



# A Distributed Content Addressable Network for Open Educational Resources

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# OER: A Problem



# The Open Web

- Began as email lists and Usenet groups.
- Grew through blogs and personal websites
- Thrived in the age of social networks, online classrooms, and massive open online courses.

# Open Education

- The philosophy of ‘open’ that characterized the early internet was also reflected in the concept of open education.
- “Open education is a philosophy about the way people should produce, share, and build on knowledge.” ([opensource.com](https://opensource.com); Colpaert, 2018)

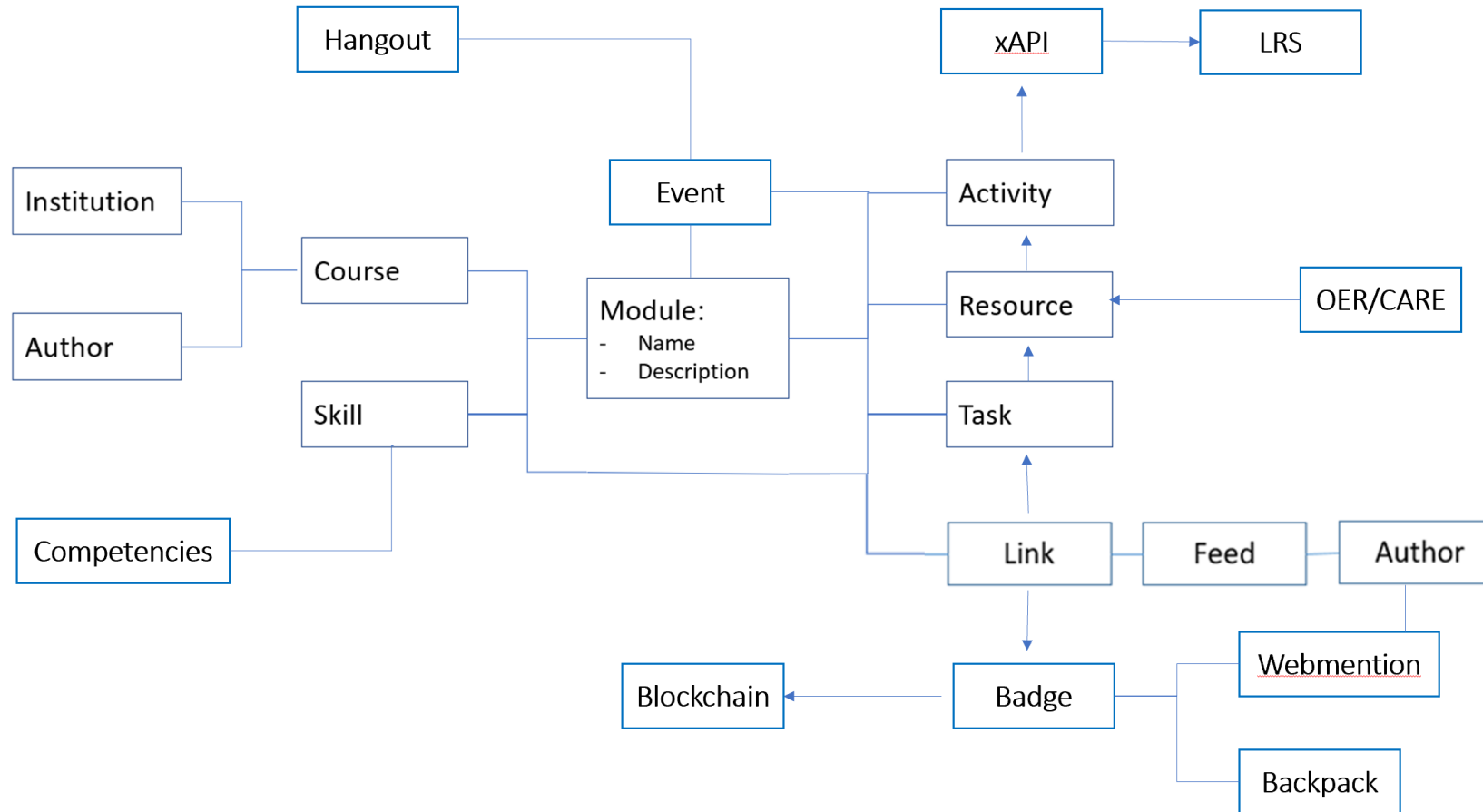
# Open Educational Resources

- Teaching, learning and research materials that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions. (UNESCO, 2002)

