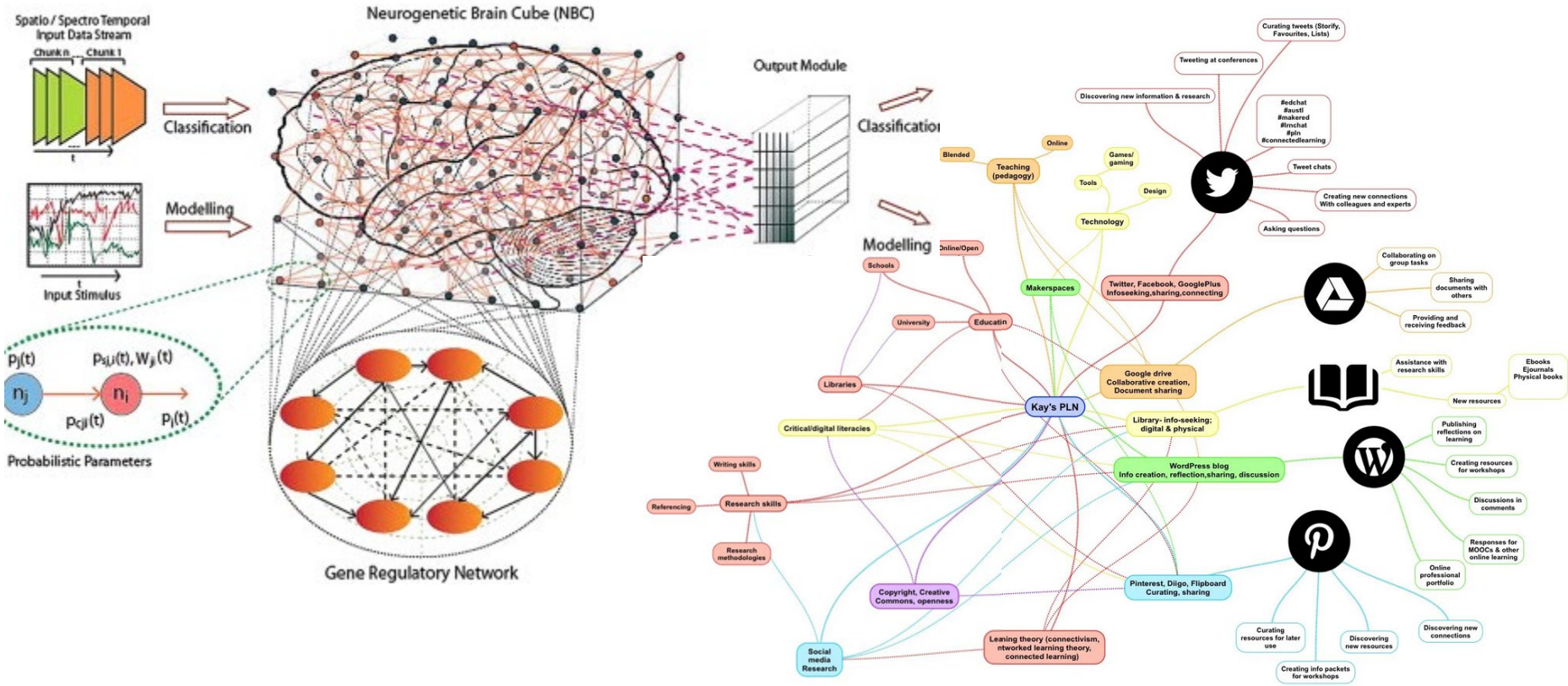
‘Learning’ is a thing that networks do, and consists specifically of some or all of the following:

- Addition or subtraction of nodes
- Addition or subtraction of connections

  (These are known as ‘plasticity’)
- Changes in the properties of nodes or connections

Connectivism can also be thought of as a way of thinking and talking about this way of learning

Things that Learn



Personal Learning
(Polanyi)

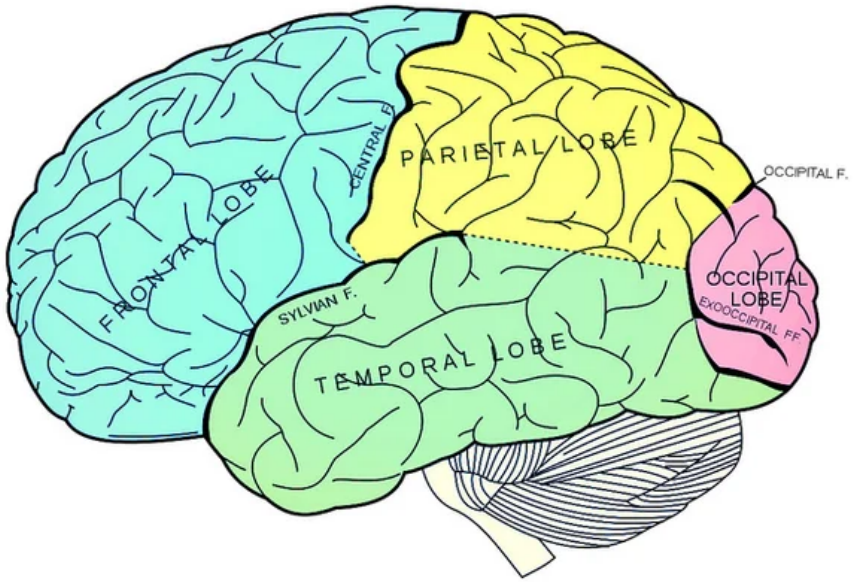
Social Learning
(Wittgenstein)

George's Principles

- Learning and knowledge rest in a diversity of opinions.
- Learning is a process of connecting specialized nodes or information sources.
- Learning may reside in non-human appliances.
- [The] capacity to know more is more critical than what is currently known.
- Nurturing and maintaining connections is needed to facilitate continual learning.
- [The] ability to see connections between fields, ideas, and concepts is a core skill.
- Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.
- Decision-making is a learning process.

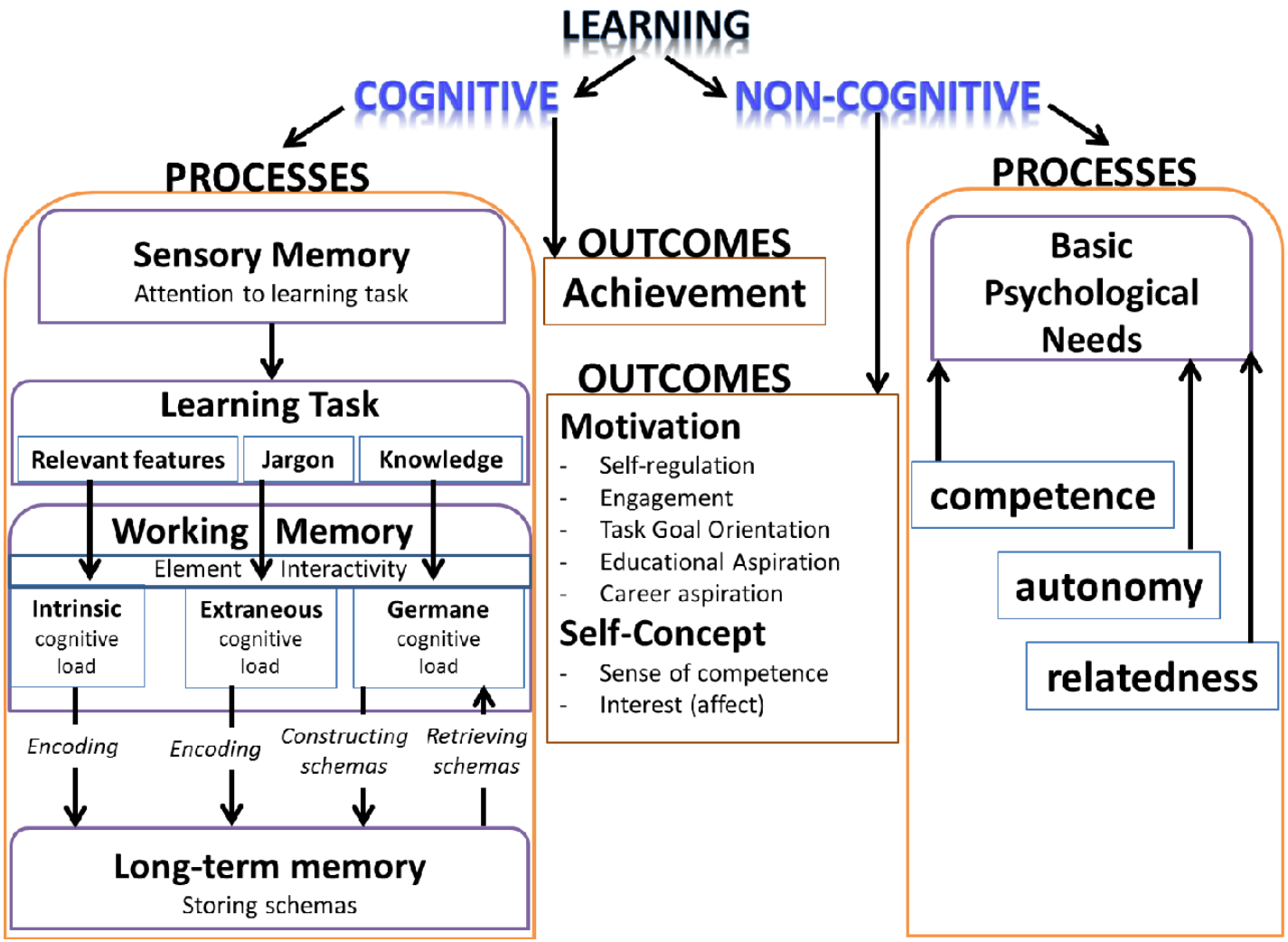
The Brain is not a Book or Library

Connectivism shares with some other theories a core proposition, that knowledge is not acquired, as though it were a thing.



This distinguishes it from content-based or information-theoretic theories of learning, like instructivist (Kirshener), and transactional distance (M.G. Moore) theories.

Connectivism is Non-Cognitivist



The Brain is Not a Computer

- What is it to 'construct an understanding' if it does not involve:
  - a representational system, such as language, logic, images, or some other physical symbol set (ie., a semantics)
  - rules or mechanisms for creating entities in that representational system (ie., a syntax)?

"Whereas computers do store exact copies of data – copies that can persist unchanged for long periods of time, even if the power has been turned off – the brain maintains our intellect only as long as it remains alive. There is no on-off switch. Either the brain keeps functioning, or we disappear." – Epstein

Connectionism = non-representational

- In connectivism, there is no real concept of transferring knowledge, making knowledge, or building knowledge.
- The activities we undertake when we conduct practices in order to learn are more like growing or developing ourselves and our society in certain (connected) ways.

2. How Does Learning Occur?

Overview

The question of how learning occurs is the question of how connections are formed between entities in a network. There is a deep and rich literature on this topic, under the heading of (not surprisingly) 'learning theory', though most of it is published outside the domain of education.

