CRAWLING TOR'S HIDDEN SERVICES AND DEPICTING THEIR INTERCONNECTIVITY

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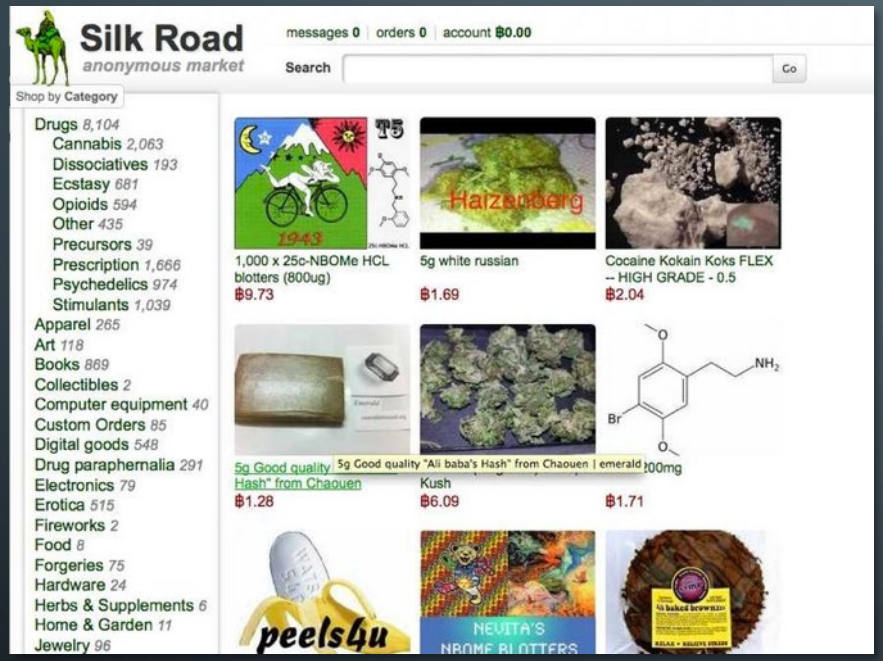
THE FALL OF (THE) SILK ROAD

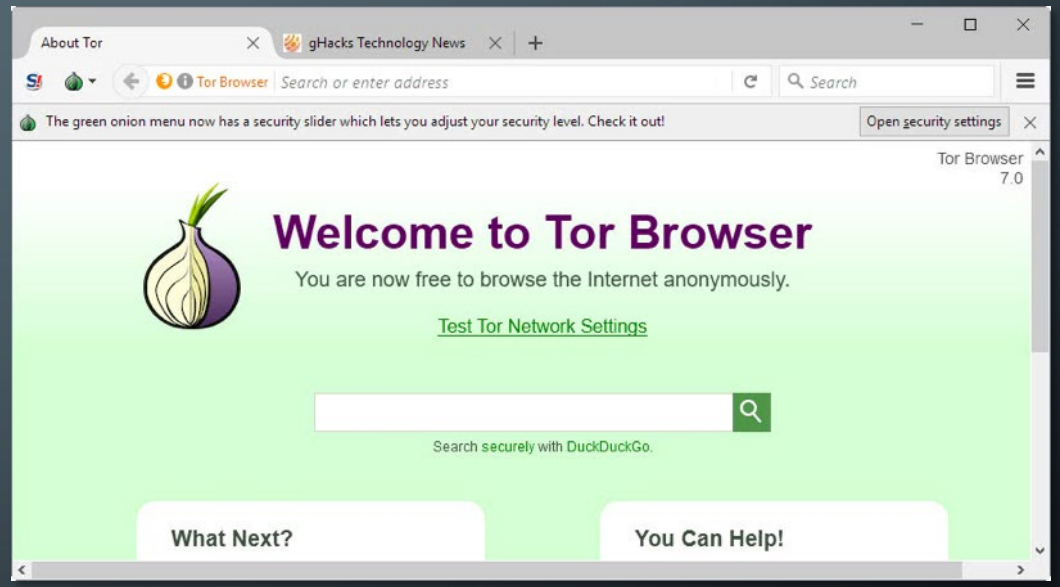


THE TOR NETWORK

- A privacy-centered network
- Anonymizes users and their websites
- Protects users from being tracked
- Wraps information in layers of encryption

