Leveraging the Power of the Crowd to Save the Web

Vishwajeet Pattanaik* Shweta Suran Dirk Draheim

Tallinn University of Technology

Estonia

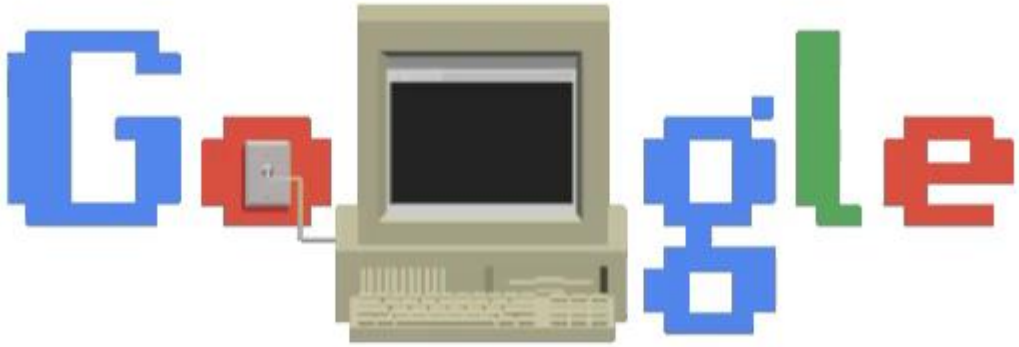
WORLD WIDE WEB

The WorldWideWeb (W3) is a wide-area hypermedia[1] information retrieval initiative aiming to give universal access to a large universe of documents.

Everything there is online about W3 is linked directly or indirectly to this document, including an executive summary[2] of the project, Mailing lists[3] , Policy[4] , November's W3 news[5] , Frequently Asked Questions[6] .

What's out there?[7]	Pointers to the world's online information, subjects[8] , W3 servers[9], etc.
Help[10]	on the browser you are using
Software Products[11]	A list of W3 project components and their current state. (e.g. Line Mode[12] ,X11 Viola[13] , NeXTStep[14] , Servers[15] , Tools[16] , Mail robot[17] , Library[18])
Technical[19]	Details of protocols, formats, program internals etc

<ref.number>, Back, <RETURN> for more, or Help:



On 12th March this year, the Web turned 30!

Tim Berners-Lee wrote his memo “Information Management: A Proposal” which outlined the World Wide Web.

*Source: Google Doodles Achieve

“The Web is starting to wane in the face of a ‘nasty storm’ of issues”

– Tim Berners-Lee*

*Tim Berners-Lee on the future of the web: 'The system is failing’, Olivia Solon, The Guardian, November’ 2017

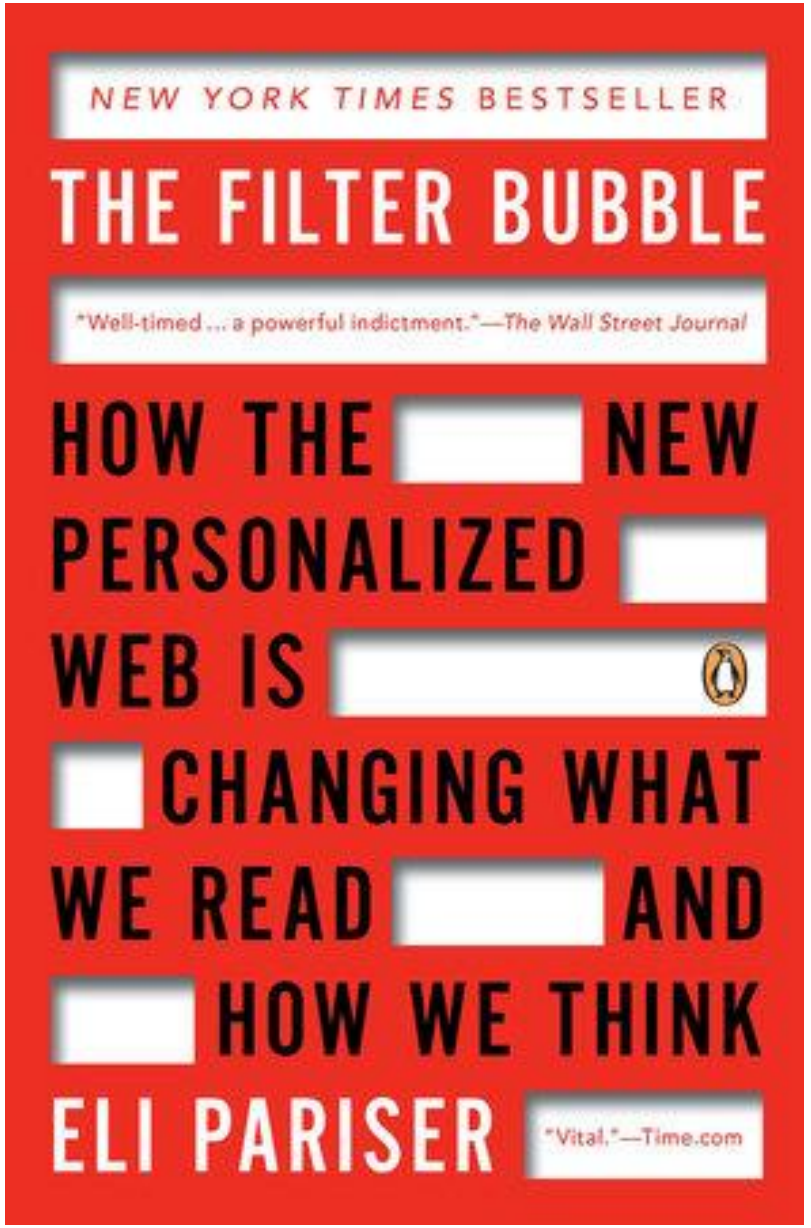
Threats Facing the Web

- filter bubble [978-1-59-420300-8]
- clickbait [10.1007/978-3-319-63751-8]
- link rot (or, web page decay) [10.1007/s00799-016-0171-9]
- fake news [10.1126/science.aao2998]
- weaponised AI propaganda (or, behavioural microtargeting) [10.1353/jod.2017.0025]

Filter Bubble

"… refers to the concept that a website's personalization algorithm selectively predicts the information that users will find of most interest based on data about each individual – including signals such as their history of Likes, search history, and other past online behavior – and that this creates a form of online isolation from a diversity of opinions …" i.e., ***echo chambers***

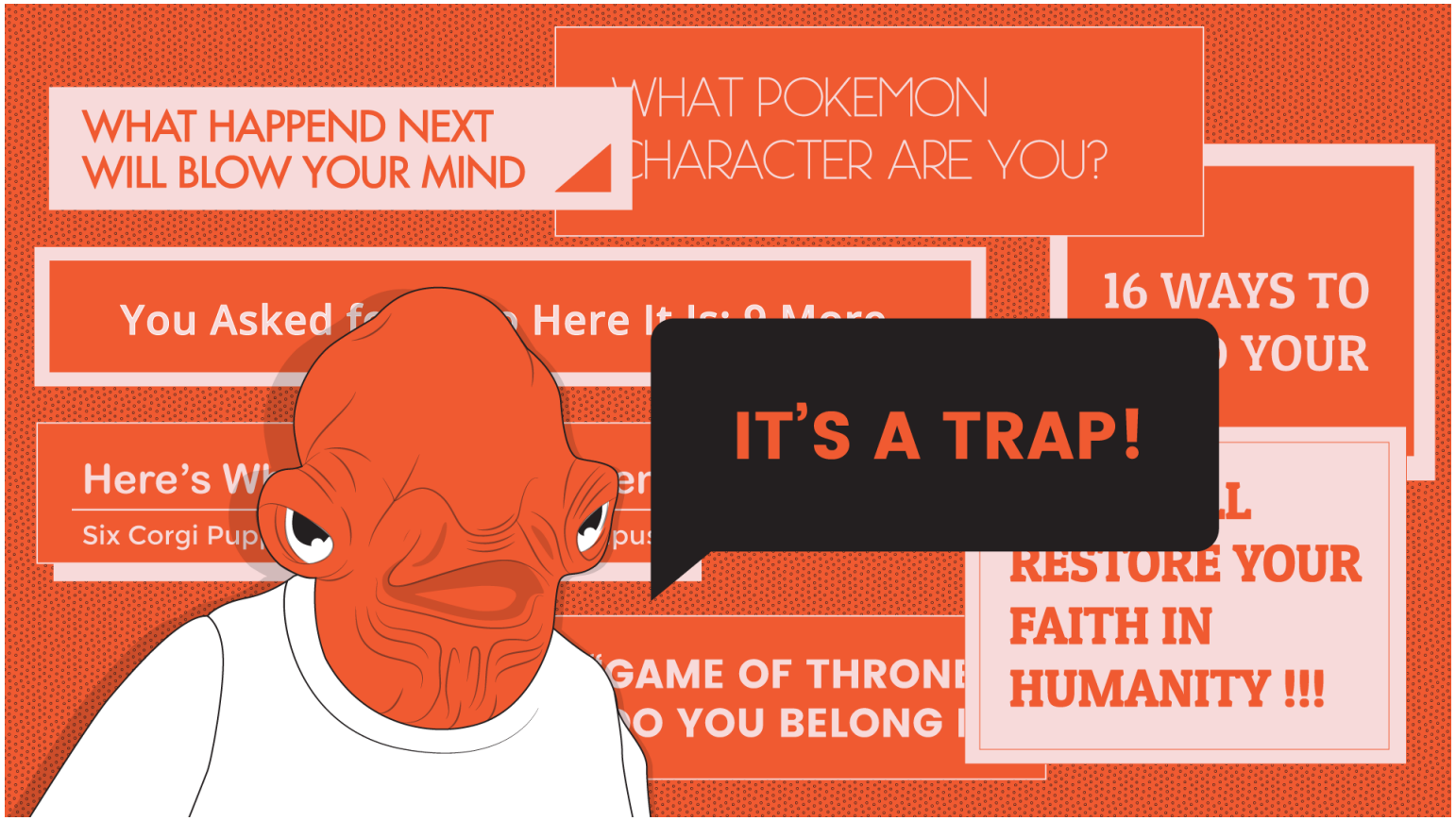
[10.1016/j.dcm.2018.03.005]