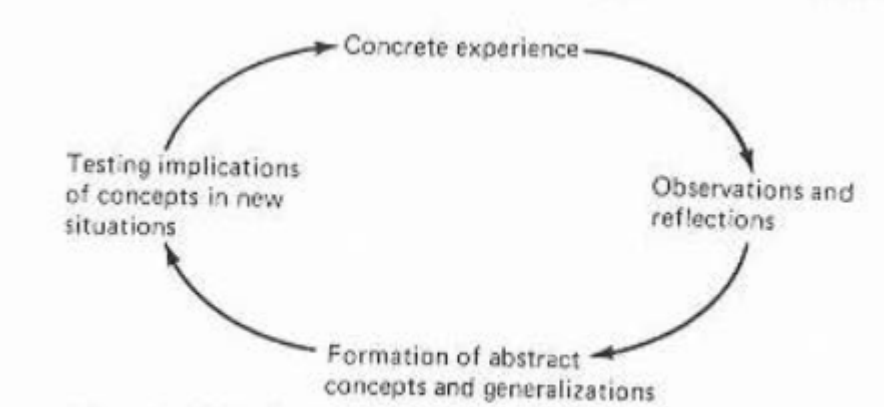


Figure 2.1 The Lewinian Experiential Learning Model

Kolb, 1984

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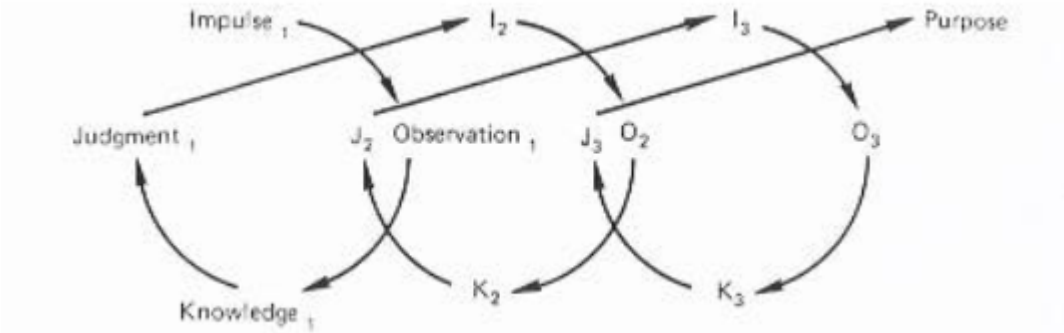

Figure 2.2 Dewey's Model of Experiential Learning

Kolb, 1984

Overview

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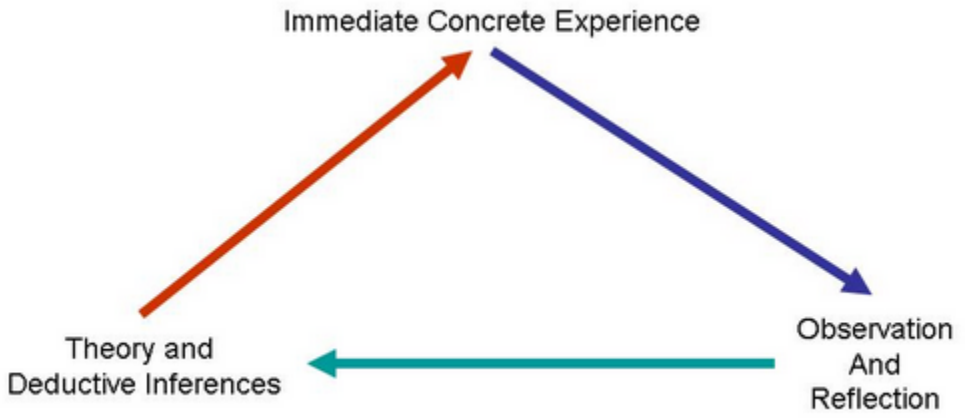
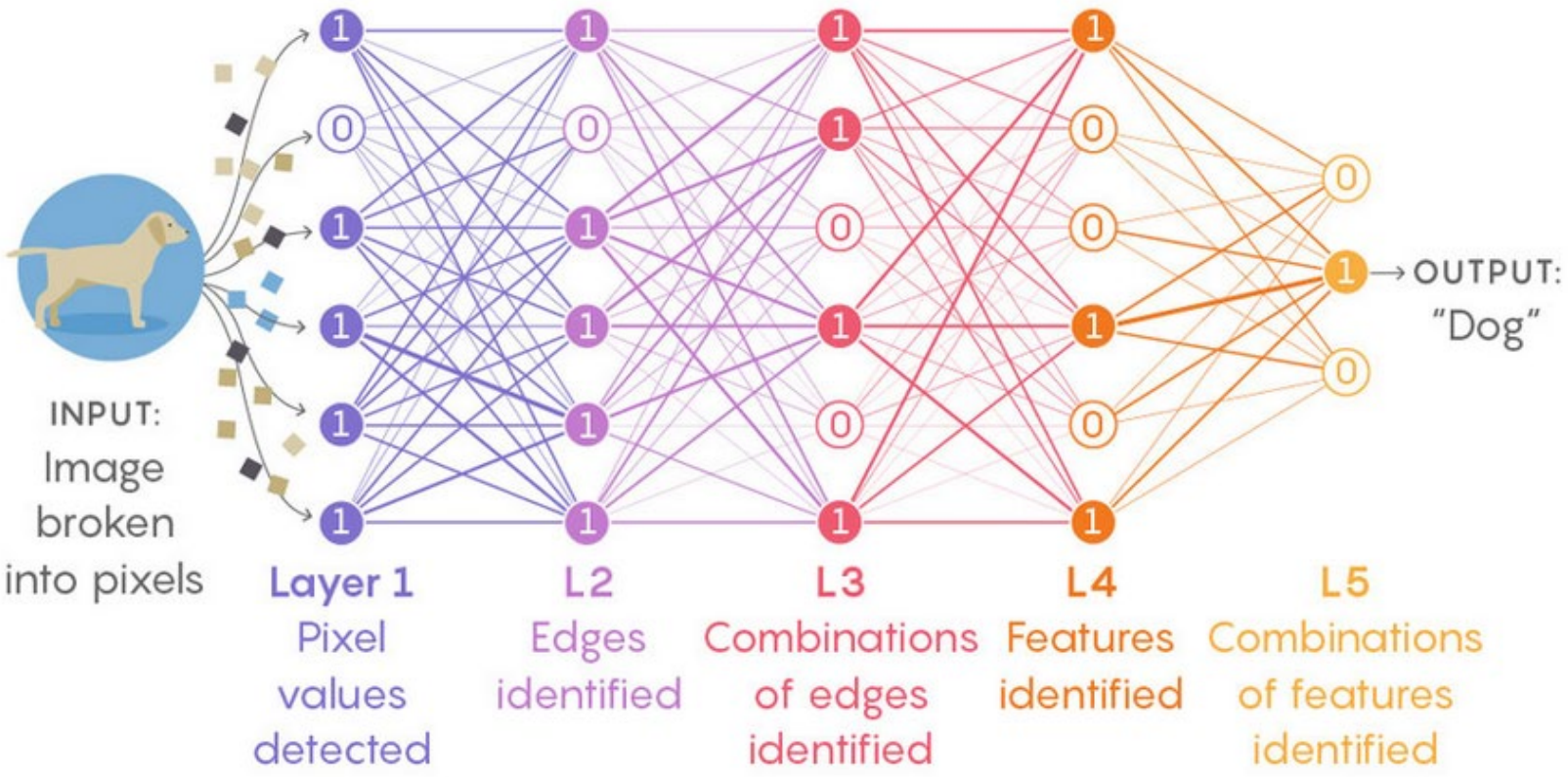


Kolb, 1984

Neural Networks



George's Networks

George Siemens describes networks as having the following characteristics or elements:

- Content (data or information)
- Interaction (tentative connection forming)
- Static nodes (stable knowledge structure)
- Dynamic nodes (continually changing based on new information and data)
- Self-updating nodes (nodes which are tightly linked to their original information source)
- Emotive elements (emotions that influence the prospect of connection and hub formations).

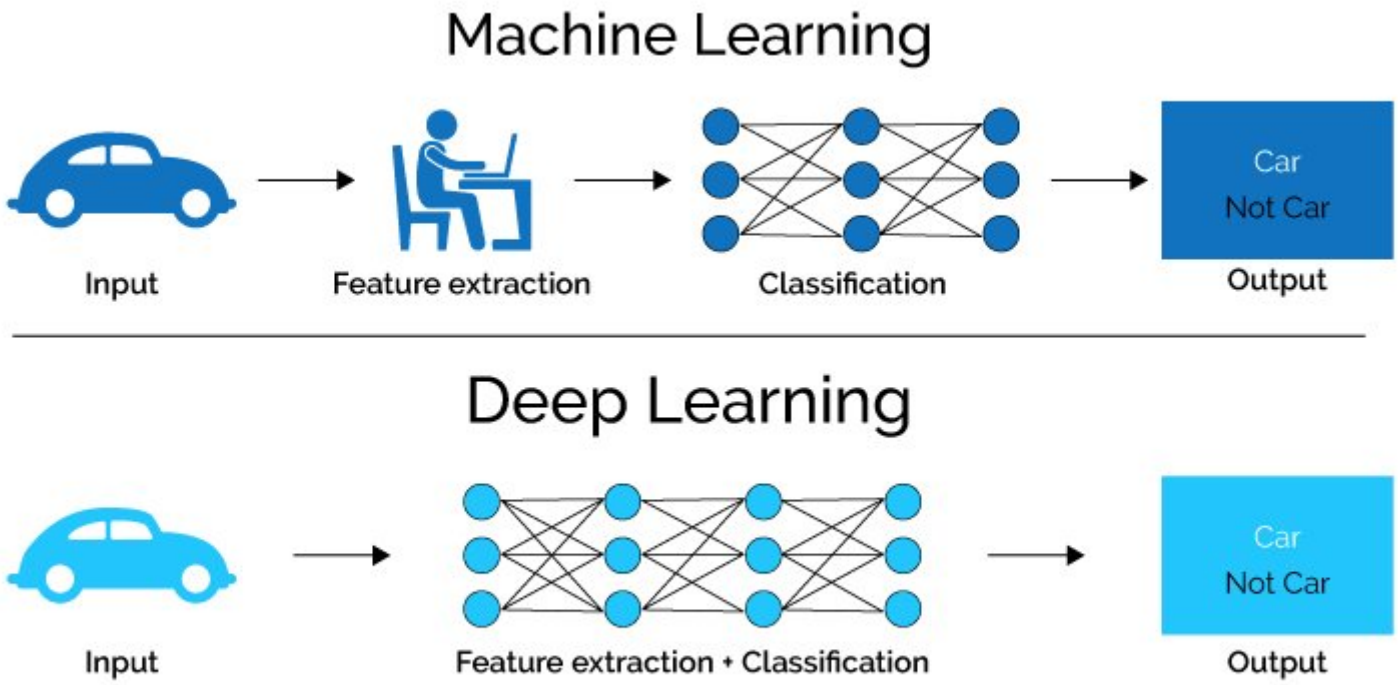
Categories of Learning Theory

In my talks I've presented four major categories of learning theory

- *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.

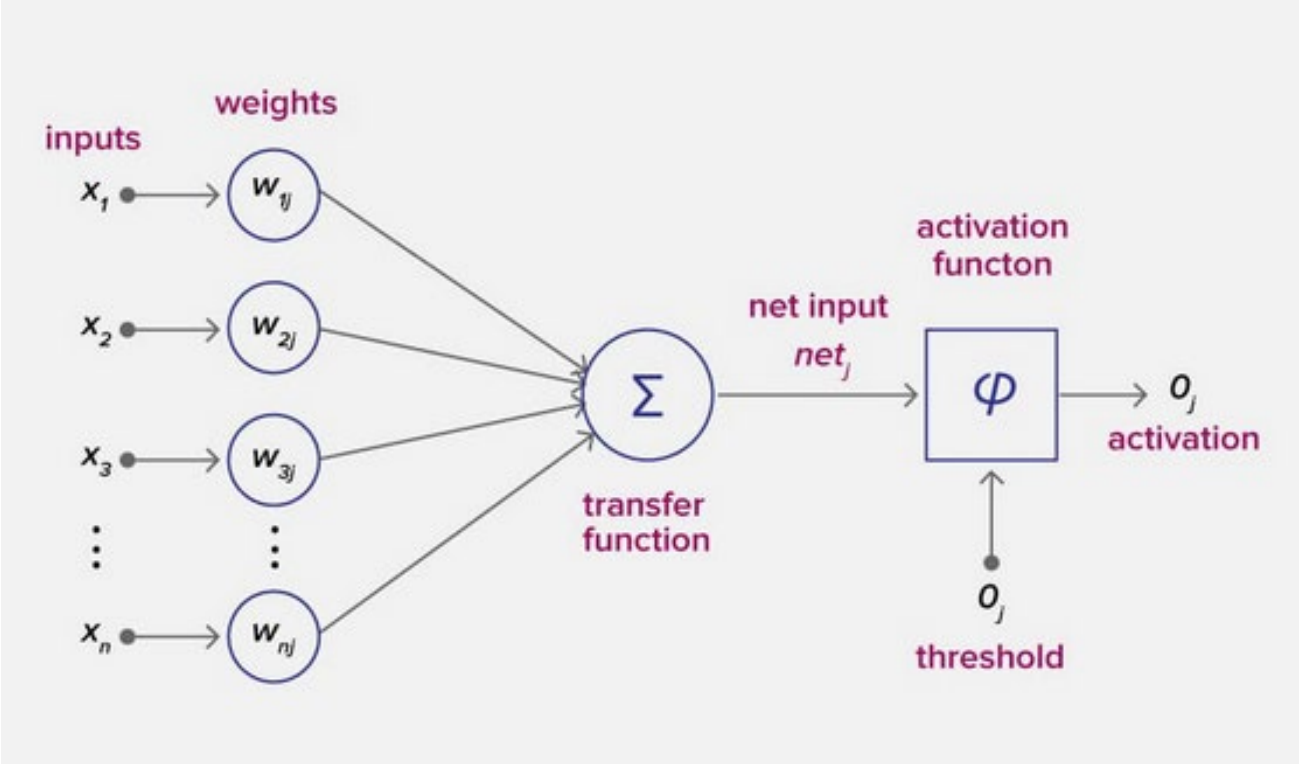
Machine & Deep Learning



Successful Networks

Properties of networks

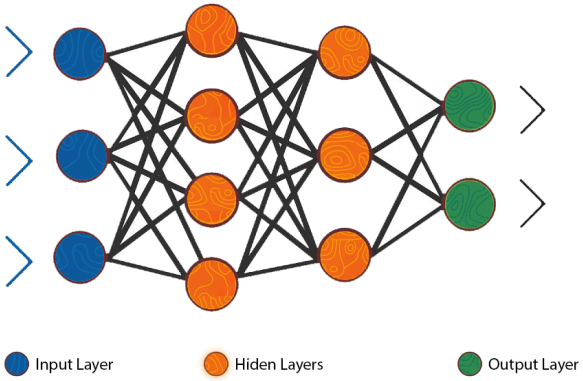
Properties of Neurons

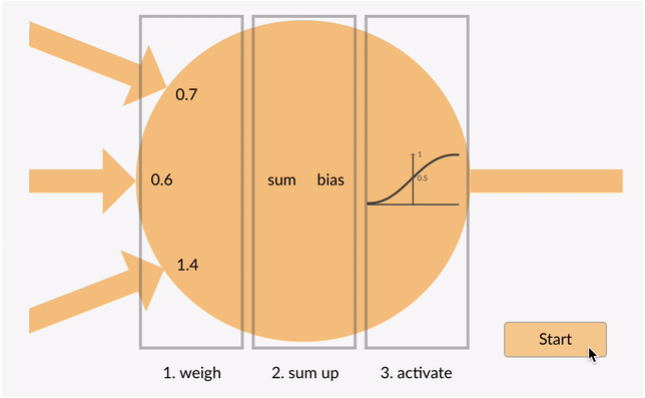


https://serokell.io/blog/deep-learning-and-neural-network-guide

Properties of networks

Feed-Forward Neural Network (Perceptron) (ANN)