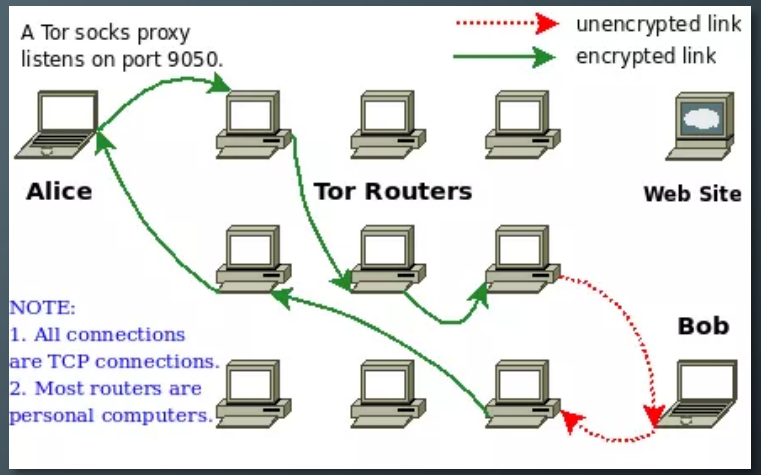
WHAT ARE *HIDDEN SERVICES?*

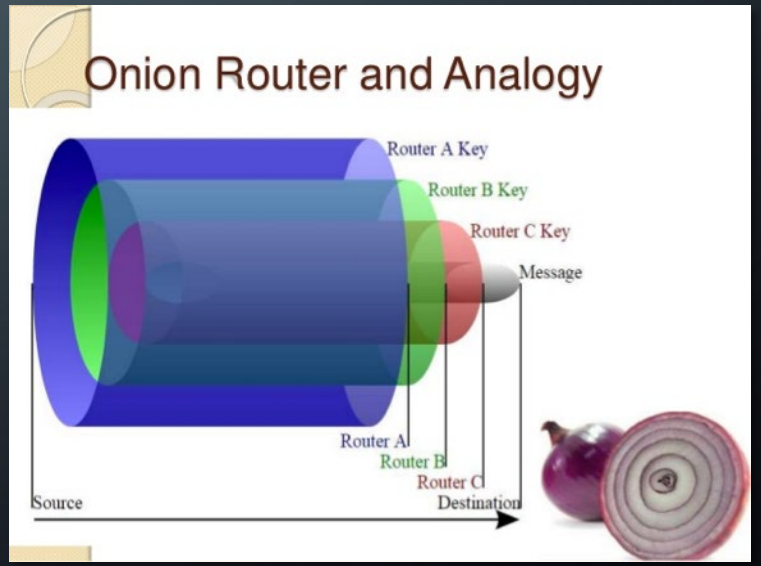
- Websites hosted on Tor
- Same protections as Tor's users
- Identifiable by a *.onion* address
- Example: *silkroad6ownowfk.onion*