Clickbait

"... refers to social media messages that are foremost designed to entice their readers into clicking an accompanying link to the posters' website, at the expense of informativeness and objectiveness ..."

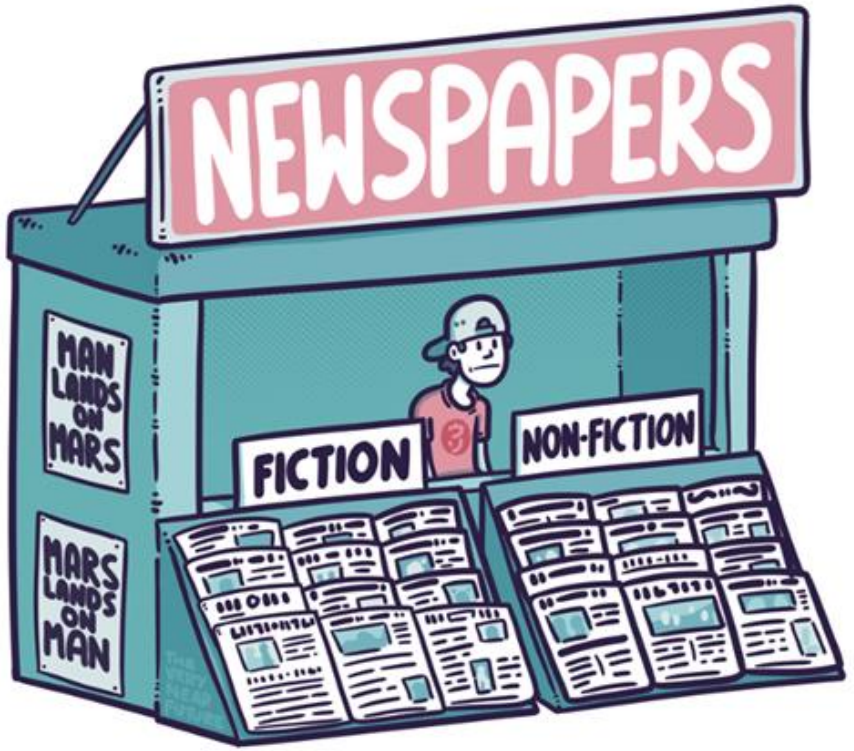
[arXiv:1812.10847v1]



Fake News

... refers to "fabricated information that mimics news media content in form but not in organizational process or intent"

[10.1126/science.aao2998]

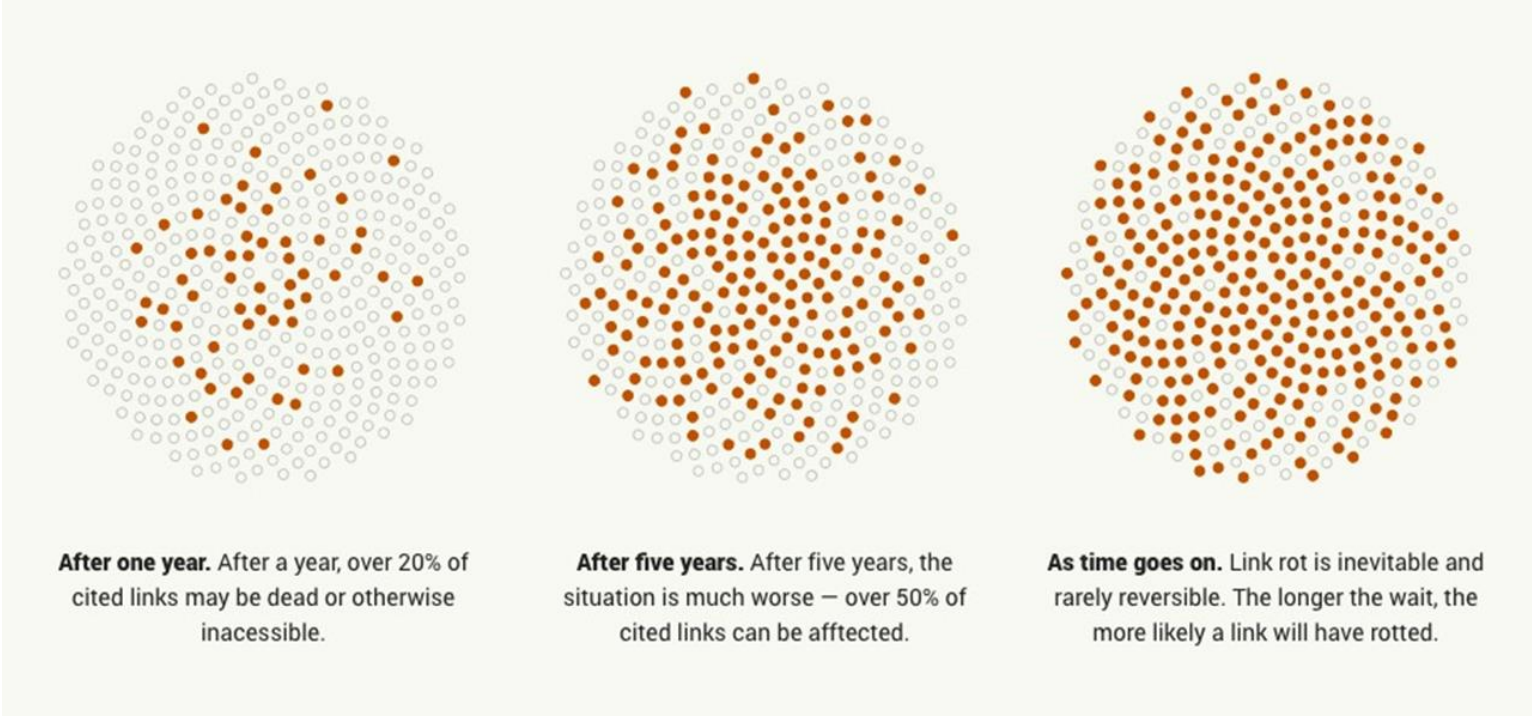


Link rot

… refers to "broken or altered links, and web content which has changed, disappeared or moved"

[10.6084/m9.figshare.7090694.v1]

- more than **69%** web pages change within days [10.1145/1326561.1326566]
- **11%** of the shared content on social media are completely lost within a year [10.1007/978-3-642-33290-6_14]
- the decay rate of web documents has dropped to **nearly two years** [10.1002/asi.23561]



After one year. After a year, over 20% of cited links may be dead or otherwise inacessible.

