Whirlpool

Data Acquisition using N-node Distributed Web Crawler

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MSCS Graduate 2018-2019

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- Motivation & Contributions

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- Crawler characteristics & history

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- Whirlpool: Event driven architecture

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- Whirlpool: Event driven architecture
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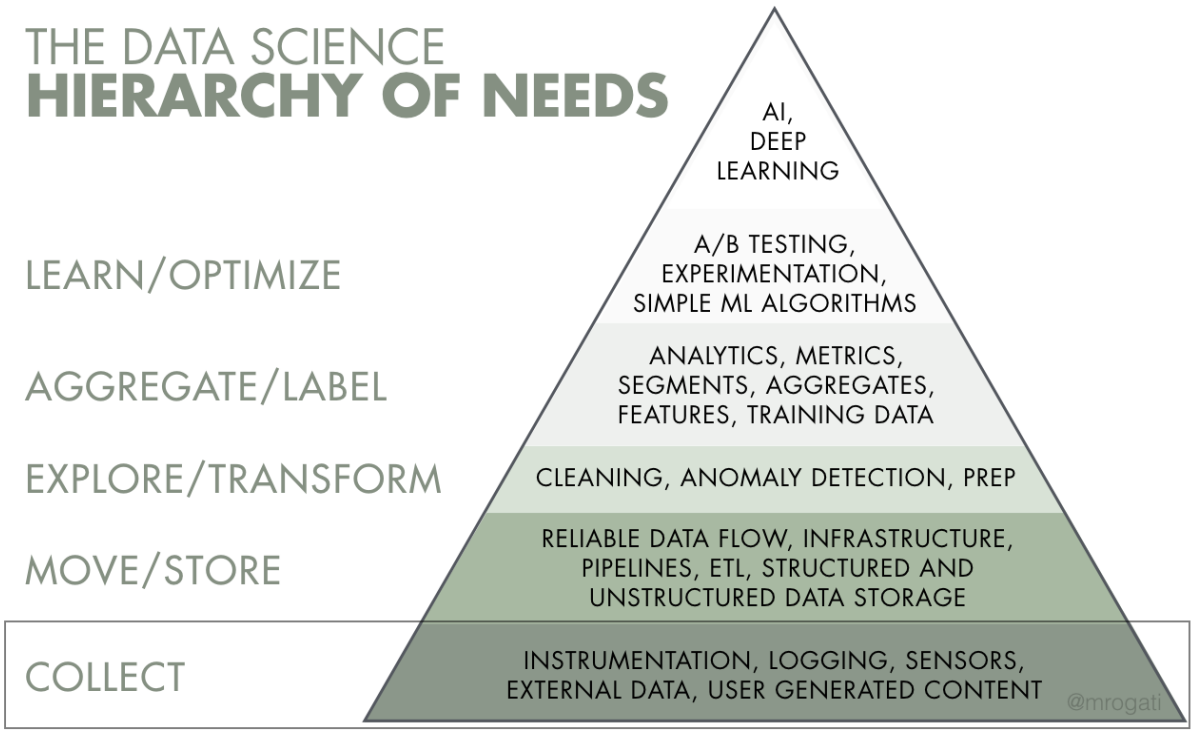
} implementation & results

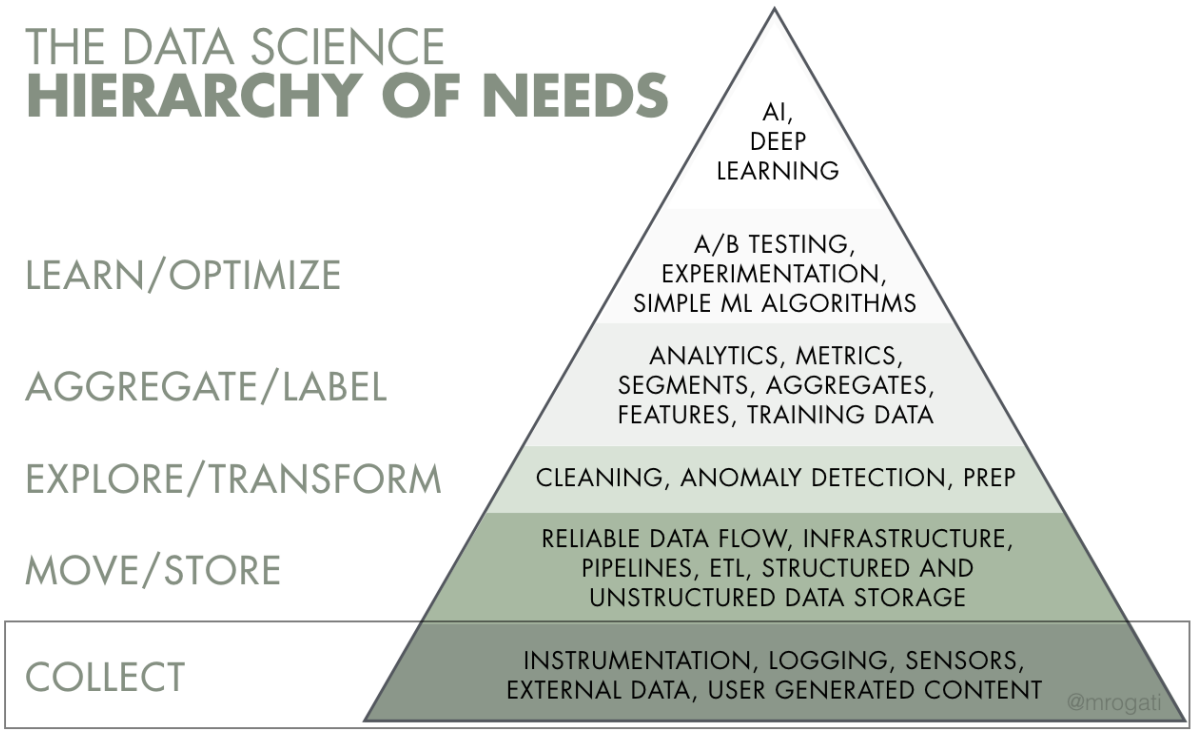
- Future work

Motivation & Contribution

Motivation


THE DATA SCIENCE
HIERARCHY OF NEEDS
AI, DEEP LEARNING
A/B TESTING, EXPERIMENTATION, SIMPLE ML ALGORITHMS
LEARN/OPTIMIZE
ANALYTICS, METRICS, SEGMENTS, AGGREGATES, FEATURES, TRAINING DATA
AGGREGATE/LABEL
CLEANING, ANOMALY DETECTION, PREP
EXPLORE/TRANSFORM
RELIABLE DATA FLOW, INFRASTRUCTURE, PIPELINES, ETL, STRUCTURED AND UNSTRUCTURED DATA STORAGE
MOVE/STORE
INSTRUMENTATION, LOGGING, SENSORS, EXTERNAL DATA, USER GENERATED CONTENT
COLLECT
@mrogati

Motivation



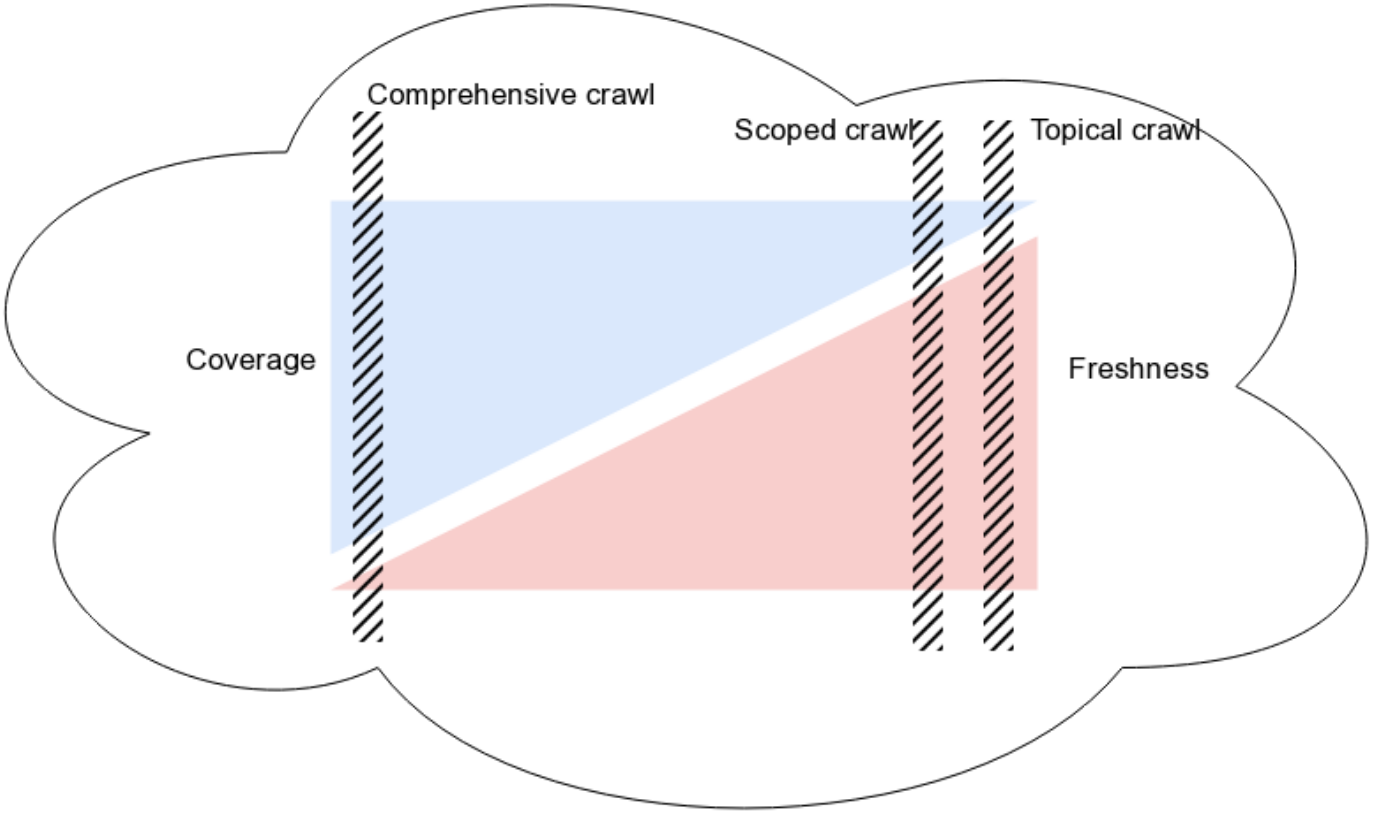
Self-actualization (AI) is great, but you first need food, water, and shelter (data literacy, collection, and infrastructure).”