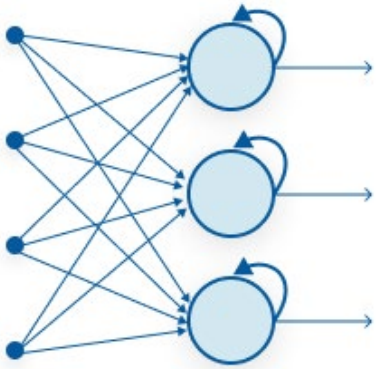
ANN can be used to solve problems related to:

- Tabular data
- Image data
- Text data

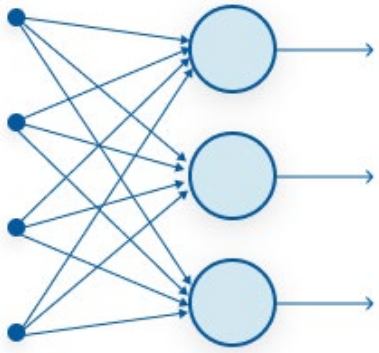
The network only learns the linear function and can never learn complex relationships.

Properties of networks

Recurrent Neural Network (RNN)



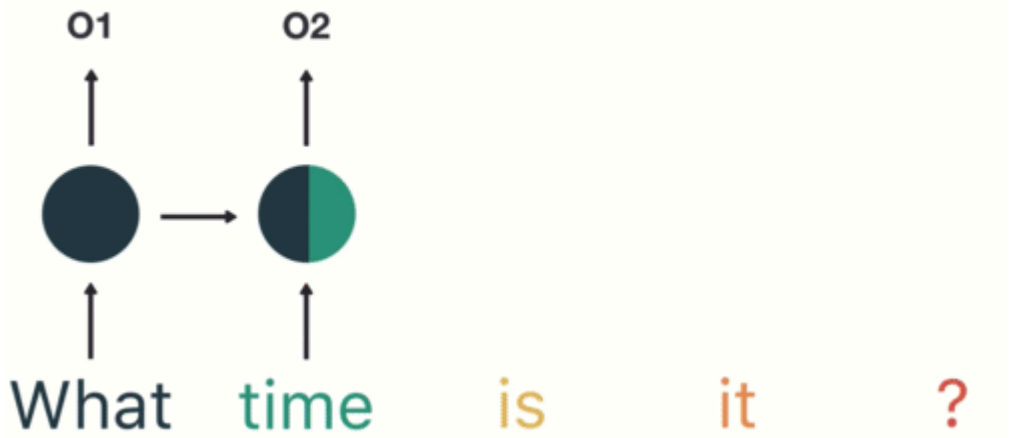
Recurrent Neural Network



Fee

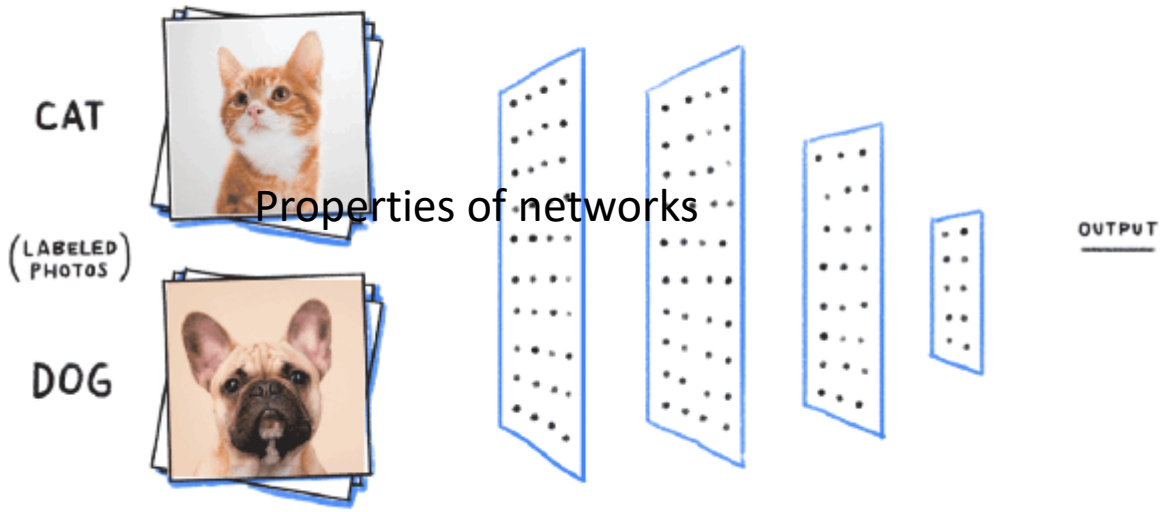
We can use recurrent neural networks to solve the problems related to:

- Time Series data
- Text data
- Audio data



Properties of networks

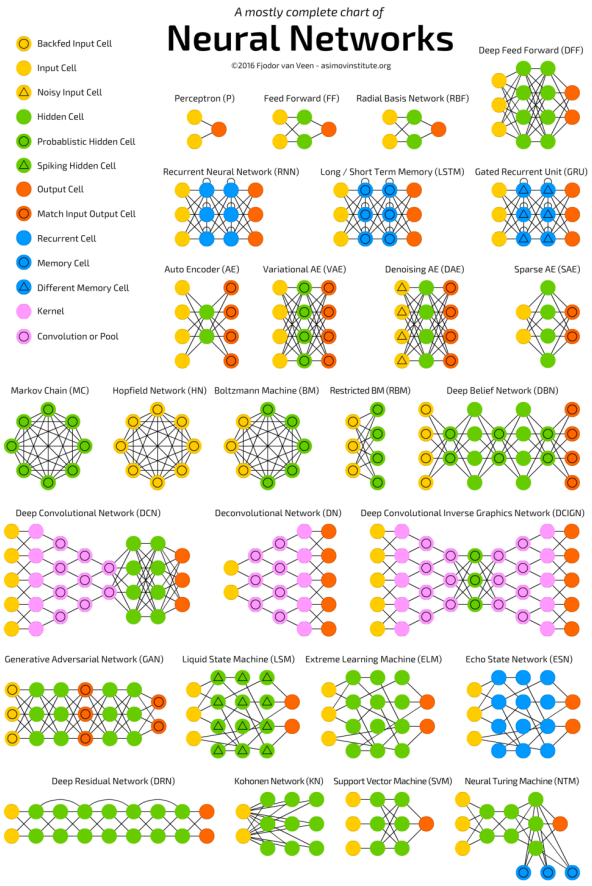
Convolution Neural Network (CNN)



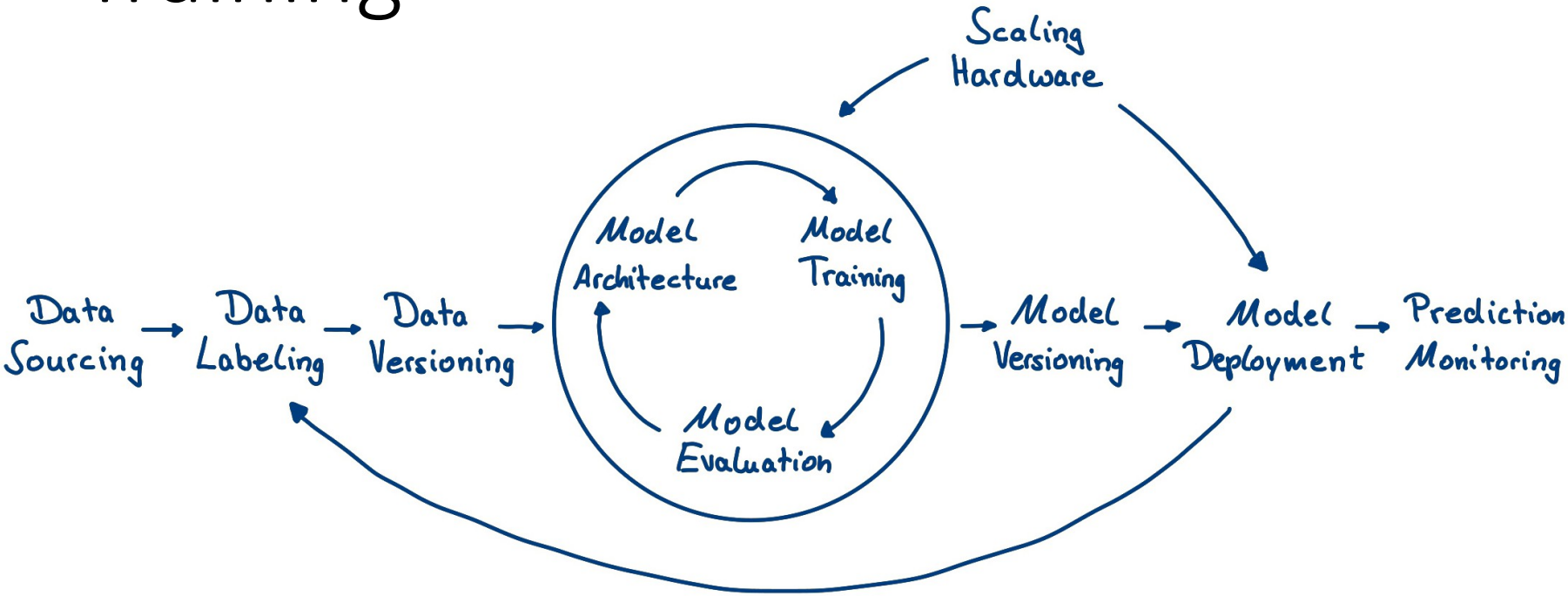
Properties of networks

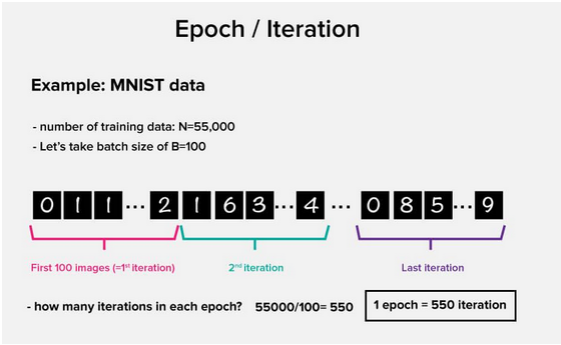
CNN captures the **spatial features** from an image. Spatial features refer to the arrangement of pixels and the relationship between them in an image.

