Welcome to INFO216:
Knowledge Graphs
Spring 2022

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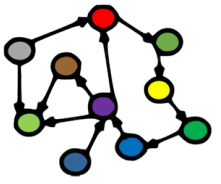
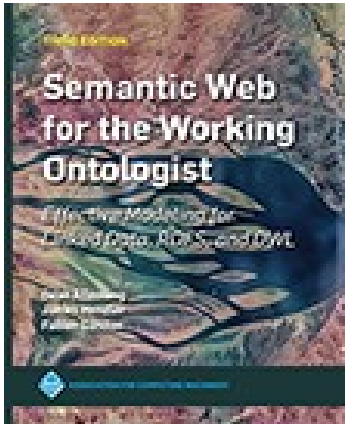
Session 6: Enterprise Knowledge Graphs

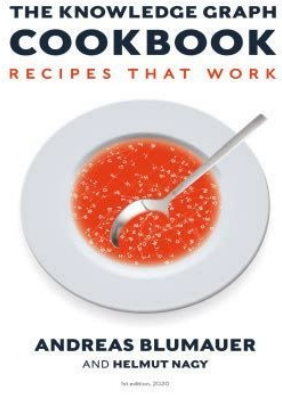
- Themes:
  - Open Knowledge Graphs *(S05)*
    - Linked Open Data resources / datasets
    - Wikidata, DBpedia, GDELT, EventKG GeoNames, WordNet, BabelNet...
  - Enterprise Knowledge Graphs (EKGs) (→ *S06)*
    - Google's knowledge graph
    - Amazon's product graphs
    - others (← F1)
    - the News Hunter infrastructure and architecture



Readings

- Sources (suggested):
  - Blumauer & Nagy (2020):
    Knowledge Graph Cookbook – Recipes that Work
    (parts 2 and 4)
- Material at http://wiki.uib.no/info216:
  - *Introducing the Knowledge Graph: Things not Strings*, Amit Singhal, Google (2012).
  - *A reintroduction to our Knowledge Graph and knowledge panels*, Danny Sullivan, Google (2020).
  - *How Amazon's Product Graph is helping customers find products more easily*, Arun Krishnan, Amazon (2018).
  - lecture slides



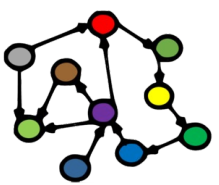


Knowledge Graphs:
Is anyone really using this?

Is anyone really using this?

Yes!

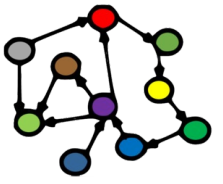
- But...



Is anyone really using this?

Yes!

- But...
  - not quite as in the semantic web vision
  - not quite as in the LOD vision either
- Knowledge graphs are (additionally) becoming:
  - company internal
  - based on other technologies
    - such as general graph databases
  - not always linked to the LOD cloud



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Many of these ideas
are widely adopted too, such as:
- microdata / schema.org
- RDF / SPARQL / … for semantic data exchange
- graph representations in general

Is anyone really using this?

Yes!

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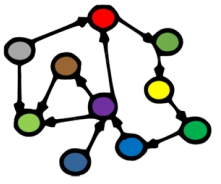
Similar ideas,
adapted to new uses
and business contexts,
using a combination of
standard and other
technologies


Tencent 腾讯
UniProt
USGS
Google
Bing
Alibaba.com
Baidu 百度
PubMed
facebook
ANTONI VAN LEEUWENHOEK FOUNDATION
MAASTRO
DEUTSCHE NATIONAL BIBLIOTHEK
BBC
The New York Times
europeana
NXP
REUTERS
KUNGL. BIBLIOTEKET
National Library of Sweden
RENAULT
EPA United States Environmental Protection Agency
IOS Press
European Commission
Walmart
SIEMENS
BEST BUY
Deloitte.
SPRINGER NATURE
ELSEVIER
amazon.com
accenture

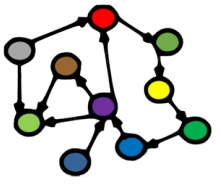
Google's Knowledge Graph



Google's Knowledge Graph

- Google Knowledge Graph (from 2012)
  - "Things, not Strings"
  - seeded from Freebase
  - facts from Wikipedia, Wikidata, CIA World Factbook
    - a growing number of other sources
  - enriched by natural-language parsing (NLP)
    - Google's Knowledge Vault
  - used internally for many purposes
  - visible in Google Search results (Knowledge Panels)
  - question answering in Google Assistant / Home

Caution: *The public documentation is limited, so this is compiled based on presentations, technical notes, forums etc.*



Google's Knowledge Graph

- Coverage:
  - claimed
    - 18 billion facts (18G, norsk: 18 milliarder) about 570 million entities *soon after start*
  - 70 billion facts claimed in (2016)
  - 500 billion facts about five billion entities (2020)
    - ...perhaps 3 times the size of the LOD cloud
  - from English to multiple languages
- Critiques:
  - source attribution, incl. Wikipedia / Wikidata

