



The Future of Learning Technology: 10 Key Tools and Methods

STEPHEN DOWNES

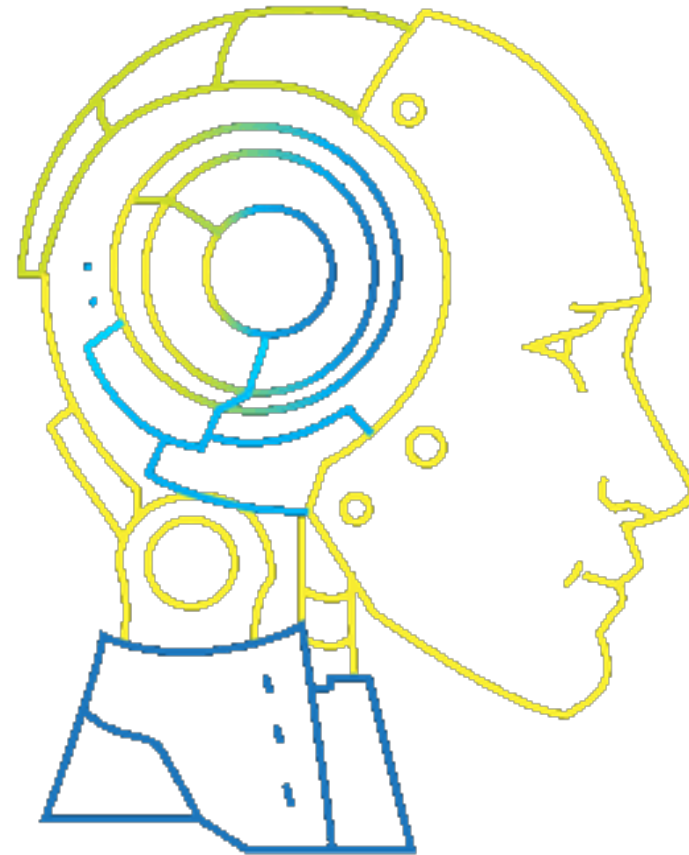


CONTACT **NORTH**
NORD



○ The Future of Learning is Here...

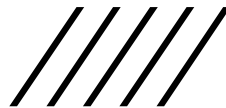
Artificial Intelligence





○ The Future of Learning is Here...

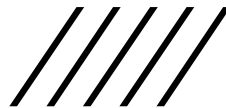
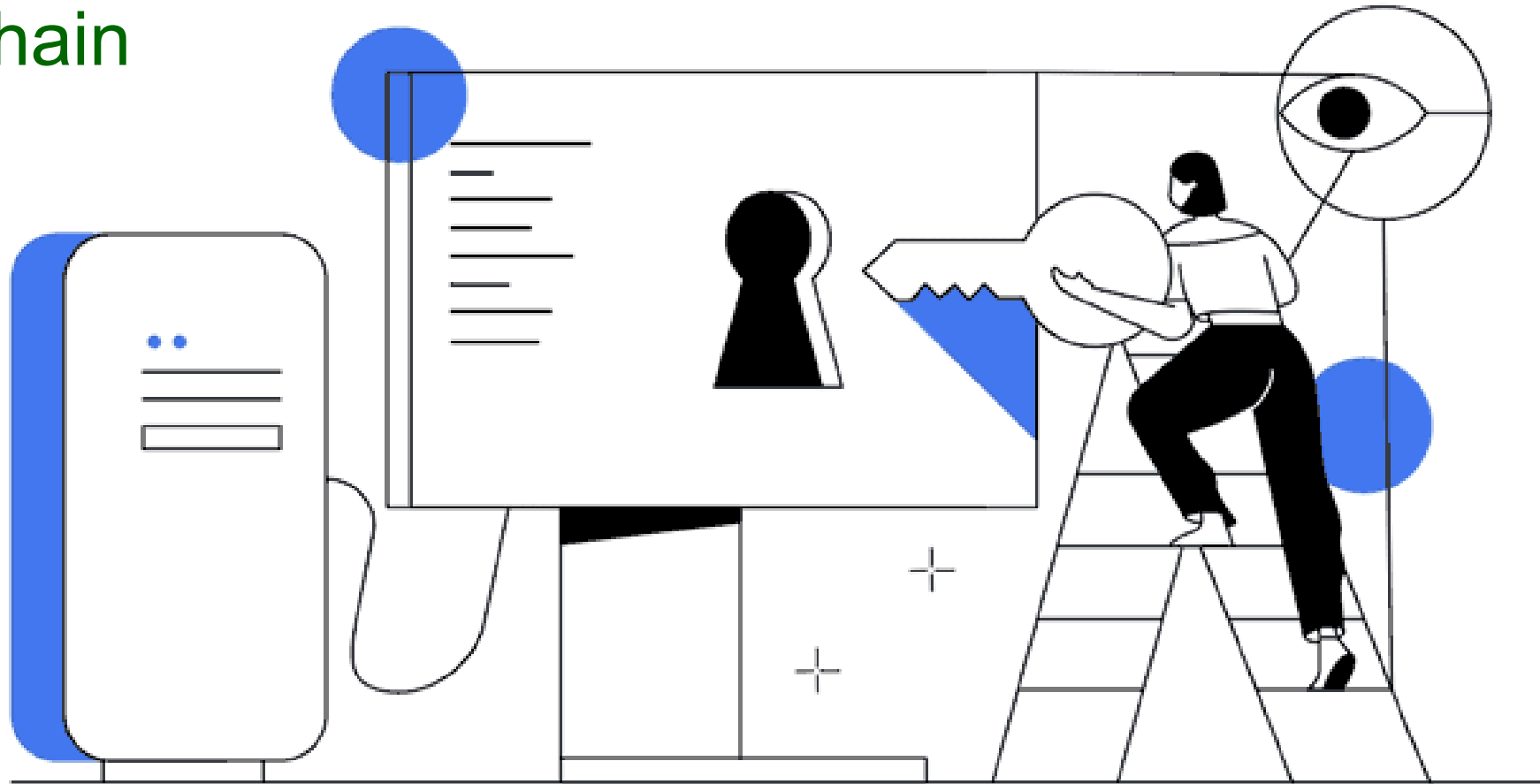
Metaverse





○ The Future of Learning is Here...

Blockchain





○ But...

The pivot to remote learning was in many ways flawed.

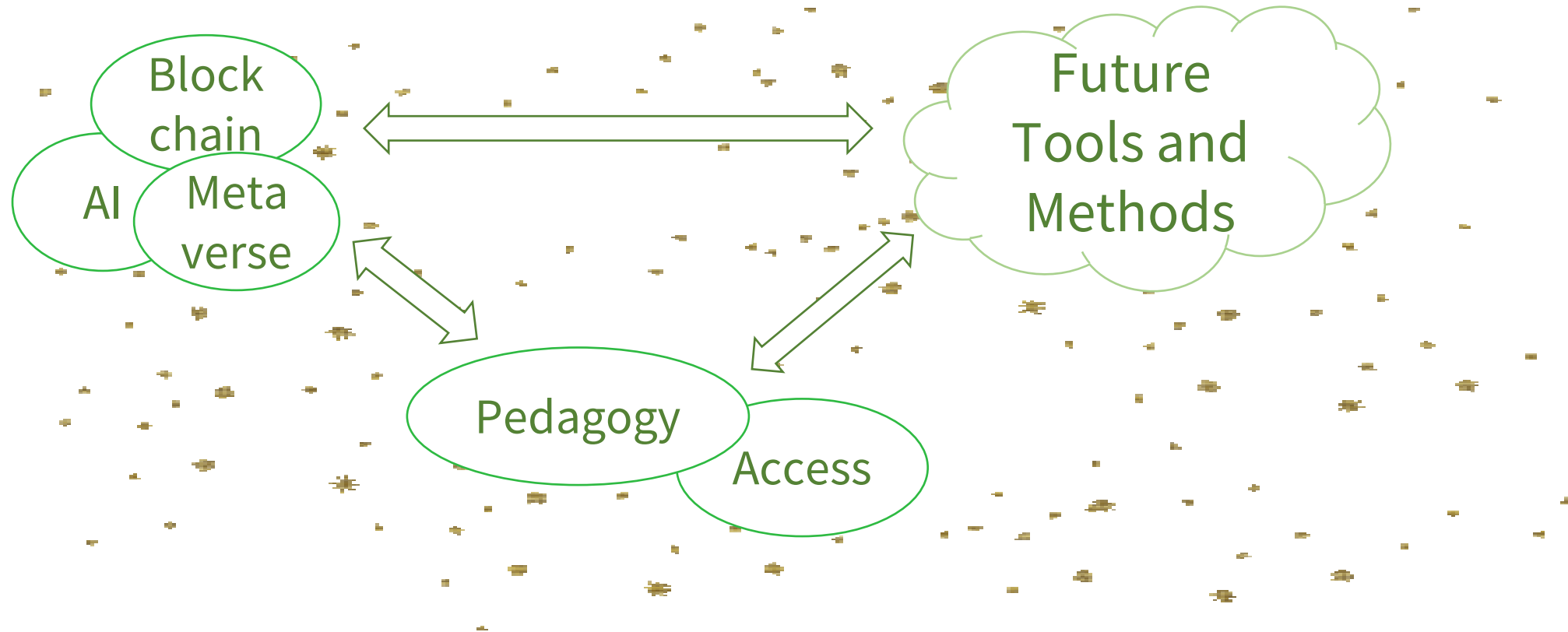


○ But...

The pivot to remote learning also exposed issues of equity and access.



○ These Issues Are In The Balance



Here's what we can do to get ready....



1. The Web of Data

Semester I – Fall

Session	Topics
Session 0 (Before start)	Finding a Research Mentor – no mtg
Session 1	Introduction to <i>Entering Research</i> Part I & Finding a Research Experience
Session 2	The Nature of Science
Session 3	Searching the Literature for Scientific Articles
Session 4	Reading Scientific Articles and Mentoring Styles
Session 5	Your Research Group's Focus
Session 6	Establishing Goals & Expectations with Your Mentor
Session 7	Who's Who in Your Research Group
Session 8	Documenting Your Research
Session 9	Defining Your Hypothesis or Research Question
Session 10	Designing Your Experiments
Session 11	Research Proposal Review Draft #1
Session 12	Research Proposal Review Draft #2
Session 13	Final Research Proposal Presentations
Session 14	Final Research Proposal Presentations

Semester II – Spring

Session	Topics
Session 15	Introduction to <i>Entering Research</i> Part II & Science Communication
Session 16	Research Project Outline & Science Abstract
Session 17	Research Project Outline & Science Abstract continued
Session 18	Science & Society
Session 19	Peer Review of General Public Abstracts
Session 20	Research Ethics
Session 21	Making Effective Scientific Presentations
Session 22	Research Careers
Session 23	Peer Review Draft #1 Poster
Session 24	Outside Review Draft #2 Poster
Session 25	Final Presentation Symposium
Session 26	The Future of Your Project – Funding/Grants
Session 27	Peer Review of Mini-grant
Session 28	Research Experience Reflections & Celebration

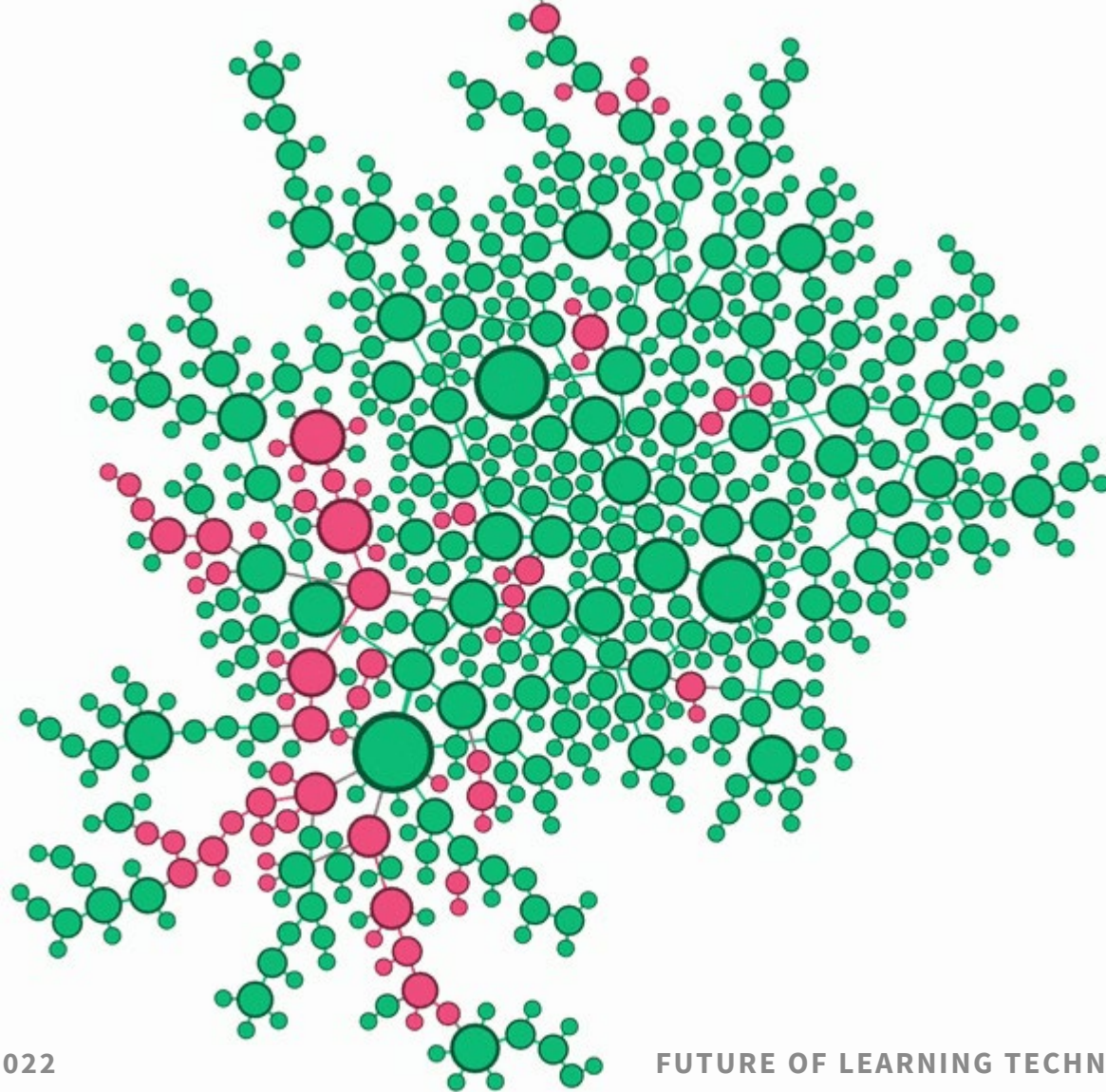
The most significant long-term transformation in knowledge and learning is the pedagogical transition from narrative to data.