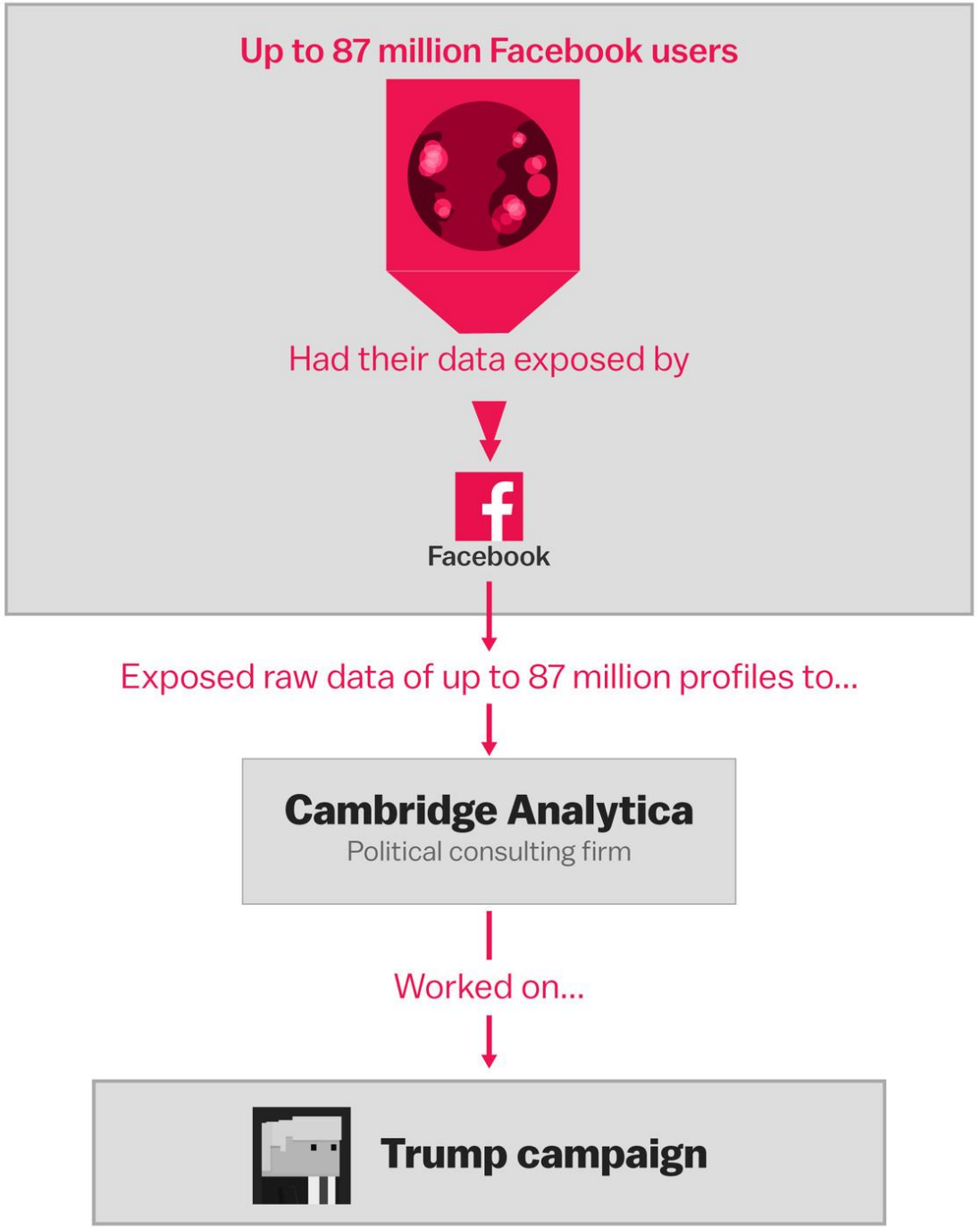
After five years. After five years, the situation is much worse — over 50% of cited links can be afftected.

As time goes on. Link rot is inevitable and rarely reversible. The longer the wait, the more likely a link will have rotted.

Behavioural Microtargeting

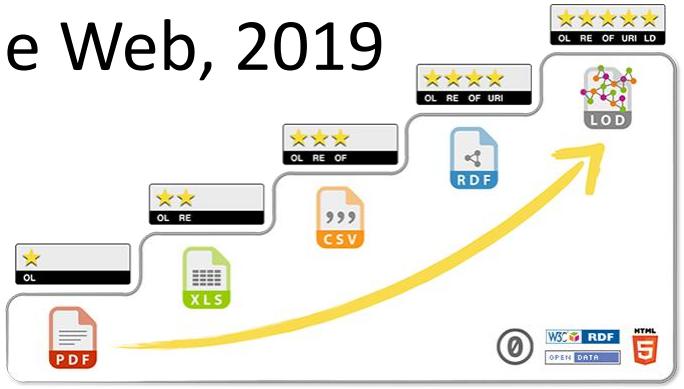
Cambridge Analytica

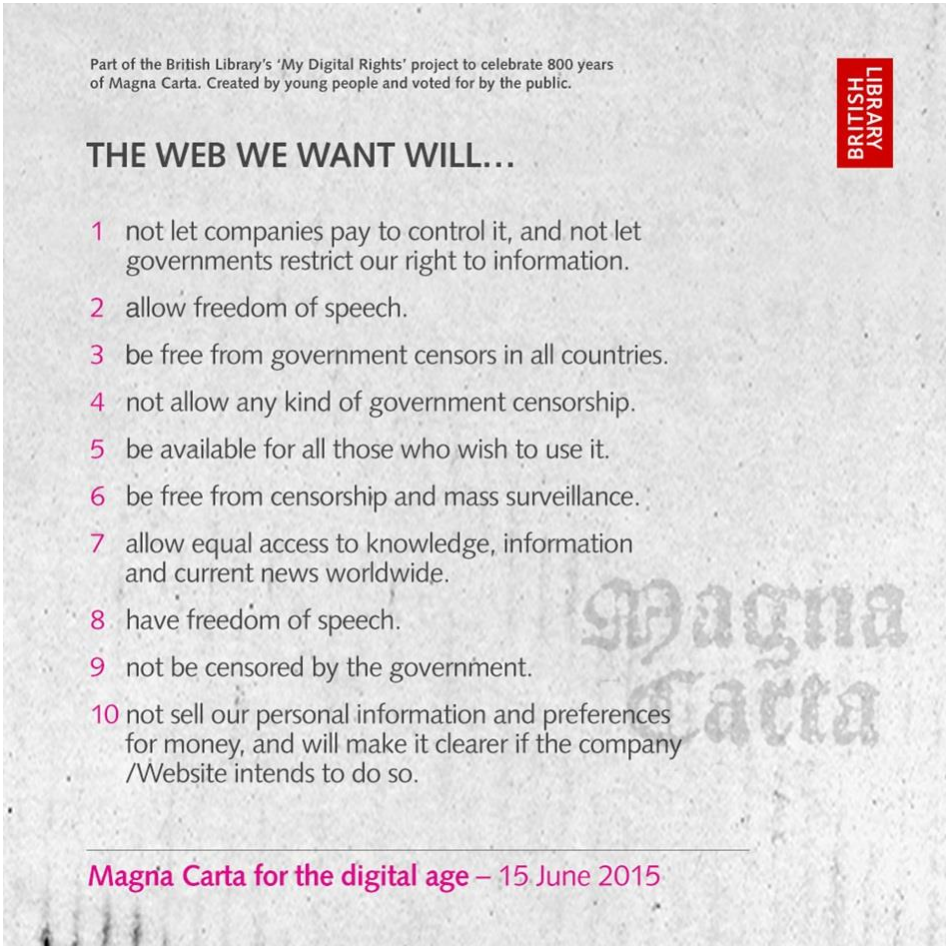
facebook



Recent Initiatives by Tim Berners-Lee

- 5 ★ Open Data, 2012
- ‘Magna Carta’ for the Web, 2014
- Solid (web decentralization project), 2016
- Contract for the Web, 2019





Recent Research Artefacts

*"If we leave the web as it is, there's a very large number of things that will **go wrong**.* We could end up with a ***digital dystopia*** if we don't turn things around. It's not that we need a 10-year plan for the web, ***we need to turn the web around now***."

- Tim Berners-Lee @ launch of "Contract for the Web"

Can we solve the ‘nasty storm’ of issues with Web, using the *wisdom of the crowd*?

…while not relying on developers and content providers…

Annotation

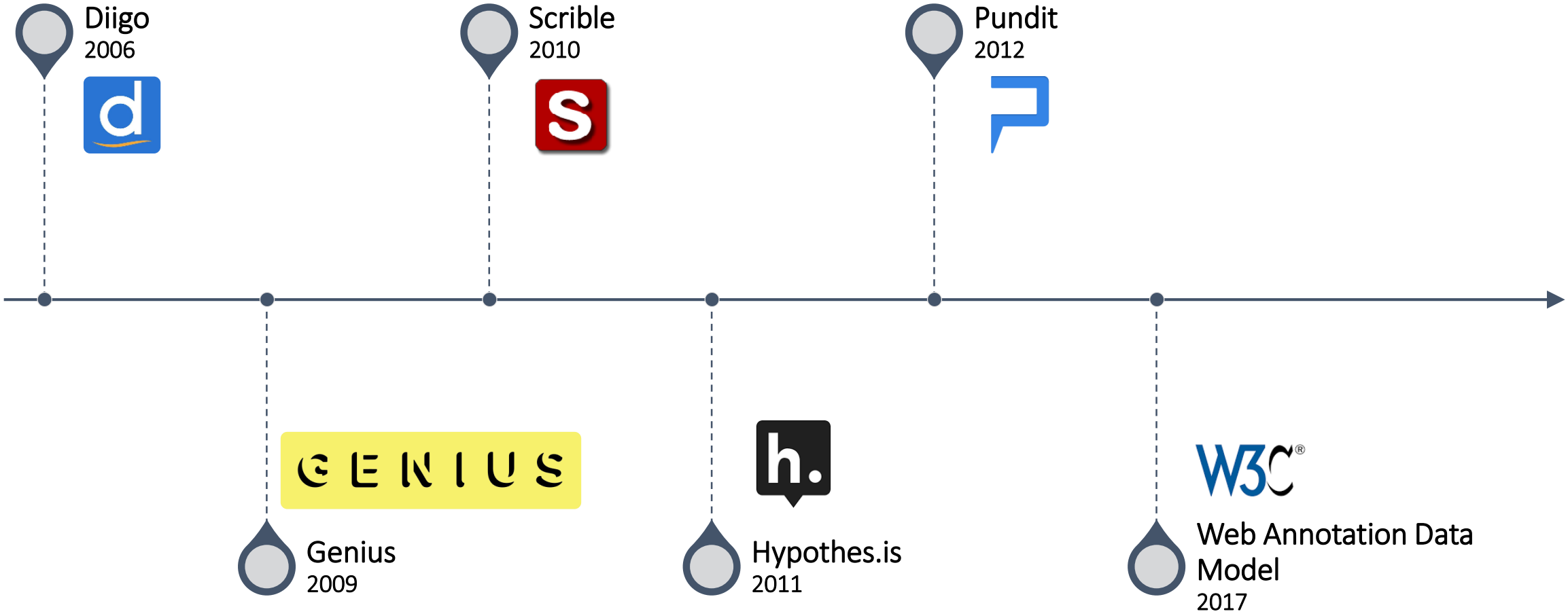
"… is a note added to a book, drawing or any other kind of text as a comment or explanation." [NYT, 2015]