# MOOCs and Open Courses

- First MOOC created in 2008 (CCK08)
- Based on the idea of open education
- Created using open educational resources, and are themselves open educational resources

# Courses as Linked Open Data



# A Pedagogy of Engagement

- OER enables students to select resources
- Use inherently involves discussion and interaction
- Content creation as important as consumption



# Open Pedagogy

Participatory	Interacting via social networks and mobile apps
People and trust	Develop trust, confidence and openness working with others
Innovation & creativity	Encourage spontaneous innovation and creativity
Sharing ideas and resources	Share freely to disseminate ideas and thoughts
Connected community	Participate in a community of practice
Learner-generated	Facilitate learner contributions to OER
Reflective practice	Create opportunities for dialogue and reflection
Peer review	Contribute to an open critique of scholarship

Gráinne Conole. 2015. MOOCs as disruptive technologies: strategies for enhancing the learner experience and quality of MOOCs. Revista de Educación a Distancia. Número 39. <http://www.um.es/ead/red/39>

Bronwyn Hegarty. 2015. Attributes of Open Pedagogy: A Model for Using Open Educational Resources. Educational Technology, July/August, 2015. [https://upload.wikimedia.org/wikipedia/commons/c/ca/Ed\\_Tech\\_Hegarty\\_2015\\_article\\_attributes\\_of\\_open\\_pedagogy.pdf](https://upload.wikimedia.org/wikipedia/commons/c/ca/Ed_Tech_Hegarty_2015_article_attributes_of_open_pedagogy.pdf)

# The Pushback Against Open

- Vendors require payment for access to resources. (Aversa, Hervas-Drane & Evenou, 2019)
- Vendors began making money through advertising.
- Both subscription-based and advertising-based models encouraged the growth of technology that herded users into content silos and that tracked and analyzed their behaviour. (Papadopoulos, Snyder & Livshits, 2019)

# Challenges to OER

- MOOCs create barriers, charging first for certification and then for access to content itself. (Shah, 2017)
- Same thing for access to OER, e.g. Flat World Knowledge
- Ongoing issues of sustainability that need to be addressed for centralized services (Downes, 2005)

# The Enclosure of OER

- As David Bollier says, the enclosure of open content is one of the greatest threats to the internet. “Enclosure is about dispossession. It privatizes and commodifies resources that belong to a community or to everyone, and dismantles a commons-based culture.” (Bollier, 2011).

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# Application Issues for OER

- Limited re-use, and almost no adaptation
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- Not easy to create and upload OER to repositories

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# Additional Issues

- OER remain hard to discover
- Individual OER often lacked educational
- No mechanism for ensuring the quality of OER

# CARE: A Solution



# Content Distribution Networks

- Content is stored on multiple servers. And when a web user requests that content, it is served from the nearest server.
- E.g. Content Distribution Networks
- Companies such as Cloudflare and Akamai now serve as much as half the content traffic on the internet

# The Distributed Web

- Rather than belonging to a company such as Akamai, servers are individual users' *computers*.
- Continuous development including services such as Napster, Gnutella, Tor and BitTorrent. (Troncoso, Isaakidis, Danezis & Halpin, Harry, 2017)
- These are called 'peers' and the system as a whole is called a 'peer-to-peer' (P2P) network.

# Decentralization

- The distributed web potentially solves issues proponents have long sought to address.
  - *traffic*, which overloads a single server.
  - *latency*, or the lag created by accessing resources half a world away.
  - national *policies* creating the need to differentiate access.
  - Reliance on a *centralized* source