Contributions

to be completed

Crawler characteristics & history

Coverage & Freshness



Seedlist


MONSTER


glassdoor

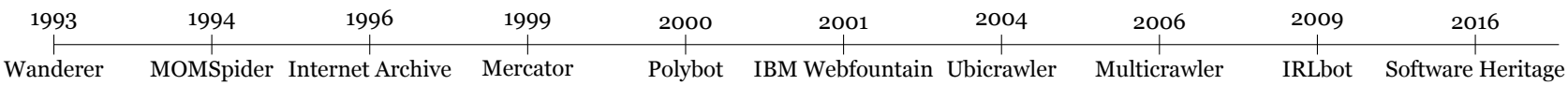

Dice


indeed
one search. all jobs.


ZipRecruiter


SimplyHired

Web crawlers (1990 - 2019)



Mercator 1999 (Heydon & Najork)

basic crawling algorithm

1: Let I $\leftarrow$ {1,2,3,4,5} such that seed set S = $\{U_i |$ i $\in$ I$\}$
2: $U_f \leftarrow$ S; where U_f is a Frontier queue
3: **procedure** Spider(U_f)
4: **while** $U_f \neq \emptyset$ **do**
5: $u \leftarrow \text{Pop}(U_f)$
6: $p \leftarrow \text{Fetch}(u)$
7: $T \leftarrow \exists p$ [{Extract(p, t) | t is a text }]
8: $L \leftarrow \exists p$ [{Extract(p, l) | l is a link }]
9: $U_f \leftarrow U_f \cup L$
10: $\exists u$ [{Delete(U_f, u) | u is a already fetched URL}]
11: **end**

Mercator background

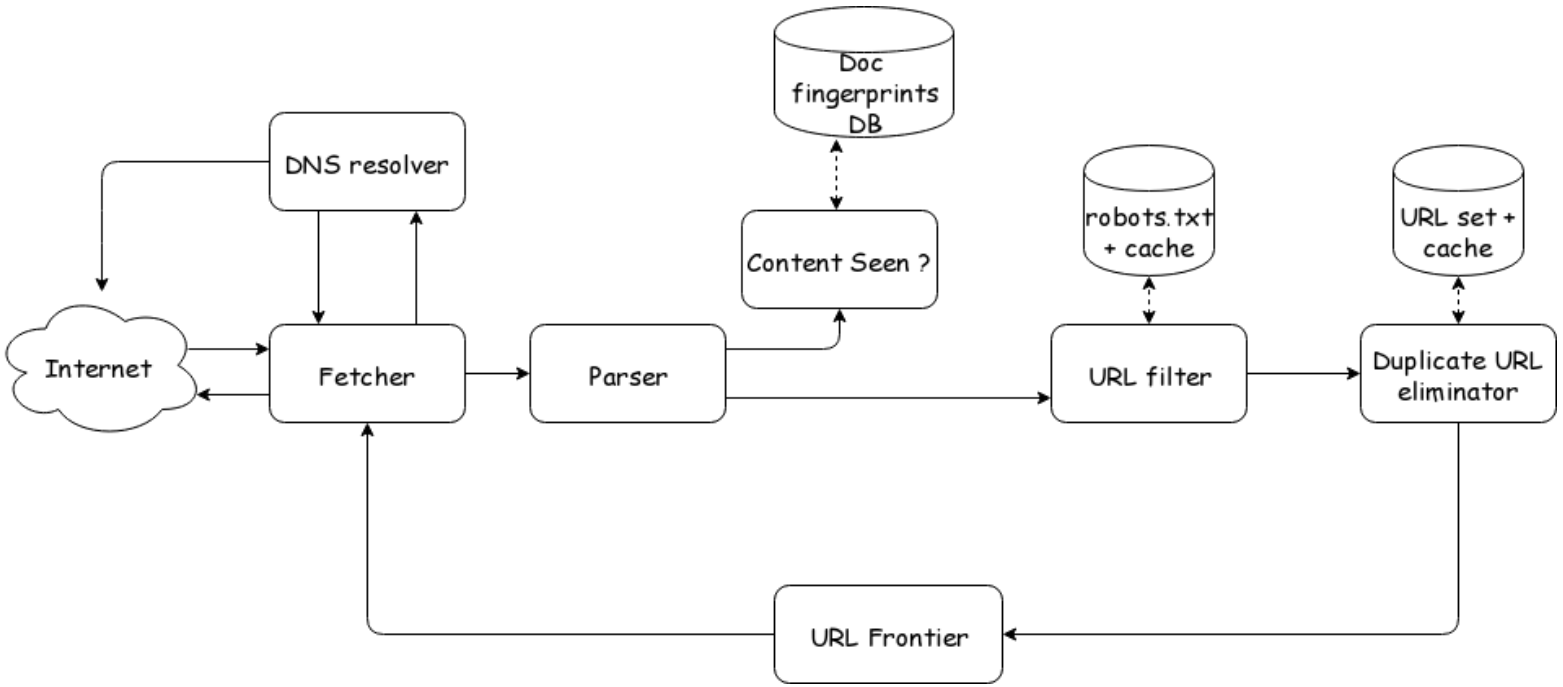
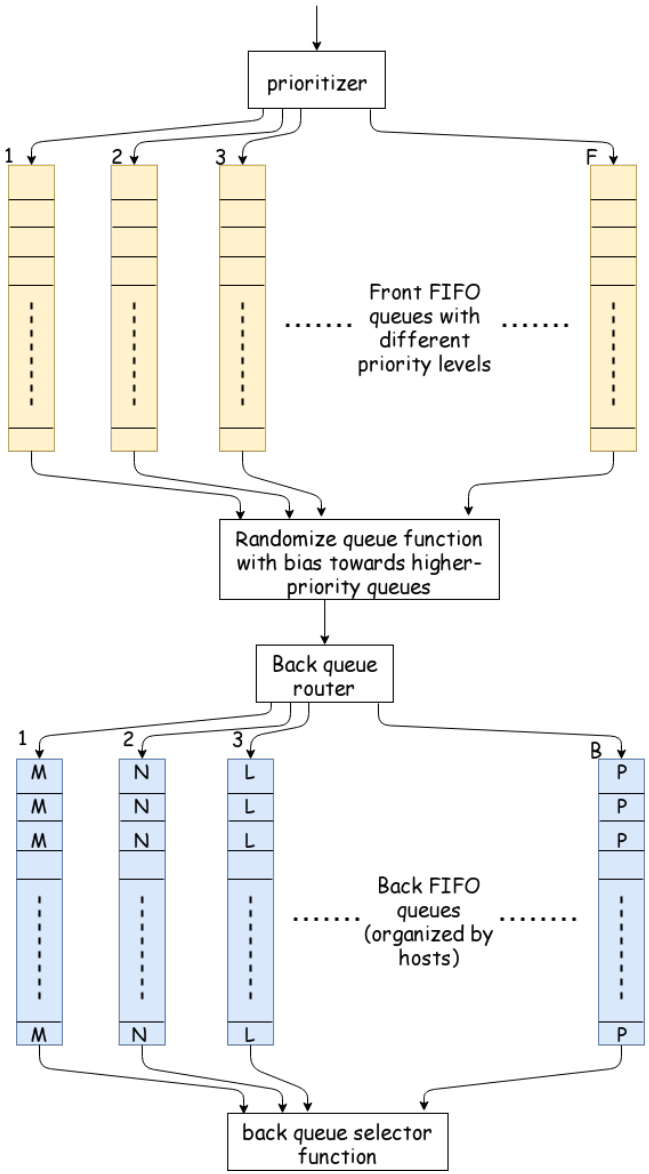


Figure: Mercator building blocks (Heydon & Najork)