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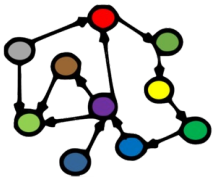

Google's Knowledge Vault Project

- Google Knowledge Vault
  - extends the Knowledge Graph
  - covers resources not from open semantic datasets
  - facts extracted from the whole web
    - NLP of text documents
    - HTML trees and tables
    - human annotated pages (e.g., schema.org)
  - probabilistic reasoning
    - graph-based priors
    - knowledge fusion

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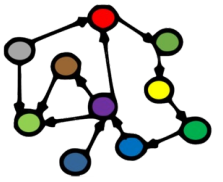
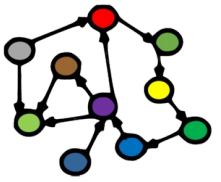
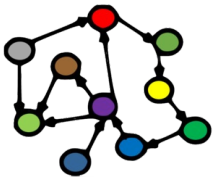


Amazon's Knowledge Graph



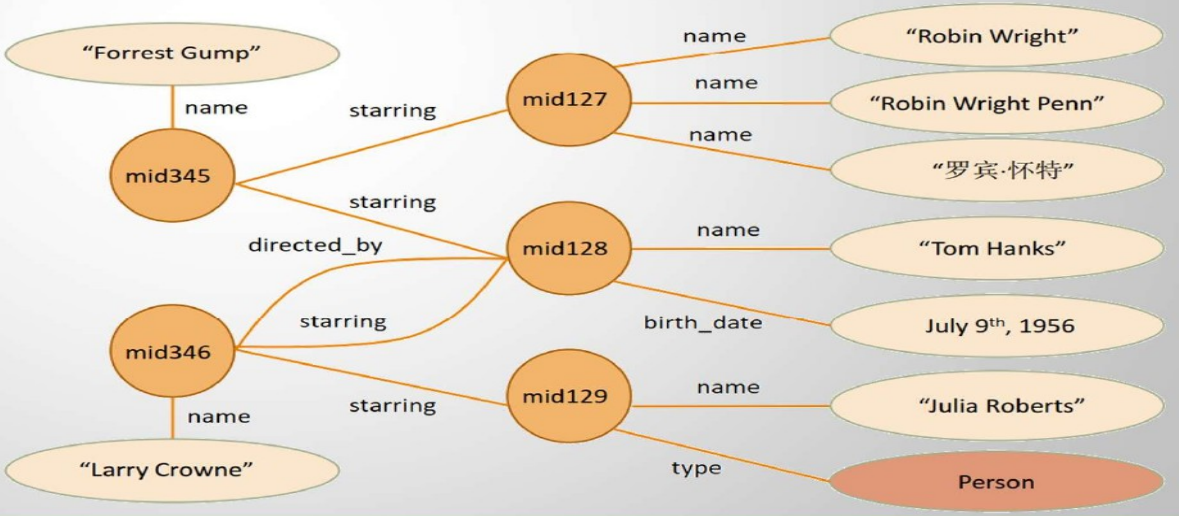
Amazon's ambition

- Let shoppers find the best products that fit their needs
  - allow greater variation in search terms
  - allow complex queries
- Structure all of the world's information as it relates to everything available on Amazon
- Describe every product on Amazon
  - concrete and abstract concepts
  - products and non-products
  - link different entities
- Enriched customer experience
  - visit Amazon to see what's new or interesting
  - discover ways to simplify and enrich their lives