Web Annotations have emerged as a First-Class Object. [10.1109/MIC.2013.123]

Web annotation tools are gaining tremendous interest among academicians [10.1038/528153a, 10.1038/d41586-019-01427-9]

Image source: Smekenseducation.com

Popular Web Annotation Systems



Hypothes.is

- free, open, non-profit, neutral, 100% community moderated, merit based, pseudonymous, and more…
- aims “to enable a conversation over the world’s knowledge”
- It’s ***215,000 users*** have added more than ***5 million comments*** on scholarly sites [10.1038/d41586-019-01427-9]

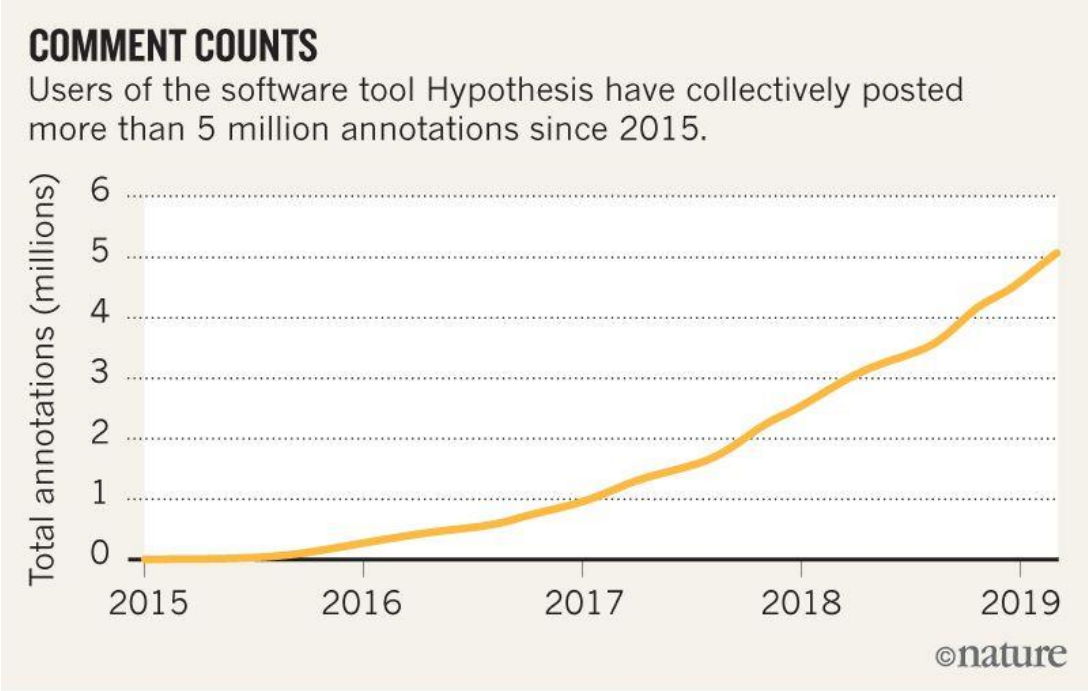
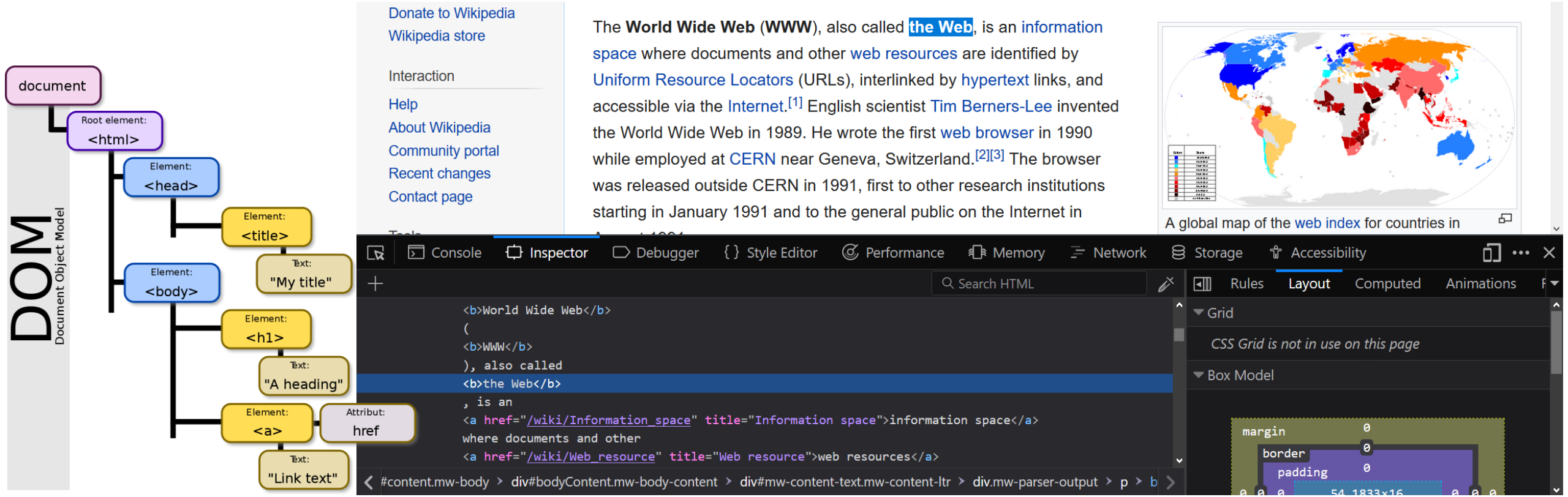


Image Source: Nature

Before Hypothes.is' Fuzzy Anchoring

- XPath (XML Path Language) [e.g. /html/body/div[3]/div[3]/div[4]/div/p[2]/b[3]] Matching



After Hypothes.is' Fuzzy Anchoring [2013]

- Robustly anchoring annotations using keywords [Brush et al. 2001 *Microsoft Research*]
- Robust anchoring of annotations to content [Brush et al. 2010 *Patent*]

- uses a modified version of Google's diff-match-patch

- Bitap matching [10.1145/135239.135244] *for text matching*
- Myers diff [10.1007/BF01840446] *for text comparison*

} Levenshtein distance [mathnet.ru/dan31411]

How does Fuzzy Anchoring work?

- Selectors
  - *RangeSelector*
  - *TextPositionSelector*
  - *TextQuoteSelector*
- Strategies
  - *From Range Selector*
  - *From Position Selector*
  - *Context-first Fuzzy Matching*
  - *Selector-only Fuzzy Matching*

How does Fuzzy Anchoring work? *(example)*

"... new Lecture Hall Complex (Neues Institutgebäude, NIG), the lecture hall complex Althanstraße (UZA), the campus on the premises of the Historical General Hospital of Vienna, the Faculty of Law (Juridicum) and others. The Botanical Garden of the University of Vienna is housed in the Third District, as are the Department of Biochemistry and related research centres..."

- Wikipedia - University of Vienna

RangeSelector: //*[@id="mw-content-text"]/div/p[9]

TextPositionSelector: String offsets (i.e., position) of first and last character in the selected text (with respect to the whole document)

TextQuoteSelector: exact, prefix and suffix

What's wrong with Fuzzy Anchoring?