Even More Networks



Training


Scaling
Hardware
Data
Sourcing
Data
Labeling
Data
Versioning
Model
Architecture
Model
Training
Model
Evaluation
Model
Versioning
Model
Deployment
Prediction
Monitoring


Epoch / Iteration
Example: MNIST data
- number of training data: N=55,000
- Let's take batch size of B=100
0 1 1 ··· 2 1 6 3 ··· 4 ··· 0 8 5 ··· 9
First 100 images (=1st iteration)
2nd iteration
Last iteration
- how many iterations in each epoch? 55000/100= 550
1 epoch = 550 iteration

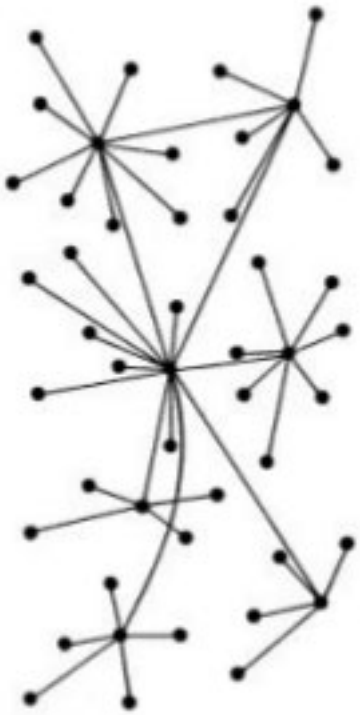
Network Design Principles

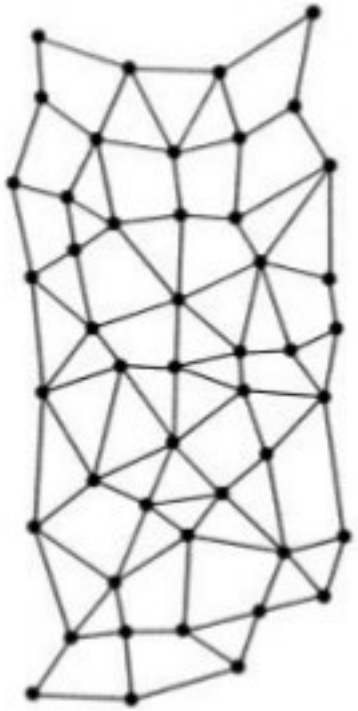
- Specifies how networks differ from traditional learning
- The idea is that each principle confers an *advantage* over non-network systems
- Can be used as a means of evaluating new technology

Decentralize

- Centralized networks have a characteristic ‘star’ shape
  - Some entities have many connections
  - The vast majority have few
  - Eg., broadcast network, teacher in a classroom
- Decentralized networks form a mesh
  - The weight of connections, flow is distributed
  - Balanced load = more stable
  - Foster connections between entities, ‘fill out’ the star

Groups vs Networks

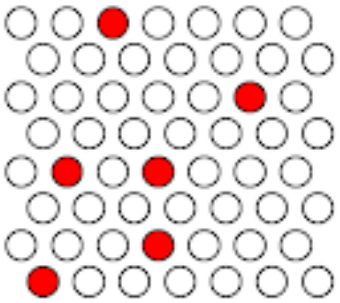




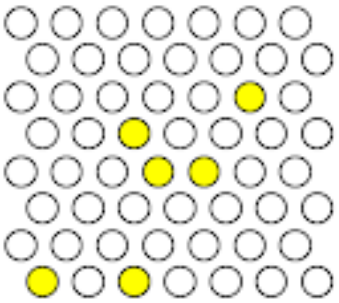
Distribute

- Network entities reside in different physical locations
  - Reduces risk of network failure
  - Reduces need for major infrastructure, such as powerful servers, large bandwidth, massive storage
- Examples:
  - Peer-to-peer networks, such as Kazaa, Gnutella
  - Content syndication networks, such as RSS
- Emphasis is on *sharing,* not copying
  - ‘Local’ copies are temporary

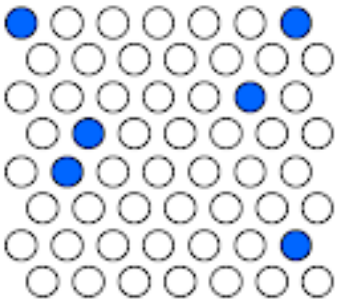
Distributed Representation



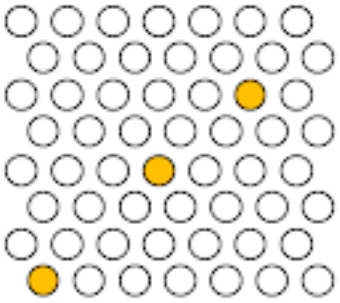
Cat



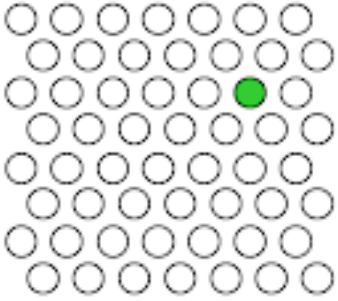
Dog



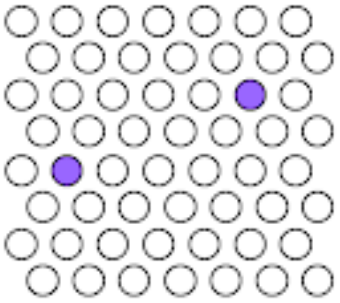
Fish



Cat ∩ Dog



Dog ∩ Fish



Cat ∩ Fish

Disintermediate

- Mediation – barrier between source and receiver
- Examples:
  - Editors, peer review prior to publication
  - Traditional media, broadcasters
  - Teachers between knowledge and student
- Where possible, provide direct access
  - The purpose of mediation is to manage flow, not information
  - It is to reduce the volume of information, not the type of information

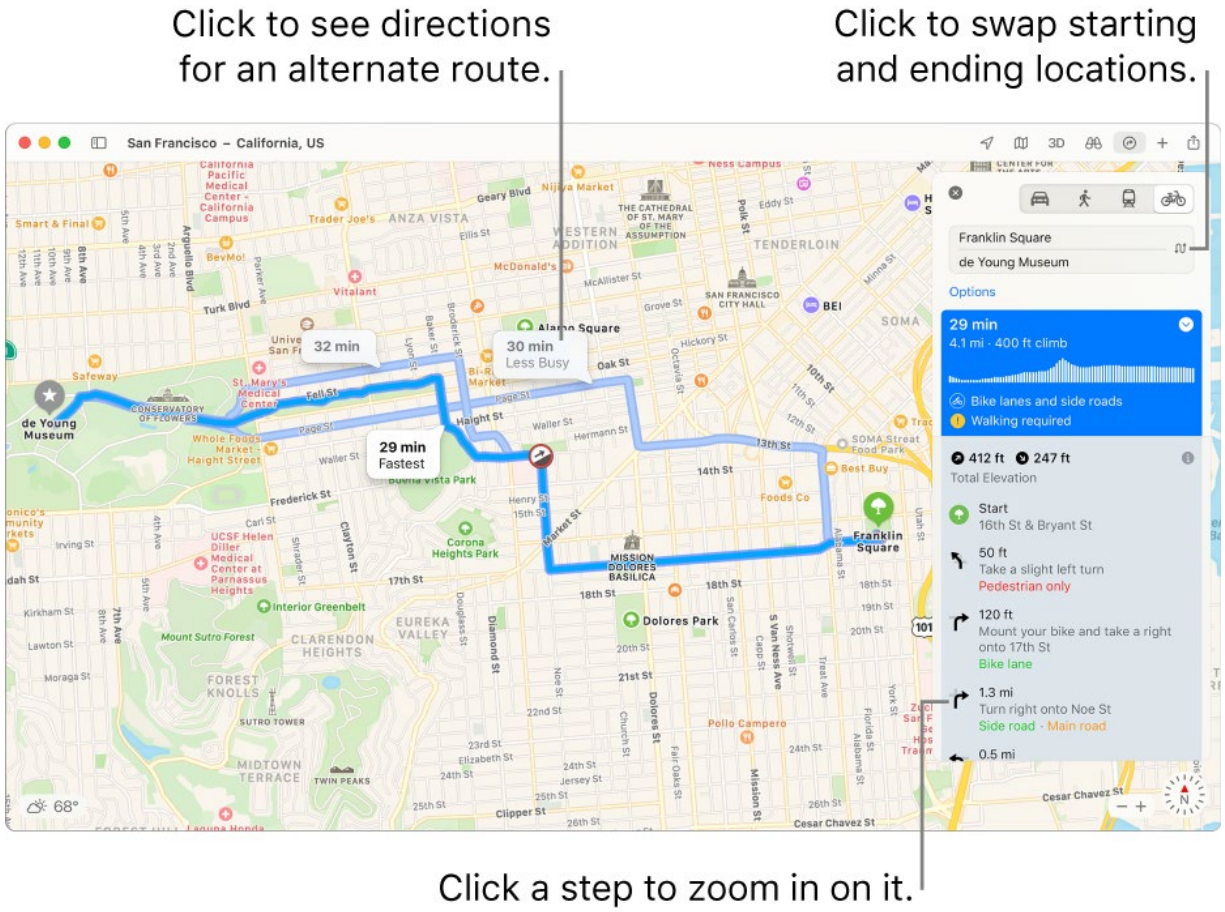
Disaggregate

- Units of content should be as small as possible
  - Content should not be ‘bundled’
  - Organization, structure created by receiver
  - Allows integration of new information with old
- This is the idea behind learning objects
  - smallest possible unit of instruction
  - Assembling into pre-packaged ‘courses’ defeats this

Dis-integrate

- Entities in a network are not ‘components’ of one another
  - Thus., eg. Plug-ins or required software to be avoided
- The structure of the message is logically distinct from the type of entity sending or receiving it
  - The message is coded in a common ‘language’
  - This code is open, not proprietary
  - No particular software or device is needed to receive the code
- This is the idea of standards, but:
  - Standards are not created, they evolve
  - Standards adopted by agreement, not requirement

Maps vs Stories



Democratize

- Entities in a network are autonomous
  - Have the freedom to negotiate connections
  - Have the freedom to send, receive information
- Diversity is an asset
  - Diversity confers flexibility, adaptation
  - Diversity enables the network as a whole to represent more than just the part
- Control is Impossible
  - Even where control seems desirable, it is not practical
  - Creating control effectively destroys the network

The Semantic Condition

SAMENESS

Groups

Collectives

ONE WAY

SCHOOL CLASS

Metallic - Elemental

UNITY → VISION STATEMENT

SOMETIMES EVEN PURITY
MELTING POT

COORDINATION

LEADERS! COLLABORATION
GROUP VALUE
(= LEADER VALUE)