Amazon

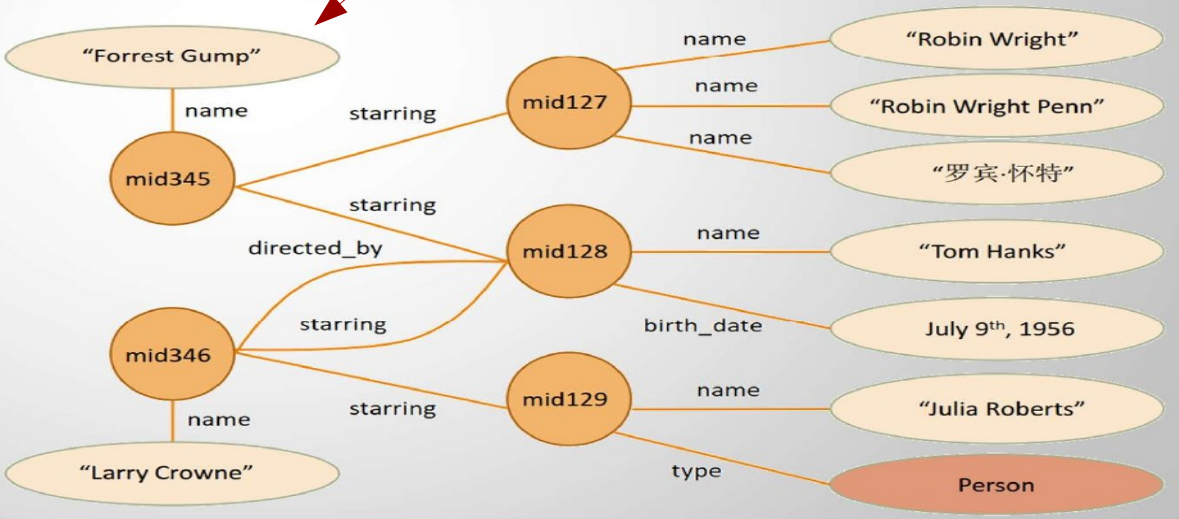
Product Graph vs. Knowledge Graph



Frank van Harmelen (2018): Keynote at CAiSE'18

Amazon

Product Graph vs. Knowledge Graph



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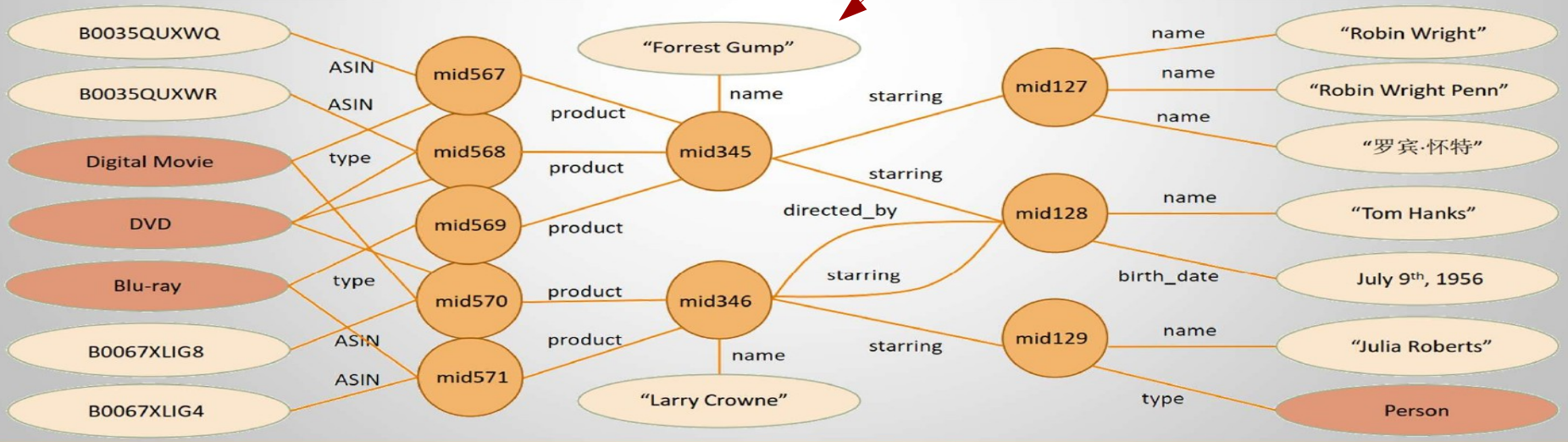
Amazon

Product details

Product

Product domain

Product Graph vs. Knowledge Graph



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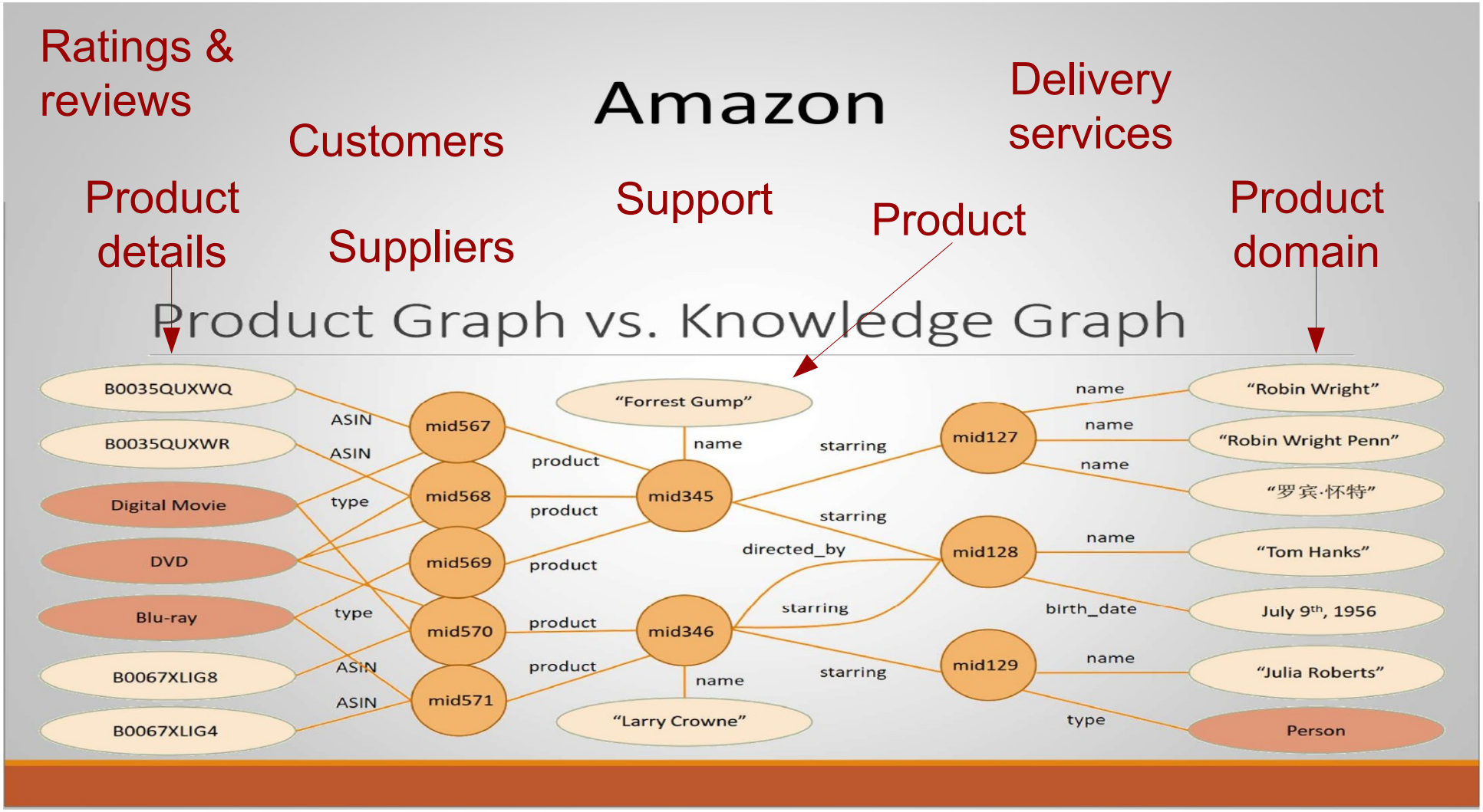
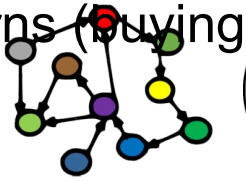