- In 2015, Aturban et al. analyzed **6281** highlighted text **annotations** from Hypothes.is [10.1007/978-3-319-24592-8_2]

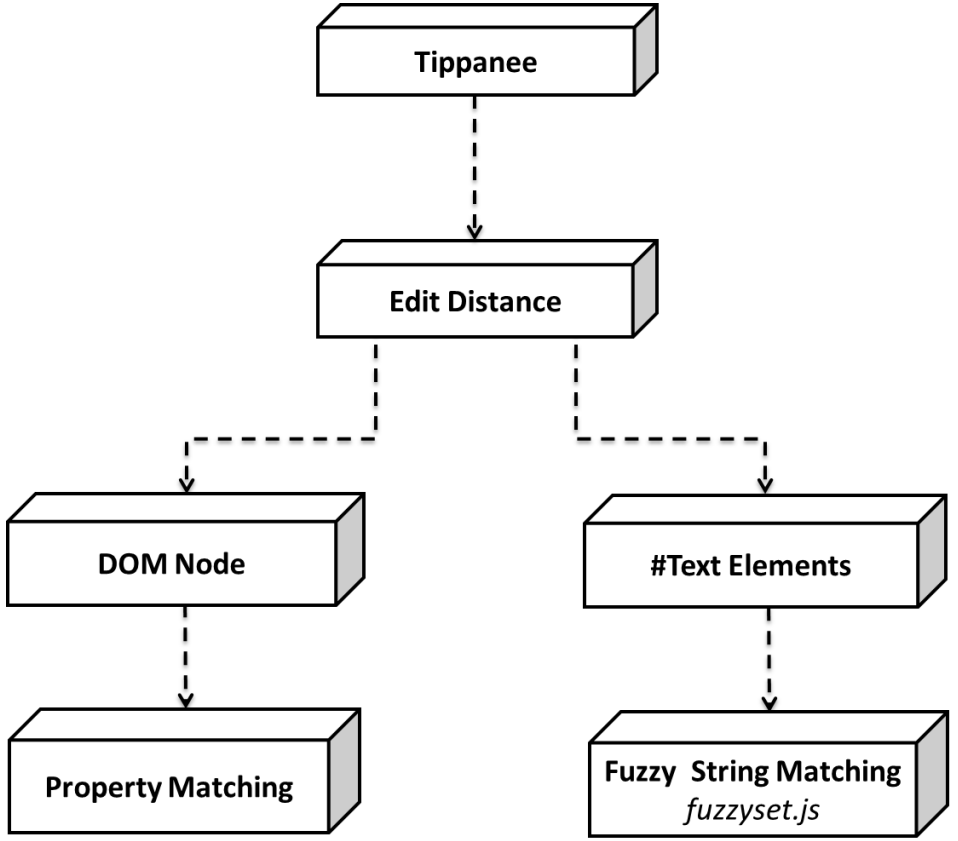
- **27%** annotations were completely **orphaned**
- only **3.5 %** of orphans **could be reattached** using public web archives
- …and **61%** were at **risk of being orphaned** due page decay

Our Goal

- Design and evaluate a web-based Crowdsourcing Information System (CIS)
  - that acts as conversation layer over the Web
  - is interoperable
  - supports activities on-the-fly
  - provides a social environment that promotes co-creation
  - provides a stable and robust approach for tracking textual contextual
  - is based on the principles for Collective Intelligence

Proposed Anchoring Approach

- Selectors
  - *TextSelector*
  - *DOMSelector* *(in prefix order)*
- Strategies
  - Edit (i.e., Levenshtein) Distance
    - *Fuzzy String Matching*
    - *DOM Property Matching*



Edit (i.e., Levenshtein) distance

$$\operatorname{lev}_{a,b}(i,j) = \begin{cases} \max(i,j) & \text{if } \min(i,j) = 0, \\ \min \begin{cases} \operatorname{lev}_{a,b}(i-1,j) + 1 \\ \operatorname{lev}_{a,b}(i,j-1) + 1 \\ \operatorname{lev}_{a,b}(i-1,j-1) + 1_{(a_i \neq b_j)} \end{cases} & \text{otherwise.} \end{cases}$$

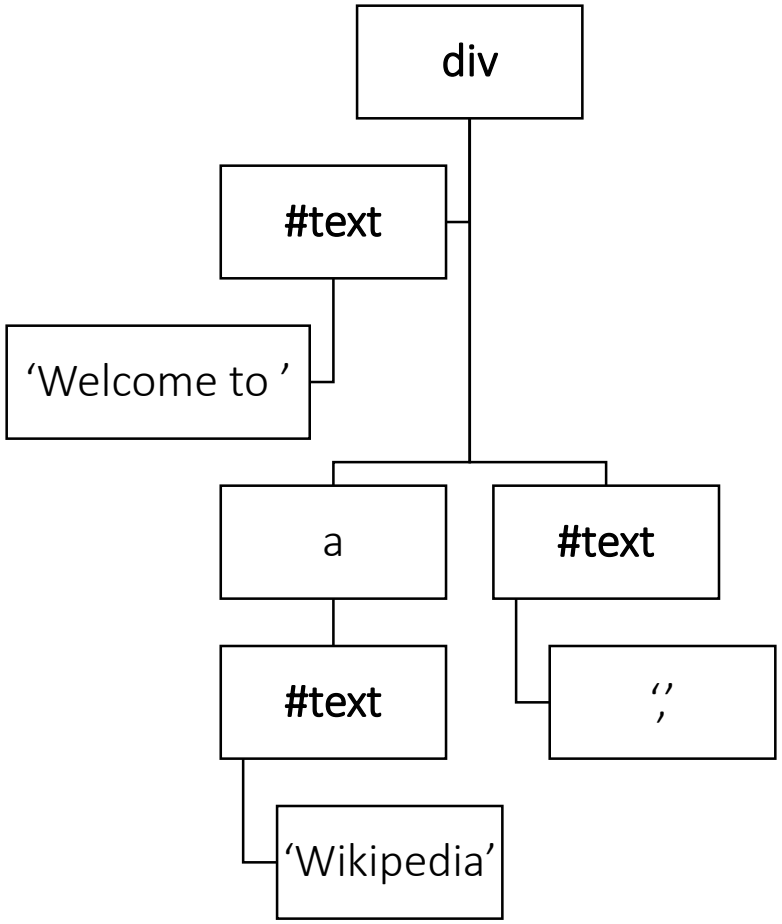
		S	A	T	U	R	D	A	Y
	0	1	2	3	4	5	6	7	8
S	1	0	1	2	3	4	5	6	7
U	2	1	1	2	2	3	4	5	6
N	3	2	2	2	3	3	4	5	6
D	4	3	3	3	3	4	3	4	5
A	5	4	3	3	4	4	4	3	4
Y	6	5	4	4	5	5	5	4	3

S A T U R D A Y

| add add | replace

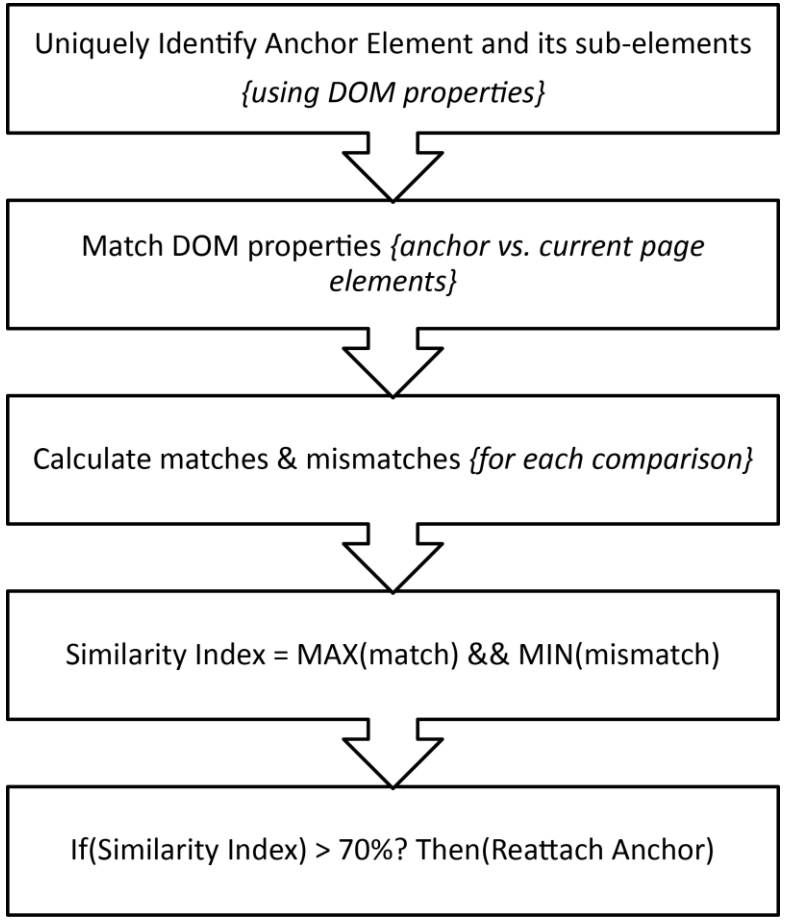
S _ _ U N D A Y

Anchors




```
"ww-1540806054738-a2ca6765" : {
  "addedon" : "October 29, 2018 11:40 AM",
  "anchor" : [ {
    "nodeDepth" : 0,
    "nodeName" : "DIV"
  }, {
    "annotated" : true,
    "endOffset" : 3,
    "nodeDepth" : 1,
    "nodeName" : "#text",
    "nodeValue" : "Welcome to ",
    "startOffset" : 0
  }, {
    "href" : "https://en.wikipedia.org/wiki/Wikipedia",
    "nodeDepth" : 1,
    "nodeName" : "A"
  }, {
    "nodeDepth" : 2,
    "nodeName" : "#text",
    "nodeValue" : "Wikipedia"
  }, {
    "nodeDepth" : 1,
    "nodeName" : "#text",
    "nodeValue" : ","
  } ],
  "owner" : "abc@abc.com",
  "selectedtext" : "Welcome ",
  "sharedwith" : "LSS",
  "transclusion" : "ww-1540823638993-7270b4f1",
  "urlHost" : "en.wikipedia.org",
  "urlParameter" : "",
  "urlPathname" : "/wiki/Main_Page",
  "urlProtocol" : "https:"
}
```