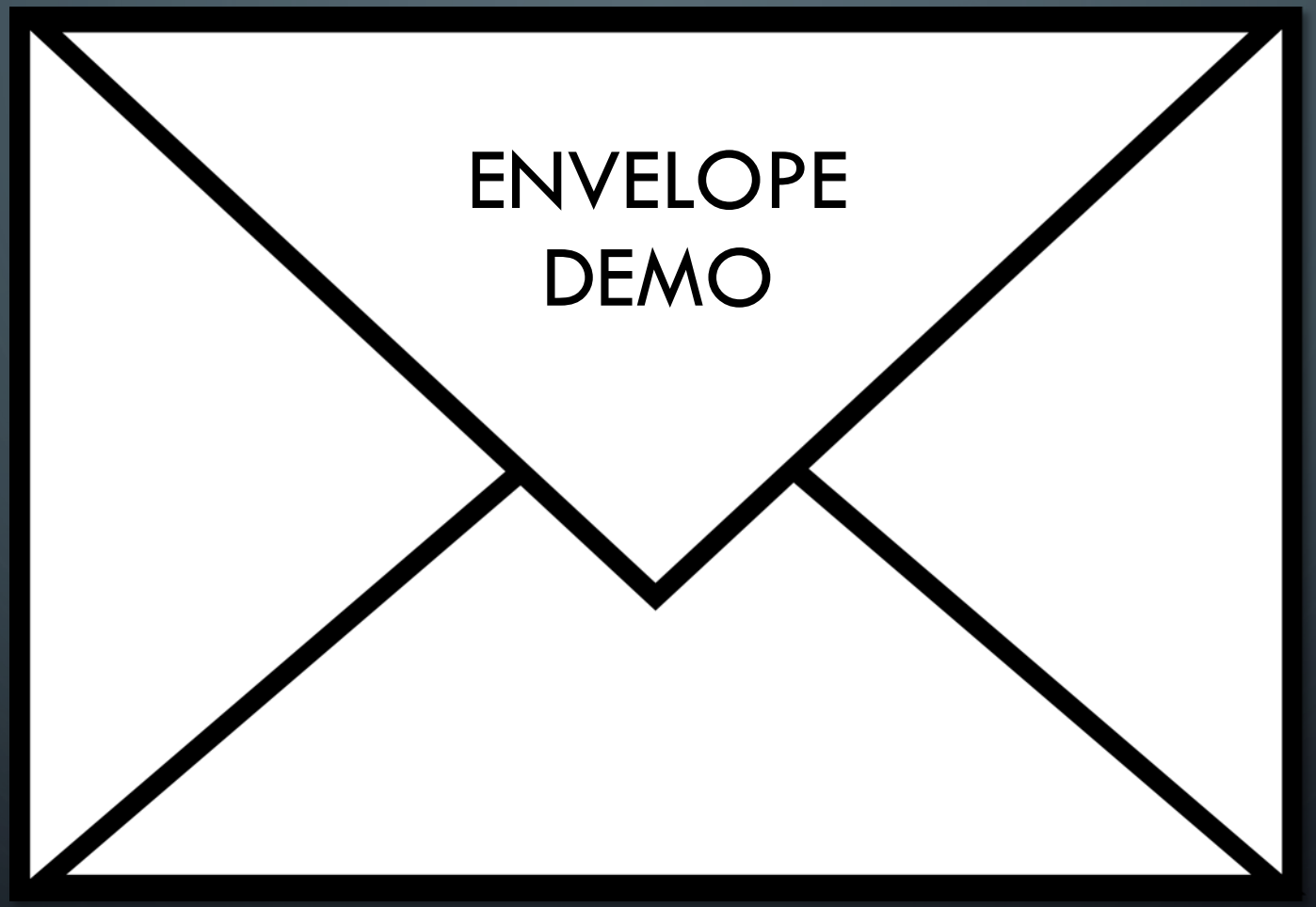


HOW DOES THE TOR NETWORK FUNCTION?

- A *circuit* of servers rotates every 10 minutes.
- Each server in the circuit helps wrap data in layers of encryption
- Each server in the circuit unwraps it's individual layer.






ENVELOPE
DEMO

THE DARKNET WEATHERMAP PROJECT

- SULI Appointment
- Cyber Operations, Analysis, and Research
- Project: Produce daily metrics on Tor content availability, distribution, and “trendiness”
- How can bulk Tor network content be downloaded with relative ease?
- How can the connections between hidden services be depicted?

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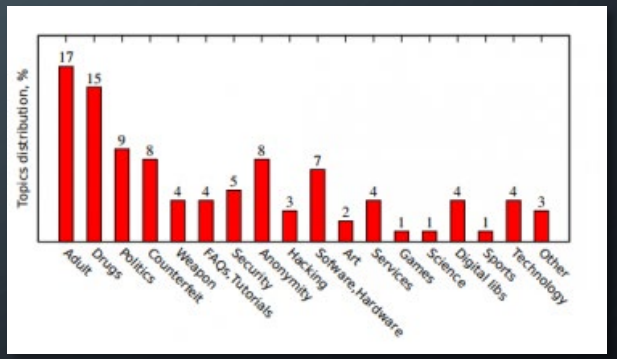
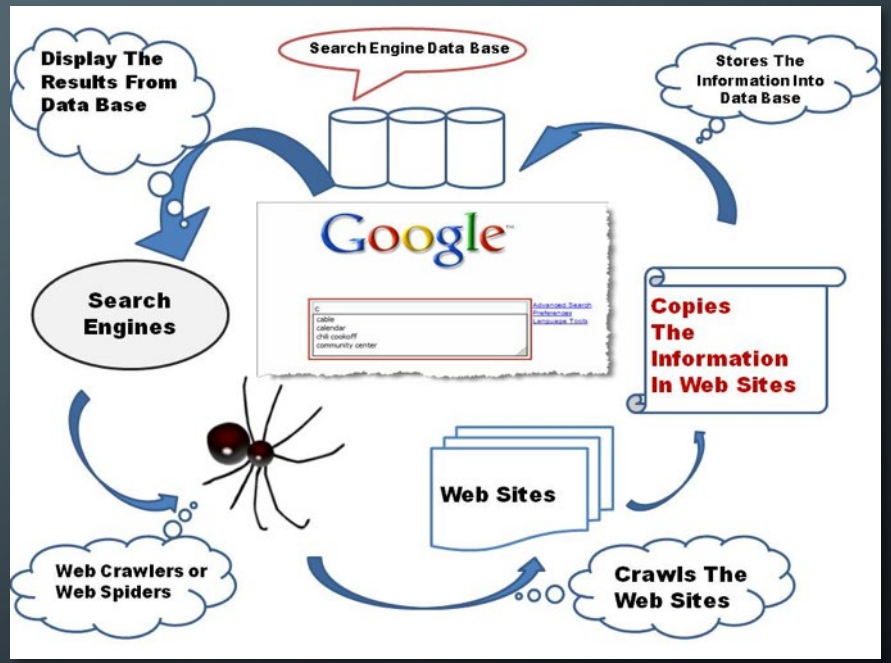