Frank van Harmelen (2018): Keynote at CAiSE'18

Challenges

- Ingest product-related information from Amazon's detail pages and from the Internet at large
  - product information is largely unstructured
  - trustworthiness of sources
- Machine learning techniques for
  - knowledge extraction, linkage and cleaning
  - distantly supervised learning
    - train on more structured subset of data
    - run on larger unstructured data space
  - open information extraction
  - graph mining techniques to identify interesting hidden patterns (buying product-X buying product-Y)

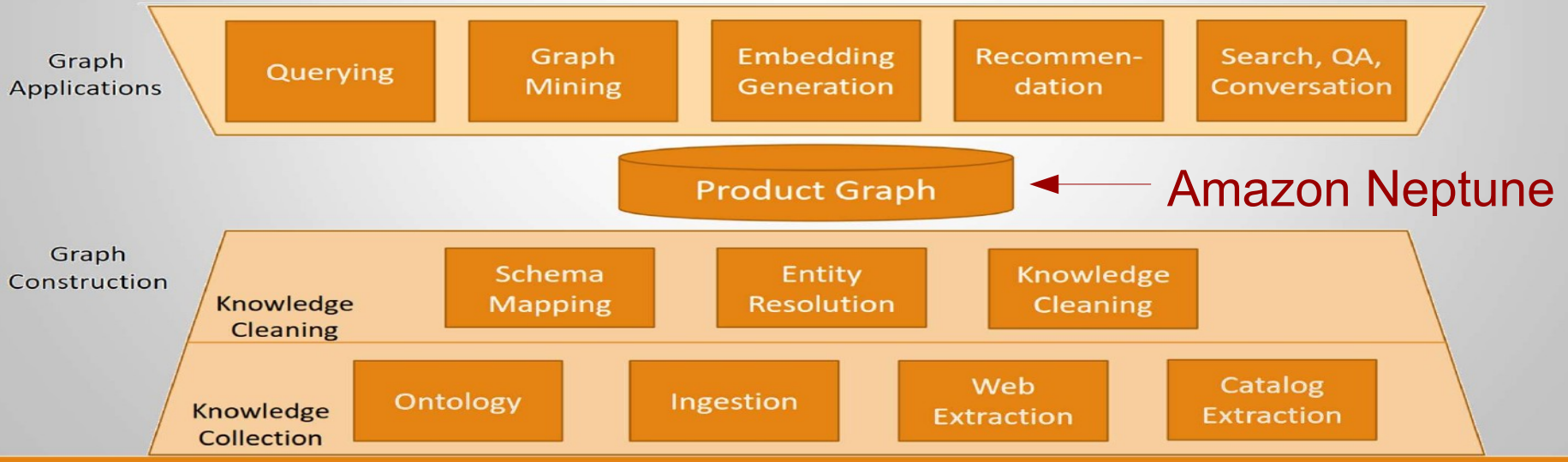


Amazon

"We aim at building an authoritative knowledge graph for all products in the world"

Xin Luna Dong, Amazon, at WSDM conf, Feb 2018

Architecture



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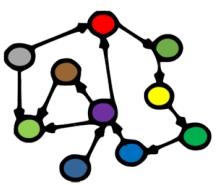
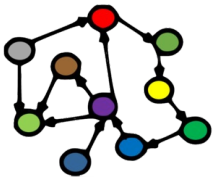
Facebook's Social Graphs