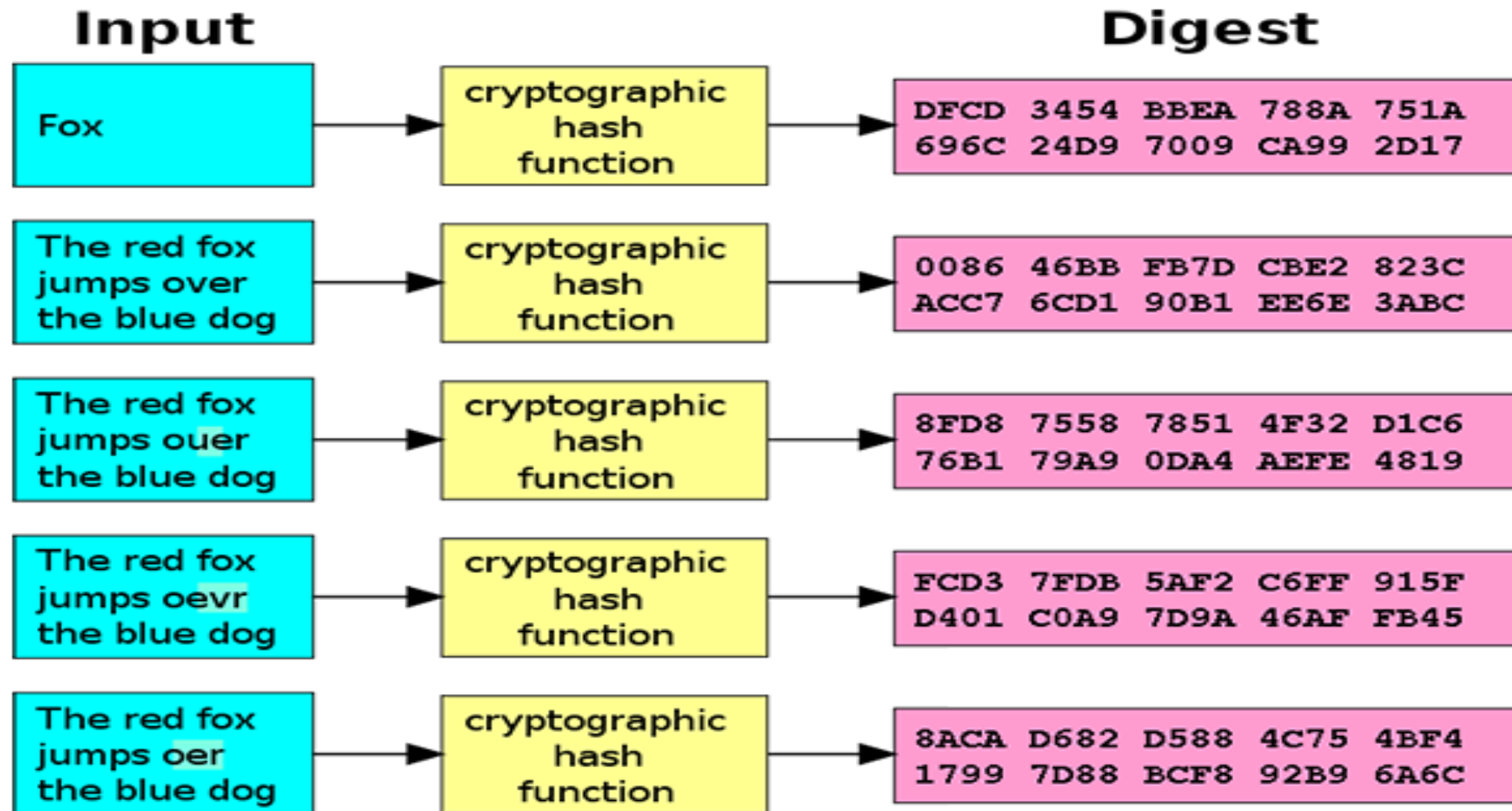
# Web3

- “Web3” (corresponding to a JavaScript library called Web3.js) (Stark, 2018)
- Chains encrypted data structures to create what may be characterized as a “stateful” distributed web.
- Beyond obvious applications such as distributed token networks such as Bitcoin or Ethereum, Web3 may offer a response to the issues of centralization and commercialization afflicting OER.

# Content Addressing

- Content of a resource is used as input to a hash algorithm that produces a scrambled string of characters - the *hash* - of the resource.
- Each hash is an essentially *unique identifier* for that resource. (Sicilia, Sánchez-Alonso & Barriocanal, 2016).
- A peer sends a request to the closest peer, which either sends us the resource, or passes the request along to more peers.