Example from technologyreview.com

WHAT IS A *WEB CRAWLER*?

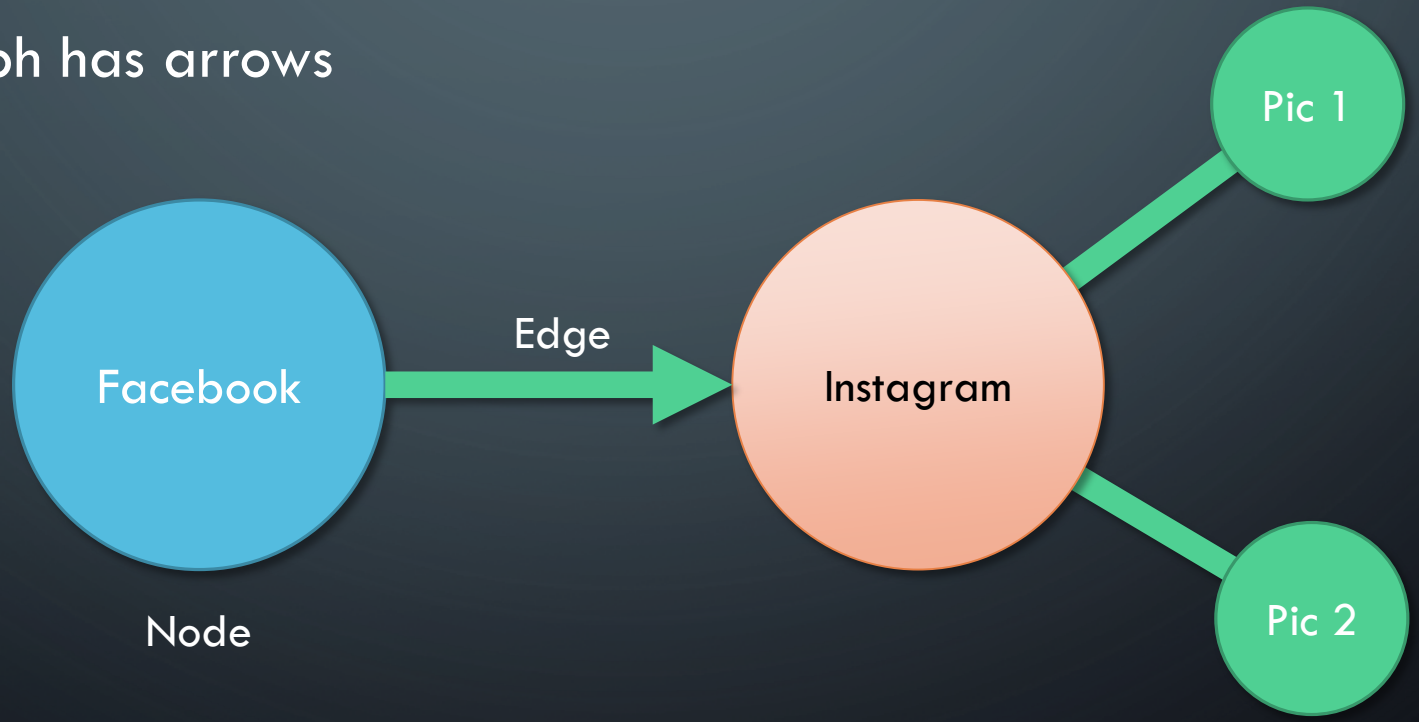
- Automated software that browses the internet and downloads information from websites.