Facebook's “Open” Graph Protocol (OGP)

- Including resources (in particular web pages), through their IRIs, in social graphs
  - targetting webmasters and content-management system (CMS) developers
- @prefix og: <http://ogp.me/ns#>
- Main properties:
  - required: og:title, og:type, og:image, og:url
  - optional: og:audio, og:description, og:determiner, og:locale, og:locale:alternate, og:site_name, og:video
    - ...some of them combines with more specific ones
  - *...markup with RDFa <meta>-tags*



OGP uses

- Uses:
  - originally developed by Facebook to extend the “Likes” mechanism to resources outside Facebook
  - also taken up by some other graph maintainers (claim: used by Google)
  - publishing side:
    - IMDb, Microsoft, Rotten Tomatoes, Yelp

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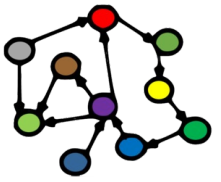
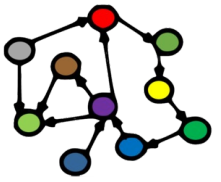


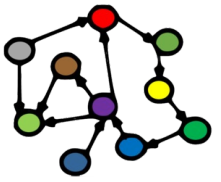
OGP resource types

- <meta property="og:type" content=”ResType" />
- Some predefined resource types for:
  - music: music.song, music.album, music.playlist...
  - video: video.movie, video.episode, video.tv_show...
  - others: article, book, profile, website
- Each predefined resource type has further type-specific properties, e.g.,
  - music:duration, music:album:track, music:musician
- Data types:
  - boolean, date/time (ISO 8601), enum, float, integer, string, URL



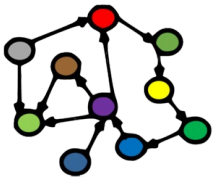
Facebook's Graph API

- Letting external applications access the information in Facebook's social graph
  - inspired by *social networks*
- *Nodes* represent “things”: *User, Photo, Page, Comment*
- *Edges* represent connections between the "things":
  - Users' *friends*, Pages' *photos*, Photos' *comments*...
- *Fields* contain information about the "things":
  - the *birthday* of a User, the *name* of a Page...
- *Seriously restricted since version 2.0... (Privacy!)*
  - *the idea remains important*
  - *open, user-owned alternatives are emerging*
    - *GNU social (StatusNet), Diaspora...*



Facebook Graph API

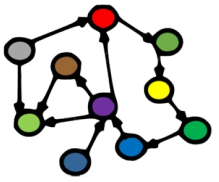
- *REST*-based (REpresentational State Transfer)
  - an example of a *web service / web API*
  - all nodes have IRIs
  - GET, POST, DELETE over HTTP
- GET graph.facebook.com/facebook/picture?redirect=false
  - this is sent over HTTP (at least):
    GET /facebook/picture?redirect=false HTTP/1.1
    Host: graph.facebook.com
- Many API operations are based on *access tokens*
  - returned by *Facebook login*
  - mandatory for POST and DELETE
  - *friends' information must be explicitly granted*



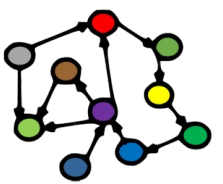
Facebook Graph API

- Most HTTP-requests go to:
  - http://graph.facebook.com/...
  - http://graph-images.facebook.com/...
- Node paths:
  - GET graph.facebook.com/{node-id}
- Edge paths:
  - GET graph.facebook.com/{node-id}/{edge-name}
- With access token:
  - GET graph.facebook.com/me
- POST and DELETE are also used

Try it out: https://developers.facebook.com/tools/explorer

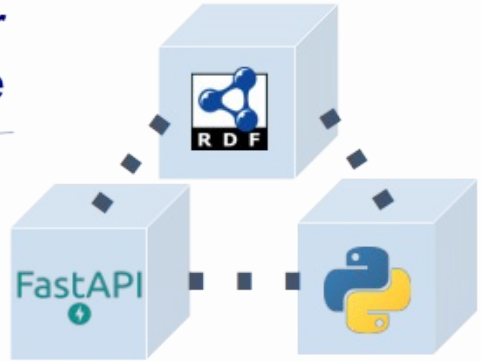


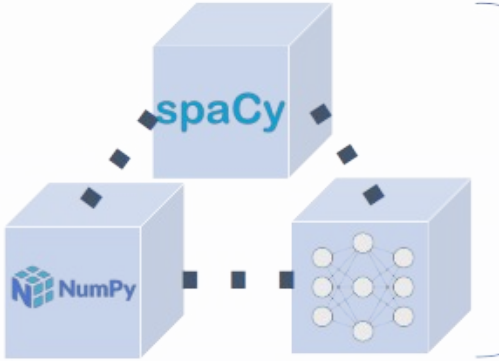
The News Hunter Platform



The News Hunter infrastructure

Service nodes
Web scraping, API, user interfaces, semantic lifting processes
- Light-to-medium processing
- Python, REST API, ...