This is not a course

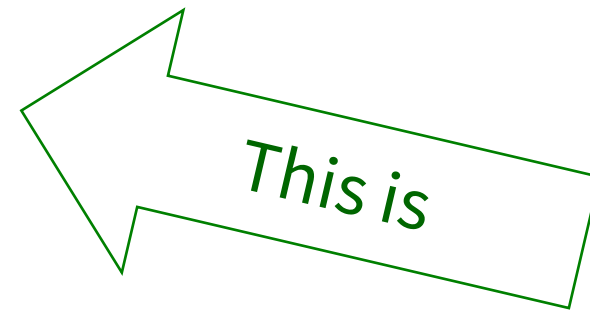




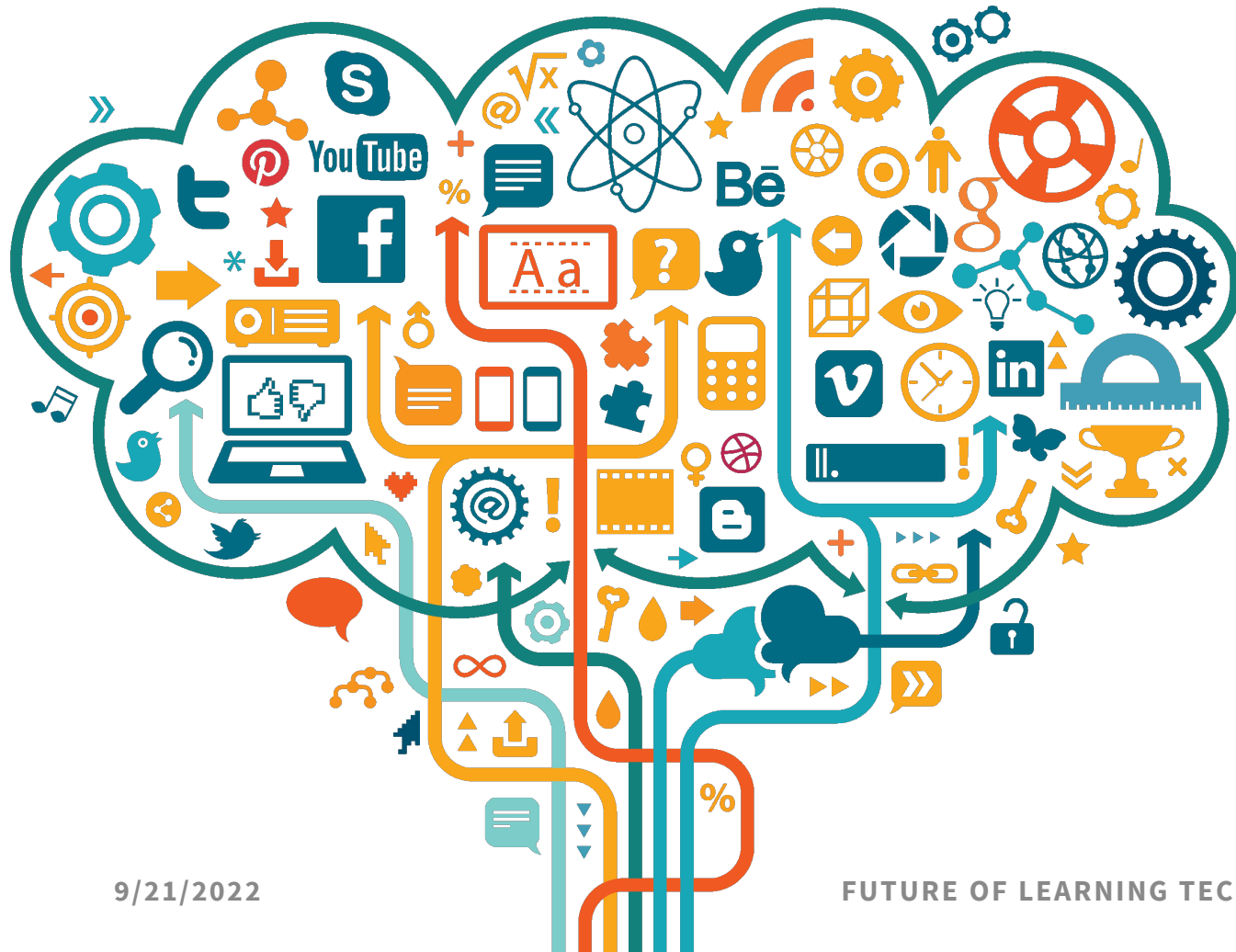
○ 1. The Web of Data



We are transformed from storytellers and narrators to explorers and guides.



1. The Web of Data

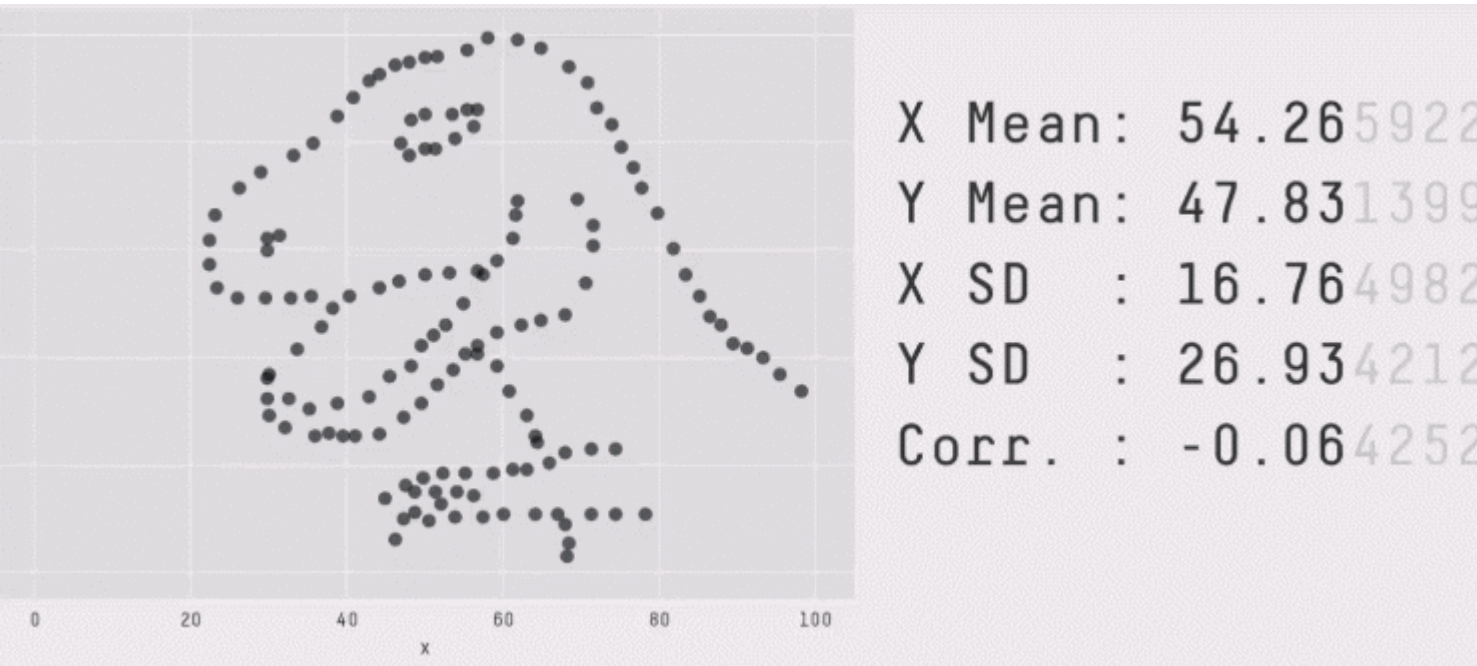


Points to Consider:

- Open Data
- Data Literacy
- Data Ethics
- Designing for Data

<https://open.canada.ca/en/open-data>
<https://www.crossref.org/>

○ 1. The Web of Data



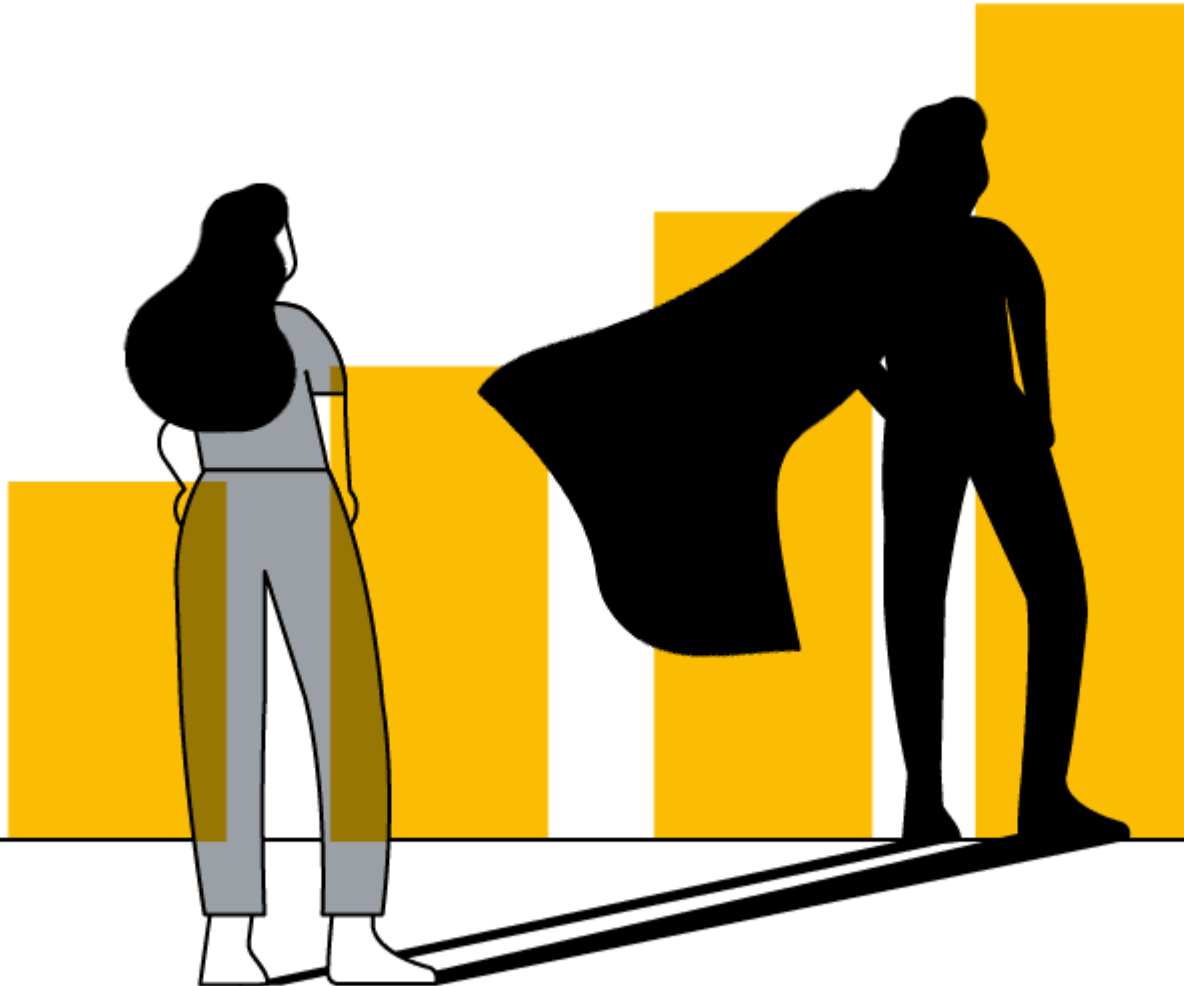
Points to Consider:

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- Data Ethics
- Designing for Data

https://www.downes.ca/files/docs/FINAL_May_2022_Data_Literacy_Report.pdf



1. The Web of Data



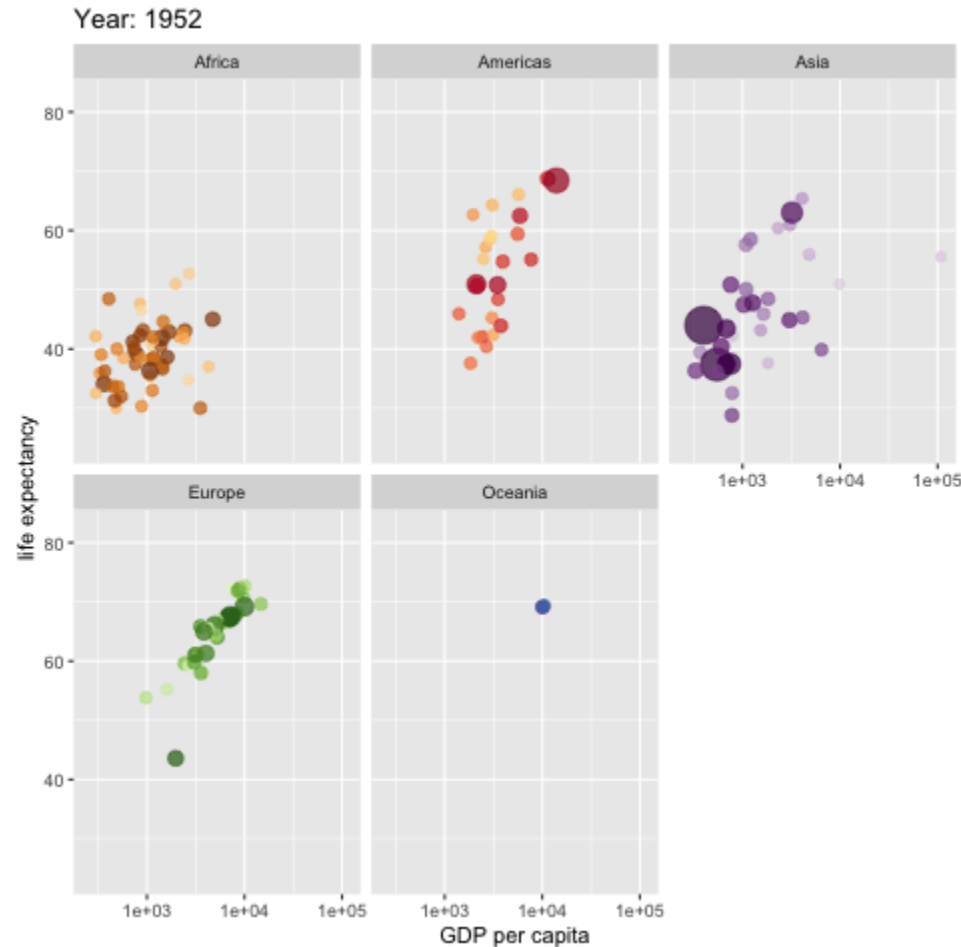
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- Open Data
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<https://royalsocietypublishing.org/toc/rsta/2016/374/2083>



1. The Web of Data



Points to Consider:

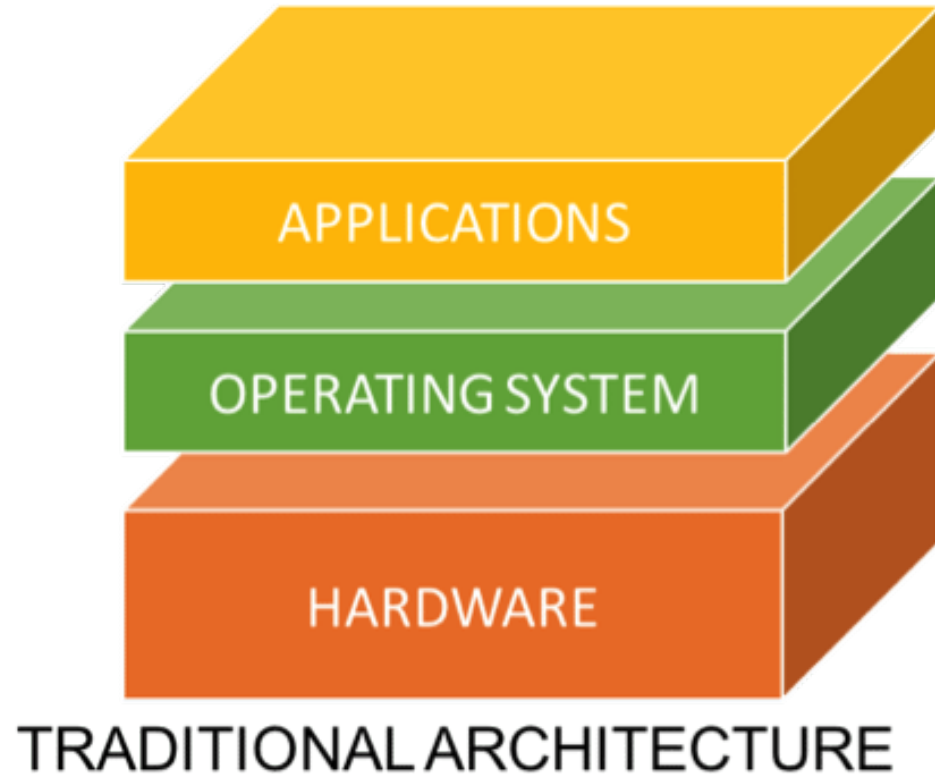
- Open Data
- Data Literacy
- Data Ethics
- **Designing for Data**

<https://towardsdatascience.com/>



○ 2. Virtualization

Virtualization takes a traditional computer environment...