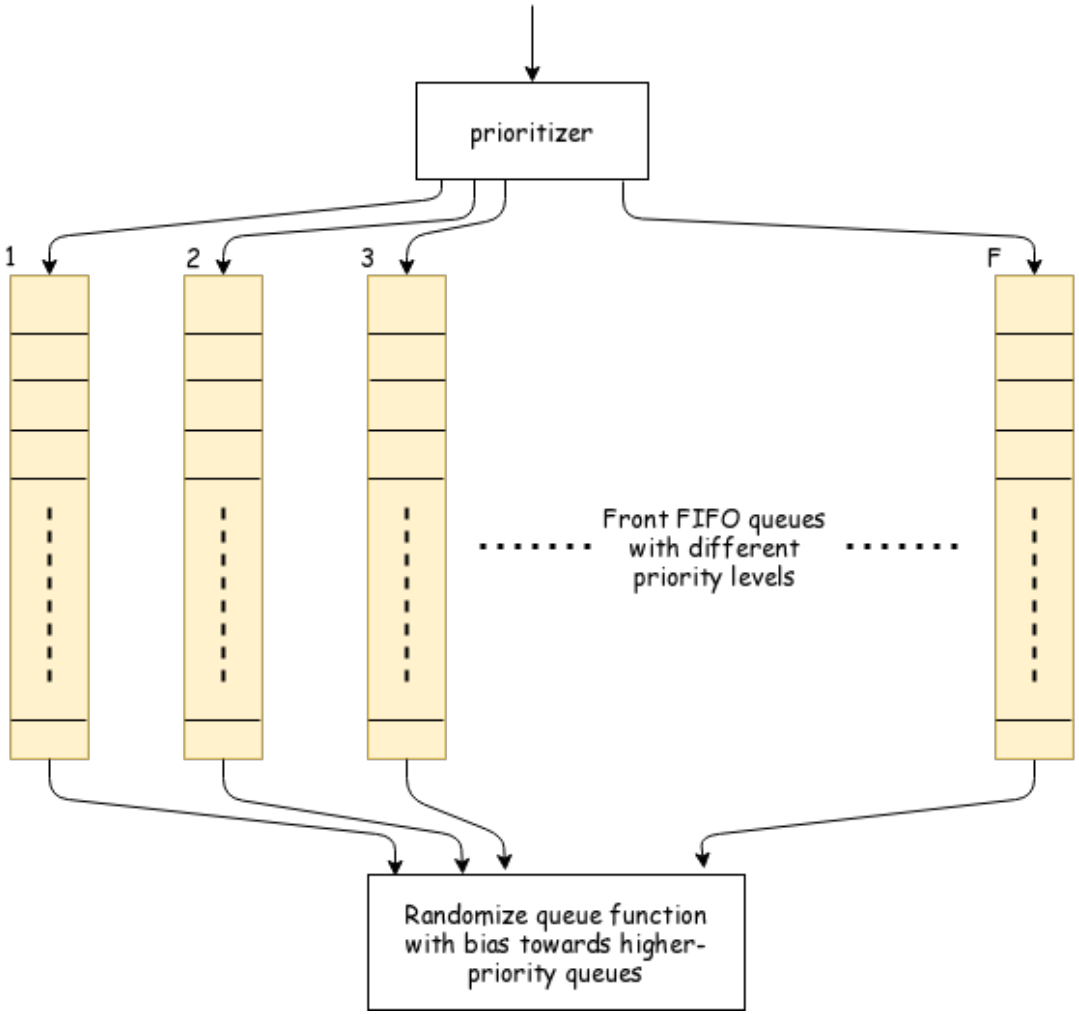
Mercator: URL filter

```
User-agent: *
Allow: /
Disallow: /unsubscribe
Disallow: /job/track-pageview
Disallow: /candidate/
Disallow: /alert-job/
Disallow: /facebook/
Disallow: /amazon/
Disallow: /job/track-apply-click
Disallow: /job/monster-apply-request
Disallow: /?search=
Disallow: /geo/job_title
Disallow: /blog/wp-admin/
Disallow: /contact/zip-resume
Disallow: /resume-database/preview-iframe
Disallow: /admin
Disallow: /login/ # want the main login page allowed, but not pages under /login/
Disallow: /mu
Disallow: /trk
Disallow: /record-event
Disallow: /events
Disallow: /apply/ # want apply allowed, but not pages under /apply/
Disallow: /eclk/
Disallow: /pixel/
Disallow: /chat/get-chat-auth-token
Disallow: /ajax/

# Block URLs that are likely added by js clipboard library
Disallow: /jobs/*/closest$
Disallow: /jobs/*/clipboard-action$
Disallow: /jobs/*/is$

# Block temporary pages of the go seo app
Disallow: /svc/seo/

User-agent: 008
Disallow: /

User-agent: OmniExplorer_Bot
Disallow: /
```

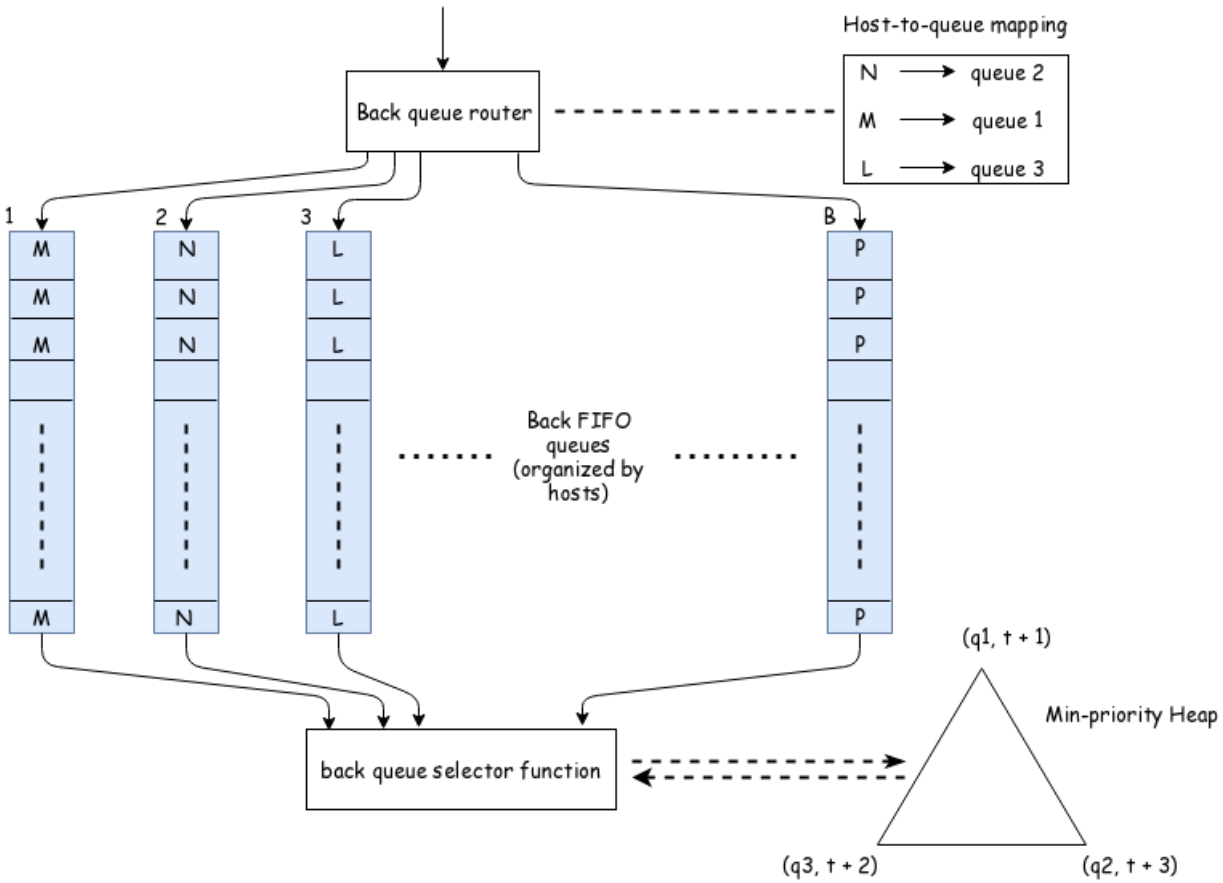
URL Frontier Scheme



Front queue (Frontier Queue)



Back queue (Frontier Queue)



Software Design Principles

Designing scalable systems

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- Adding identical copies of components