- Used by Google and other Search Engines



WHAT ARE *CONNECTED GRAPHS*?

- Used to show relationships between objects
- Directed graph has arrows

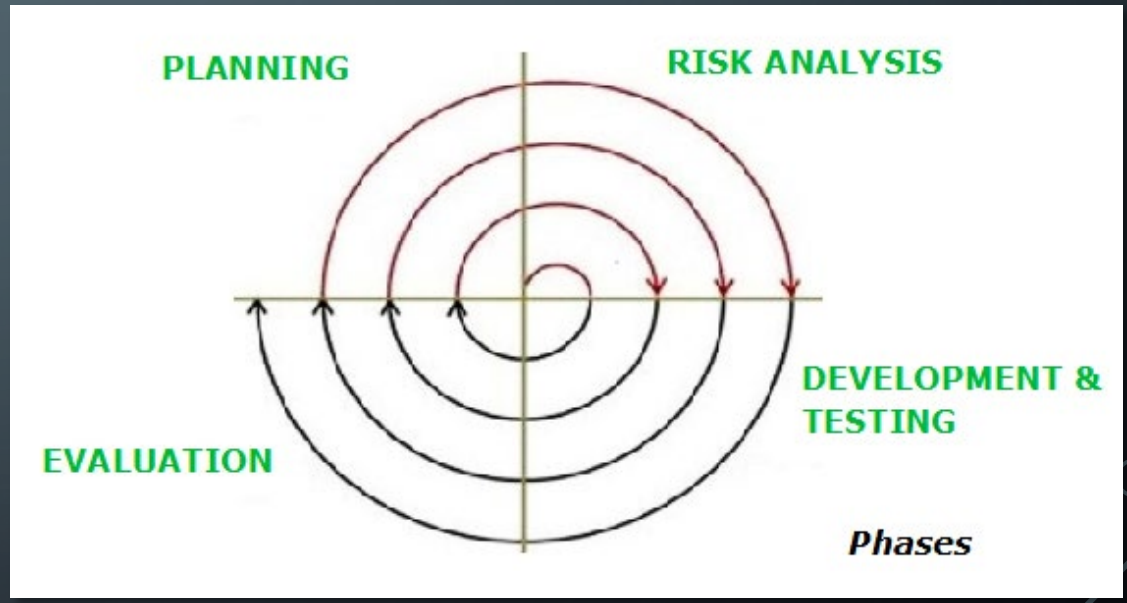


PREVIOUS WORK

- Cryptopolitik and the Darknet – Moore & Rid
  - Developed tools to download and analyze Tor content
- The Tor Dark Net – Gareth & Savage
  - Operated multiple Tor data-mining projects, emphasized manual textual analysis
- Towards a Comprehensive Insight on the Thematic Organization of the Tor Hidden Services – Spitters, et al.
  - Developed another Tor data mining tool, implemented alternative searching strategies.
  - Emphasized extensive textual analysis on resulting data.