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# Dweb

- One significant current project implementing such a protocol is called Dweb (for ‘distributed web’ or ‘decentralized web’). (Ayala, 2018)
- Based on the dat protocol, (<https://www.datprotocol.com/>) a mechanism for finding and distributing content  
dat://502bdf152d00a35f9785f78d107b9037b5eca9354bcf593e7b4995f9be97a614/
- This address is in fact the dat:// address for the first *Content Addressable Resource for Education* (CARE).

# Peer Applications

- An application that runs on your computer and communicates with other nodes in a P2P network to share resources.
- [Beaker Browser](#)
  - allows users to explore Dweb resources, 'clone' those resources and create or edit new resources.
  - manages Dweb functionality like creating hashes and chaining resources together. (Robinson, Hand, Madsen, Buus & McKelvey, 2018).
  - Addresses 'dat name service'



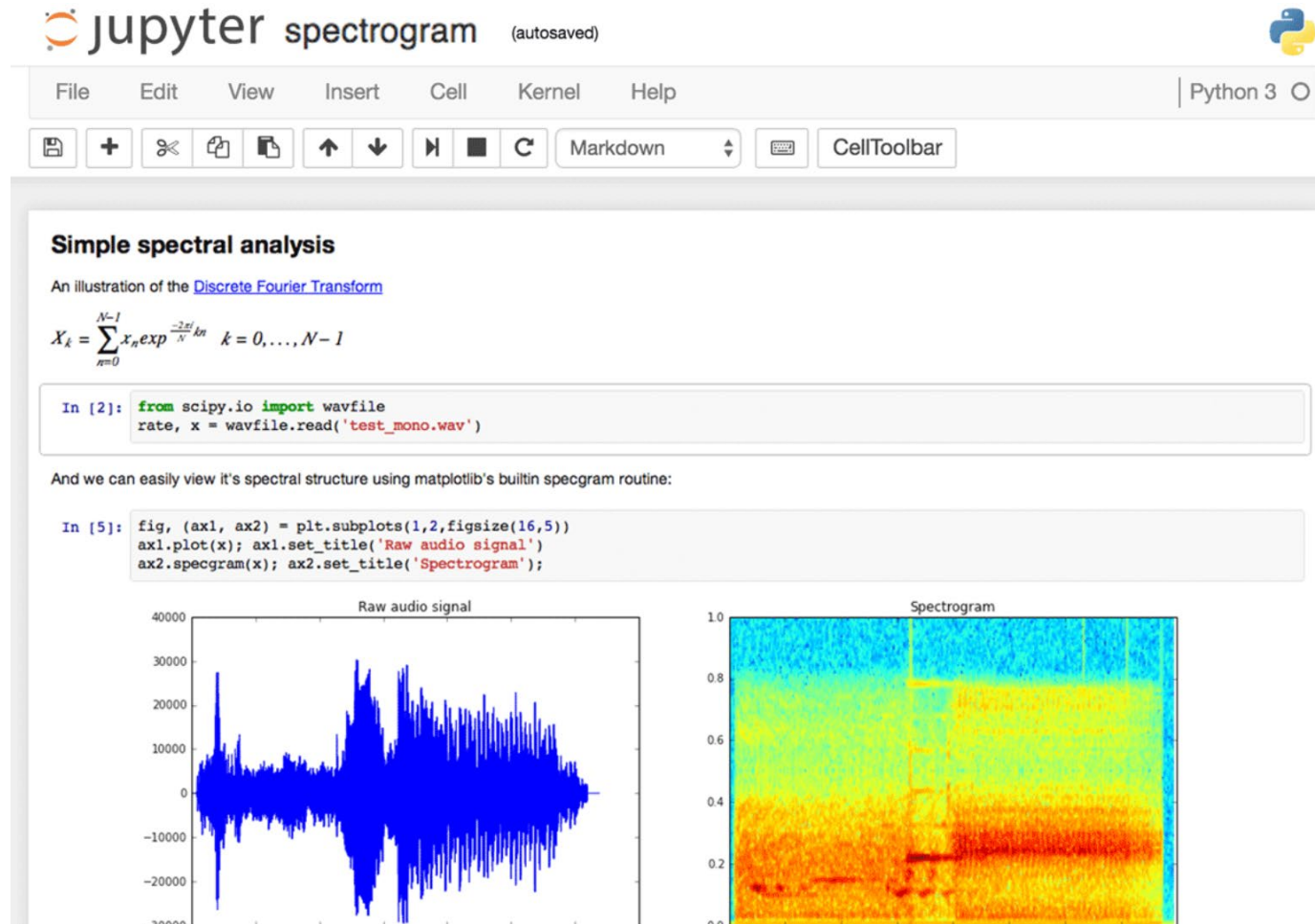
# Other Applications

- [Blockchain](#) - the resources in question are entries in financial ledgers.
- [Git](#) (with services based on the protocol like [GitHub](#) and [GitLab](#)), chains resources in different versions or branches of a software development project.
- [Interplanetary File System](#) (IPFS) along with the associated project, Inter Planetary Linked Data ([IPLD](#)).