CLOSED → LOCK-IN

MEMBERSHIP / IN CAMERA
STANDARDS - JARGON
WALLS

DISTRIBUTIVE

AKA TRICKLE DOWN

BROADCAST
☆ STARS AND GURUS ☆
CENTRALIZED
POWER – POWER LAWS

KNOWLEDGE, LIKE MONEY, FLOWS FROM AUTHORITY

AFFINITY

Networks

Communities

MANY WAYS

Organic - Biological

DIVERSITY

MIXTURES
SALAD BOWL

AUTONOMY

COOPERATION
EXCHANGE
MUTUAL VA:UE

OPENNESS

CONNECTION
PERSPECTIVE / CONTEXT
BRIDGES

INTERACTIVE

CONVERSATION
DISTRIBUTED
DEMOCRACY (OR POST-DEMOCRACY)
→ KNOWLEDGE EMERGES

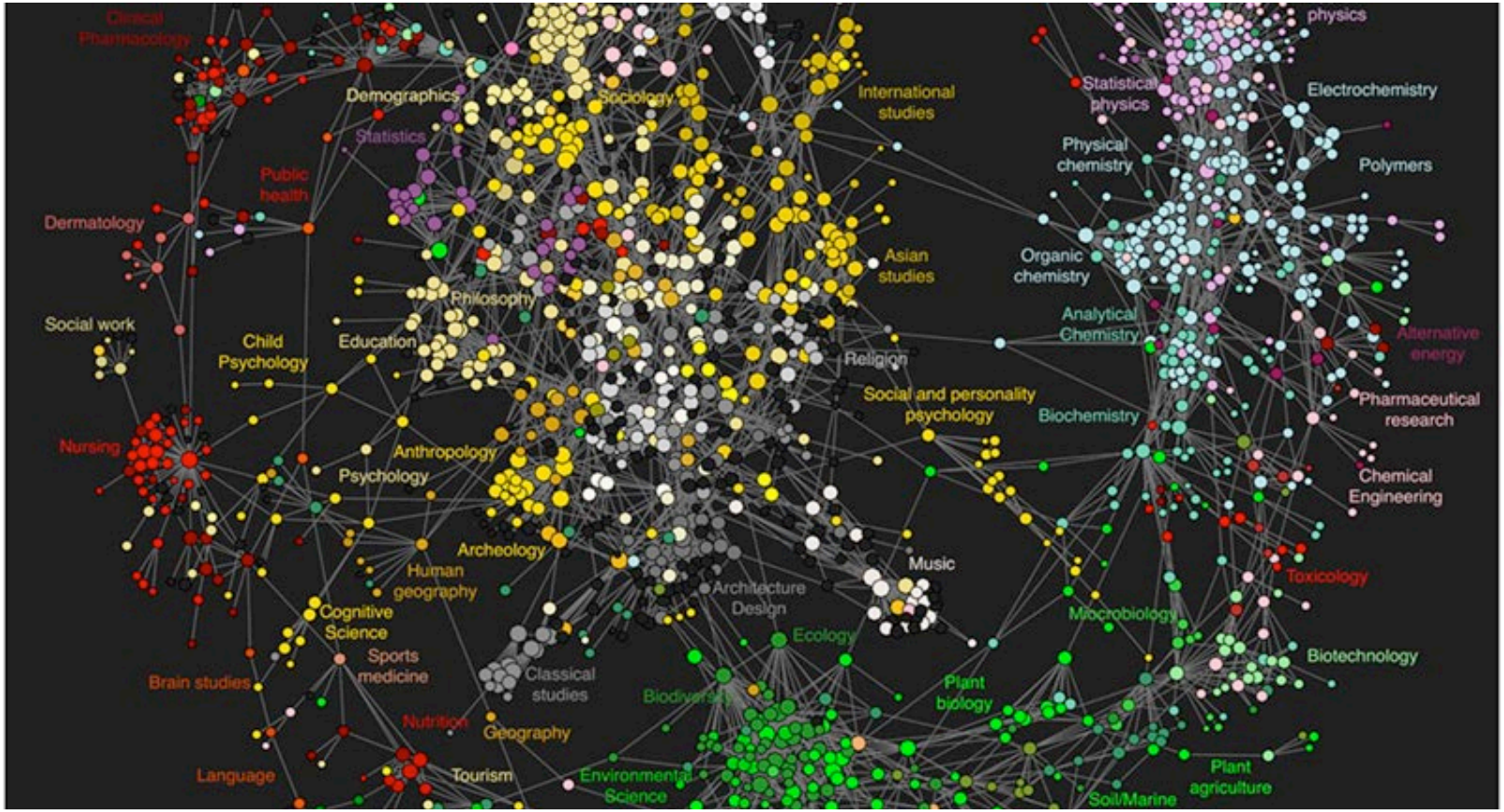
Dynamize

- A network is a fluid, changing entity
  - Without change, growth, adaptation are not possible
  - It is through the process of change that new knowledge is discovered
- The creation of connections is a core function

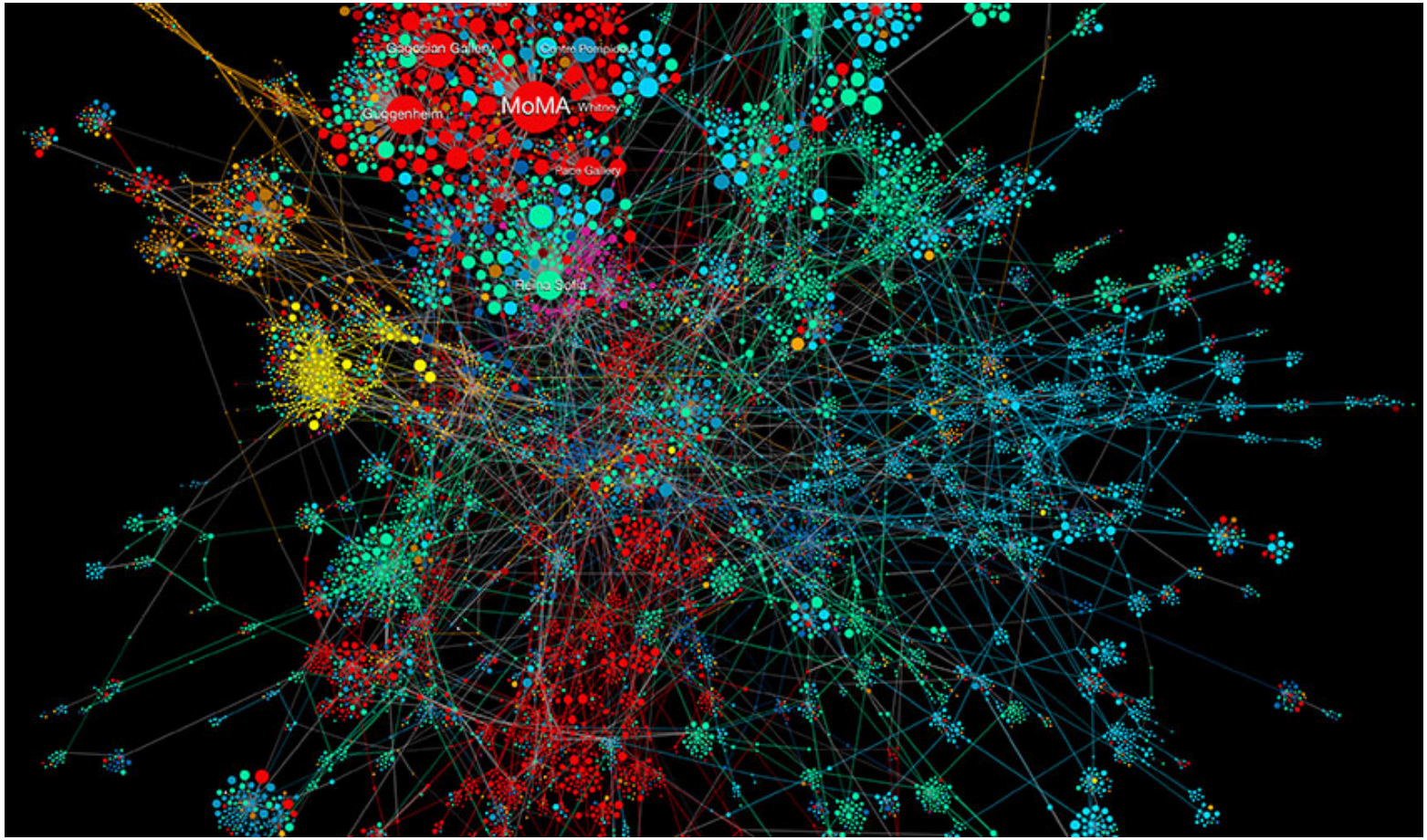
Desegregate

- Example: Learning is not a Separate Domain
  - Do not need learning-specific tools, processes
  - Learning is a *part* of living, of work, of play
  - The *same* tools we use to perform day-to-day activities are the tools we use to learn
- The Network as Infrastructure
  - Computing, communicating, not something we ‘go some place to do’
  - The idea of network resources as a utility, like electricity, like water, like telephones – the network is everwhere

The Web of Science



The Art Network



3. Interpreting Connectivism

Parsimony

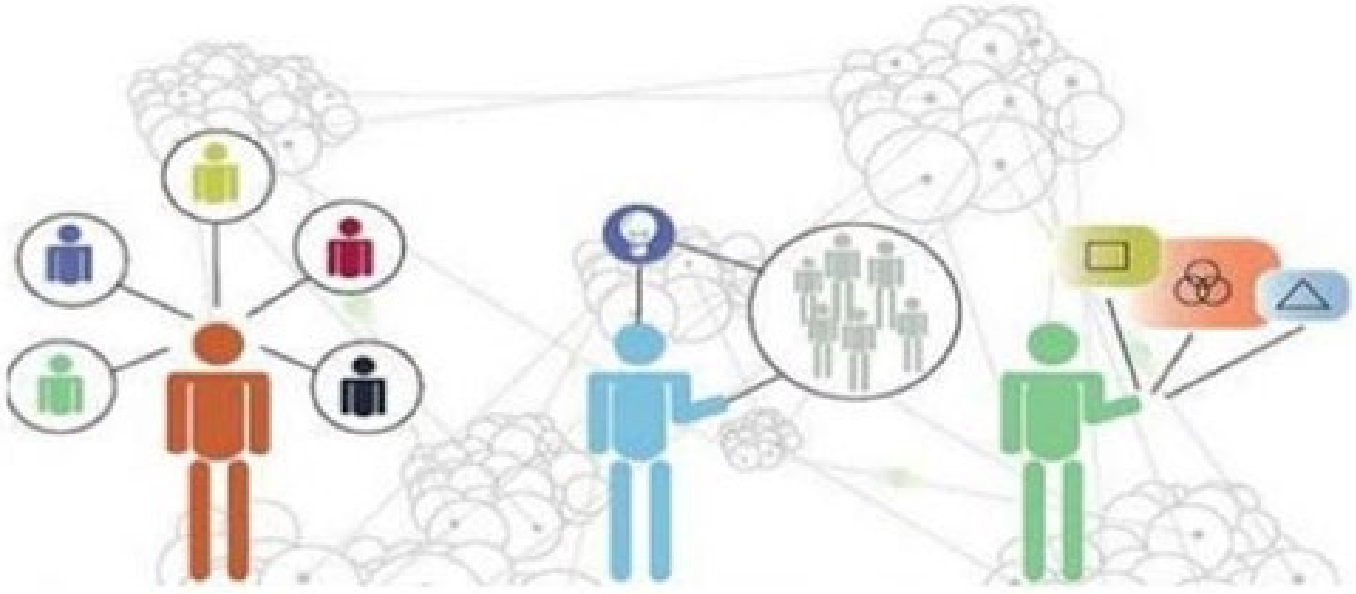
- Network theory is established in multiple domains
  - Foundation in mathematics, as graph theory
  - Computer science – connectionism and neural networks
  - Biology – ecology and ecosystems
  - Sociology – social network analysis
  - Physiology – perception, neuroscience
  - Philosophy – information theory, distributed representation

Networks in the World

- Networks in nature, such as the murmuration
- Social organization, such as corporate networks, political networks
- Infrastructure, such as the electrical grid
- The internet, a worldwide information network
- Social networks, such as discussion boards, web sites, Facebook, Twitter

A Theory for the Digital Age

In December 2004, Siemens posted his first article on this new learning theory, “Connectivism: A Learning Theory for the Digital Age.” What does that mean?



What is Knowledge?

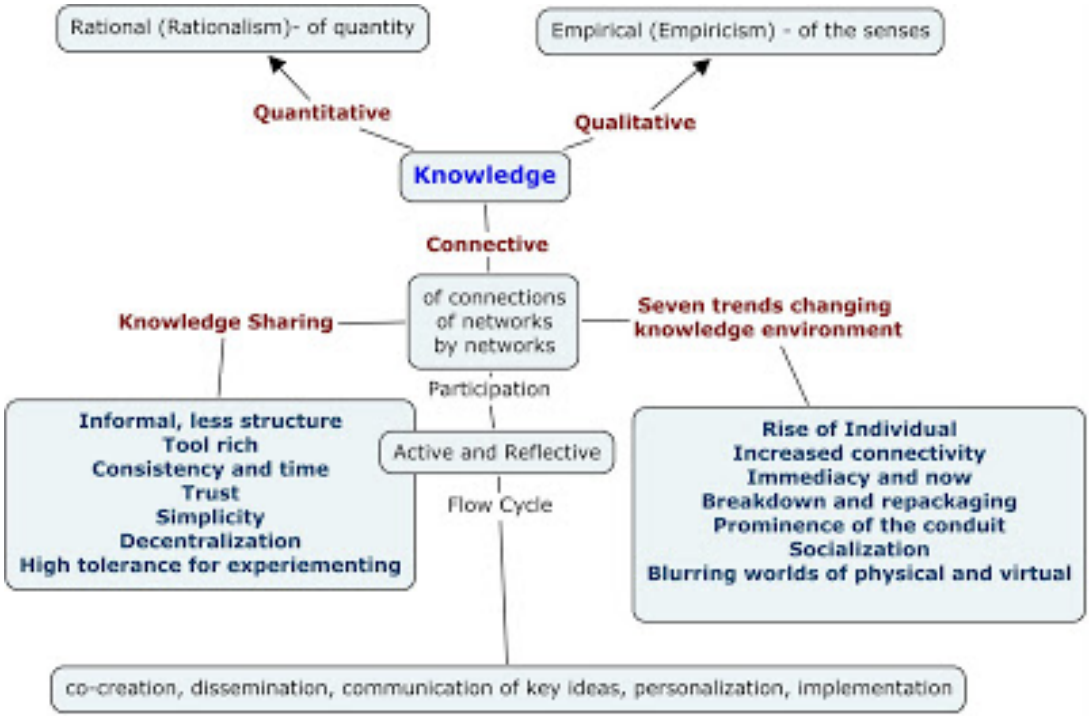
Is it knowledge if the person memorizes the multiplication table or Pythagorean Theorem but never uses that information?