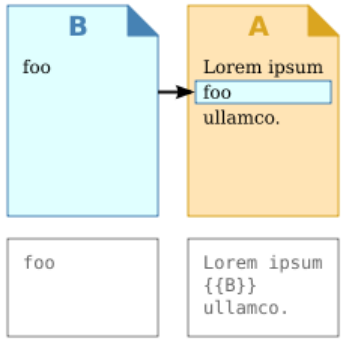
Similarity Index




```
{
    "strIdxMAXmat": 6,
    "strMat": [
        4.98,
        4.98,
        4.98,
        4.98,
        4.98,
        4.98,
        4.98
    ],
    "strMis": [
        75.89999999999999,
        48.940000000000005,
        9.959999999999999,
        9.51,
        9.06,
        4.53,
        0
    ],
    "strSimIdx": 0.9960000000000001
}
```

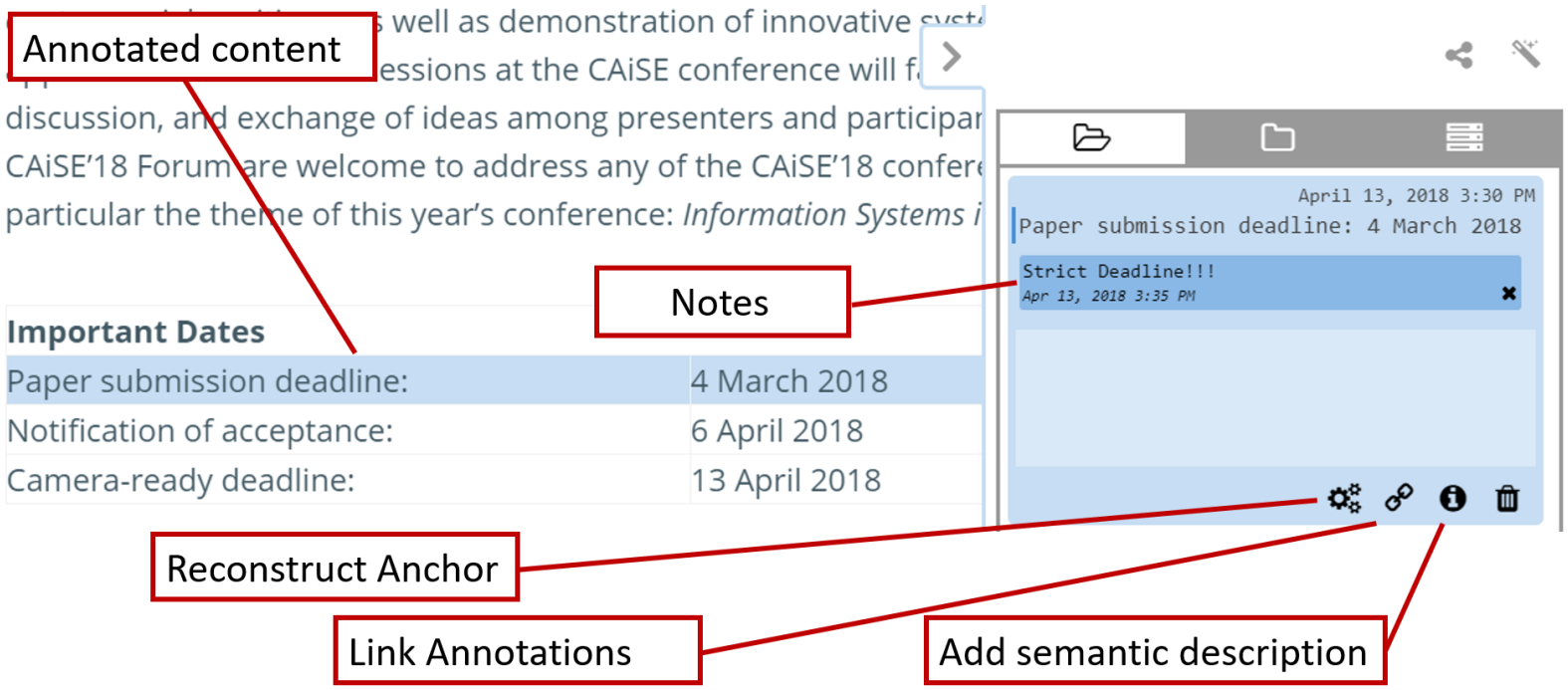
Advantages over Fuzzy Anchoring

- *new* **robust** anchoring approach
  - resilient to content or structure change
- preserves both the annotated content and it's surrounding content
- enables transclusions



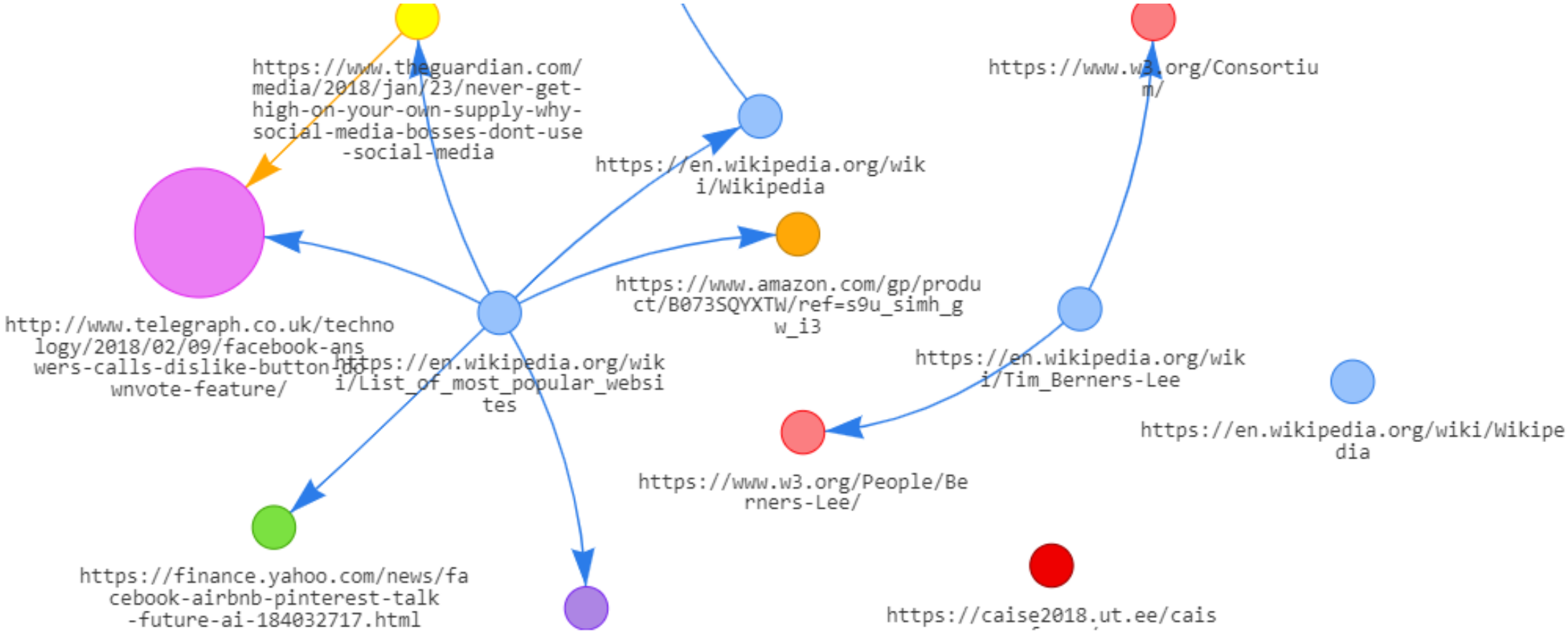
- support knowledge/information exchange by enabling "web of annotations"