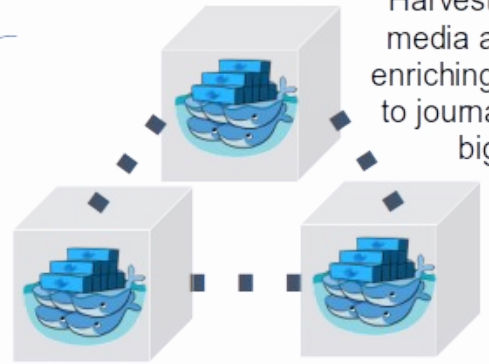


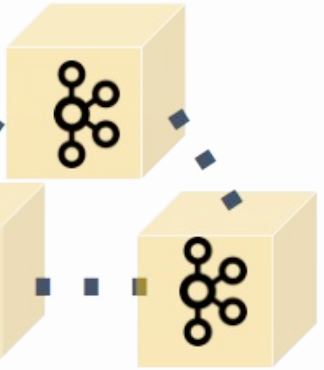


Computation-intensive nodes
Complex AI services and training processes.
- CPU, RAM, GPU intensive
- *Python, spaCy, ...*

Harvesting news-related information from social media and other sources; analysing, organising, enriching and presenting news-related information to journalists. Implemented using state-of-the-art big data and distributed technologies.

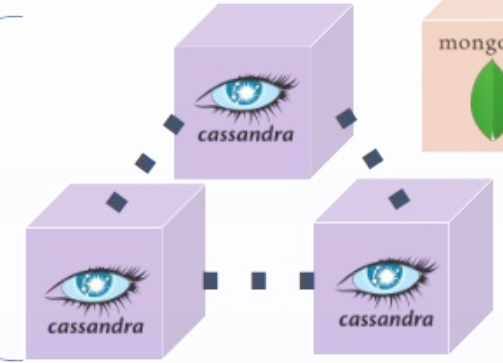
Management nodes
Service orchestration and monitoring
- Lighter processing
- Docker Swarm

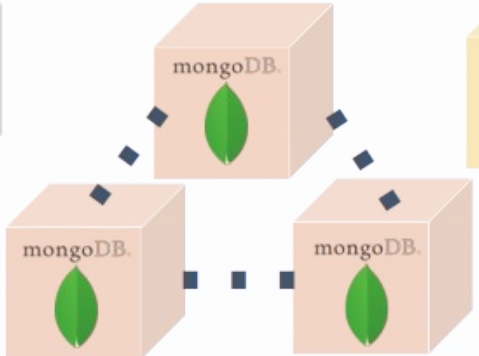




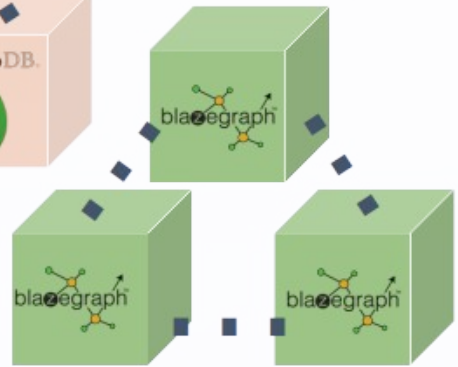
Message queue nodes
Message exchange, queueing (TBD)
- Lighter processing
- Kafka

Raw data nodes
Distributed storage for raw data files (textual, multimedia)
- Disk intensive
- *Cassandra, ...*





Configuration nodes
- Lighter processing
- *MongoDB, files*



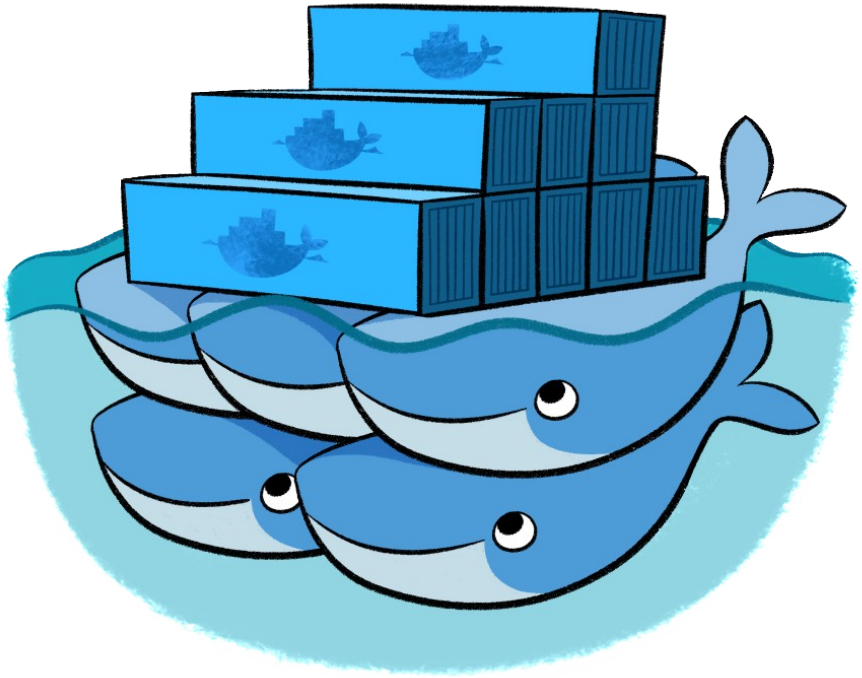
Knowledge graph nodes
News semantic representation storage.
- Disk, CPU and RAM intensive
- *Blazegraph*