# Content Addressable Resources for Education

- CARE are content-addressable, they are stored and access in the web as a whole
- CARE are also associated with each other in an Open Resource Graph (ORG)
- CARE can be *cloned* and *edited* by any user

# Example: Notebooks



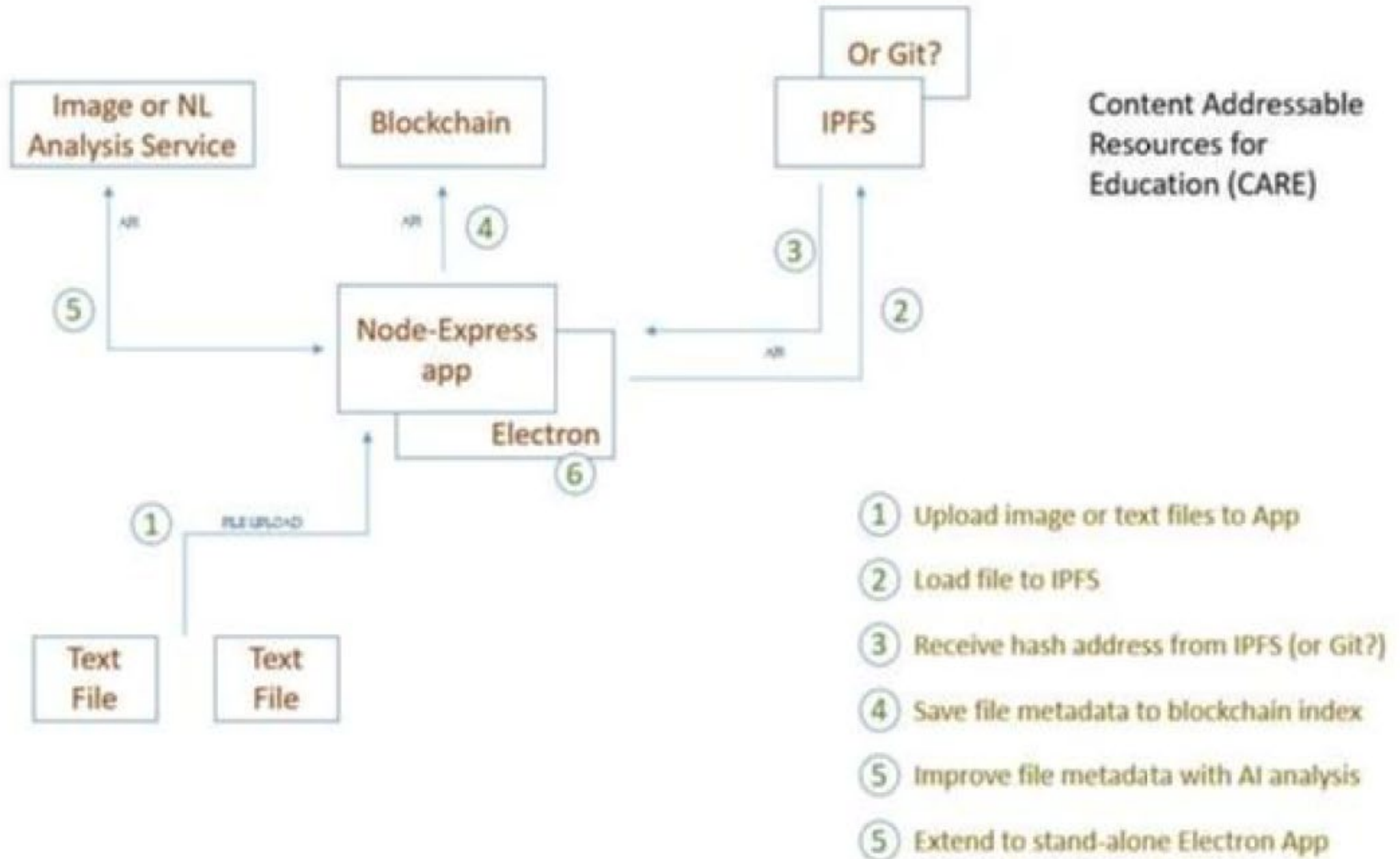
<https://github.com/jupyter/jupyter/wiki/A-gallery-of-interesting-Jupyter-Notebooks#machine-learning-statistics-and-probability>