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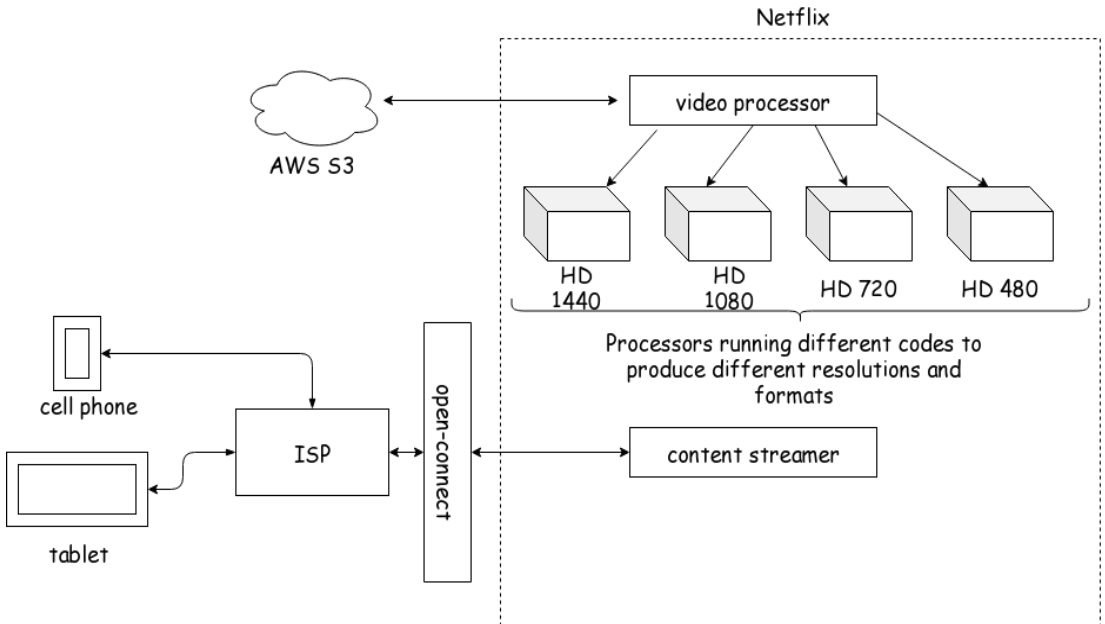
- Functional partitioning



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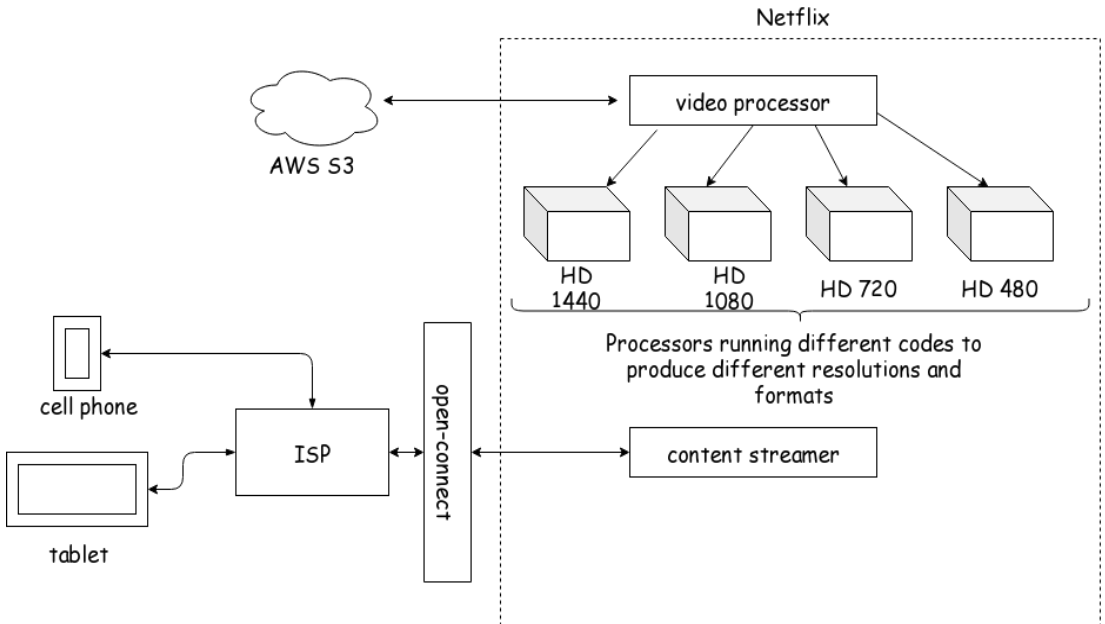


- Data partitioning

State Management

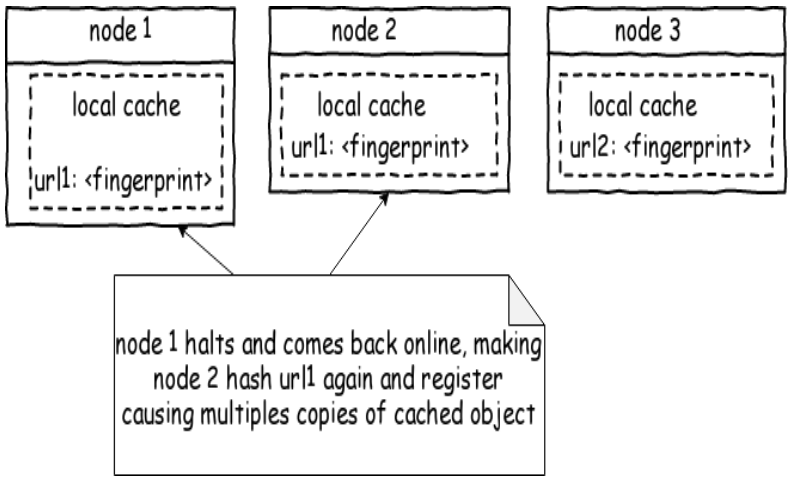


Figure: identical copies of same cached object

State Management

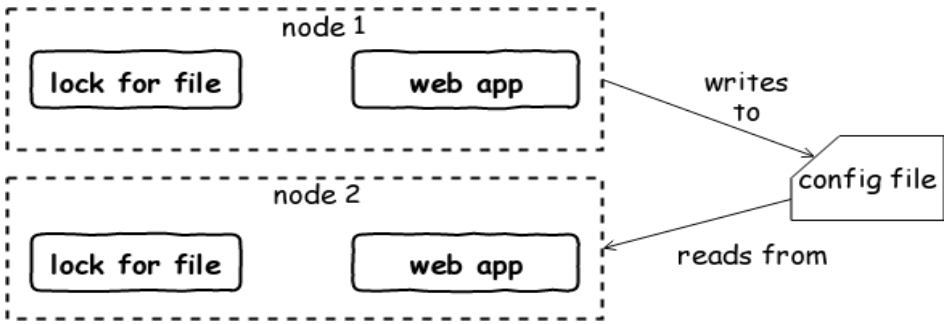


Figure: Using local locks to access shared resources

State Management

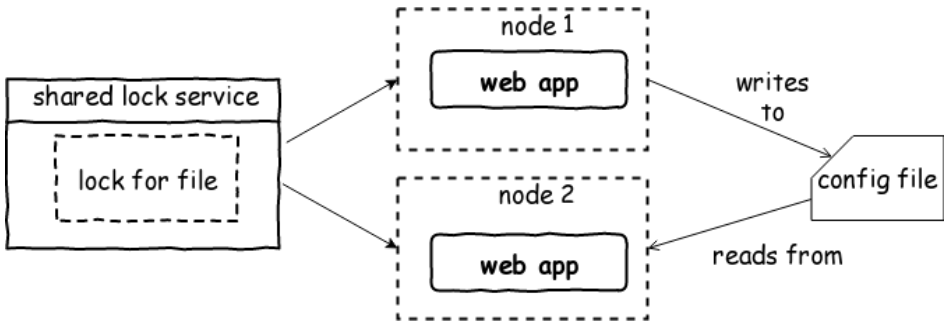
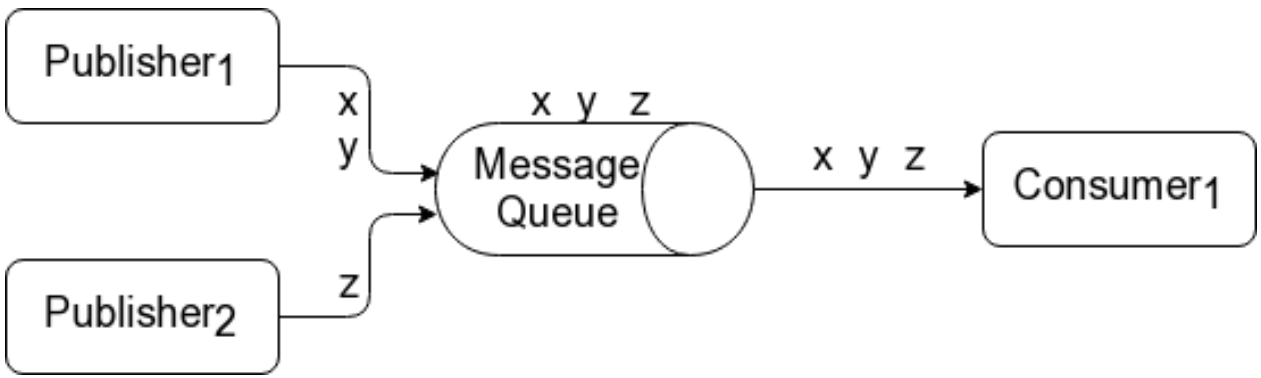


Figure: using shared locks to access shared resources

Whirlpool: Event-driven architecture

Message buses

Message Queue(MQ)