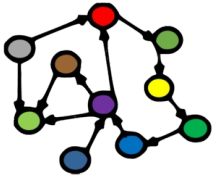
M. Gallofré Ocaña & A.L. Opdahl (2021)

Cloud infrastructure deployment tools

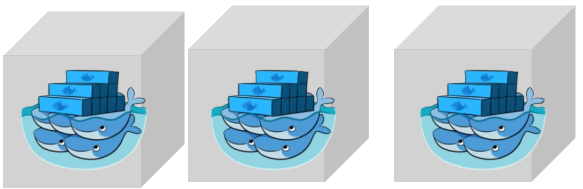
Slide by Marc Gallofré Ocaña

Service orchestration (Docker Swarm)



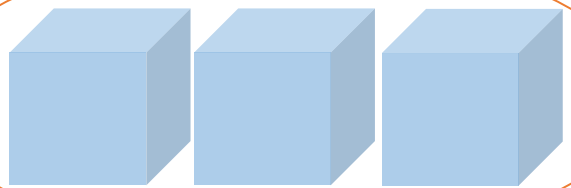


Service instances.
For running services
for AI, Web scraping,
API ...

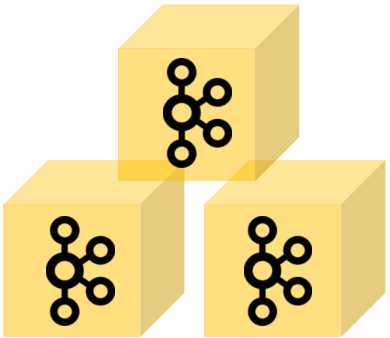


3x m1.medium
- 1 (3) vCPUs
- 4 (12) GB RAM

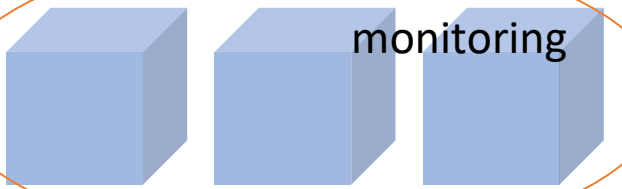
Manager nodes. For Swarm orchestration and monitoring



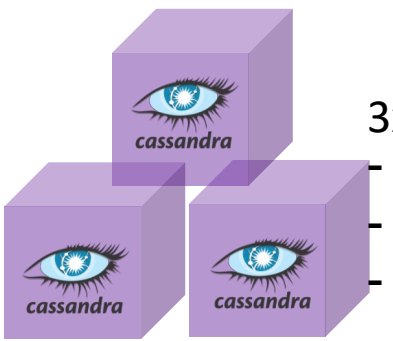
3x m1.large
- 2 (6) vCPUs
- 8 (24) GB RAM



3x m1.large
- 2 (6) vCPUs
- 8 (24) GB RAM

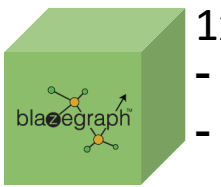


3x m1.xlarge
- 4 (12) vCPUs
- 16 (48) GB RAM



3x m1.large
- 2 (6) vCPUs
- 8 (24) GB RAM
- 3 (9) TB Disk

1x m1.medium
- 1 vCPUs
- 4 GB RAM
- 20 GB Disk



1x m1.xlarge
- 4 vCPUs
- 16 GB RAM
- 11 TB Disk

1 vCPU = 0.5CPU

Slide by Marc Gallofré Ocaña

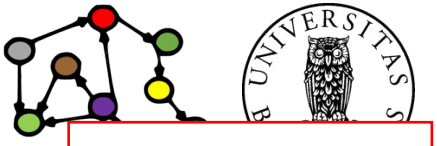
News Hunter Platform:

- **38 vCPUs**
- **152GB RAM**
- **20TB Disk**
- **17 Instances**

+

1 Launcher instance for deploying the cloud infrastructure:

- **1 vCPU**
- **4 GB RAM**

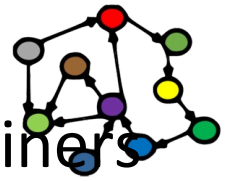


1 vCPU = 0.5CPU

Technologies

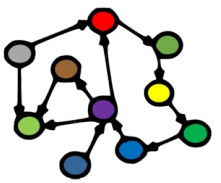
- Docker Swarm
- Kafka (as pub/sub message queue to communicate between all services in the platform)
- Zookeeper
- Cassandra (storing raw data in a distributed cluster)
- Blazegraph (Knowledge graph with news and events representations)
- MongoDB (configuration and metadata)