Three Types of Knowledge

Qualitative – based on figure or property

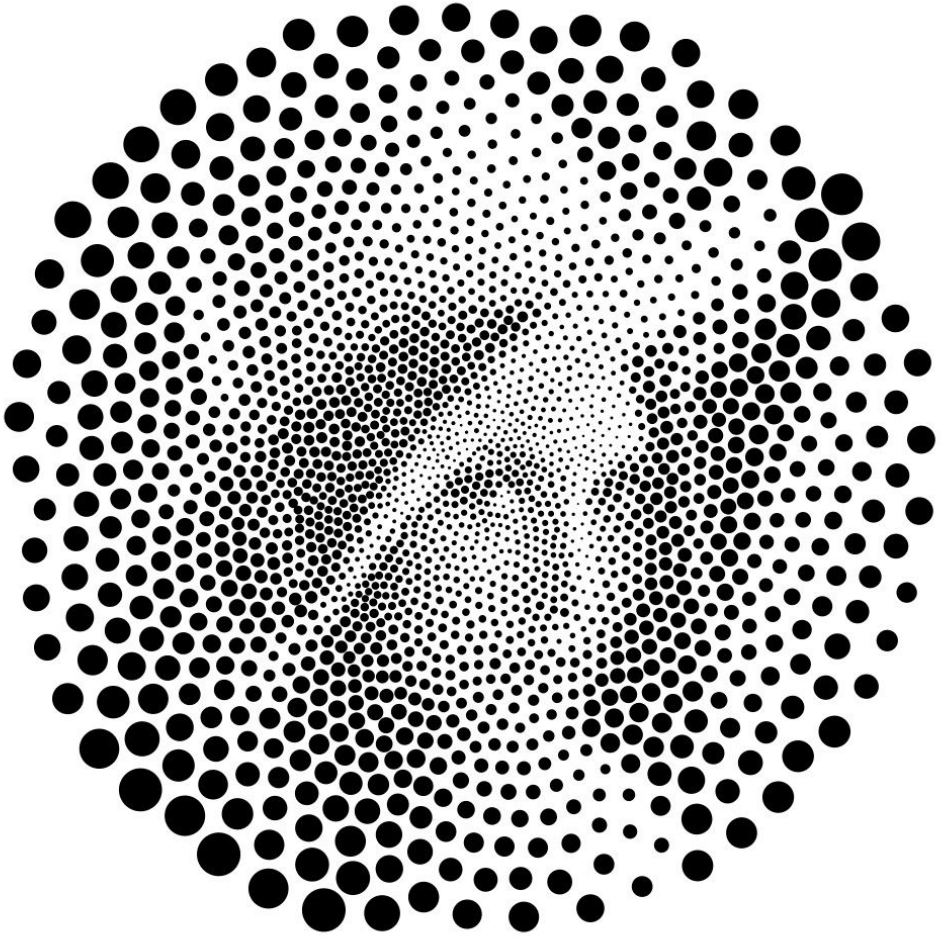
Quantitative – based on mass or quantity

Connective – based on organization or structure



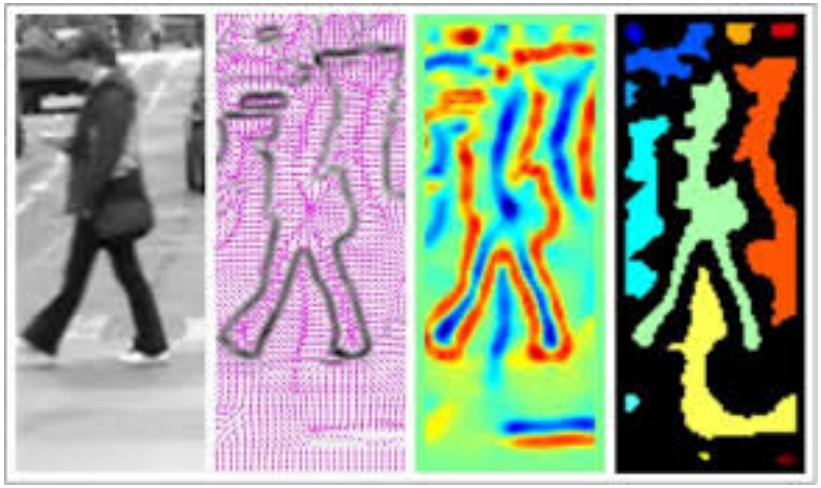
Emergence

Connective knowledge is emergent



Knowledge as recognition

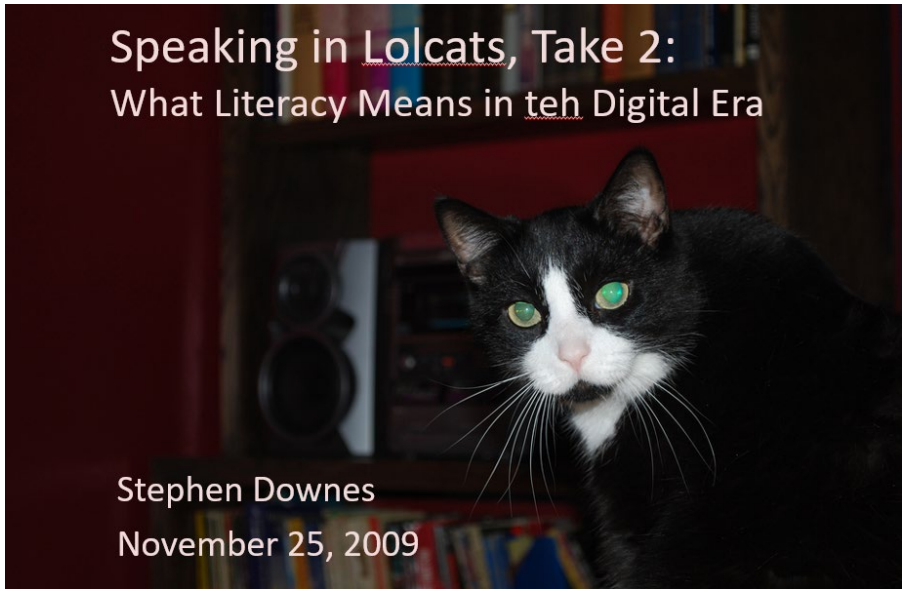
Knowledge is a network phenomenon. To ‘know’ something is to be organized in a certain way, to exhibit patterns of connectivity. To ‘learn’ is to acquire certain patterns. This is as true for a community as it is for an individual



Literacy

A connectivist model of literacy isn’t about language, it’s about patterns.

In my 'Speaking in LOLcats' presentation, I propose a six-element connectivist account of literacy, one that also includes elements of cognition, context and change.



Understanding new media

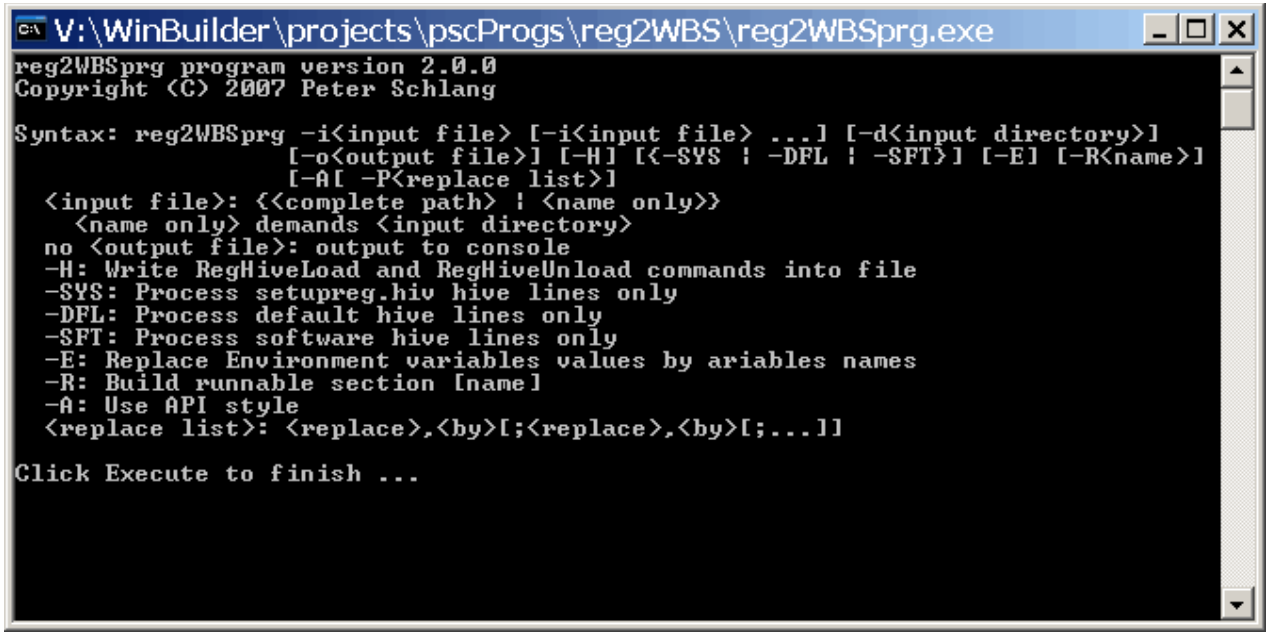
Morris, Derrida and a little Lao Tzu

Syntax	Cognition
Semantics	Context
Pragmatics	Change

We need this frame because (as Jukes said) if we aren't looking for these things, we just won't see them.

Syntax

Not just rules and grammar



Forms: archetypes? Platonic ideals?

Rules: grammar = logical syntax

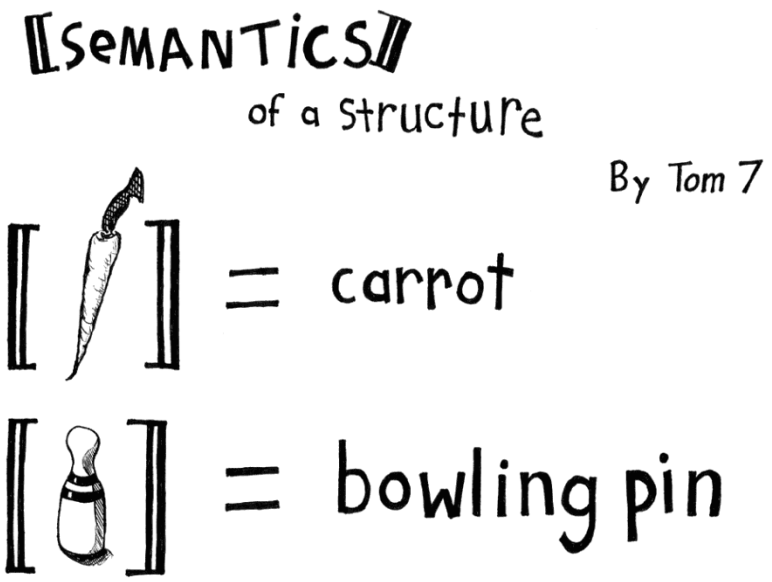
Operations: procedures, motor skills

Patterns: regularities, substitutivity (eggcorns, tropes)

Similarities: Tversky - properties, etc

Semantics

theories of truth / meaning / purpose / goal



http://www.cs.cmu.edu/~tom7/csnotes/fall02/semantics.gif

- Sense and reference (connotation and denotation)
- Interpretation (Eg. In probability, Carnap - logical space; Reichenbach - frequency; Ramsey - wagering / strength of belief)
- Forms of association: Hebbian, contiguity, back-prop, Boltzmann
- Decisions and decision theory: voting / consensus / emergence

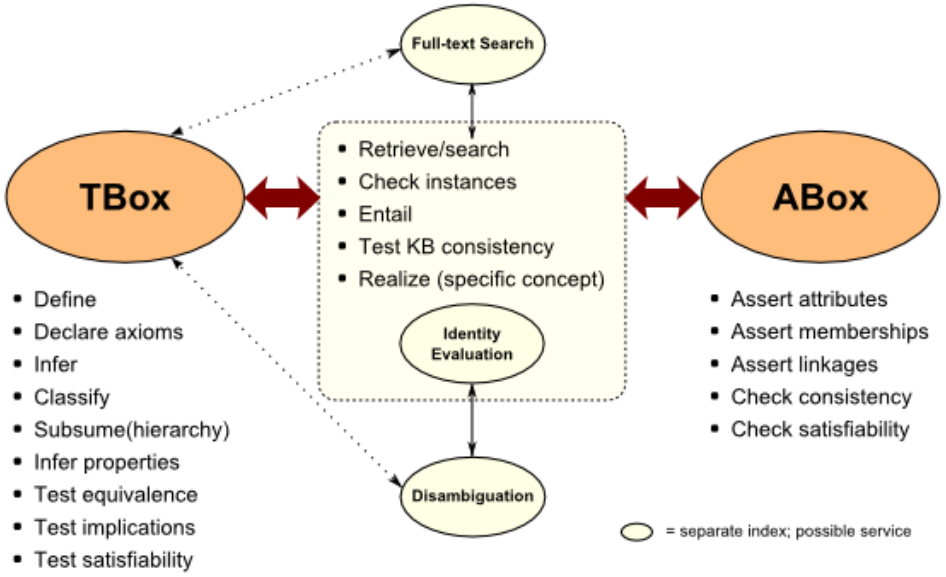
Pragmatics

use, actions, impact

- Speech acts (J.L. Austin, Searle) assertives, directives, commissives, expressives, declarations (but also - harmful acts, harassment, etc)
- Interrogation (Heidegger) and presupposition
- Meaning (Wittgenstein - meaning is use)