OpenLearn [Jupyter Books Remix](#), TM351 [Notebooks in VM and Electron](#).















<https://www.dataquest.io/blog/jupyter-notebook-tips-tricks-shortcuts/>

# Implementation of CARE

- distributed through IPFS and Dweb - resources are uploaded into IPFS, where they receive a content-based address. This address is stored on an Ethereum blockchain
- not only of educational content, but interactive applications and service interfaces as well.
- CARE can be *cloned* and *edited* by any user



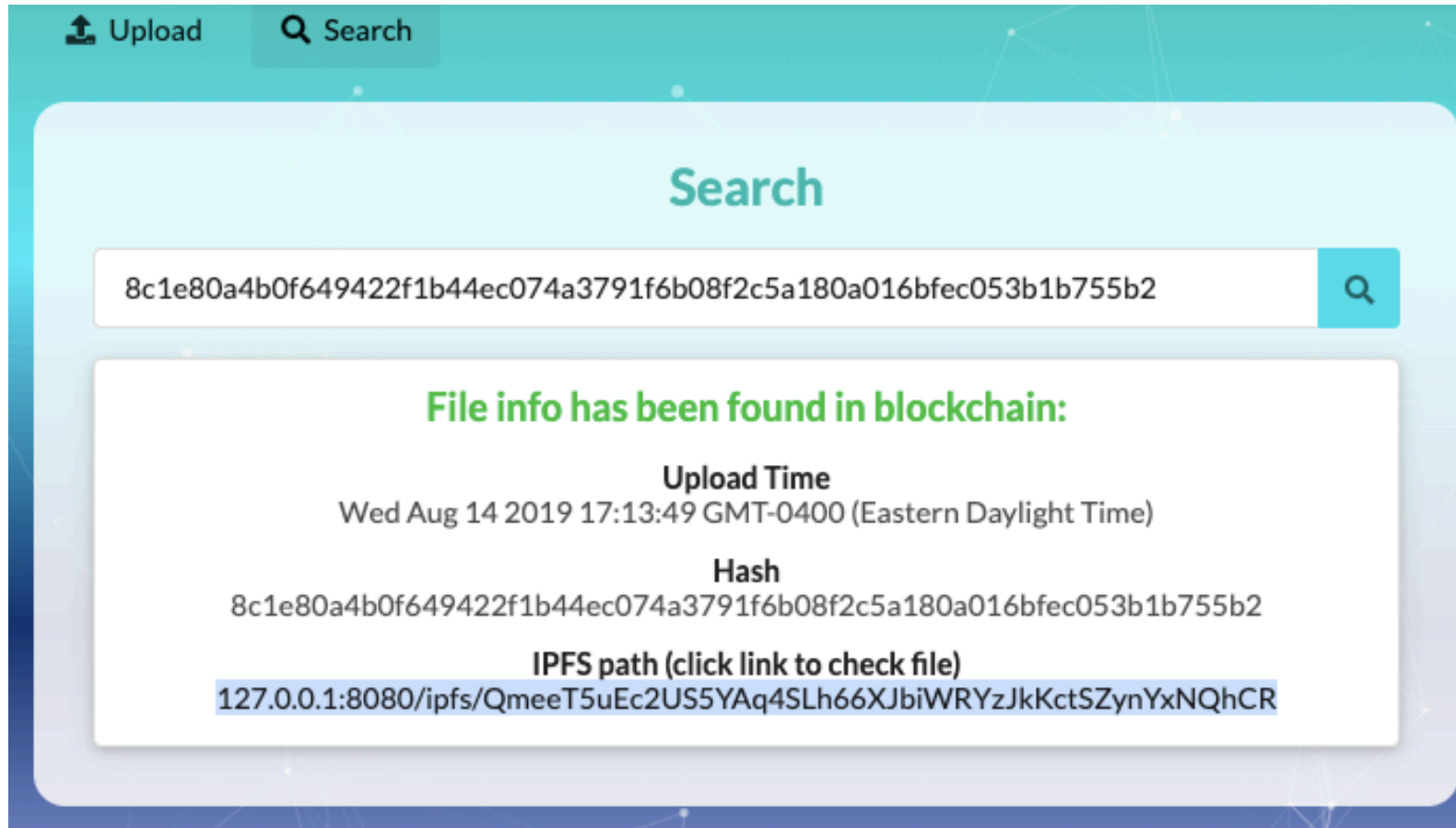
# Software

 Downes Merge pull request #4 from Downes/dependabot/npm_and_yarn/lodash.merg... <span>...</span>		Latest commit fb8d921 5 days ago
 <a href="#">app</a>	Minor Changes	3 months ago
 <a href="#">build</a>	Contract build	3 months ago
 <a href="#">contracts</a>	Project files	3 months ago
 <a href="#">img</a>	Project files	3 months ago
 <a href="#">migrations</a>	Project files	3 months ago
 <a href="#">services</a>	Deployed contract address	3 months ago
 <a href="#">test</a>	Project files	3 months ago
 <a href="#">.gitignore</a>	Project files	3 months ago
 <a href="#">README.md</a>	Update	3 months ago
 <a href="#">package-lock.json</a>	Merge pull request #4 from Downes/dependabot/npm_and_yarn/lodash.merg...	5 days ago
 <a href="#">package.json</a>	Project files	3 months ago
 <a href="#">server.js</a>	Project files	3 months ago
 <a href="#">truffle-config.js</a>	Project files	3 months ago

Authored by Rashi Nagpal as part of NRC summer co-op program -  
<https://github.com/Downes/CARE-project>