* All of them have been deployed using Docker containers



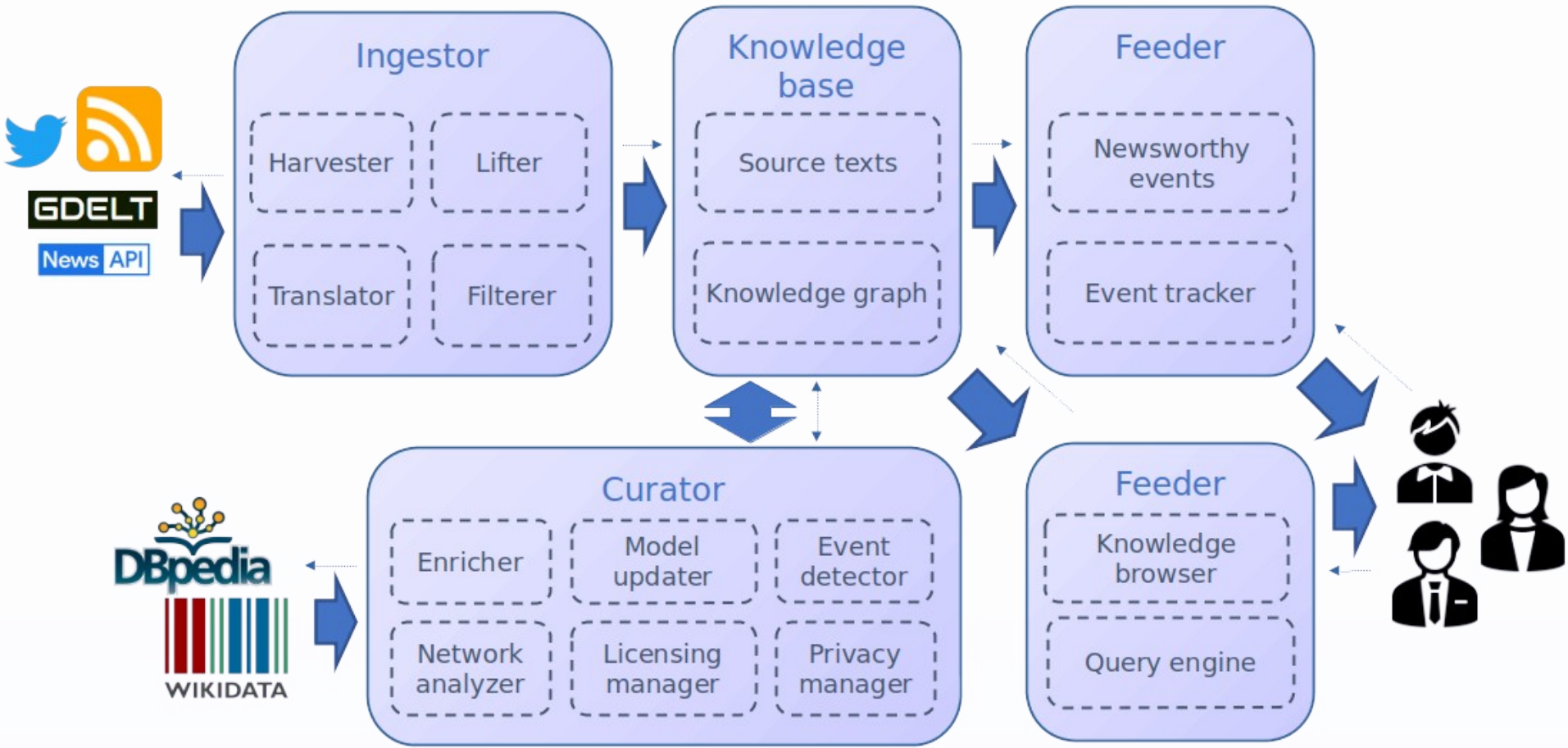
Services

- Written in Python 3.8-3.9
- All services are deployed in docker containers
- FastAPI as the main python library for writing APIs



The News Hunter architecture

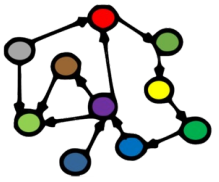
Harvesting news-related information from social media and other sources; analysing, organising, enriching and presenting news-related information to journalists. Implemented state-of-the-art big data and distributed technologies.



M. Gallofré Ocaña & A.L. Opdahl (2021)

Services - harvesters

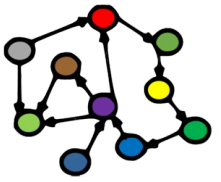
- Twitter harvester: connects to the Twitter API to read streams of tweets from news organizations accounts
- RSS harvester: downloads RSS feeds from news organisations
- GDELT harvester: gets the events and GKG datasets from GDELT projects
- NewsAPI harvester: use NewsAPI.org API to get real-time feeds of news from thousands of news outlets



Services - lifters

Lifters for news and GDELT that use NER to represent the information into knowledge graphs

- DbpediaSpotlight NEL: using DBpediaSpotlight for named entity linking
- SpaCy NEL: using SpaCy for named entity linking
- Kolitsas NEL: using Kolitsas algorithm for named entity linking



Next week:
Rules (RDFS)