Cognition

reasoning, inference and explanation



http://www.mkbergman.com/category/description-logics/

- description - X (definite description, allegory, metaphor)
- definition - X is Y (ostensive, lexical, logical (necess. & suff conds), family resemblance - but also, identity, personal identity, etc
- argument - X therefore Y - inductive, deductive, abductive (but also: modal, probability (Bayesian), deontic (obligations), doxastic (belief), etc.)
- explanation - X because of Y (causal, statistical, chaotic/emergent)

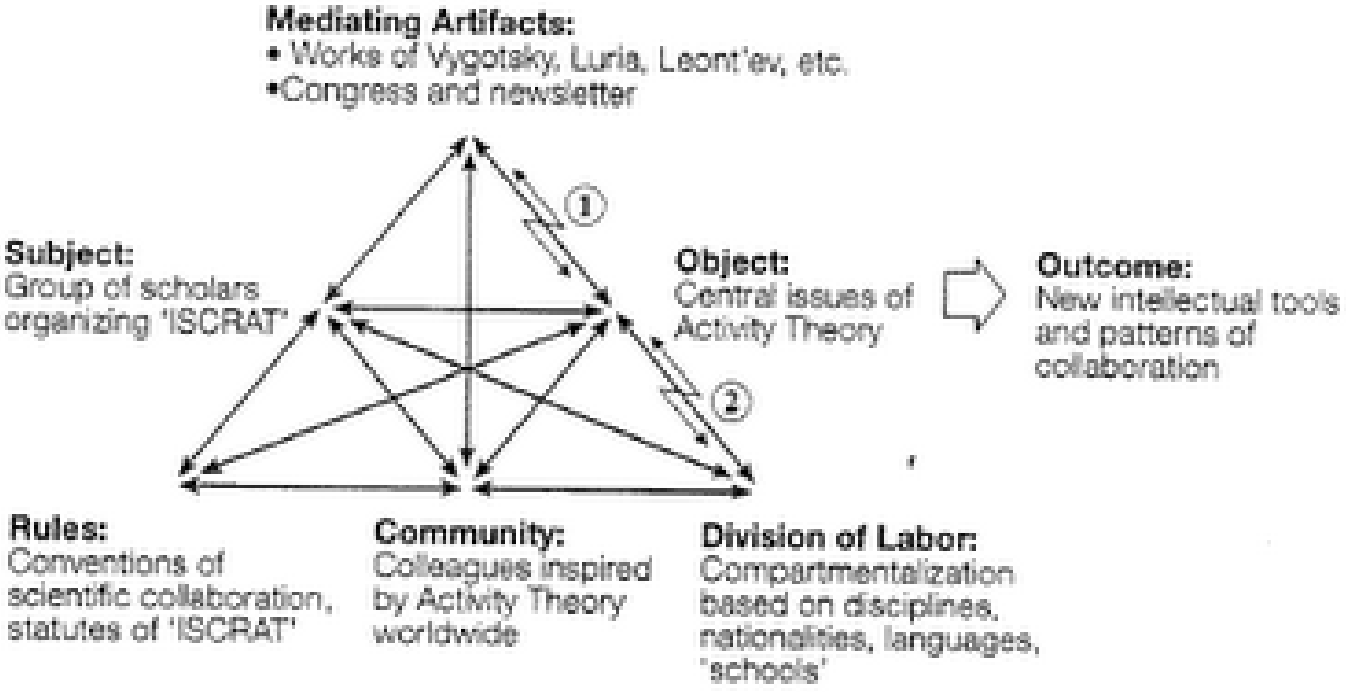
Context

placement, environment

http://www.occasionbasedmarketing.com/what-it-is

- explanation (Hanson, van Fraassen, Heidegger)
- meaning (Quine); tense - range of possibilities
- vocabulary (Derrida); ontologies, logical space
- Frames (Lakoff) and worldviews

Change



- relation and connection: I Ching, logical relation
- flow: Hegel - historicity, directionality; McLuhan - 4 things
- progression / logic -- games, for example: quiz&points, branch-and-tree, database
- scheduling - timetabling - events; activity theory / LaaN

21st Century Languages

Languages / Elements	Performance	Simulation	Appropriation
Syntax			
Semantics			
Pragmatics			
Cognition			
Context			
Change			

Example: Performance - Syntax

Languages / Elements	**Performance** (the ability to adopt alternative identities for the purpose of improvisation and discovery)**(subcategories?)**
Syntax: - Forms - Rules - Operations - Patterns - Similarities	- Presentation acting, method acting - "Know your lines" etc http://filmtvcareers.about.com/od/gettingthejob/a/GJ_Actor_Tips.htm - Stanislavski's system (etc…) http://en.wikipedia.org/wiki/Stanislavski%27s_system - Ritual Performance (etc.) http://www.let.rug.nl/koster/papers/JHP.Koster2.Edit.pdf - Comparing Tales (etc.) http://artsedge.kennedy-center.org/content/2343/

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Evaluation of Learning

- Community

- Social learning

4. Connectivism as Pedagogy

Instructional theories

- Bruner (1966) an instructional theory should deal with four major elements:
  (1) the learning predisposition,
  (2) the design of concepts to be presented and its structure for ease of understanding,
  (3) the most successful progression of ideas in which to present a body of knowledge, and
  (4) the administration of rewards and punishments.

This is not exactly the connectivist approach…

ARRFF

Connectivism offers a methodology for such learning, and this methodology is noted by several authors. Kultawanicha, Koraneekija, and Na-Songkhlaa (2015) observe that “the model of connectivism learning consists of 4 steps including:

(1) Aggregating,

(2) Remixing,

(3) Repurposing, and

(4) Feed Forward”

As an instructional theory

“The core skill is the ability to see connections between information sources and to maintain that connection to facilitate continual learning.

“Decisions are supported by rapidly altering fundamentals as new information is quickly integrated to create a new climate of thinking.

“This constant update and shift of knowledge also can be contained outside the learner, such as in a database or other specialized information source.”

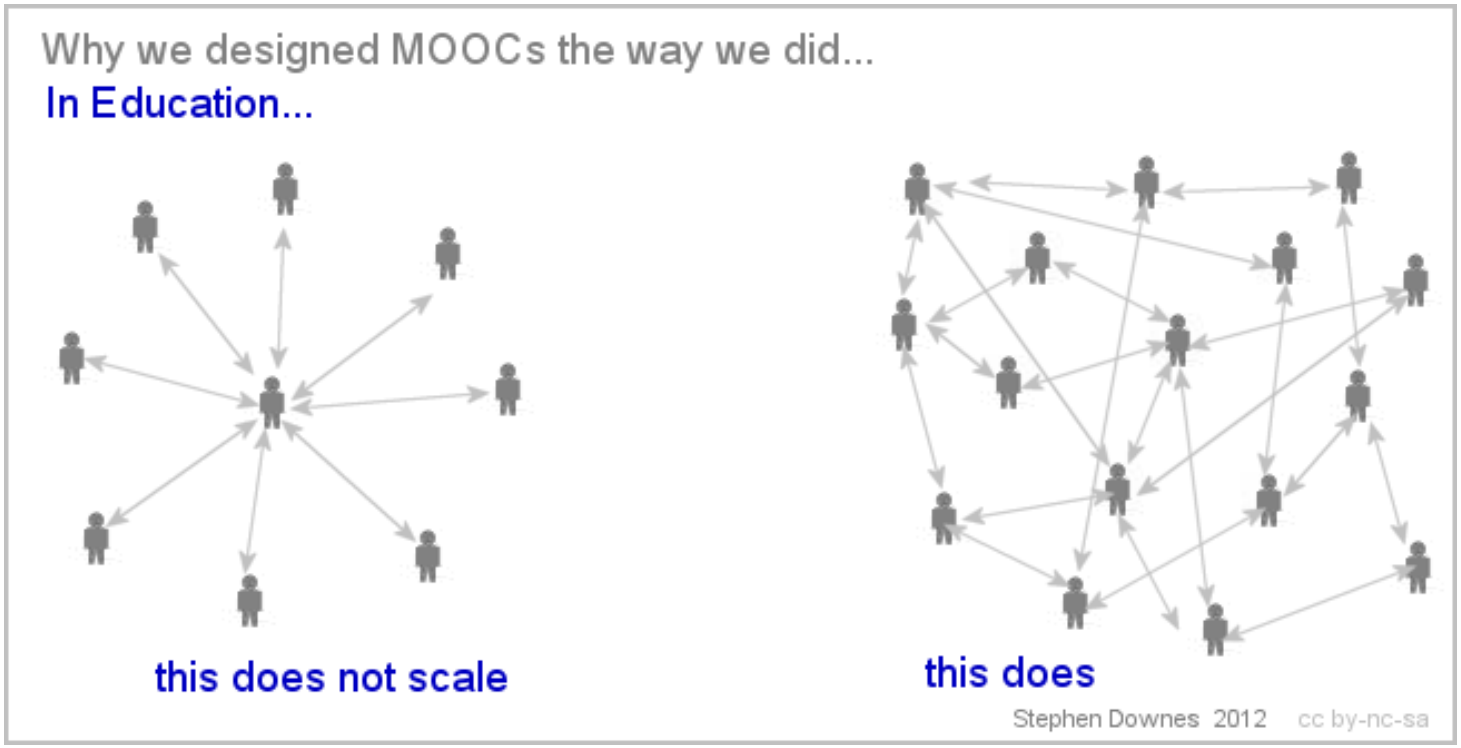
https://www.hetl.org/wp-content/uploads/2013/09/HETLReview2013SpecialIssueArticle1.pdf

The learning activity

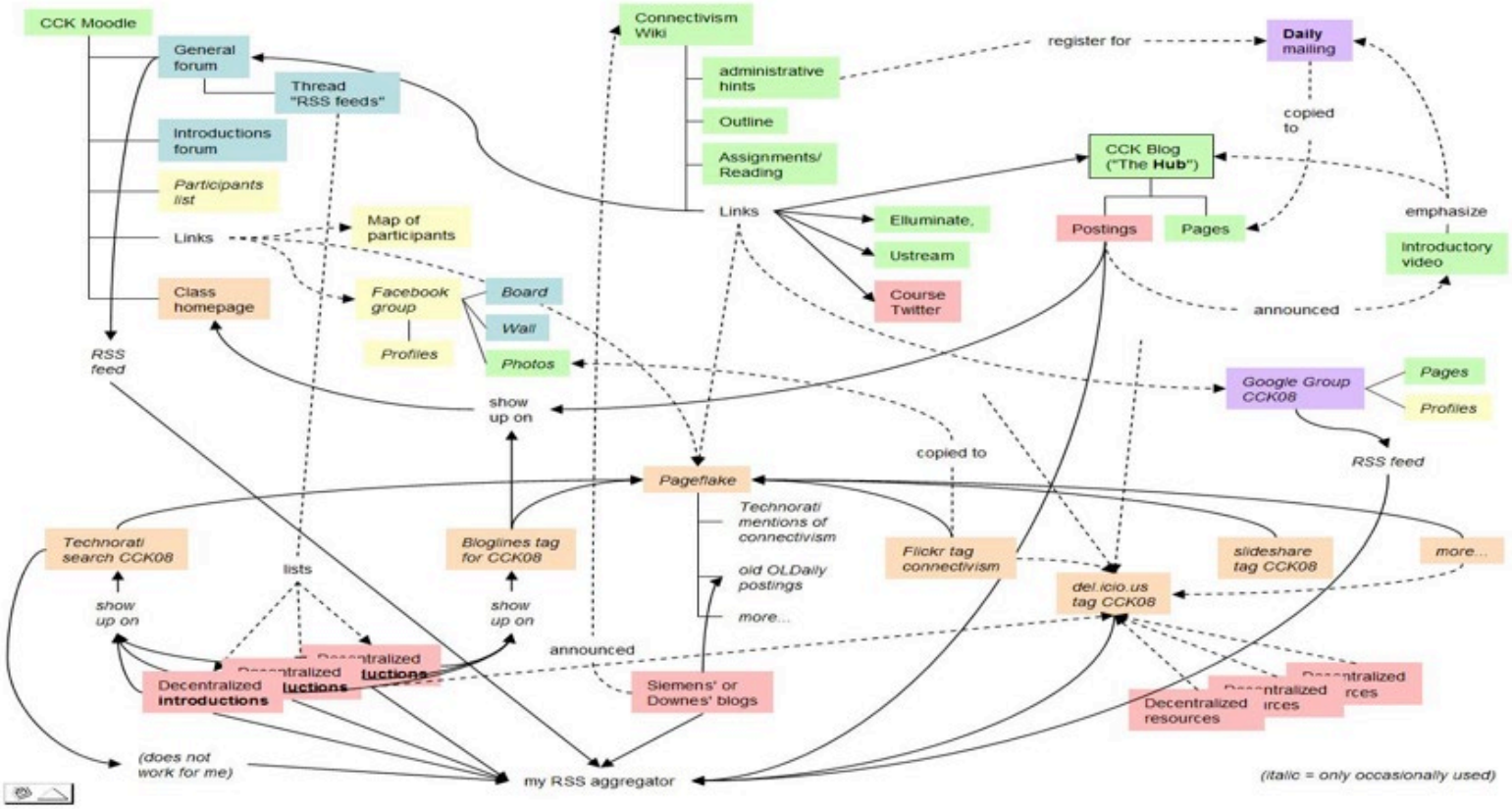
Each connectivist learner develops an individual knowledge base focused on his or her own learning goals. Knowing that this type of learning may, at least in part, be informal learning that does not take place within the designated course structure, connectivist teachers need to tune in to their students' unique motivations and interests.