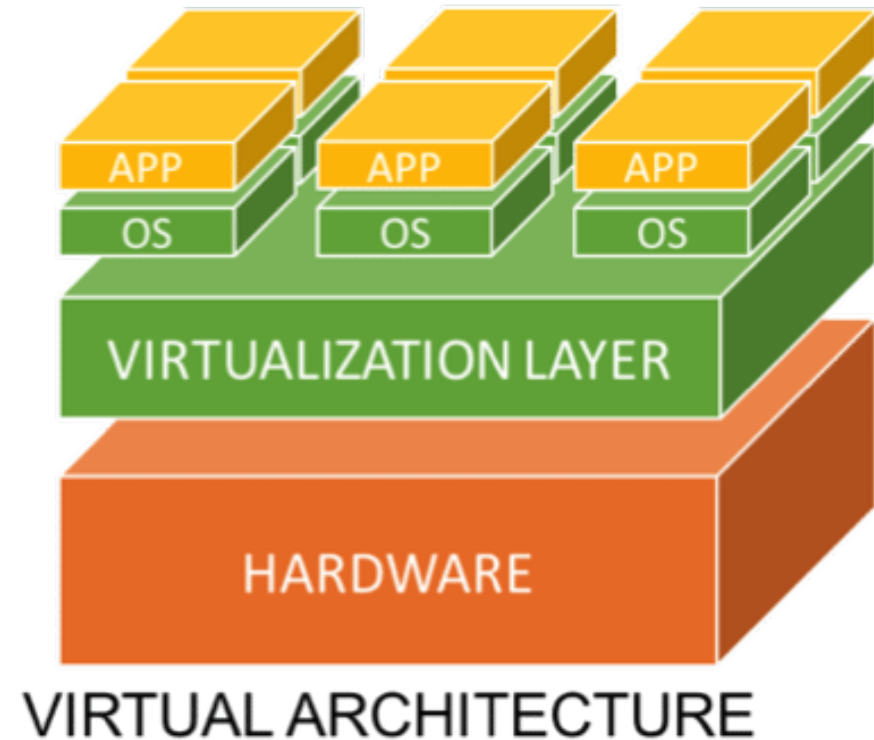




○ 2. Virtualization

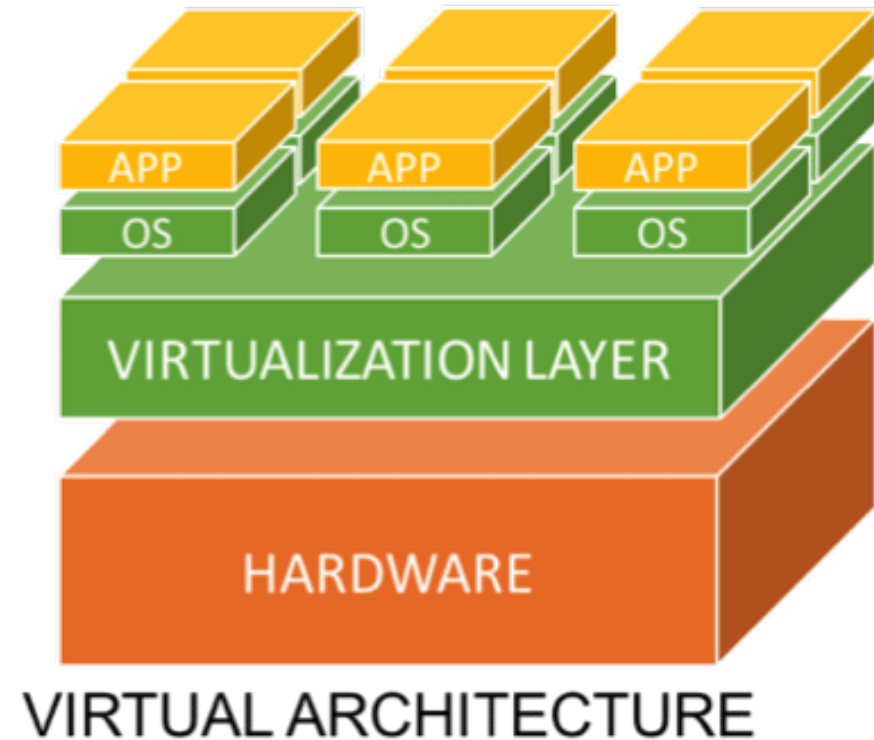
... and simulates it with software using a 'virtualization layer'

This allows one computer to run different virtual environments called 'images'



○ 2. Virtualization

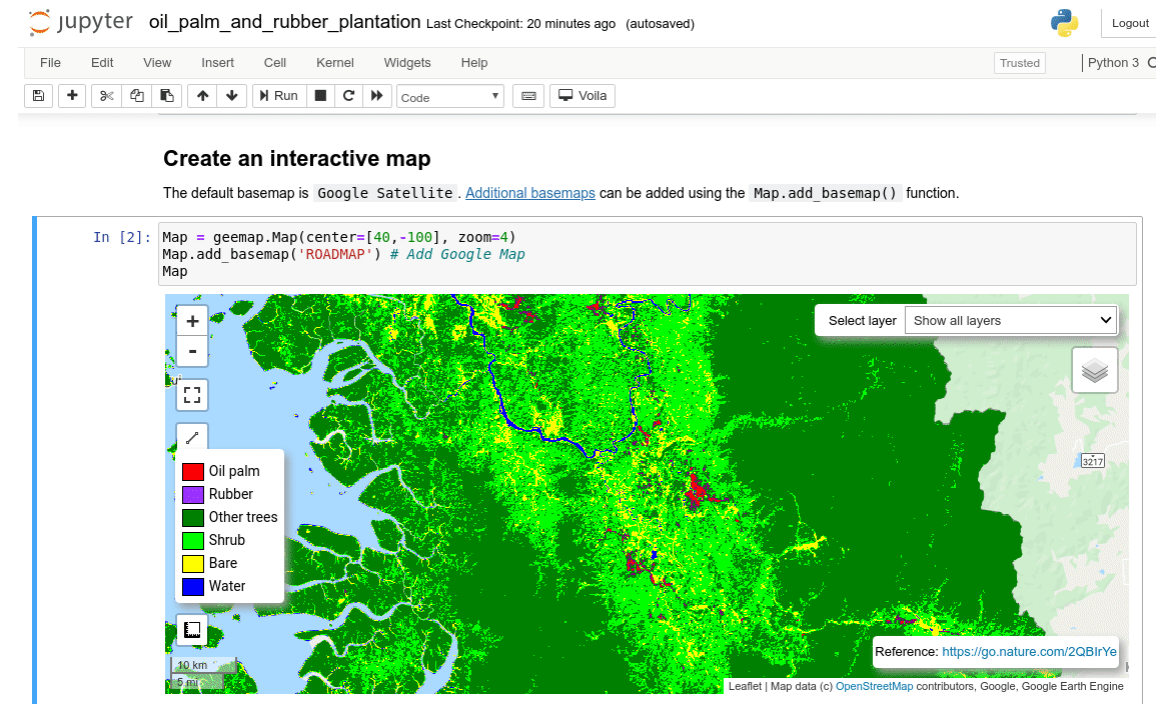
The same image can run on many different computers



○ 2. Virtualization

These new resources allow us to redefine what we mean by “textbooks” and even “learning objects.”

Students can easily access a complex computing environment preconfigured to support learning or research



The screenshot displays a JupyterLab environment titled "oil_palm_and_rubber_plantation". The interface includes a menu bar (File, Edit, View, Insert, Cell, Kernel, Widgets, Help) and a toolbar with icons for file operations, zooming, and running code. Below the toolbar, a code cell contains the following Python code:

```
In [2]: Map = geemap.Map(center=[40,-100], zoom=4)
Map.add_basemap('ROADMAP') # Add Google Map
Map
```

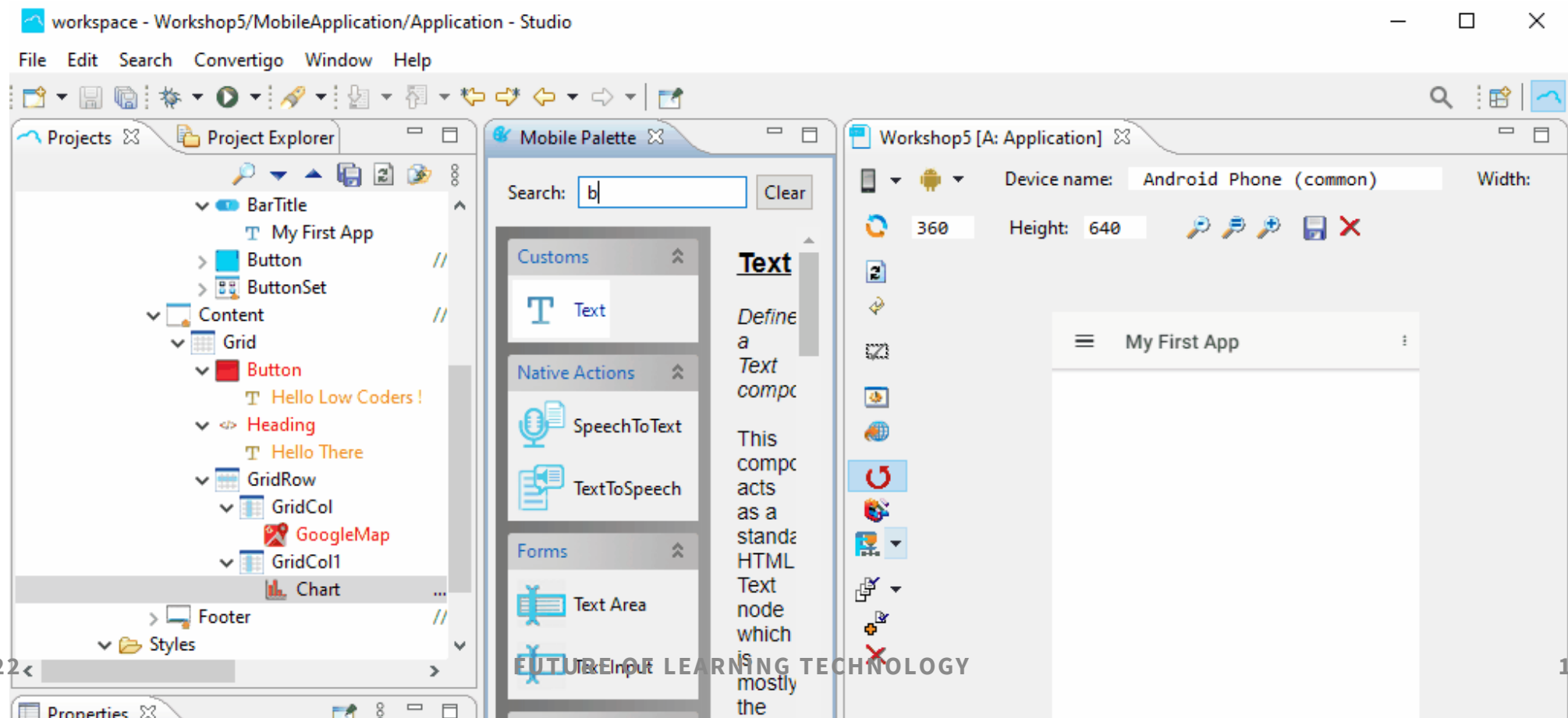
The code cell is followed by an interactive map visualization. The map shows a satellite-style view of a region with various land use categories overlaid. A legend on the left side of the map identifies the following categories:

- Oil palm (Red)
- Rubber (Purple)
- Other trees (Green)
- Shrub (Light Green)
- Bare (Yellow)
- Water (Blue)

The map also features a "Select layer" dropdown menu, a "Show all layers" button, and a reference link at the bottom right: [Reference: https://go.nature.com/ZQBirYe](https://go.nature.com/ZQBirYe). The map is powered by Leaflet and uses data from OpenStreetMap contributors, Google, and Google Earth Engine.