# Results



The screenshot shows a web application with a teal header bar containing 'Upload' and 'Search' buttons. Below the header is a large light blue box with the title 'Search'. Inside this box is a search input field containing the hash '8c1e80a4b0f649422f1b44ec074a3791f6b08f2c5a180a016bfec053b1b755b2' and a search icon. Below the input field is a white box with green text stating 'File info has been found in blockchain:'. This box contains the following information: 'Upload Time' (Wed Aug 14 2019 17:13:49 GMT-0400 (Eastern Daylight Time)), 'Hash' (8c1e80a4b0f649422f1b44ec074a3791f6b08f2c5a180a016bfec053b1b755b2), and 'IPFS path (click link to check file)' (127.0.0.1:8080/ipfs/QmeeT5uEc2US5YAq4SLh66XJbiWRYzJkKctSZynYxNQhCR).

Upload Search

## Search

8c1e80a4b0f649422f1b44ec074a3791f6b08f2c5a180a016bfec053b1b755b2

**File info has been found in blockchain:**

**Upload Time**  
Wed Aug 14 2019 17:13:49 GMT-0400 (Eastern Daylight Time)

**Hash**  
8c1e80a4b0f649422f1b44ec074a3791f6b08f2c5a180a016bfec053b1b755b2

**IPFS path (click link to check file)**  
[127.0.0.1:8080/ipfs/QmeeT5uEc2US5YAq4SLh66XJbiWRYzJkKctSZynYxNQhCR](http://127.0.0.1:8080/ipfs/QmeeT5uEc2US5YAq4SLh66XJbiWRYzJkKctSZynYxNQhCR)

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# Current Issues for CARE

- Speed - can be very fast, in practice, it often isn't
- Ease of Use - while it may seem that creating and sharing a web resource should be easy, in practice it often isn't
- There isn't yet a good Dweb search engine. Additionally, resources can disappear when a host goes offline.
  - development of semi-centralized intermediaries such as Hashbase (<https://hashbase.io/>)
- Acceptance - many institutions officially disapprove of P2P

# Future Work

- Addressing speed issues with a set of known CARE repositories functioning as IPFS nodes (known as CARE Net)
- Development of multi-part CARE resources (known as CARE Packages).
- Develop mechanisms for content creation through remixing and reusing existing resources.

# Stephen Downes



Photo by Lorelei

<https://www.downes.ca>