Tippanee Chrome Extension



Similarity Index

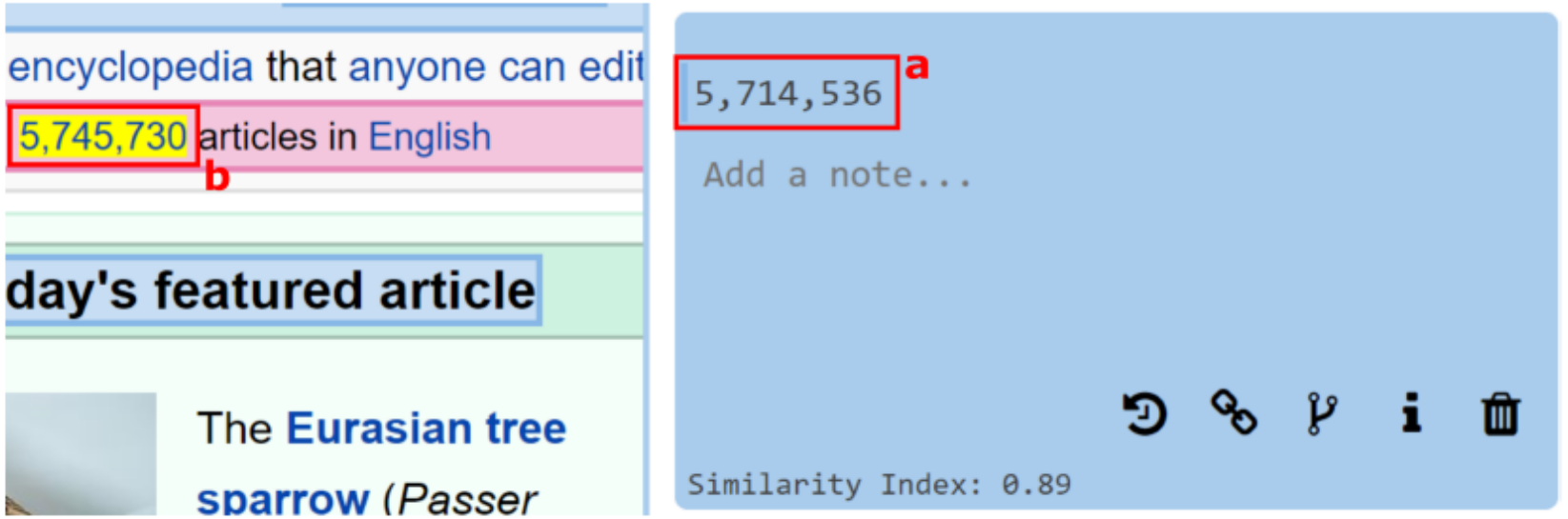
Web of Annotations



Hypothes.is

vs.

Tippanee



Preliminary Evaluation

- Experiment 1:
  - replicated *735 (Hypothes.is) annotations* from *more 650 different websites*
  - observed annotations over 3 months *(expecting some web page decay)*

  - **91.41%** annotations were successfully attached
  - **12.41%** over Hypothes.is' 79% expected success

- Experiment 2:
  - presented the tool to 25 candidates
    - found the tool useful and easy to use
    - users preferred the tool for social interactions, expression of opinion and information sharing
    - helped identify bugs and suggested additional UI features

Tippanee's Features

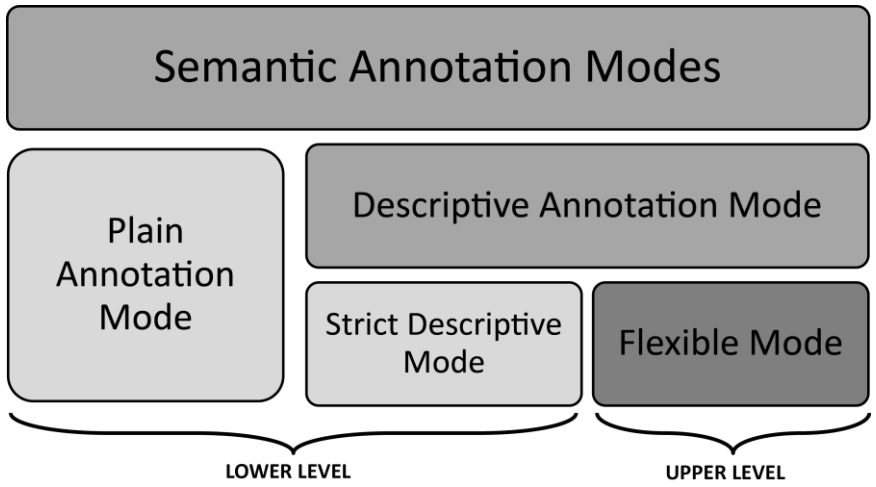
- Novel anchoring approach
  - stable and robust
  - works both online-offline
- End-user oriented features
  - data critiquing and content quality monitoring
  - personalized archival of textual content
  - social knowledge management
    - Linking and visualizing annotated content (*i.e.,* *knowledge graph*)
  - enriching web content with semantic metadata
    - allows for creation of new semantic vocabularies* work in progress

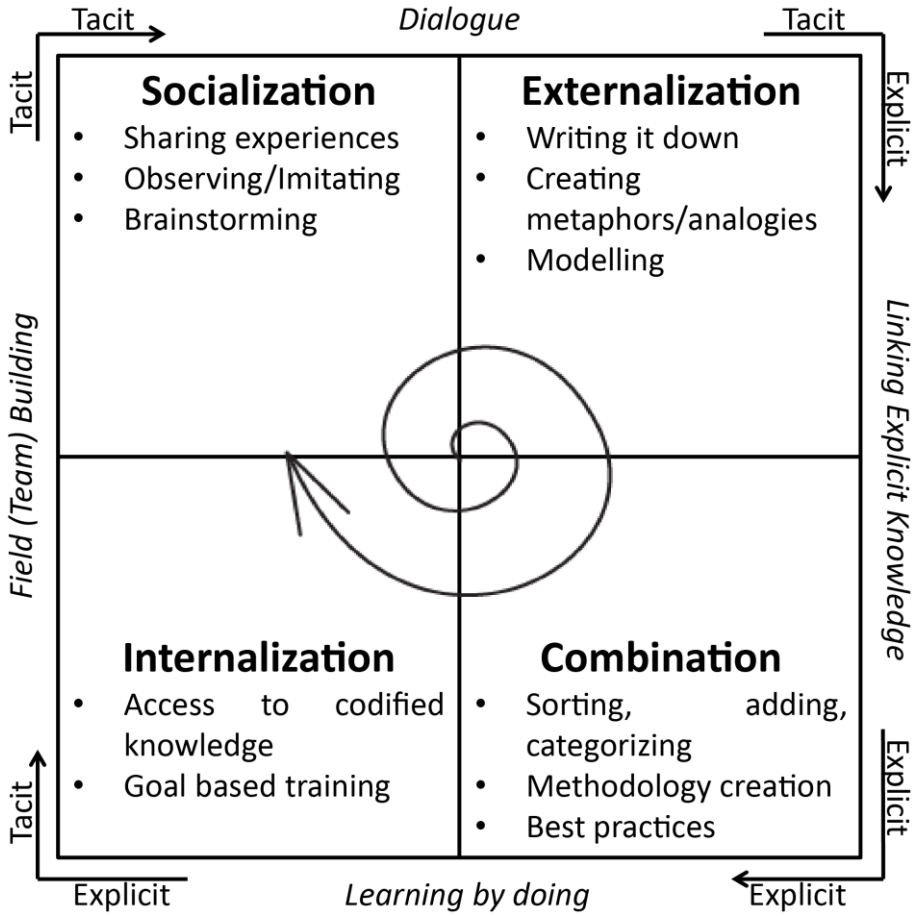
Some More Motivation (but from Organizations)

- Knowledge Management in organizations is a challenging task [10.1080/23311975.2015.1127744]
  - heterogeneous environments
  - lack of knowledge sharing
  - tacit knowledge transfer
  - … especially in todays Social Media Landscape