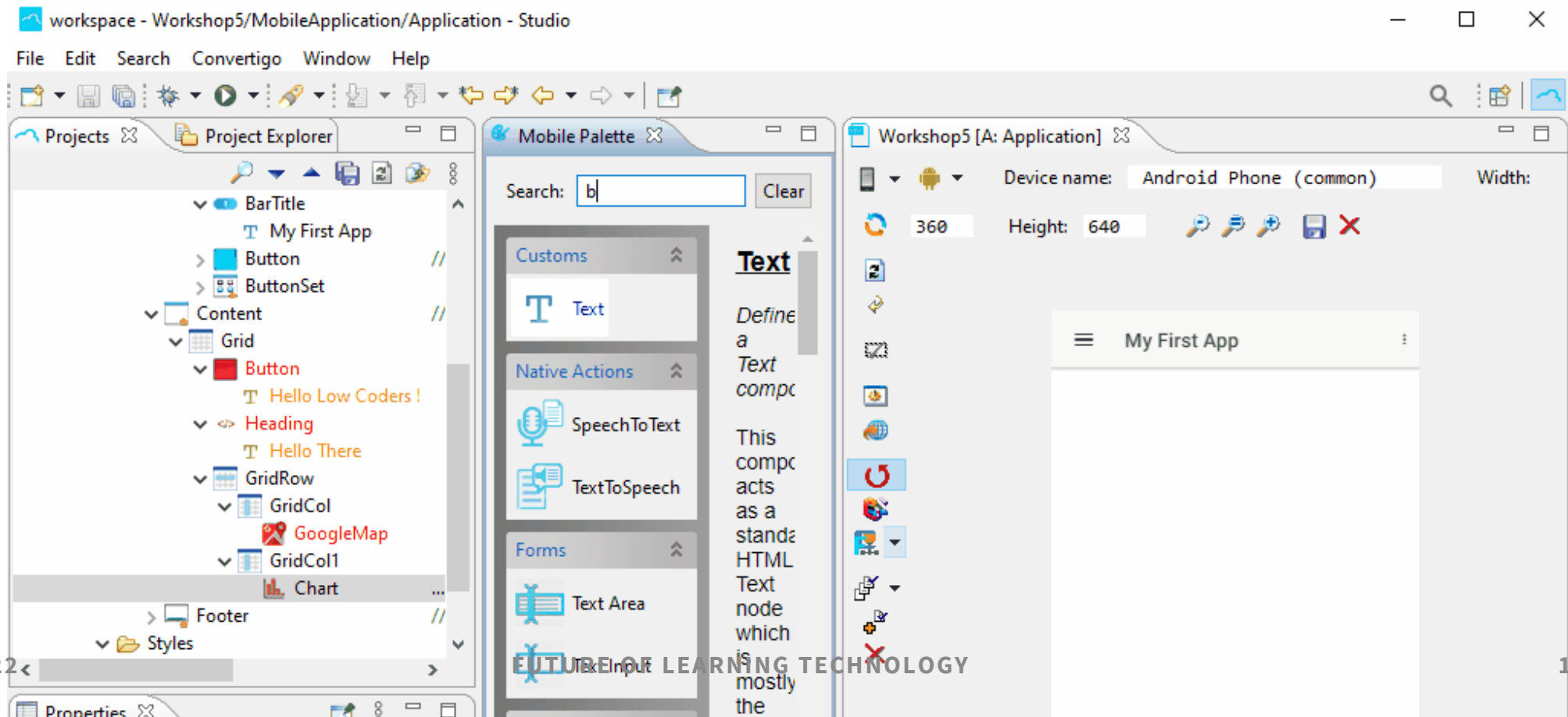
2. Virtualization

Or they can build their own resources...



○ 2. Virtualization

Or they can build their own resources...



○ 3. Graph



A graph is a network of things that are connected together.



○ 3. Graph



A graph is a network of things that are connected together.

A social graph connects people



○ 3. Graph



A graph is a network of things that are connected together.

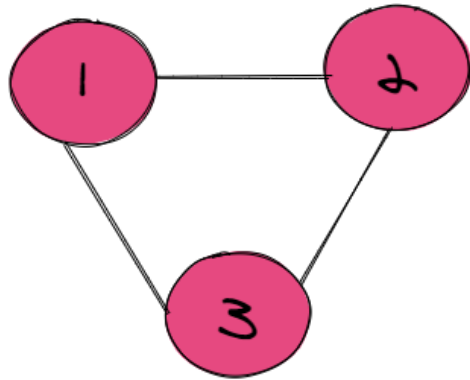
A hash graph connects hashes



3. Graph

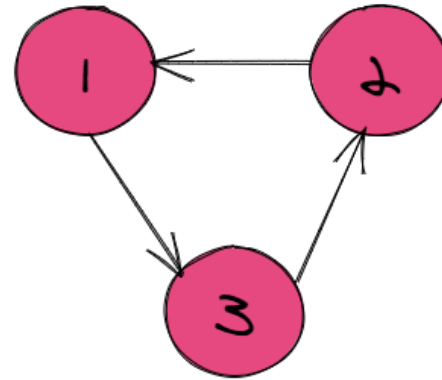
A graph can be directed or undirected

Undirected graph

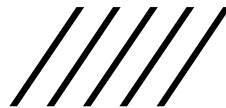


Vertices = $\{1, 2, 3\}$
Edges = $\{ \{1, 2\}, \{2, 3\}, \{3, 1\} \}$

Directed graph



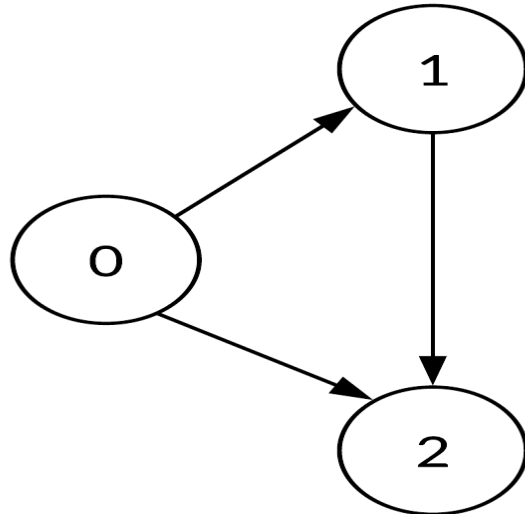
Vertices = $\{1, 2, 3\}$
Edges = $\{ \{2, 1\}, \{1, 3\}, \{3, 2\} \}$



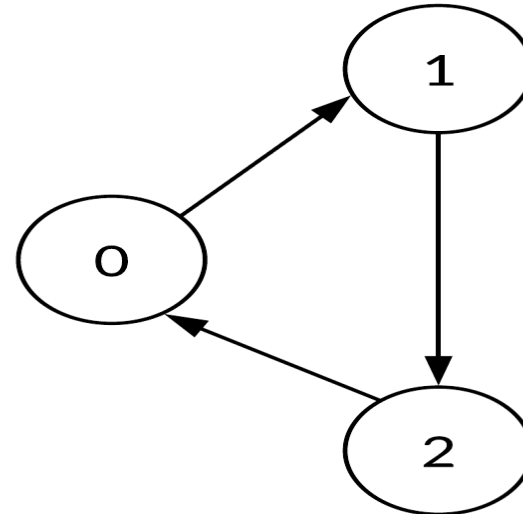
○ 3. Graph

A graph can be cyclic or acyclic

Acyclic Graph

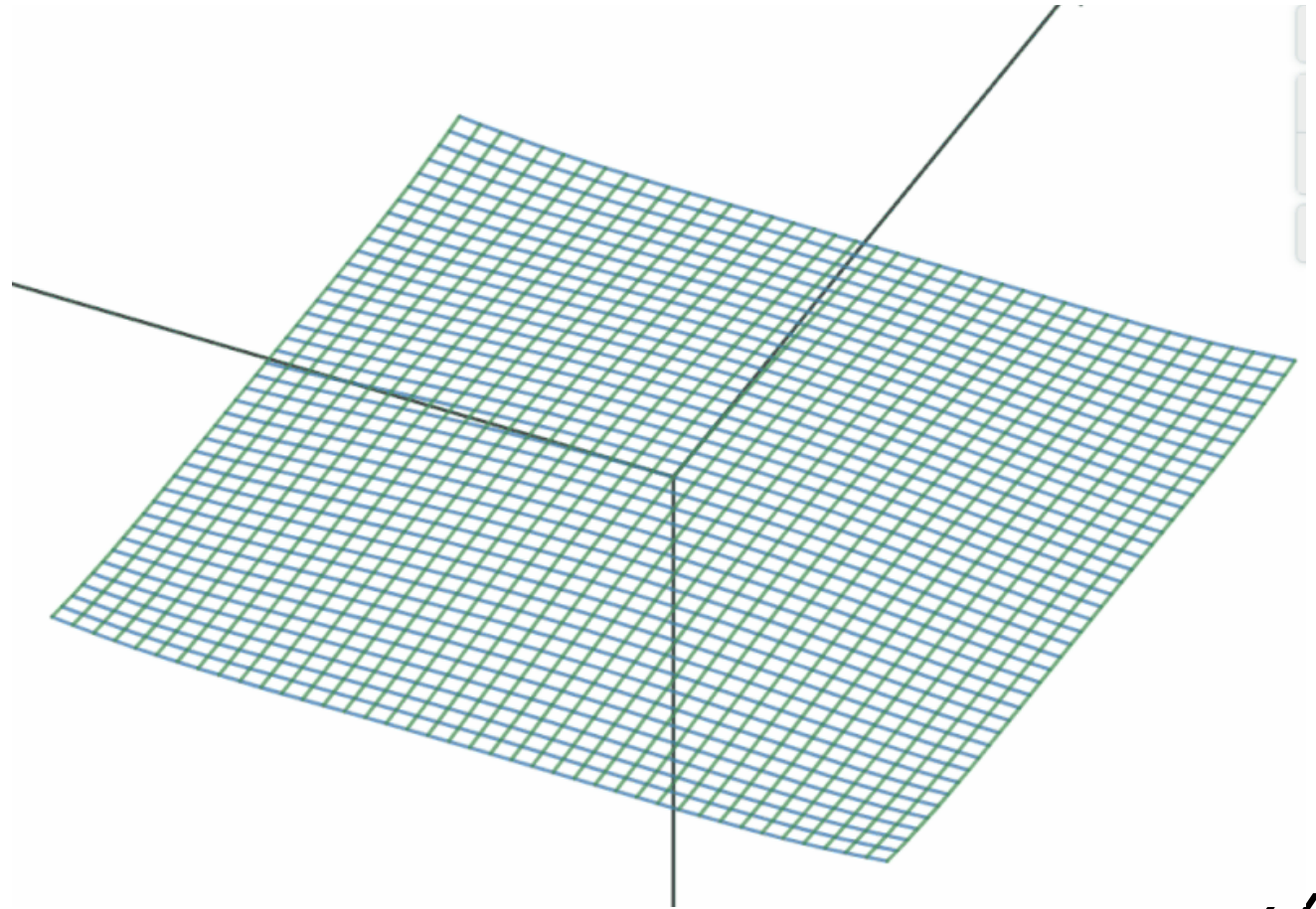


Cyclic Graph



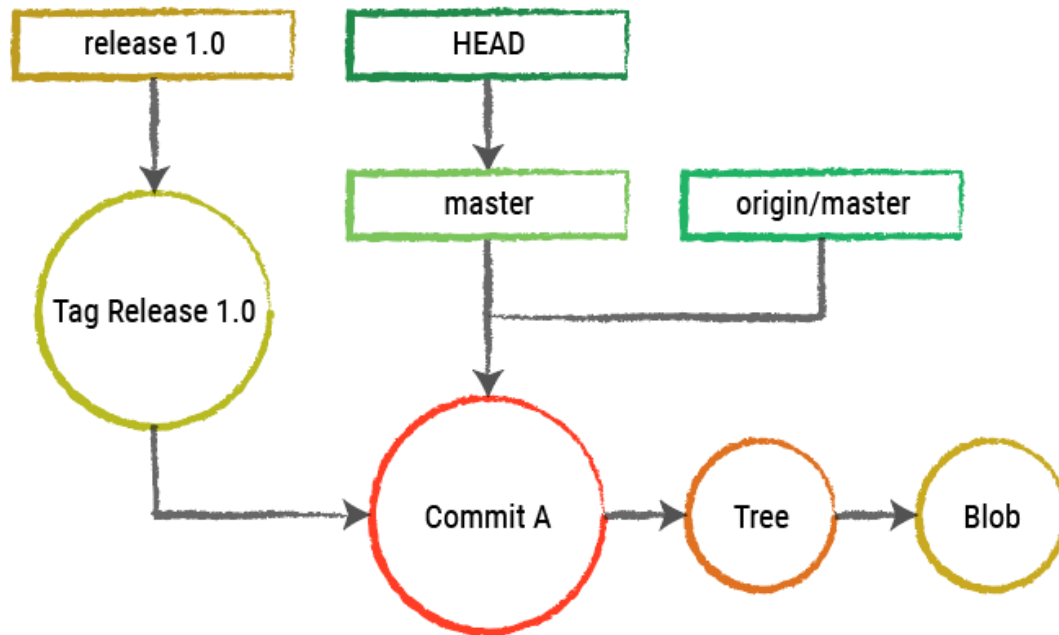
○ 3. Graph

Graphs are important because they represent knowledge, not only as collections of facts and statements, but also as patterns of connectivity.