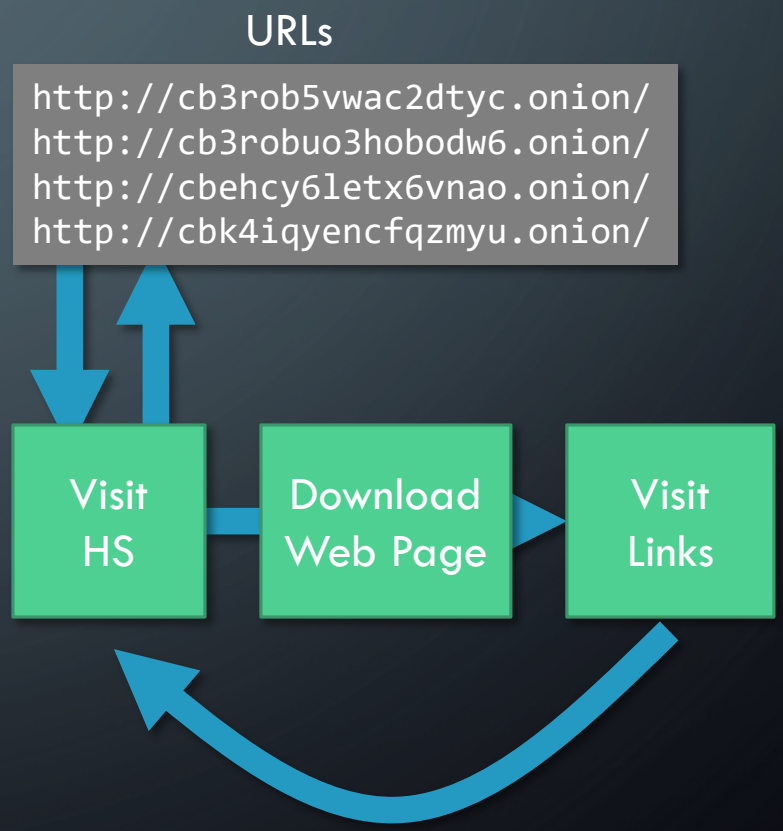
SOFTWARE DEVELOPMENT STRATEGIES

- Adhered to Spiral Model of Software Development
- Frequent code reviews
- Lots of testing, debugging, and documentation
- Frequent meetings with mentors



THE TOR WEB CRAWLER – CRAWLER BASICS

- Written entirely in Python
- Crawler needs an initial list of Hidden Service URLs
- Visit hidden service, download content, click links, repeat



THE TOR WEB CRAWLER – DEALING WITH DATA

- Dataset contains:
  - Downloaded HTML
  - Links to other hidden services
- Avoids downloading too much data
  - Page-count limits
  - Depth limits

Dataset Sample

```
MyHiddenWebPage:
    - homepage.html
    - pictures.html
    - contact.html
    - social.html
    - links.txt
```

URL:	https://www.andrews.edu/services/honors/research/		
Depth:	0	1	2

THE TOR WEB CRAWLER - SECURITY

- Tor integration also protects crawler
- User-agent rotations
  - Pretend to be a human!
  - Avoid software that blocks bots
- Keyword blacklists
  - Prevent downloading unwanted content
  - Avoid undesirable websites in the future

AVOID:
- Classify
- Classified
- Military Secret
- Redacted

THE CONNECTIVITY GRAPH PROGRAM

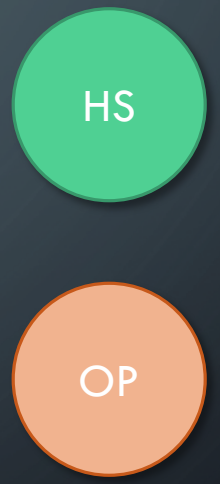
- Written in Python with the Networkx library
- Takes crawler datasets as input
- For each crawled hidden service:
  - Insert the URL as a node
  - Check the links file, insert edges between two matching nodes

Folders

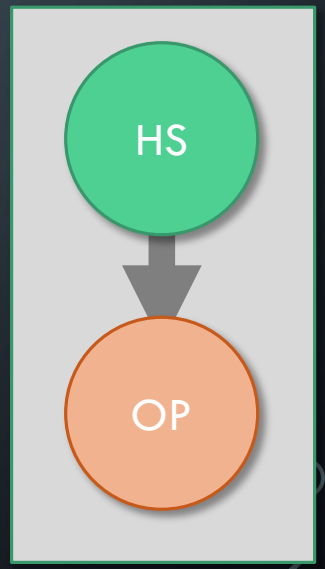
hiddensite
- Links
  - helloworld.onion
  - otherplace.onion