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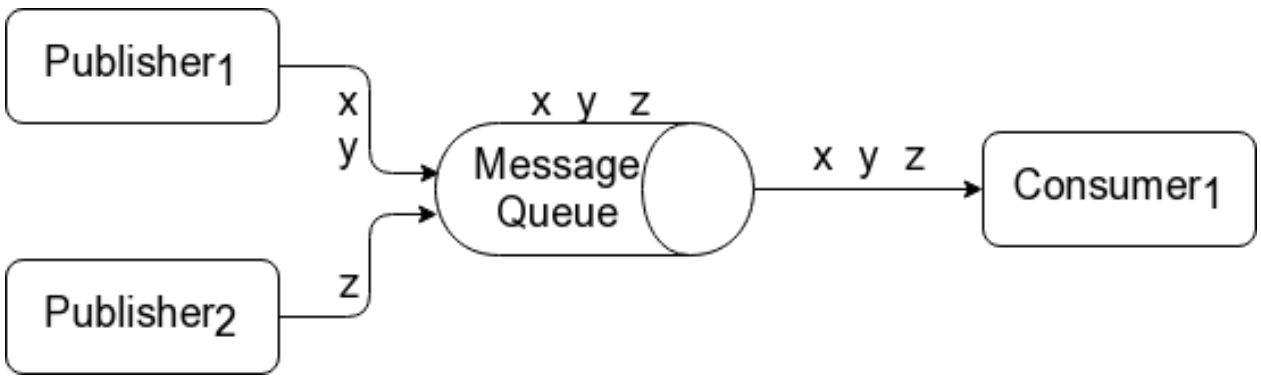
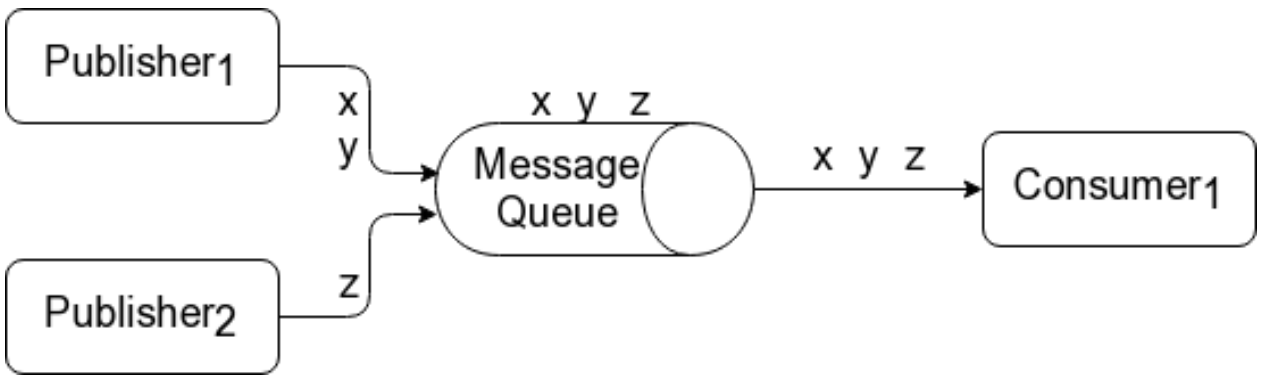


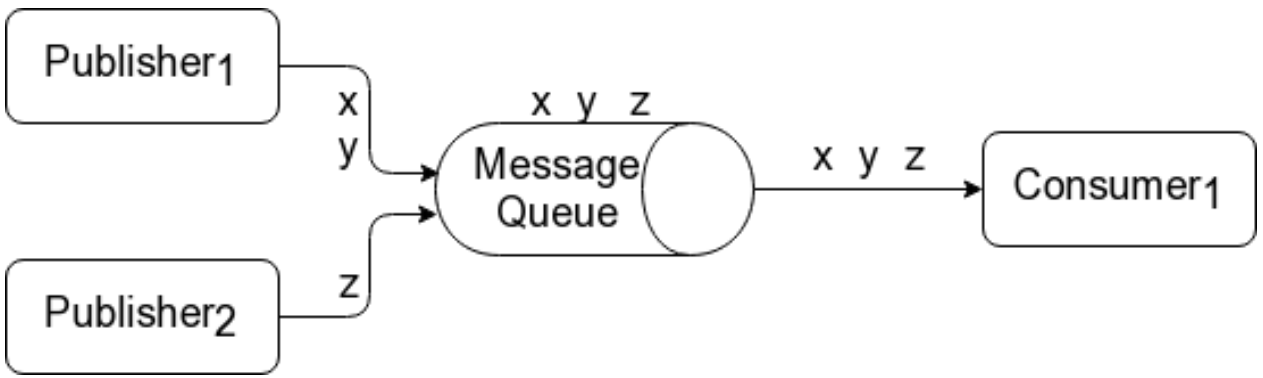
- decoupling

Message Queue(MQ)



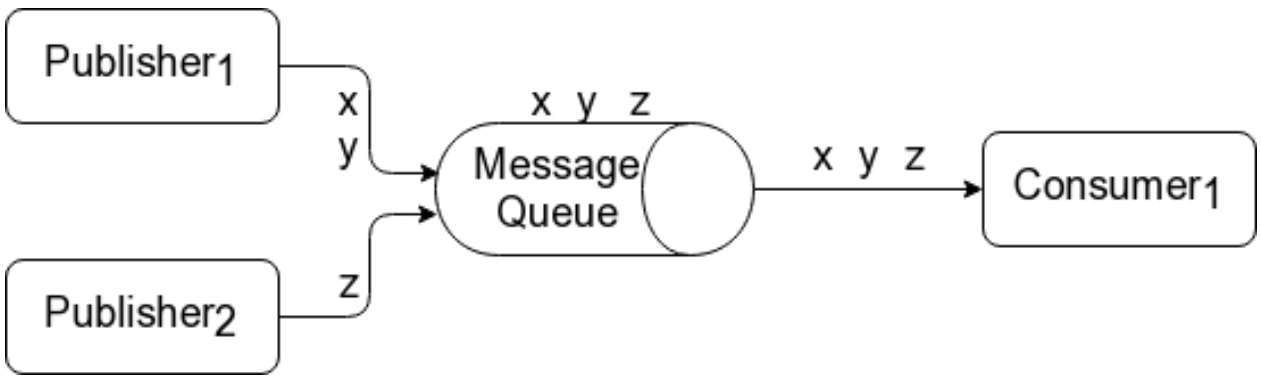
- decoupling
- scaled independently

Message Queue(MQ)



- decoupling
- scaled independently
- balancing traffic

Message Queue(MQ)



- decoupling
- scaled independently
- balancing traffic
- fault-tolerance

MQ: Routing mechanisms

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- Direct Worker Queue Data Flow

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- Fanout

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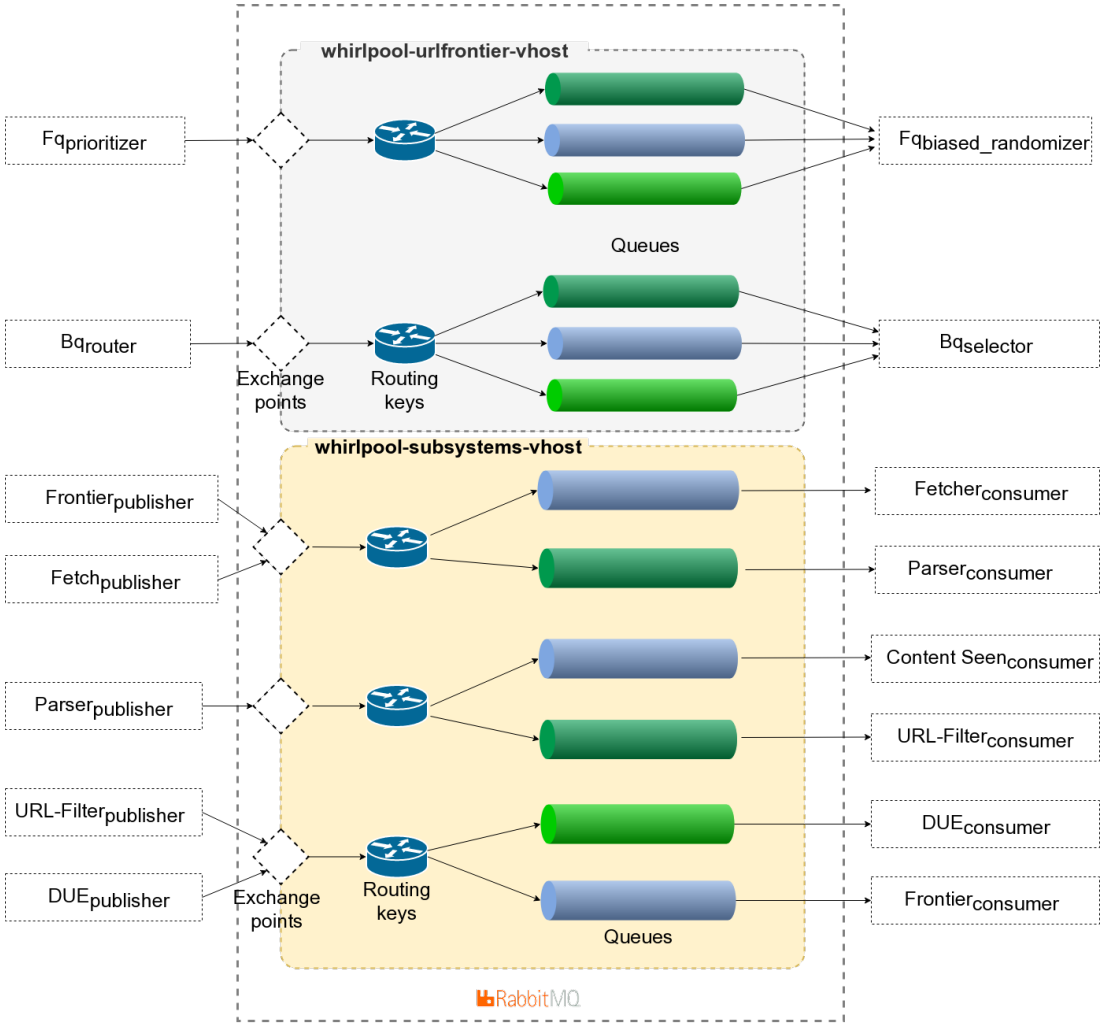
- Topic