○ 3. Graph

Graphs are everywhere in modern technology



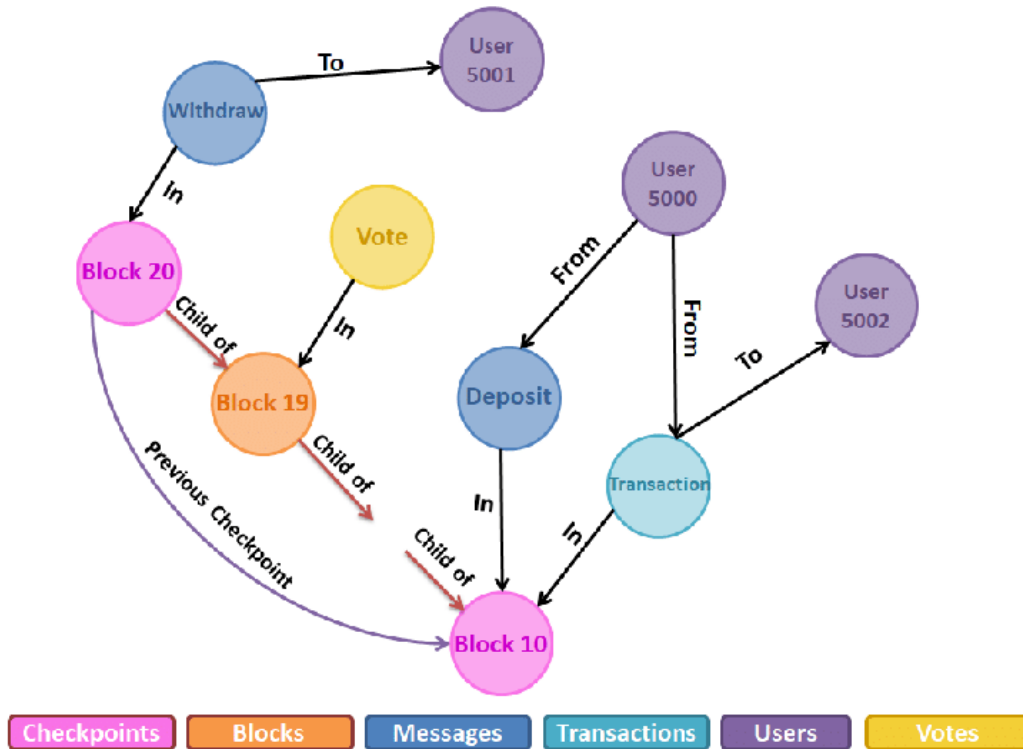
GitHub

<https://blog.10pines.com/2018/05/21/the-model-behind-git/>



3. Graph

Graphs are everywhere in modern technology



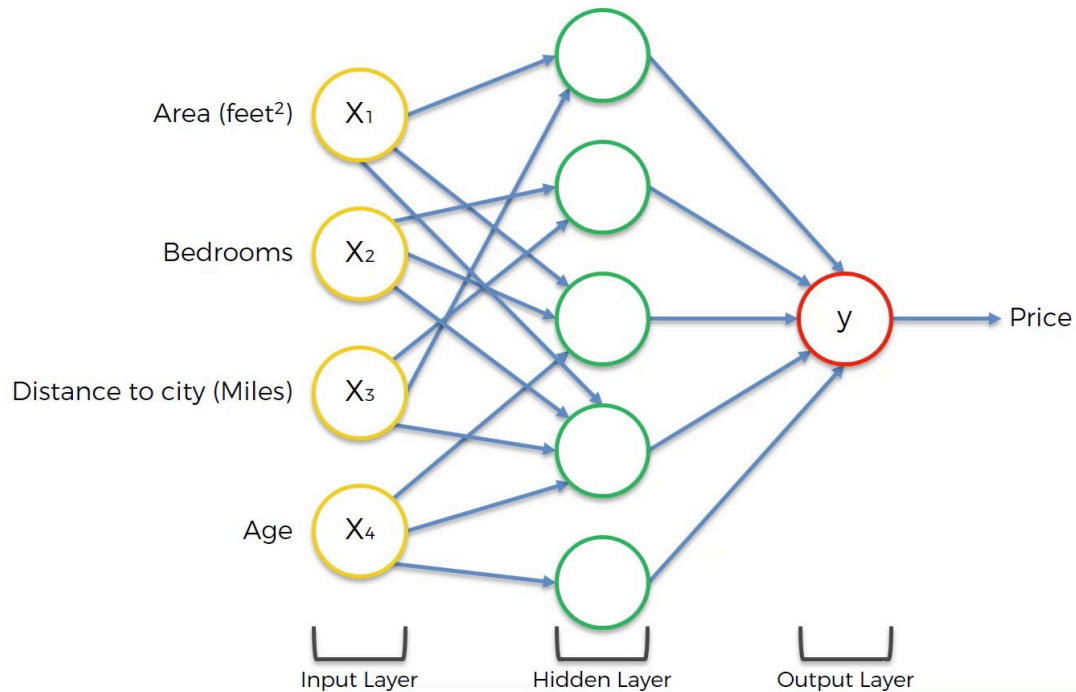
Blockchain

<https://www.researchgate.net/publication/342616825> A Graph Model Based Blockchain Implementation for Increasing Performance and Security in Decentralized Ledger Systems



○ 3. Graph

Graphs are everywhere in modern technology



Neural Networks

<https://www.freecodecamp.org/news/deep-learning-neural-networks-explained-in-plain-english/>





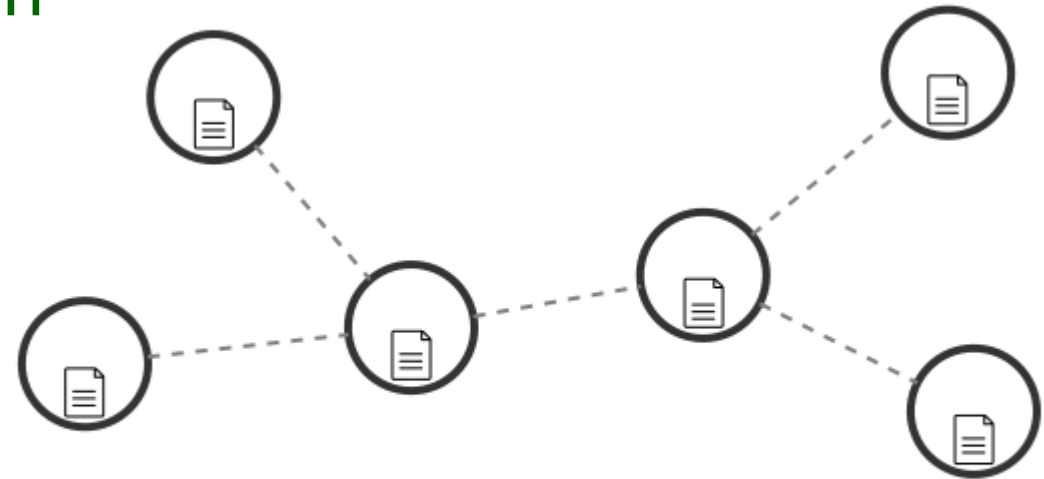
○ 4. Distributed Resources

The same piece of content can be in multiple locations at the same time

No single location needs to contain all the resources

Think:

- Content delivery networks (CDN)
- Content sharing networks like BitTorrent or Napster

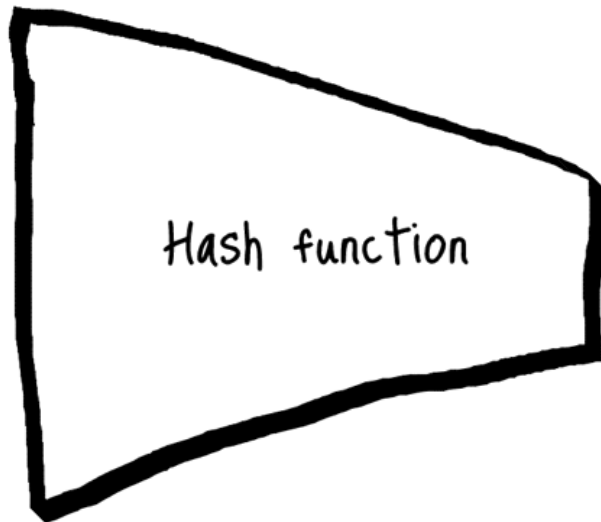




○ 4. Distributed Resources

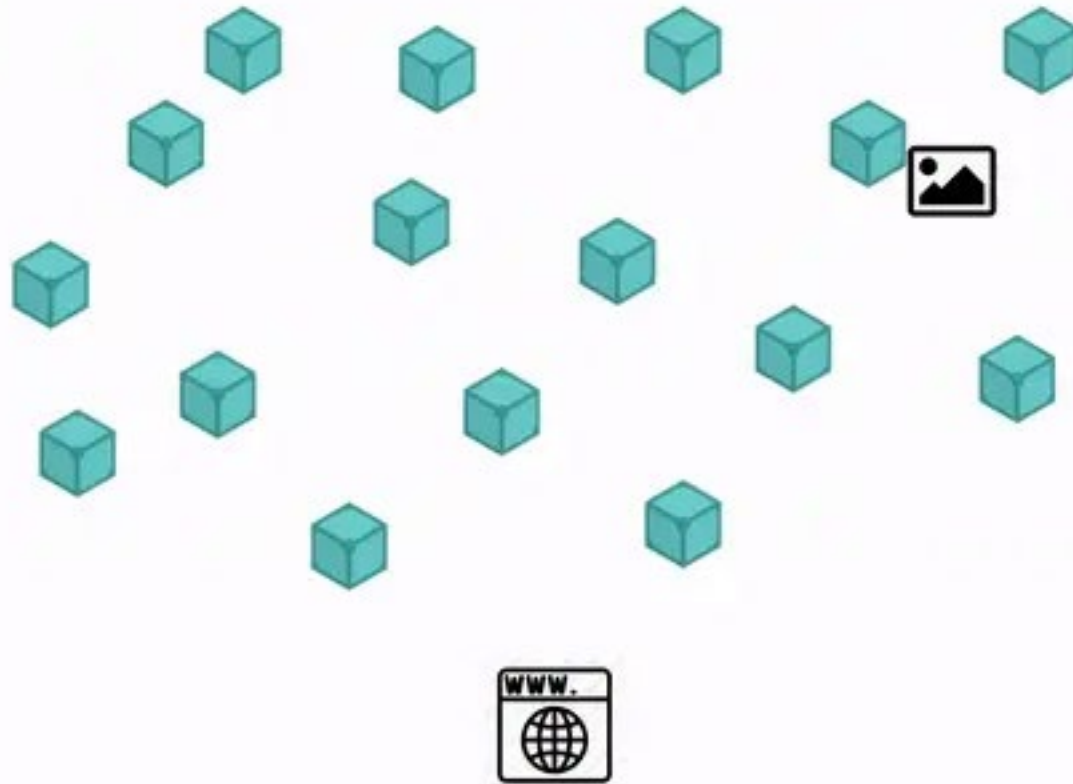
Distributed networks use *hash addressing* to identify data

(Compare with the existing internet, which uses *location*)





○ 4. Distributed Resources



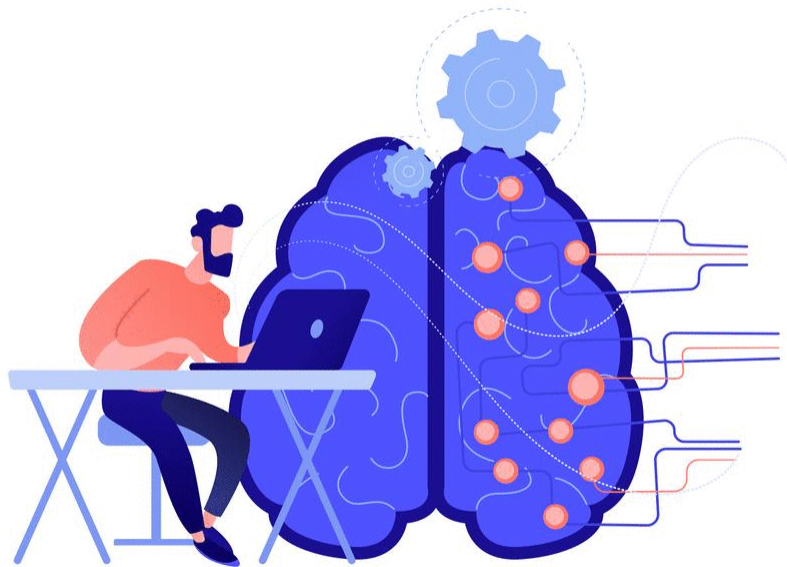
Distributed web content protocols such as Dat and the interplanetary file system (IPFS) are running as prototypes using content addressing to create a distributed network of resources



○ 4. Distributed Resources

Distributed resources in education include:

- Content Addressable Resources for Education (CARE)
- Digital badge and microcredential networks



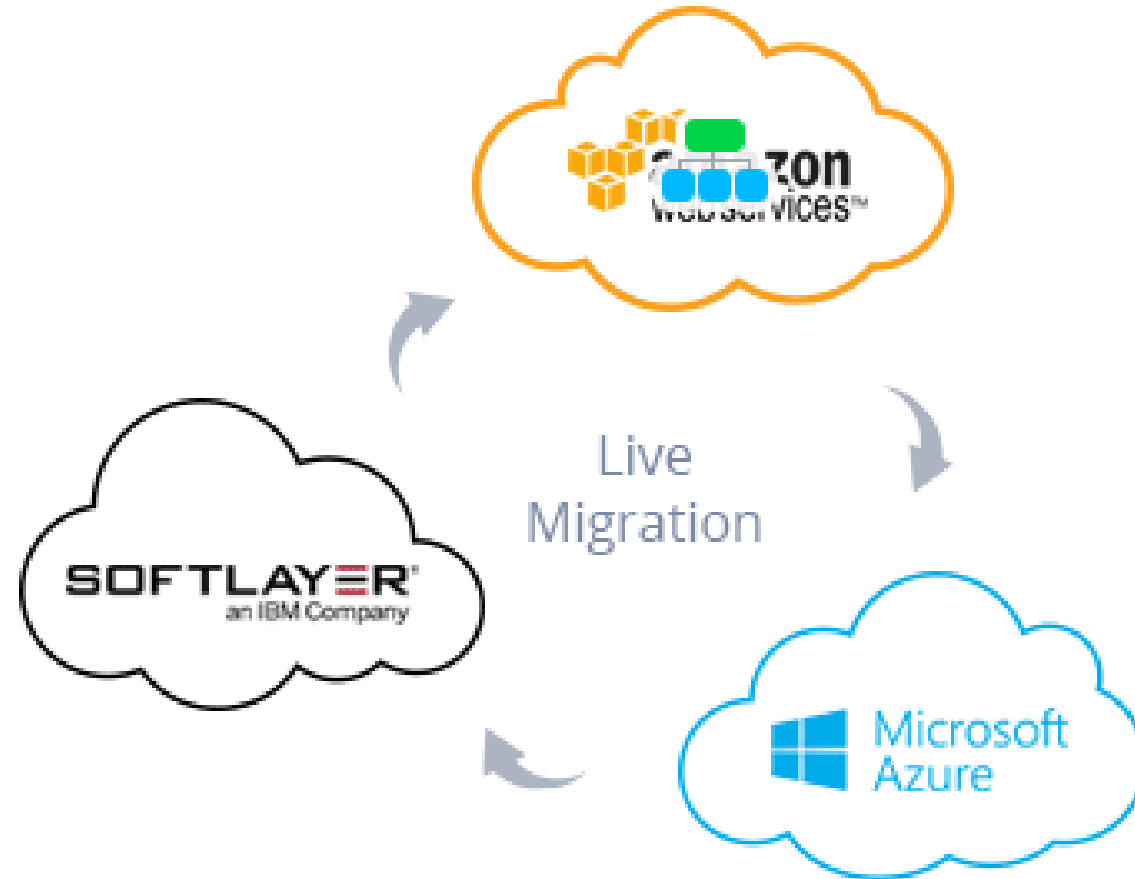
<https://www.downes.ca/post/70094>





○ 4. Distributed Resources

Cloud

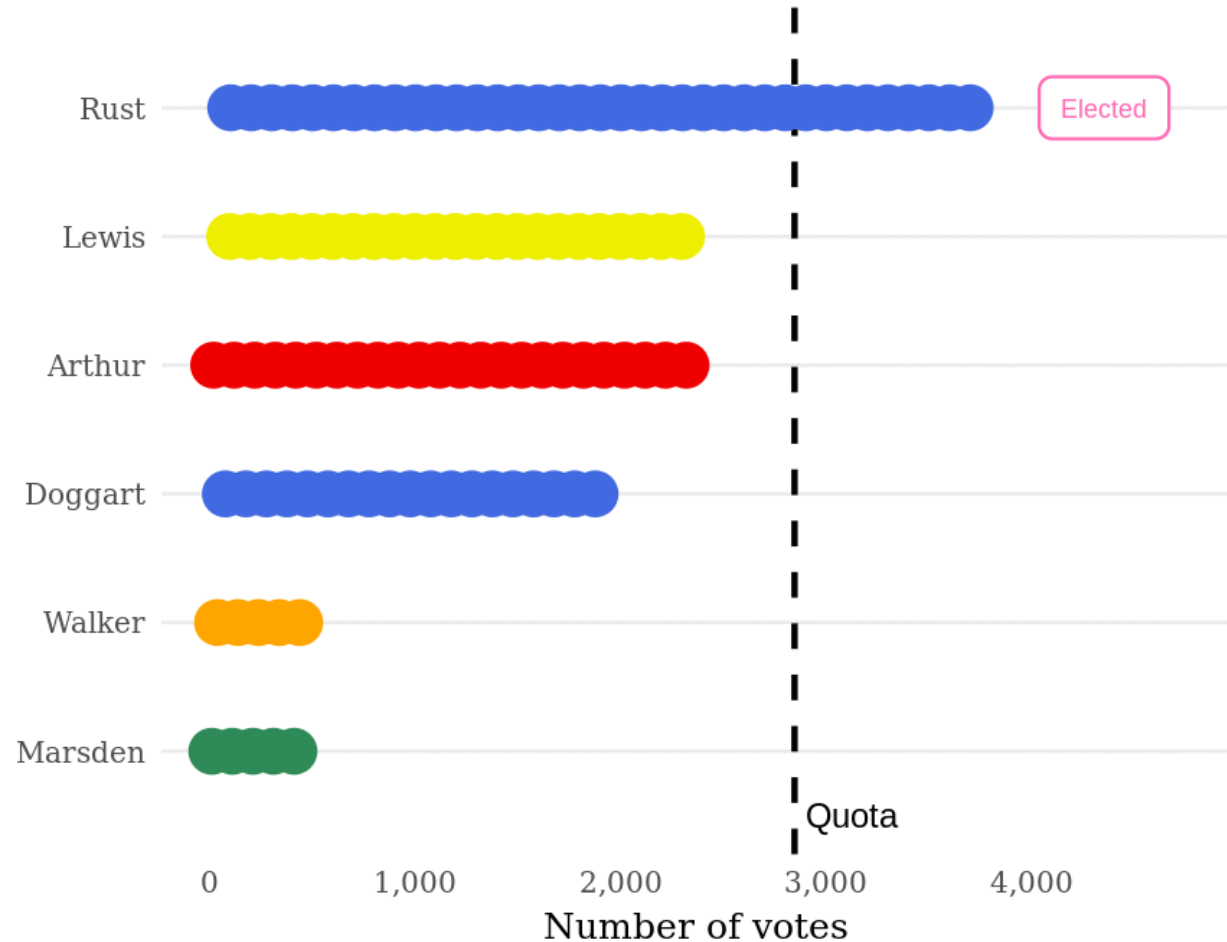


○ 5. Consensus

The fundamental challenge to community is to make decisions.