otherplace
- Links
  - buystuff.onion

Nodes

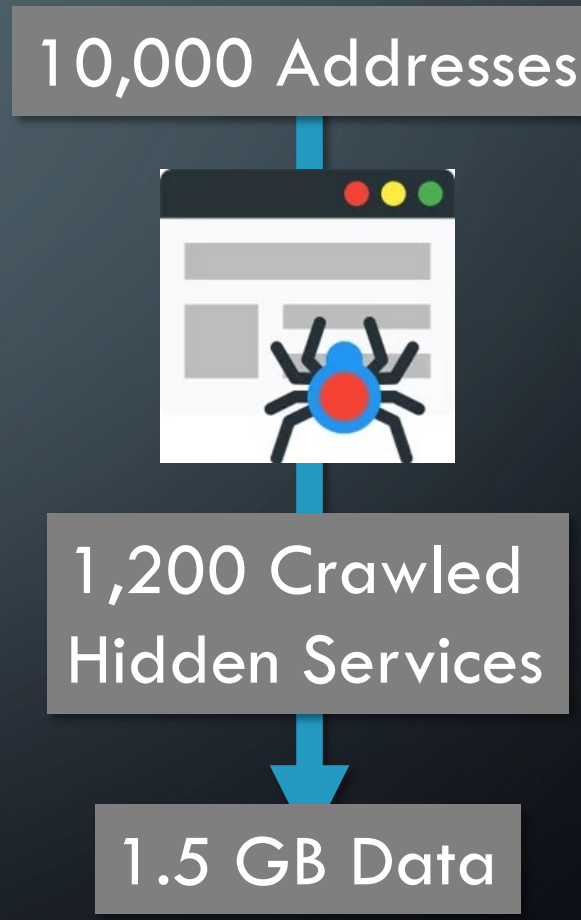


Edges



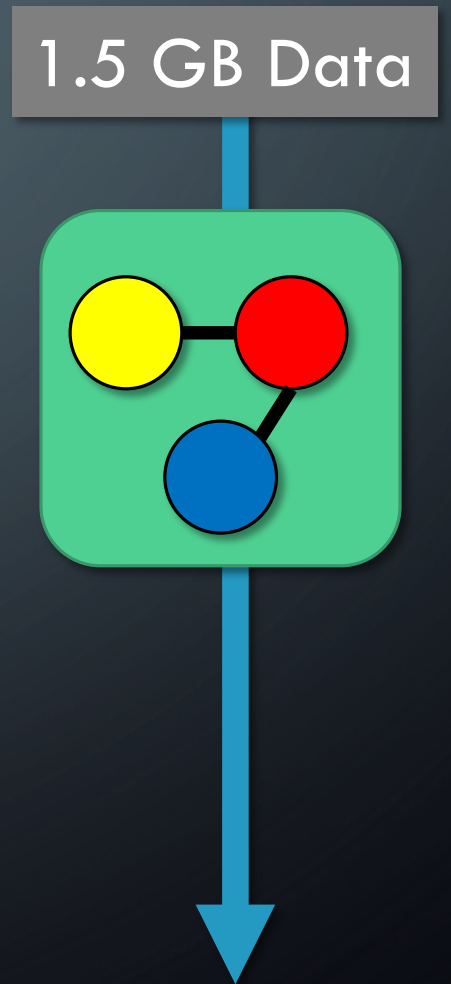
TOR WEB CRAWLER PERFORMANCE

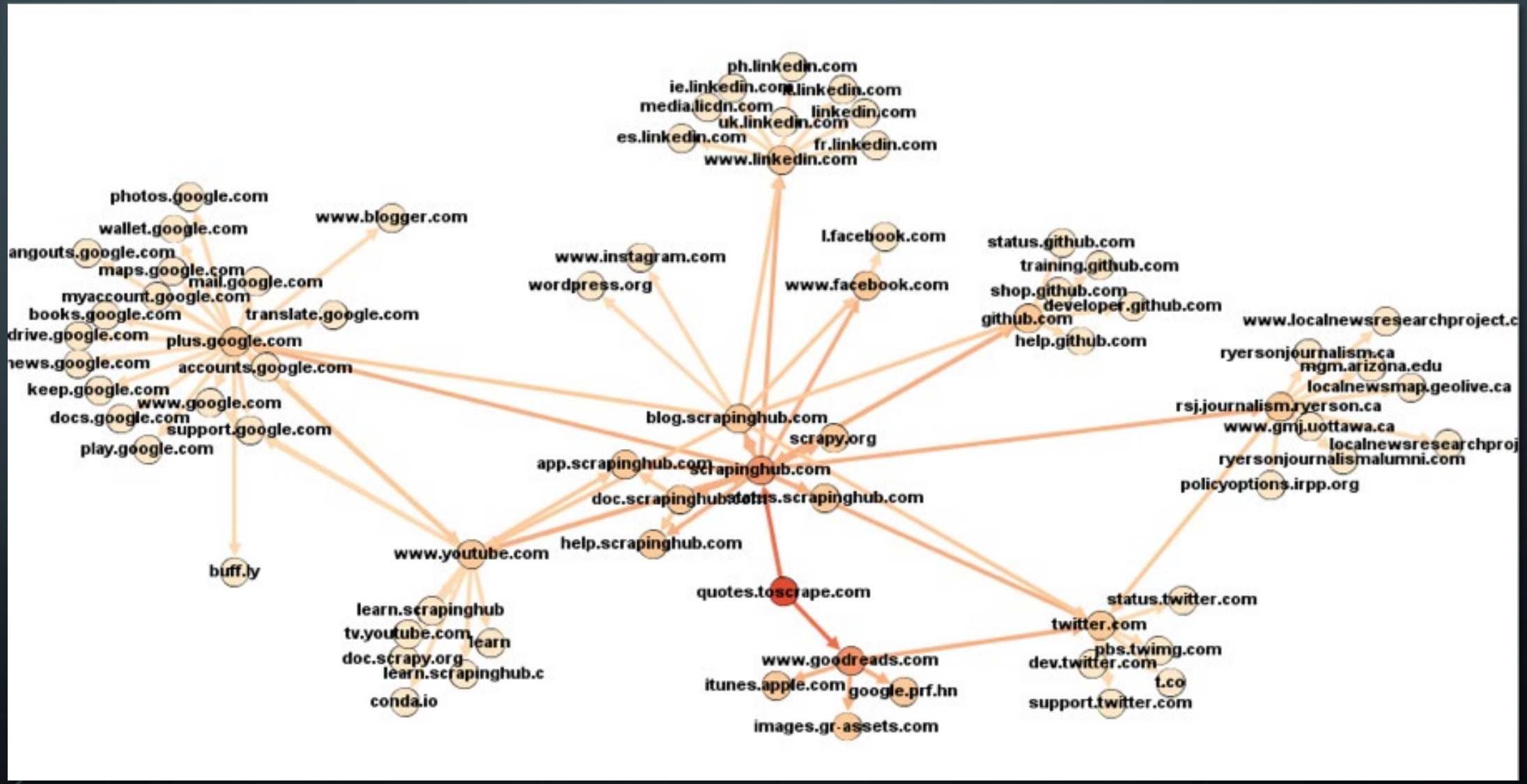
- Most extensive session based on starting list of ~10,000 URLs
- Over the course of four hours:
  - ~1,200 hidden services successfully crawled
  - ~1.5 GB total HTML downloaded
- Acceptable results, as roughly 85% of hidden services are short-lived (Owen & Savage)