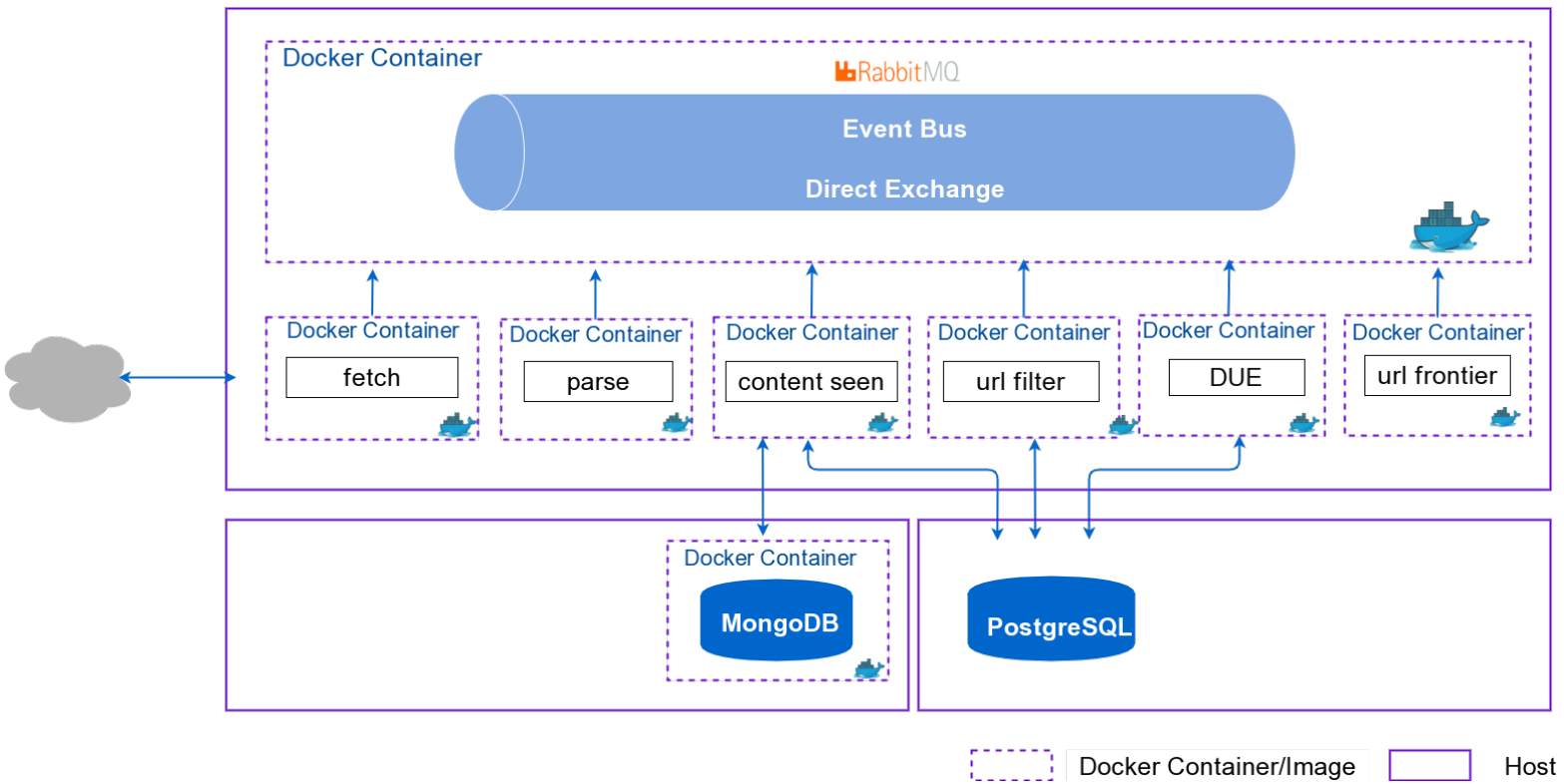
MQ: Routing mechanisms

- Direct Worker Queue Data Flow
- Fanout
- Topic
- Header

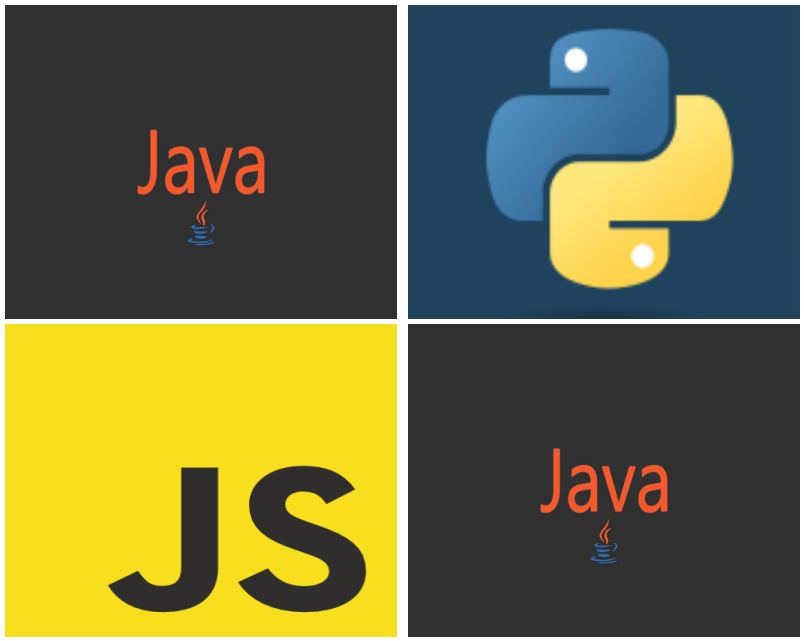
Direct Worker Queue Data Flow



RabbitMQ: Message bus



Language runtime



development vs. production docker containers

```yaml
version: '2.4'

networks:
  default:
    external:
      name: whirlpool-net

services:

  base:
    image: python:3.7.4-buster
    command: bash -c "useradd --create-home --shell /bin/bash whirlpool && chown -R whirlpool:whirlpool /home/whirlpool/whirlpool-due"
    volumes:
      - .:/home/whirlpool/whirlpool-due
      - wh-due:/usr/local/lib/python3.7/site-packages
    working_dir: /home/whirlpool/whirlpool-due
    environment:
      - PY_ENV=development
    networks:
      - default

  install:
    extends:
      service: base
    command: pip3 install -r requirements.txt

  quick-up:
    extends:
      service: base
    command: python3 ./due/main.py

volumes:
  wh-due:
    external: true
```

development vs. production docker containers

```
1  FROM python:3.7.4-buster as whirlpool-due-base
2
3  ENV PYTHONDONTWRITEBYTECODE=1
4  ARG WH_DUE_ROOT=/home/whirlpool/whirlpool-due
5  WORKDIR $WH_DUE_ROOT
6
7  RUN apt-get update \
8    && apt-get install -y --no-install-recommends netcat \
9    && rm -rf /var/lib/apt/lists/* \
10   && useradd --create-home --shell /bin/bash whirlpool \
11   && chown -R whirlpool:whirlpool $WH_DUE_ROOT
12
13 # files necessary to build the project
14 COPY .pylintrc ./
15 COPY requirements.txt ./
16
17 RUN mkdir logs/ \
18   && pip3 install -r requirements.txt
19
20 COPY scripts/ scripts/
21 COPY due/ due/
22
23 # docker image for dev target
24 FROM whirlpool-due-base as whirlpool-due-dev
25
26 COPY scripts/wait-for-it.sh scripts/wait-for-it.sh
27 ENTRYPOINT ["bash ./scripts/wait-for-it.sh"]
28
29 # docker image for prod target
30 FROM whirlpool-due-base as whirlpool-due-prod
31
32 COPY scripts/wait-for-it-prod.sh scripts/wait-for-it-prod.sh
33 ENTRYPOINT ["bash ./scripts/wait-for-it-prod.sh"]
```