In a democracy, many of these decisions are made through some form of majority rule

Colinton/Fairmilehead 2017 Scottish council election: votes after Round 1
Each circle represents 100 votes





○ 5. Consensus

But many are not.

Some of the alternative systems we use include:

- Authoritarianism
- Hierarchy and delegation
- Markets
- Rumour and Innuendo
- Anarchy

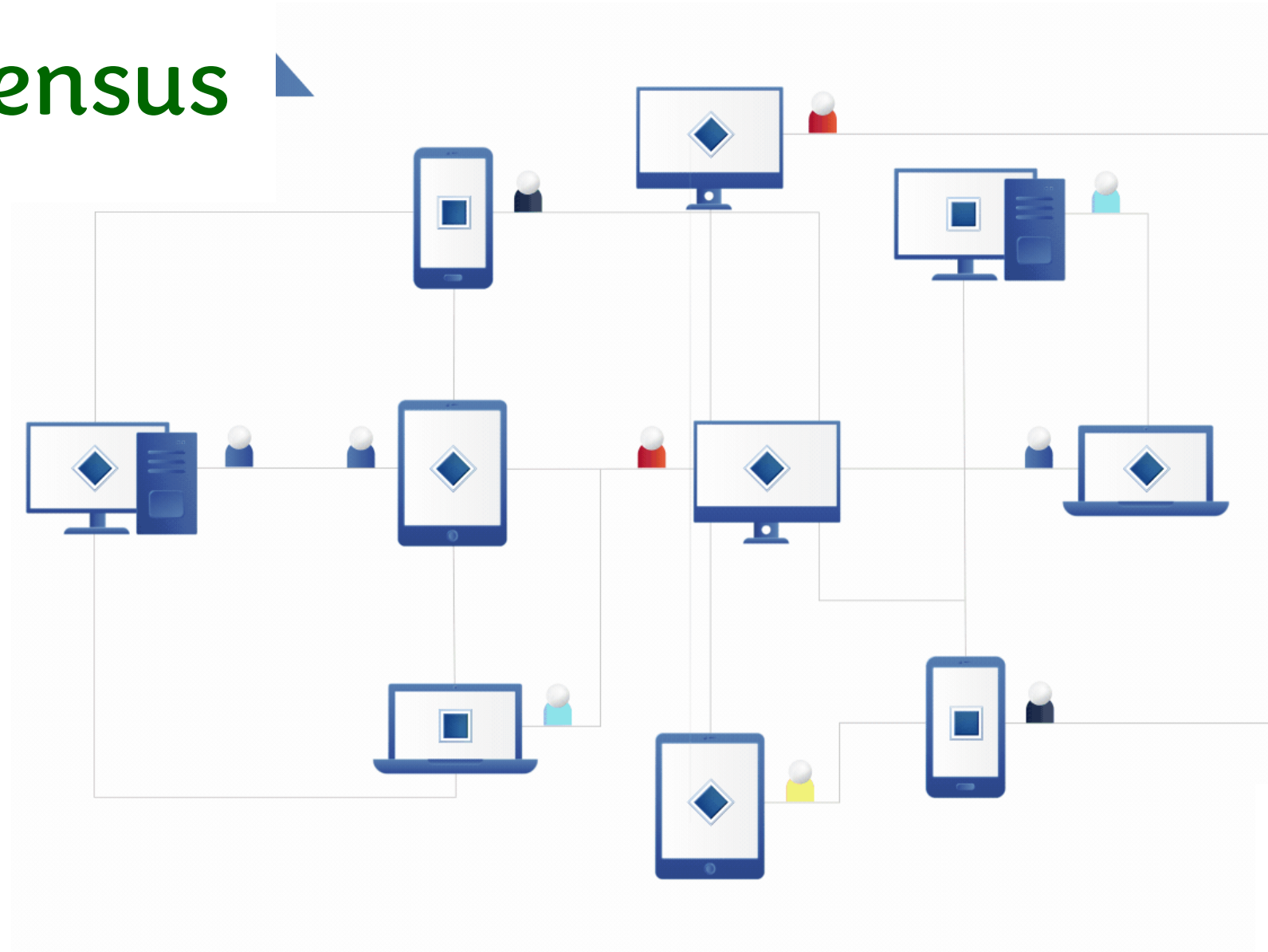




5. Consensus

Enter
consensus
algorithms

...





○ 5. Consensus

Community is defined by membership in the network

Membership in the network is based on agreement with the consensus protocol

Data networks depend on single sources of truth

The consensus protocol defines what members agree is a source of truth





○ 5. Consensus

The adoption of new learning technologies can and should include room for new forms of community and promote new literacies enabling students to thrive in them:

- Teams, collaborations, unions
- Cooperatives and networks
- Distributed Autonomy (DAO)

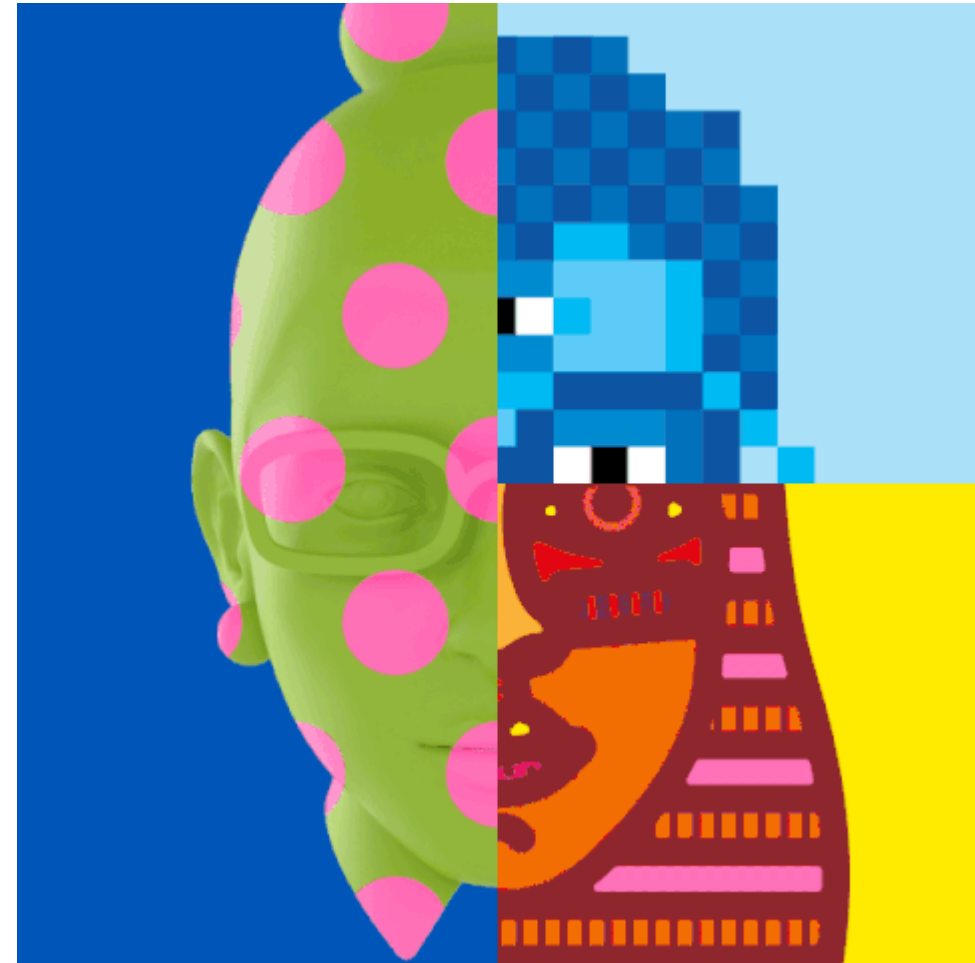




○ 6. Digital Identity

Soon, simple passwords will be replaced, and identity theft will be a thing of the past.

Our attention will shift from how we prove we are who we are to how we define ourselves online.



6. Digital Identity

New secure identities backed by decentralized identifiers (DID) and verifiable credentials will become commonplace.

You already carry them in your chip card or Google Pay.

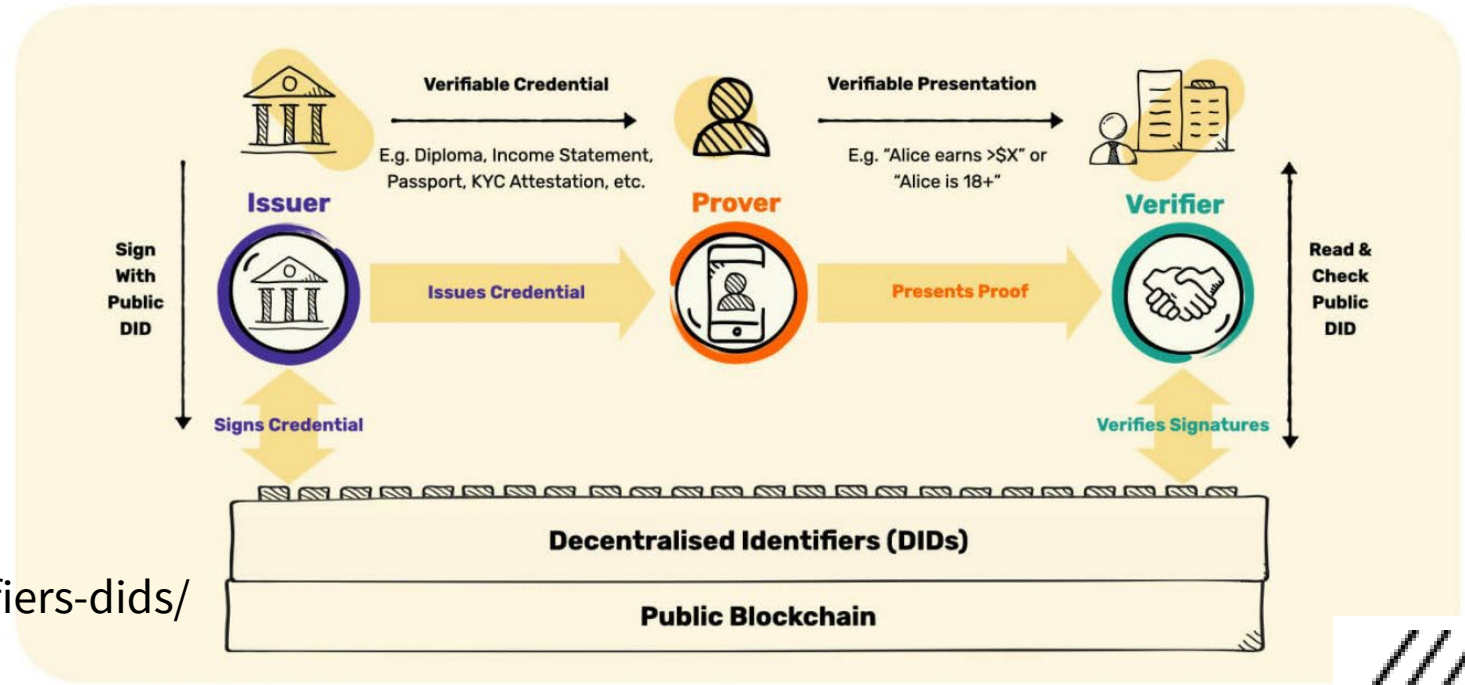
<https://www.w3.org/TR/did-core/>



6. Digital Identity

New secure identities backed by decentralized identifiers (DID) and verifiable credentials will become commonplace.