CONNECTIVITY GRAPH PROGRAM PERFORMANCE

- Successfully reads crawler output files
- Generates graphs in multiple formats
  - These can be viewed by external applications
- Can be made more legible by applying graph-drawing algorithms

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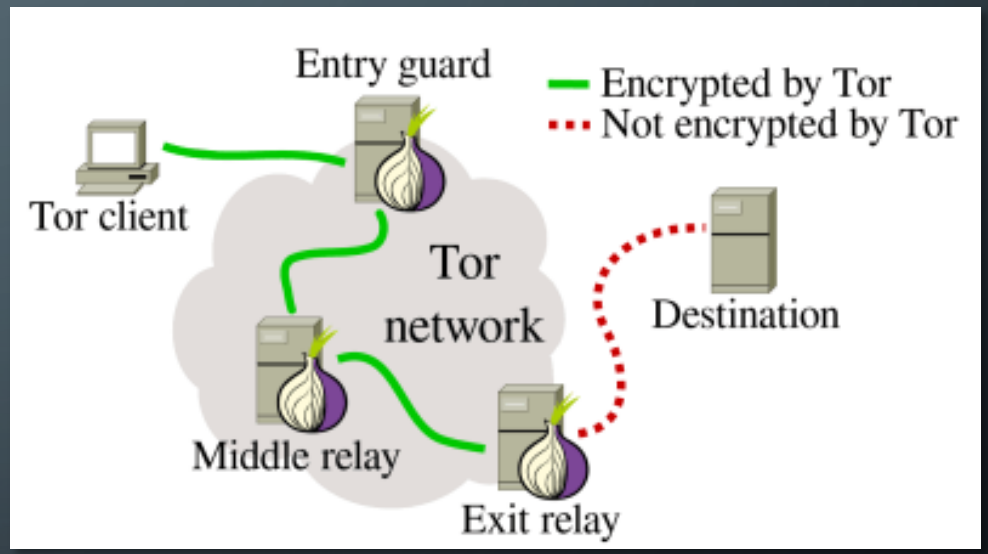
PROJECT DIFFICULTIES

- Crawler accidentally downloaded stolen personally identifiable information (PII)
- Security concern
- Hard drives confiscated and destroyed!

CONCLUSIONS

- The Tor Web Crawler was able to effectively traverse the Tor network and download hidden service content with no difficulties
- The Connectivity Graph program was successful at depicting links between hidden services



ACKNOWLEDGEMENTS

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SOURCE CODE

https://github.com/Argonne-National-Laboratory/torantula

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QUESTIONS?