https://read.aupress.ca/read/teaching-health-professionals-online/section/157a9ad3-a0b2-4400-a946-d71d97ab63b7

MOOCs


Why we designed MOOCs the way we did...
In Education...
this does not scale
this does
Stephen Downes 2012
cc by-nc-sa

MOOCs (2)


CCK Moodle
General forum
Thread "RSS feeds"
Introductions forum
Participants list
Links
Class homepage
RSS feed
Map of participants
Facebook group
Board
Wall
Profiles
Photos
show up on
Connectivism Wiki
administrative hints
Outline
Assignments/ Reading
Links
Elluminate,
Ustream
Course Twitter
register for
Daily mailing
copied to
CCK Blog ("The Hub")
Postings
Pages
emphasize
Introductory video
announced
Google Group CCK08
Pages
Profiles
RSS feed
copied to
Pageflake
Technorati mentions of connectivism
old OLDaily postings
more...
Technorati search CCK08
show up on
lists
Bloglines tag for CCK08
show up on
Flickr tag connectivism
slideshare tag CCK08
more...
del.icio.us tag CCK08
announced
Decentralized introductions
Siemens' or Downes' blogs
Decentralized resources
(does not work for me)
my RSS aggregator
(italic = only occasionally used)

cMOOC vs xMOOC

xMOOCs		cMOOCs
Scalability of provision	**Massive**	Community and connections
Open access - Restricted license	**Open**	Open access & licence
Individual learning in single platform	**Online**	Networked learning across multiple platforms and services
Acquire a curriculum of knowledge & skills	**Course**	Develop shared practices, knowledge and understanding

Classrooms

- Profit (2019) examined connectivism as being utilized is in Active Learning Classrooms (ALC) but suggested that the theory would need to be modified
- Montebello (2018) employs connectivism in the context of classroom interaction. Connectivism "justifies how learners employ networked resources, as potentially those within an AmI classroom."

Microlearning

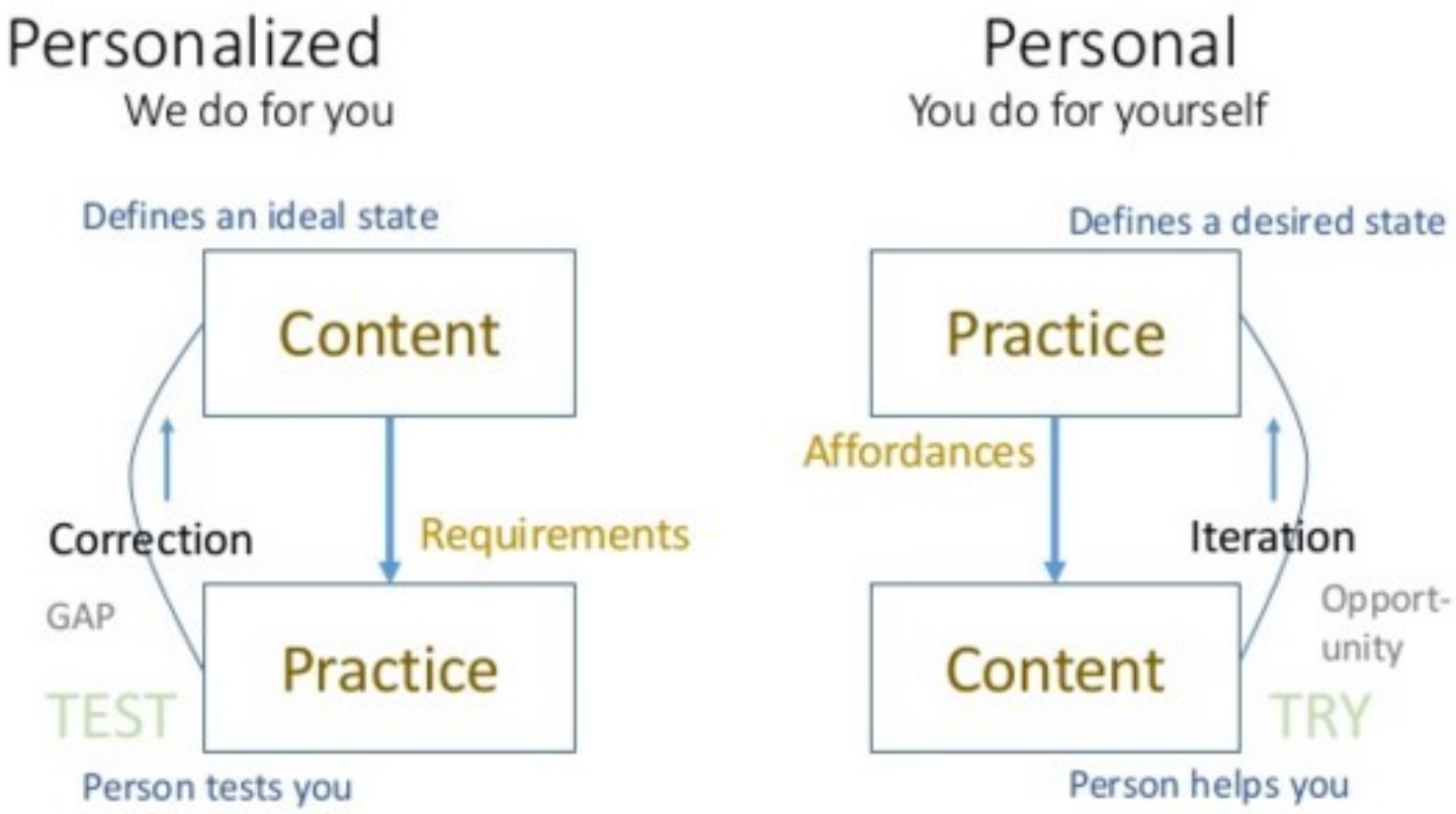
- De Gagne et al. (2018) argue that “The theoretical basis of microlearning is connectivism”, because connectivism is focused on the development of the ability to form links between many ideas, each with each other and with different source of information.
- “These connections between ideas in individual learners’ brains are formed, developed and maintained in what Siemens calls learning ecologies”, they write. “Learning ecologies can vary in size, scope and complexity, but they are all composed of networks of individuals and information Sources”.

Personalization

In the 'model' approach, personalization typically means *more*: more options, more choices, more types of tests, etc. You need to *customize* the environment (the learning) the fit the student.

In the 'connections' approach, personalization typically means *less*: fewer rules, fewer constraints. You need to grant the learner *autonomy* within the environment.

Personal Learning



Personal Learning networks

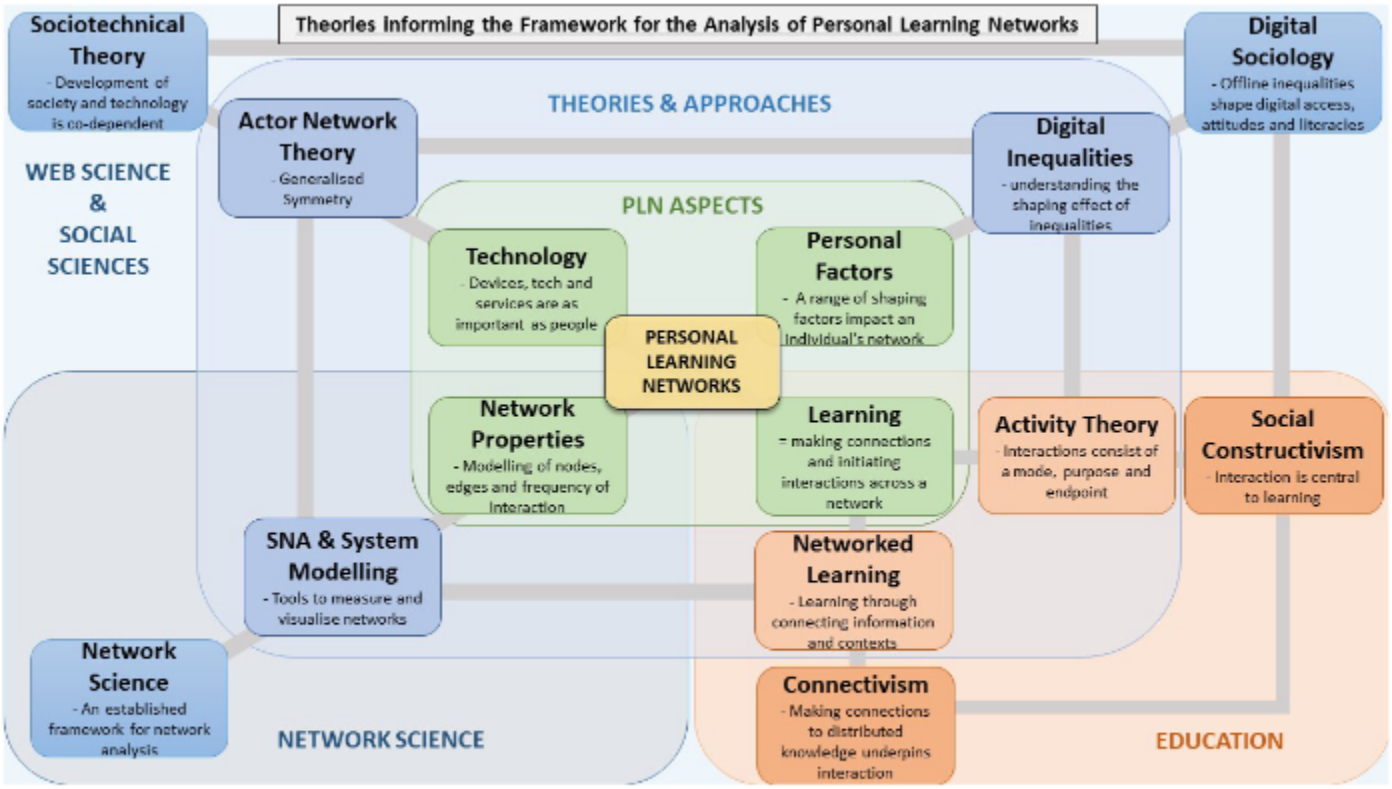


Figure 1: The networked theoretical foundations for the framework for the analysis of PLNs

Role of Connectivism

- “It is important to reflect on concepts such as open education, open educational resources, connectivism and rhizomatic learning environments, given that these are themes that are articulated and strengthened due to the cyberculture.” (Zaduski, Lopes, & Schlunzen, 2018)
- Connectivism also fosters critical thinking and deep learning, which educators see as essential moving forward.

Thinking of Connectivism More Widely

- Its success isn't measured in summative evaluations of pre-established learning objectives. Rather, it focuses on a wider understanding of learning and fosters a broad-based capacity to learn and adapt in dynamic and chaotic environments (Bowes & Swanwick, 2018).

Videos

- Murmurations - https://www.youtube.com/watch?v=uV54oa0SyMc
- Neural network animations - https://www.youtube.com/watch?v=3JQ3hYko51Y
- 3 of these things - https://www.youtube.com/watch?v=Ect-kgxBb4M – more complex - https://www.youtube.com/watch?v=gCxrkl2igGY
- But also - https://www.youtube.com/watch?v=R1PgFShZ3z4

- Networked Student – Wendy Drexler - https://www.youtube.com/watch?v=XwM4ieFOotA&t=309s
- Overview of connectivism - Dr George Siemens - https://www.youtube.com/watch?v=yx5VHpaW8sQ
- Metronomes - https://www.youtube.com/watch?v=T58lGKREubo