They will be issued and verified in a distributed network

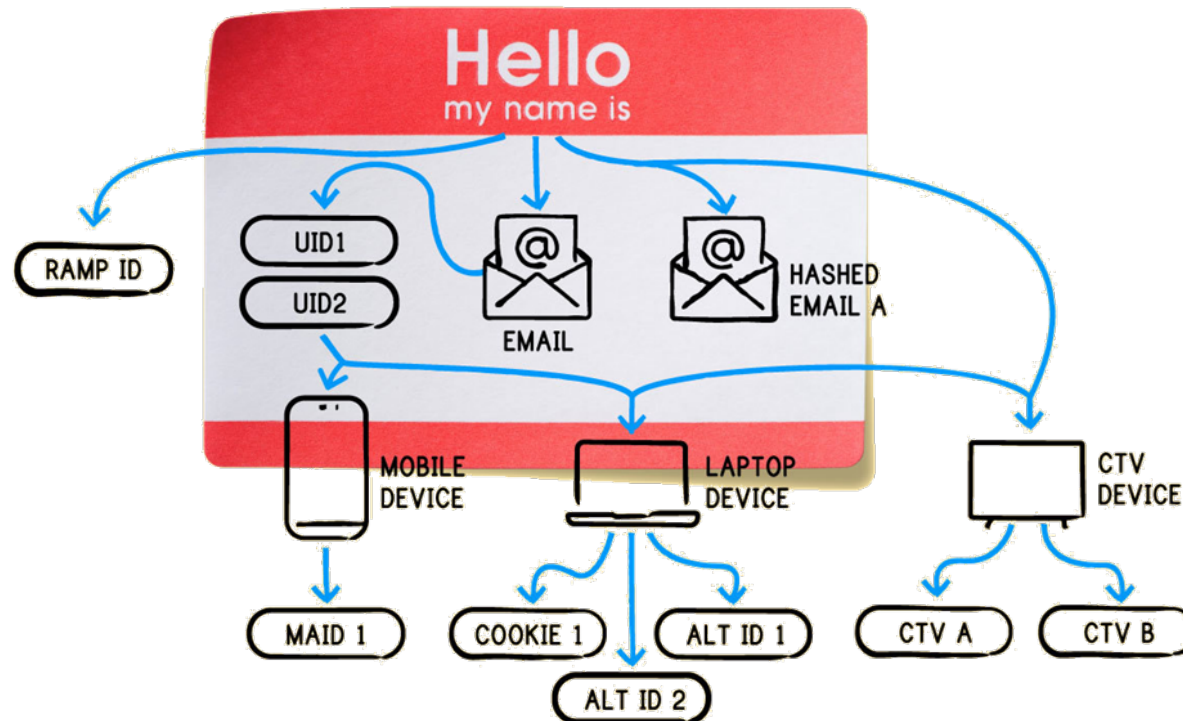


<https://tykn.tech/decentralized-identifiers-dids/>



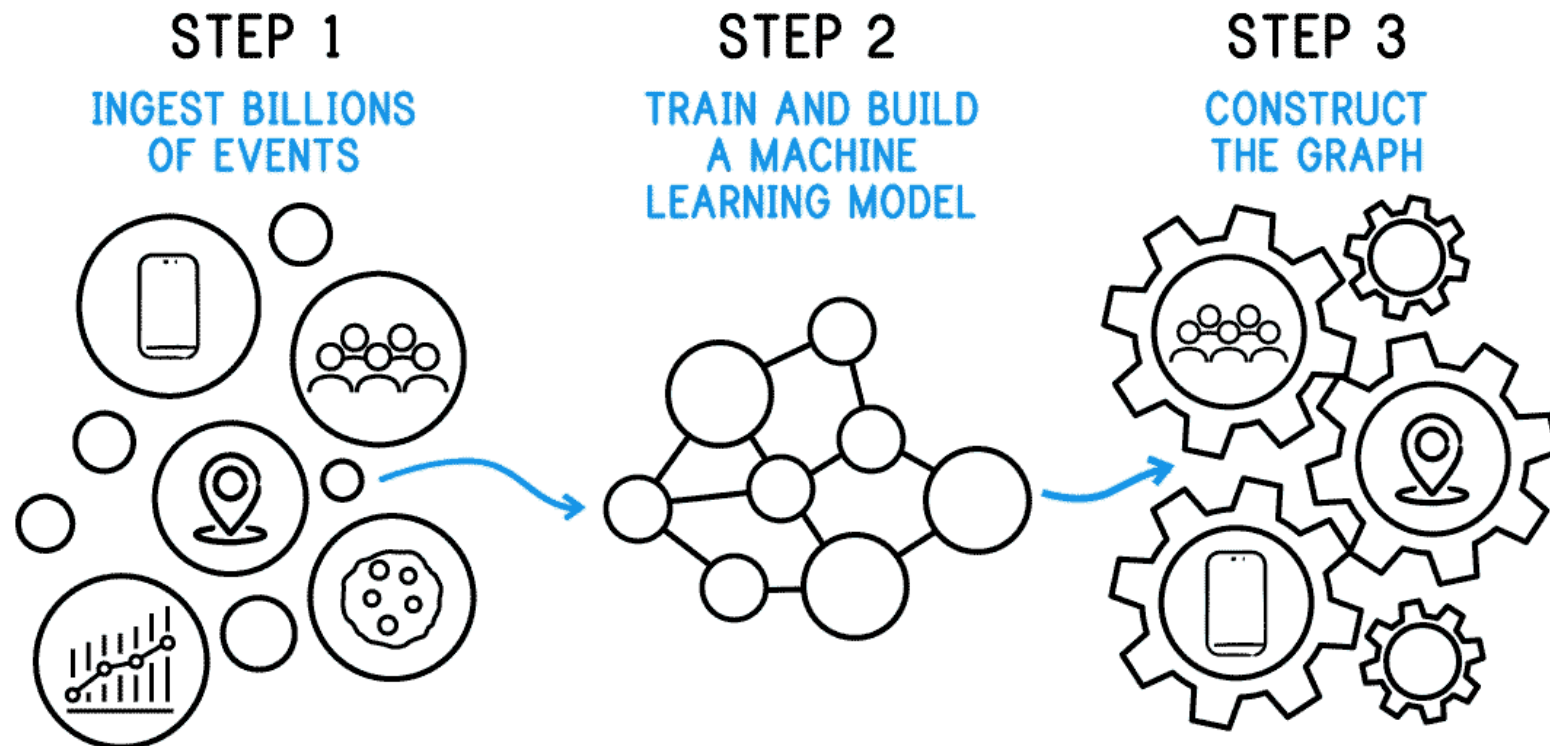
6. Digital Identity

But new, robust online identity raises a host of new questions. Who are we? What does our digital identity look like?



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But new, robust online identity raises a host of new questions. Who are we? What does our digital identity look like?



How Identity
Graphs are Built



○ 6. Digital Identity

In this new data-rich world, *we are the content.*

<https://indieweb.org/>





○ 7. Creative Experiences



So much of education continues to rely on indirect methods that depend on knowledge transfer — reading, lectures, videos — rather than hands-on practice and knowledge creation.

This is about to change.



○ 7. Creative Experiences

Instead of delivering content, a teacher will model and demonstrate successful practice, and learners will seek to emulate and build on what they see and experience.





○ 7. Creative Experiences

Open Working
Job Shadowing
Apprenticeships



<https://www.youtube.com/playlist?list=PLeBQHgzQN9x3Ef-JuV-HQw2on-RkjTBM>

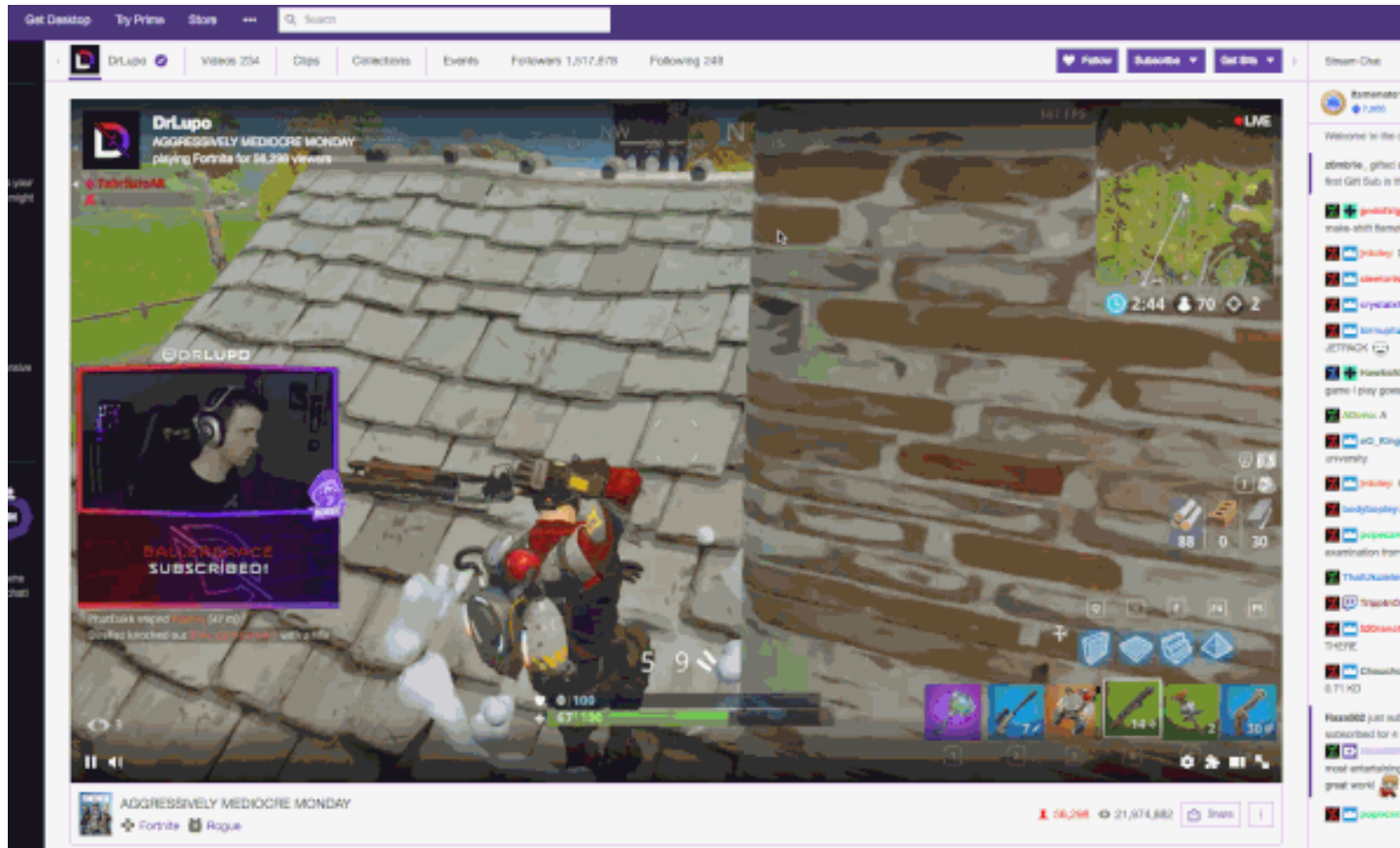
<https://nbold.co/working-in-the-open/>



○ 7. Creative Experiences

Tools

- Twitch
- OBS
- Teams / Slack
- Discord



○ 7. Creative Experiences



The dialogue and interactivity that takes place sets the work into context and enables learners to see it as a process rather than an artifact.



○ 8. Recognition

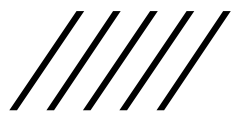
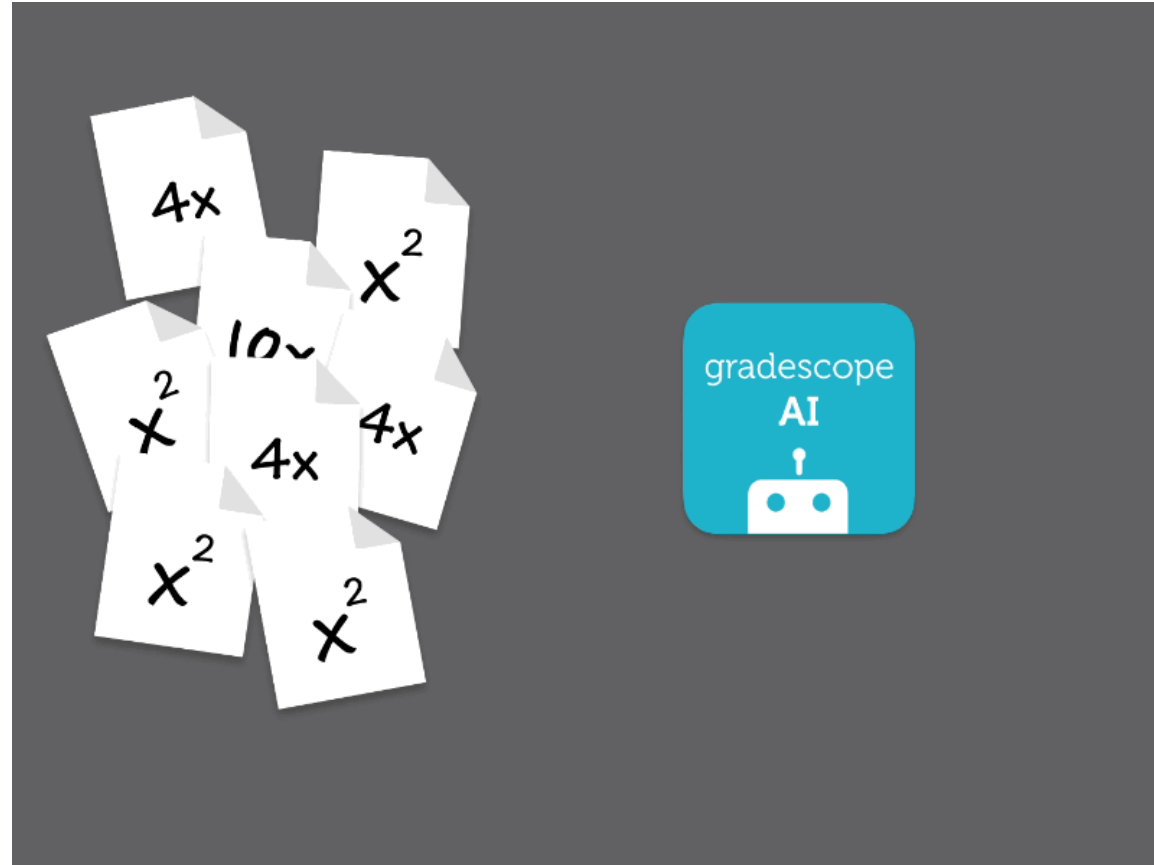
Today we rely on artificial forms of assessment like tests and exams...





○ 8. Recognition

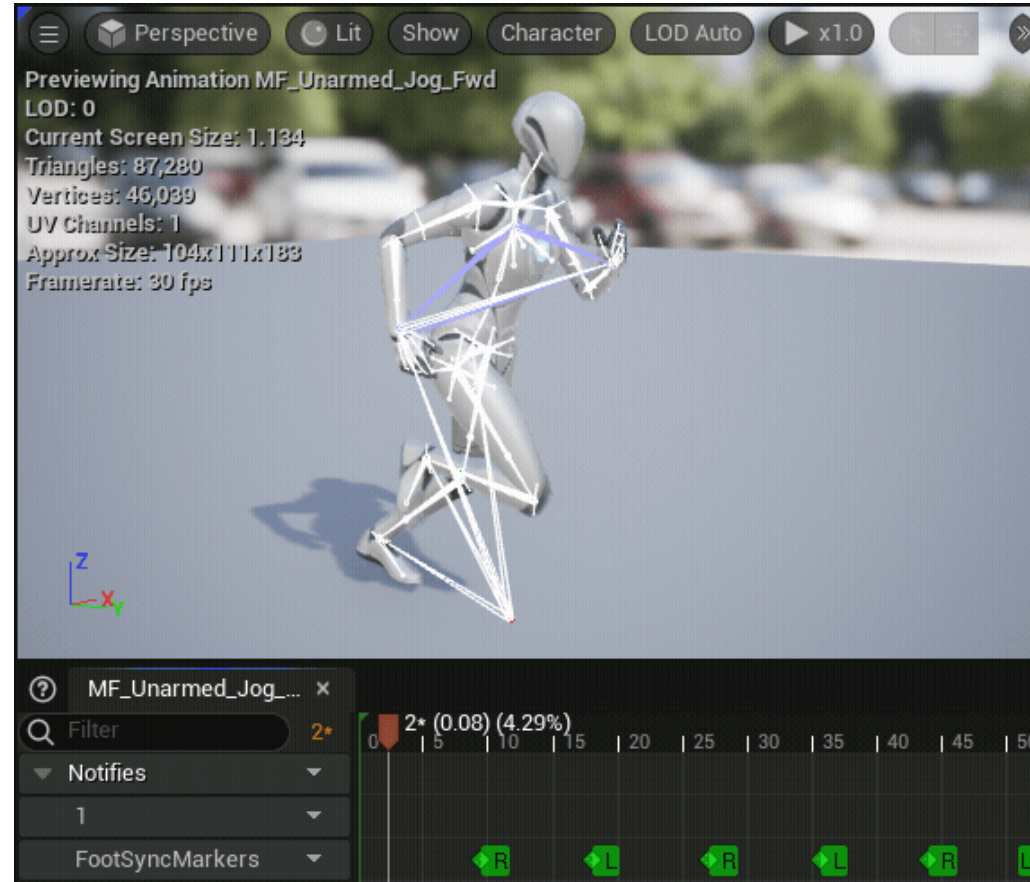
We used to assess these by hand but the future belongs to automated assessment tools already used to grade natural language content.