development vs. production docker containers

Whirlpool: Fetcher

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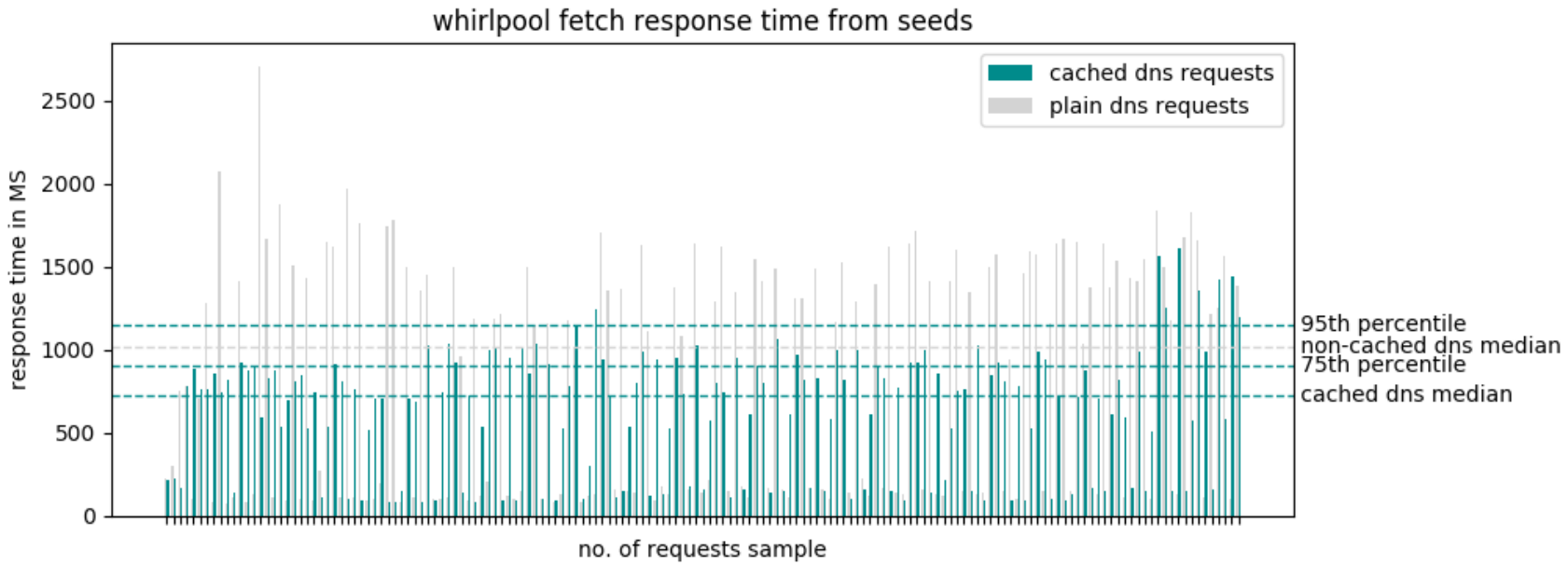
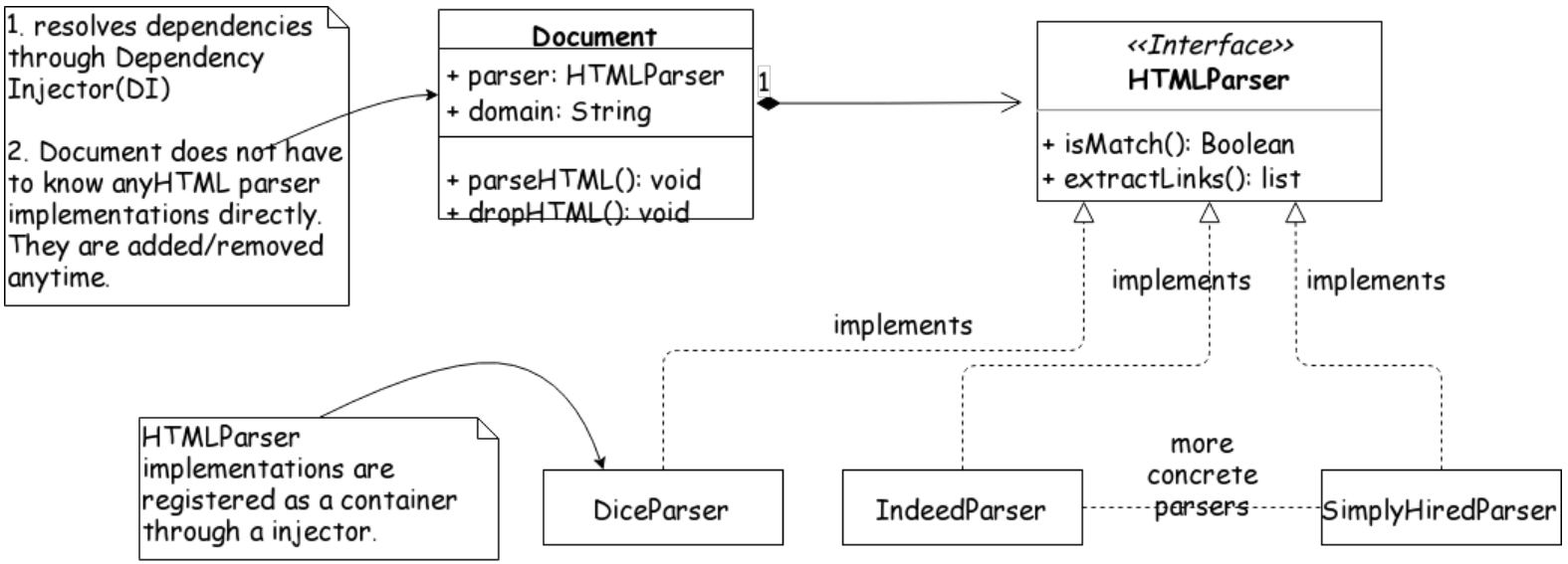


Whirlpool: Parser

Parser


1. resolves dependencies through Dependency Injector(DI)
2. Document does not have to know anyHTML parser implementations directly. They are added/removed anytime.
Document
+ parser: HTMLParser
+ domain: String
+ parseHTML(): void
+ dropHTML(): void
1
<<Interface>>
HTMLParser
+ isMatch(): Boolean
+ extractLinks(): list
implements
implements
implements
HTMLParser implementations are registered as a container through a injector.
DiceParser
IndeedParser
more concrete parsers
SimplyHiredParser

Whirlpool: Deduplication

Fingerprinting

id [PK] integer	page_fp character varying (255)	page_type character varying (255)	whirlpool_page_id character varying (255)	domain character varying (255)	fp_alg character varying (255)	content_page_id character varying (255)
24	b838fe385ab57d3a1fe538ed...	nc	5d8d51539b96be004f5af9f4	www.simplyhired.com	sha1	5d8d5153436a1c002d1f72a0
25	def9e10d1c7ad7bf92465d41...	nc	5d8d57469b96be004f5af9f6	www.dice.com	sha1	5d8d5756a17e4d002da669c1
26	fa4cbe7184263bb6ee885638...	nc	5d8d57be9b96be004f5af9f8	www.dice.com	sha1	5d8d57bea17e4d002da669c3
27	d30ccf29df3fa34e6f562e428...	nc	5d8d57f89b96be004f5af9fa	www.dice.com	sha1	5d8d57f8a17e4d002da669c5
28	3dba207c69927ca4dc78d426...	nc	5d8d8d71db02b70052383520	job-openings.monster.com	sha1	5d8d8d71825679002db3cd2f
29	d4c714f73c767bdcd021d8a1...	nc	5d8d8e36db02b70052383522	job-openings.monster.com	sha1	5d8d8e36825679002db3cd31
30	10ae4d73bbc028349caffac81...	nc	5d8d8e70db02b70052383524	job-openings.monster.com	sha1	5d8d8e70825679002db3cd33

Bloom filter

Shingling: Near Deduplication

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- gather analyze design develop and test applications using agile methodology
- using agile methodology gather analyze design develop and test applications