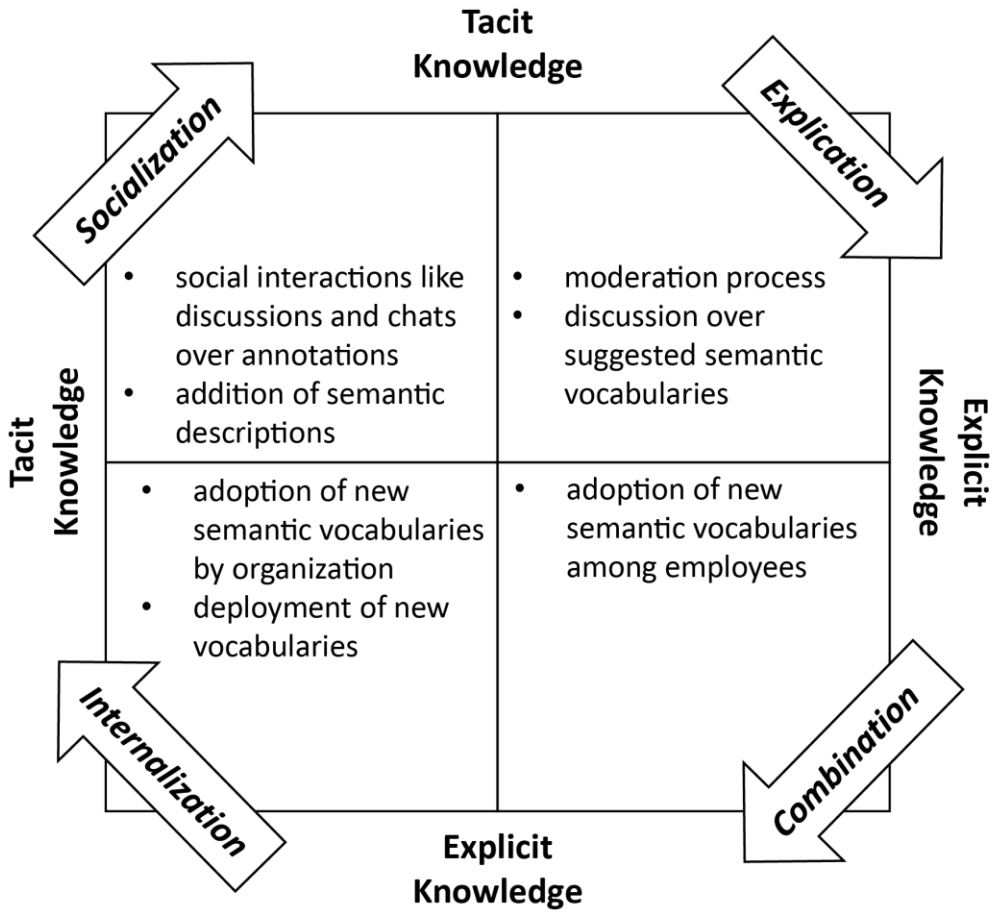
SECI through Web Annotations

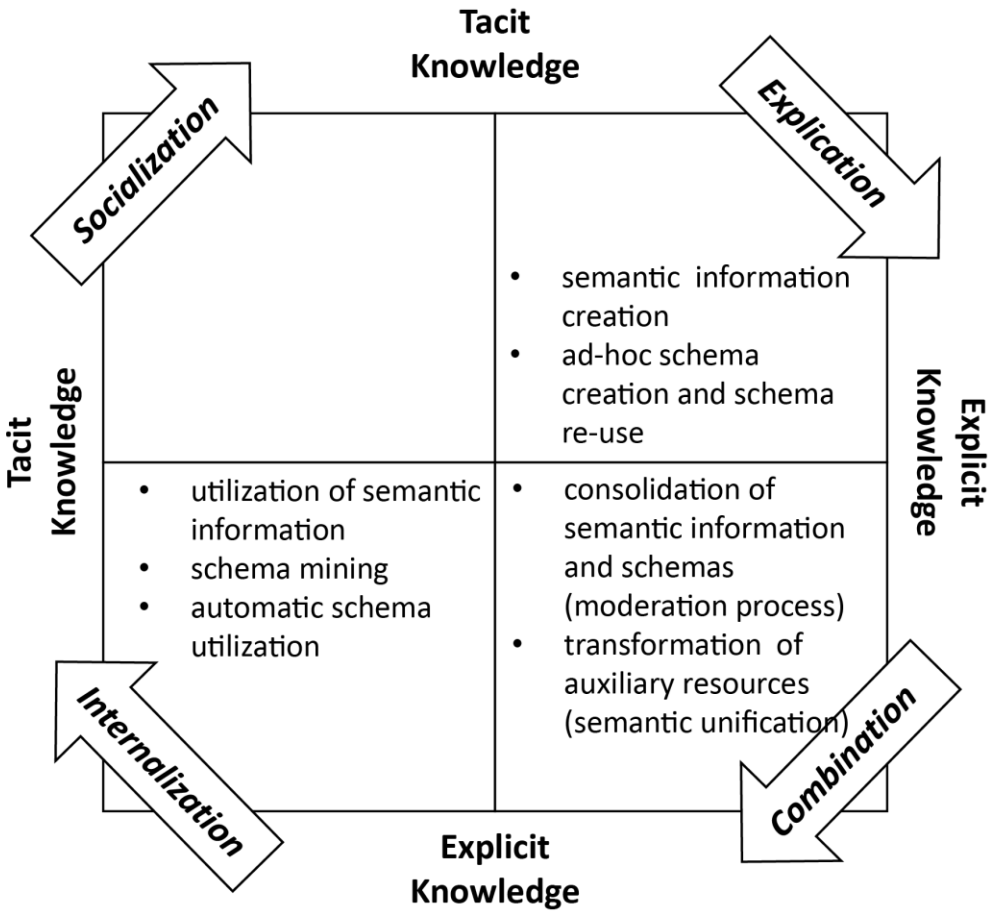
- based on “Nonaka’s Knowledge Spiral”
- for “Knowledge Creating Companies”



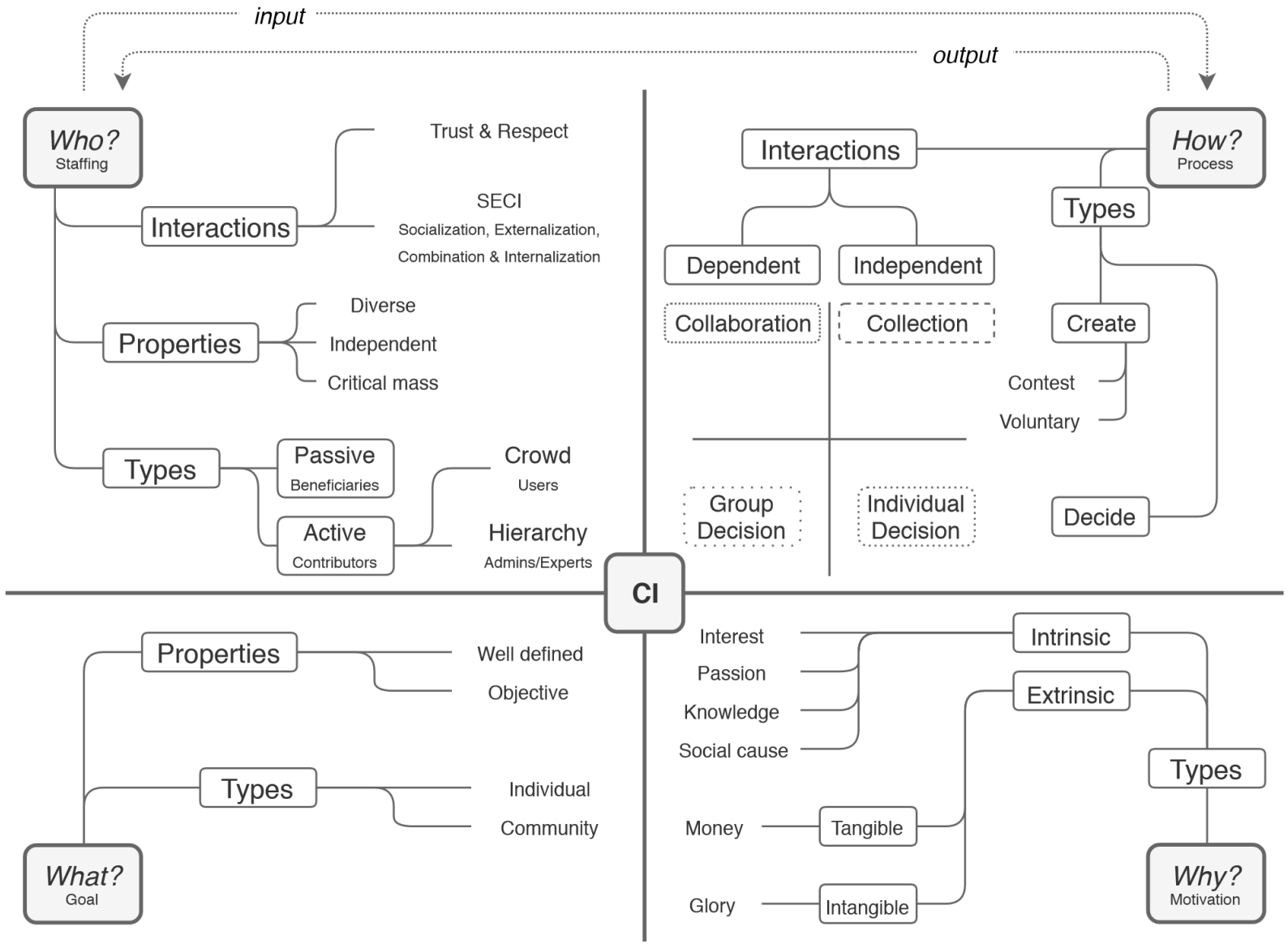


Lower (left) and Higher (right) Level Annotation Activities





‘Generic’ framework for CI Systems



Other Ongoing Work

- Anchoring approach test bench:
  - 50 websites
  - 120 webpages
  - 9 annotations per page
  - 96 variants per annotation
  - *103,680 data points for evaluation*
- Implement & evaluation of “SECI through Web Annotations”
- Develop a novel user reputation model *[less prone to bias]*

Source: NYT, 2019