8. Recognition

We will need to refine these tools.

Actual authentic tasks designed or contributed by humans may be needed to balance the possibility of biased algorithms.



○ 8. Recognition



But this means that *anyone* can perform assessments

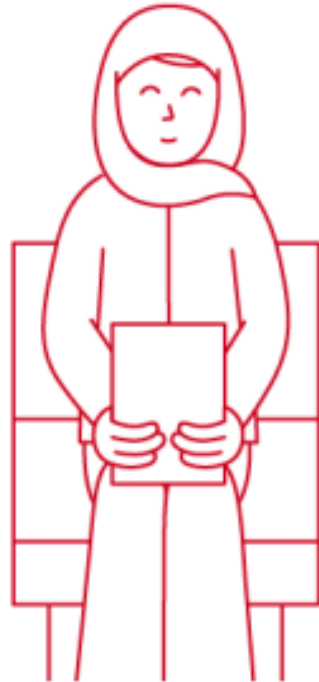
And they will base these assessments on *actual public performance* or *personal portfolios*





○ 8. Recognition

The credential of the future will be a job offer



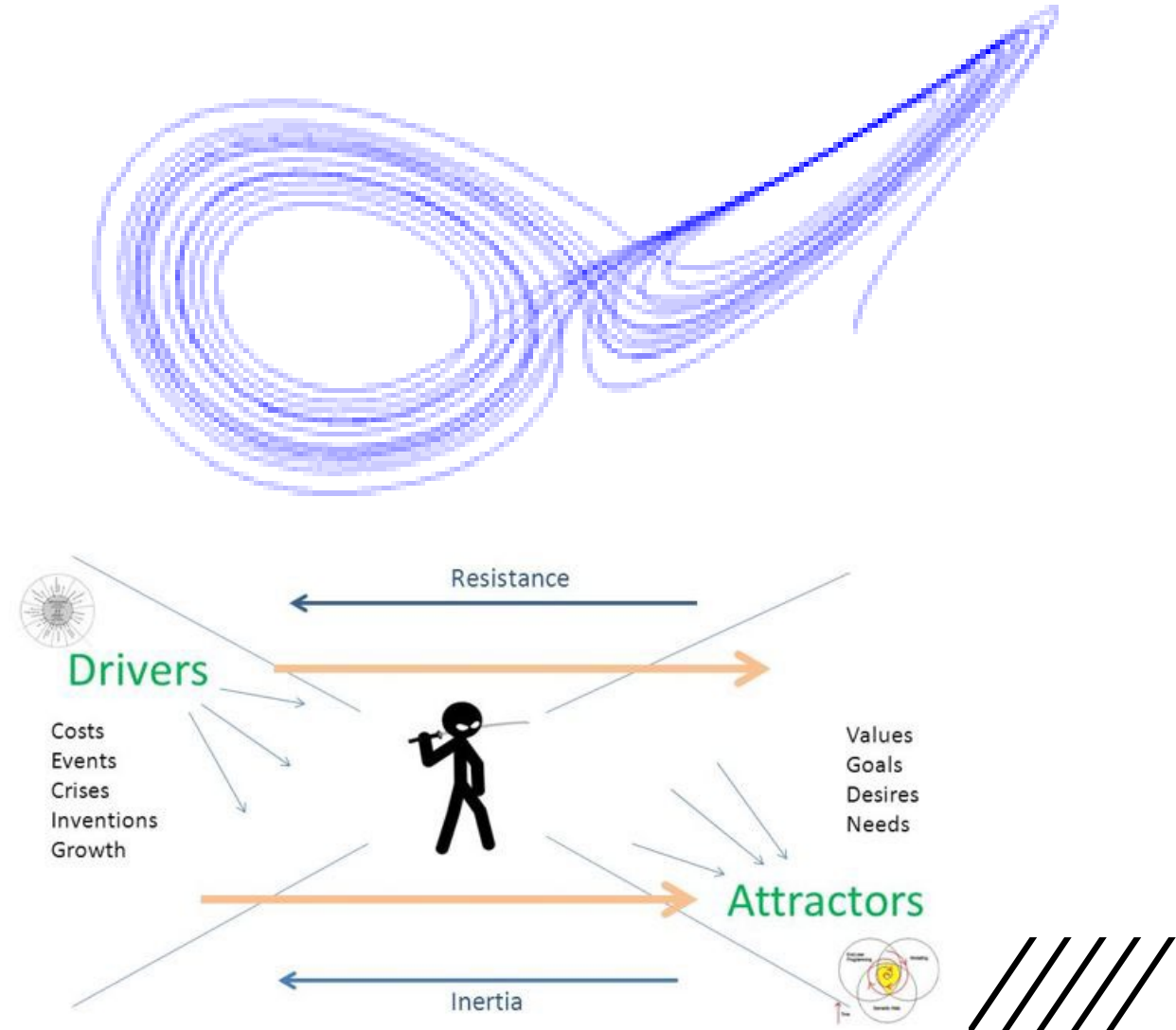
Learning institutions may need to consider how to contribute to a desirable profile that satisfies a wide range of currently undefined performance criteria.



○ 9. Agency

What we learn depends on why we learn, and the idea of agency is to enable this to be shaped by the learner.

We can think of this as the attractor as opposed to a driver.





○ 9. Agency



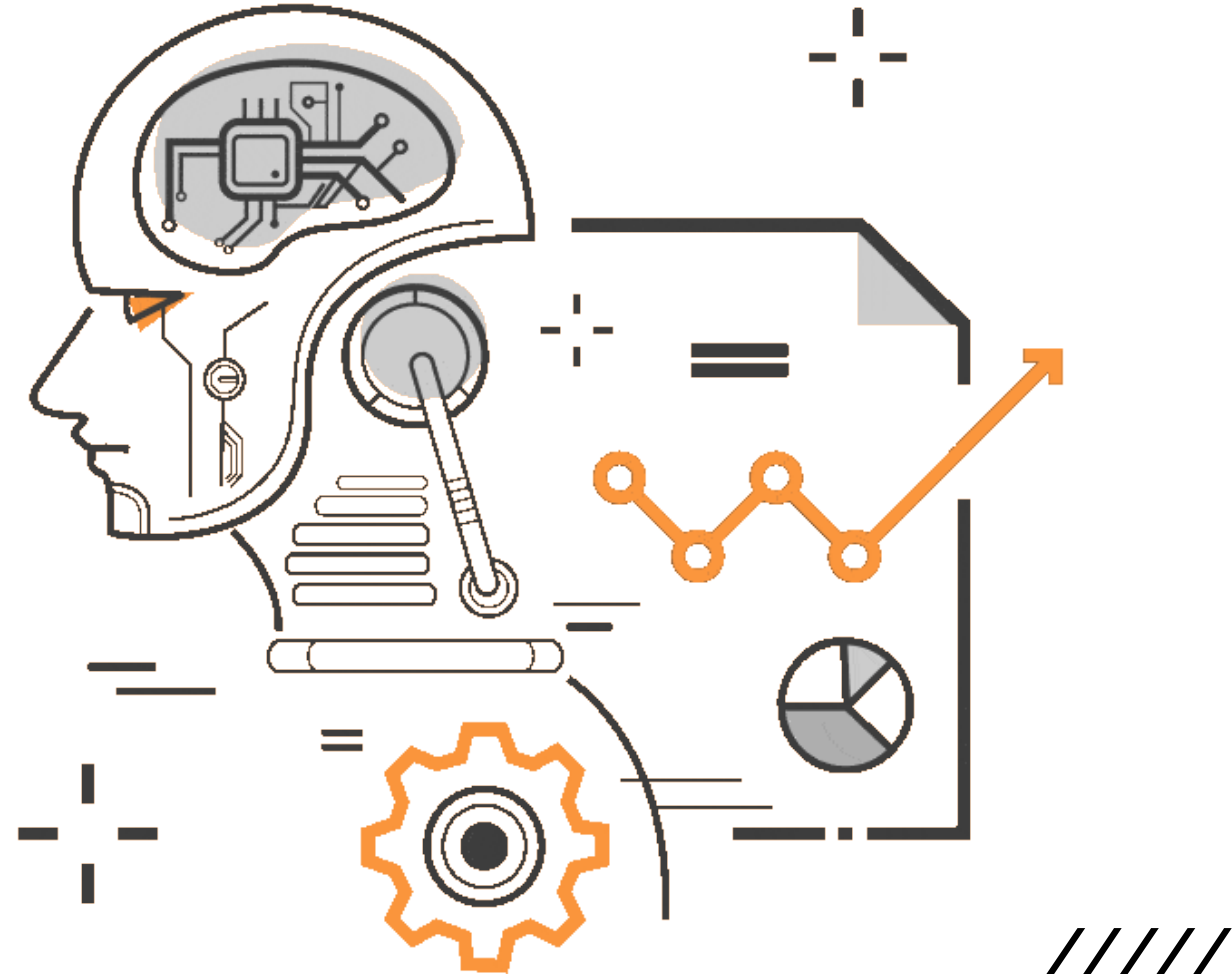
Agency - a shift in the relative standing of the individual with respect to community, institutions and governments, for better or worse - is impacted by technology.



○ 9. Agency

There is a growing development and acceptance of digital agents working on our behalf:

- Automated publishing
- Algorithmic stock trading
- Content alerts





○ 9. Agency

Individual agency is what consensus-based decentralized communities are designed to augment.



How much agency is enough? Too much?

What types of agency do we want? Do we lack?



○ 9. Agency

What counts as success?

Priorities are established by individual conditions and character, and may include elements such as security, identity, voice and opportunity. Success therefore needs to be evaluated according to these wider metrics



○ 10. Infrastructure

People are rethinking what they value in their lives and how their work and learning should be structured.

The outcome of this process is a reorganization of social infrastructure to fit these new priorities.



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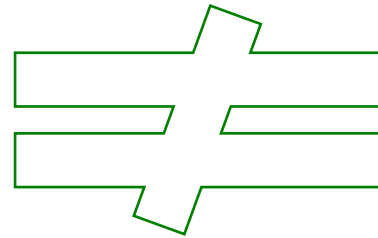
The outcome of this process is a reorganization of social infrastructure to fit these new priorities.





○ 10. Infrastructure

Anonymity,
encryption and
zero-knowledge
data networks



Accountability,
resilience,
security,
robustness



○ 10. Infrastructure

The gaps in our social fabric...





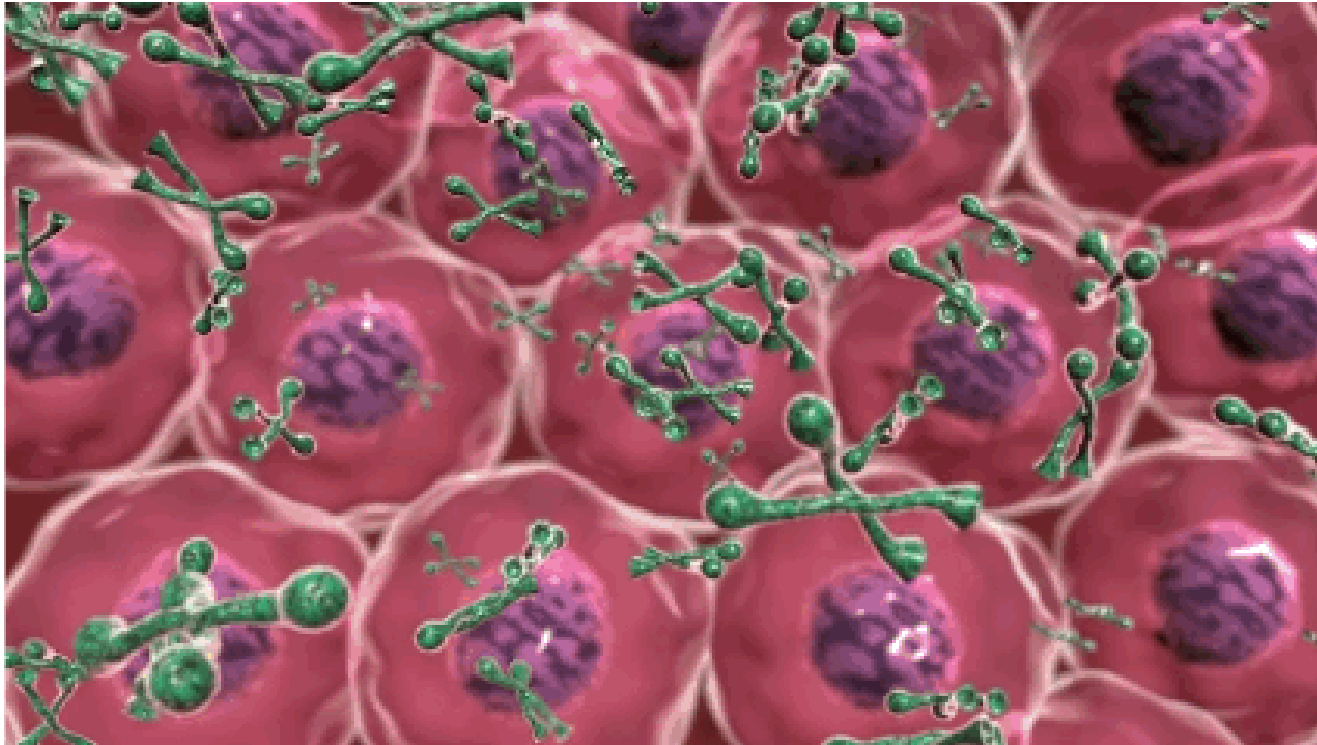
○ 10. Infrastructure

The greater need for individual and collective capacity



○ 10. Infrastructure

Resilience of our scientific and industrial infrastructure



○ 10. Infrastructure

Climate and environmental sustainability







Stephen Downes
<https://www.downes.ca>