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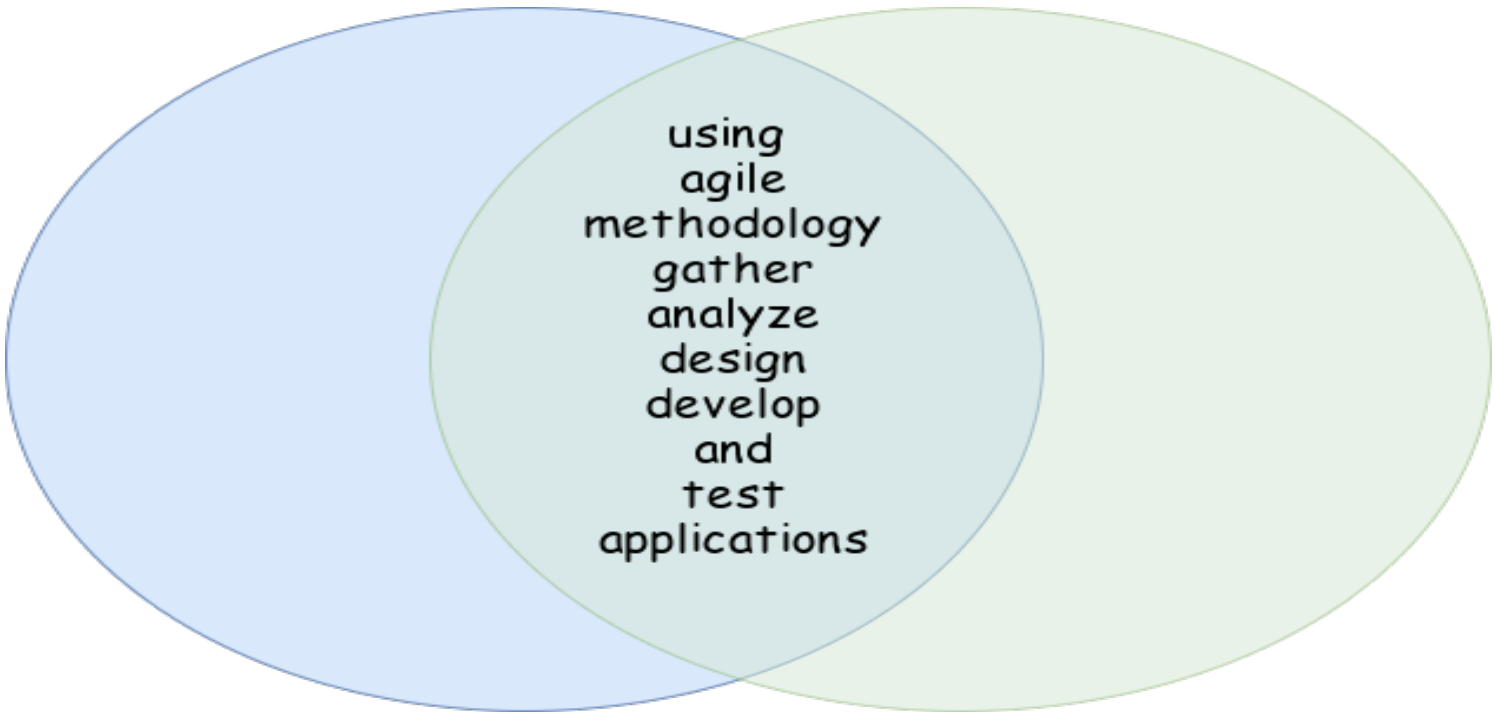

Shingling: Near Deduplication

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- As per google trends Typescript to be among the popular programming languages in the next five years

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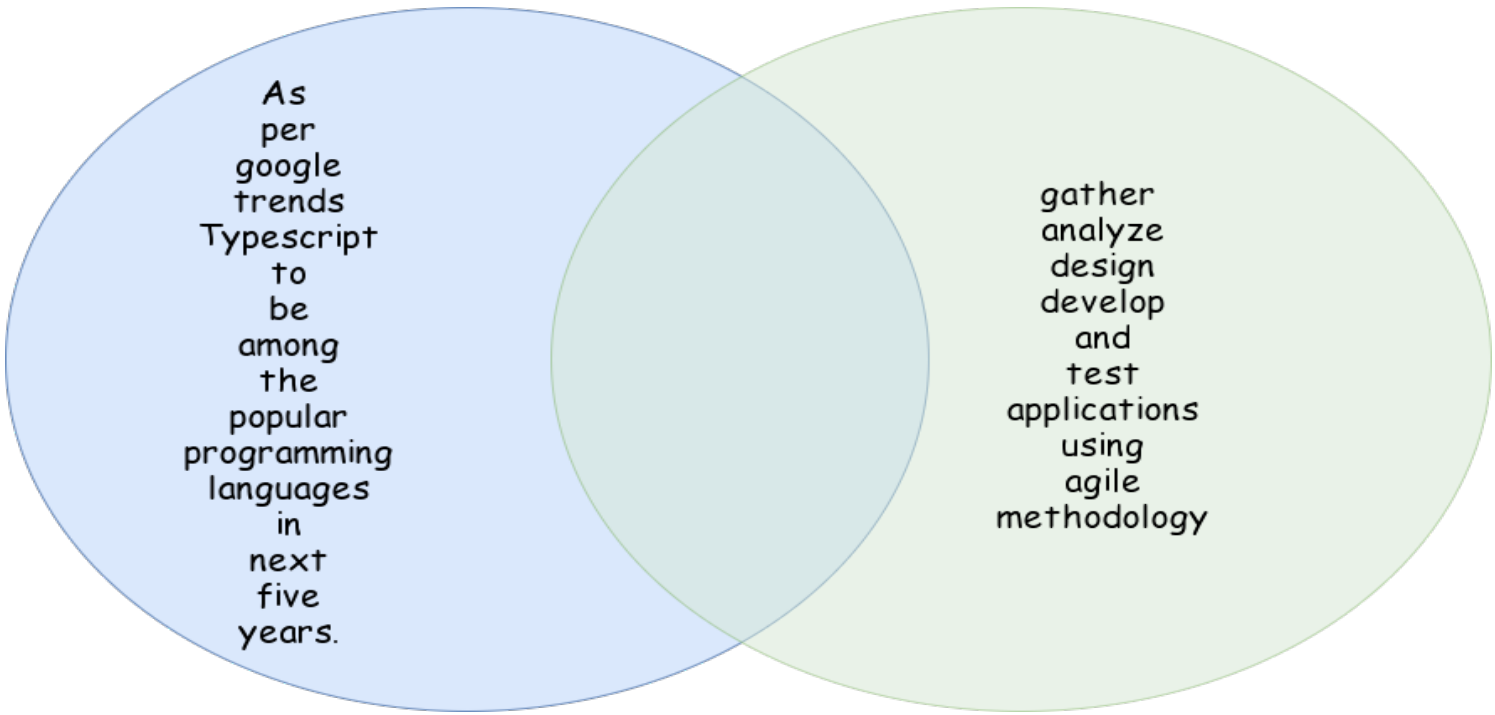

Shingling: Near Deduplication

- Here are the next top five programming languages in coming years according to google trends
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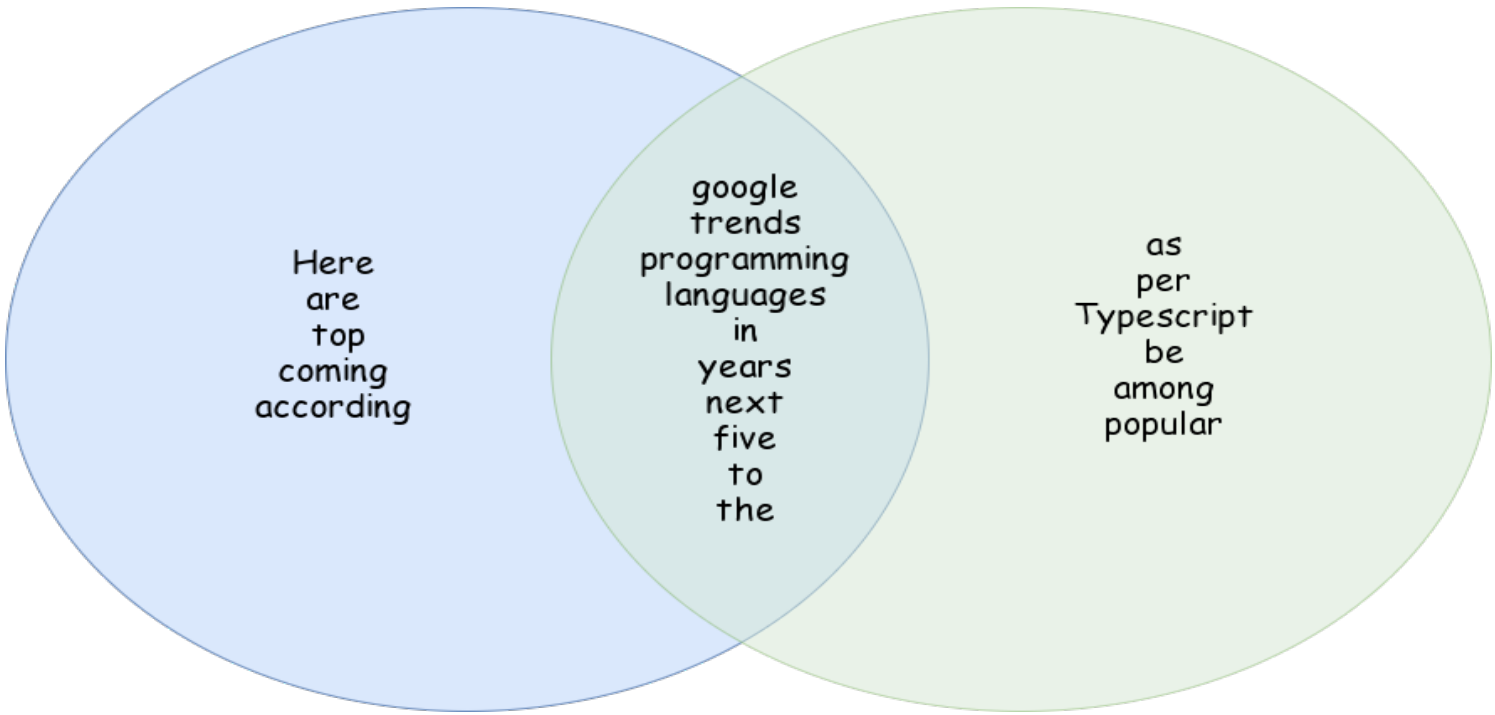

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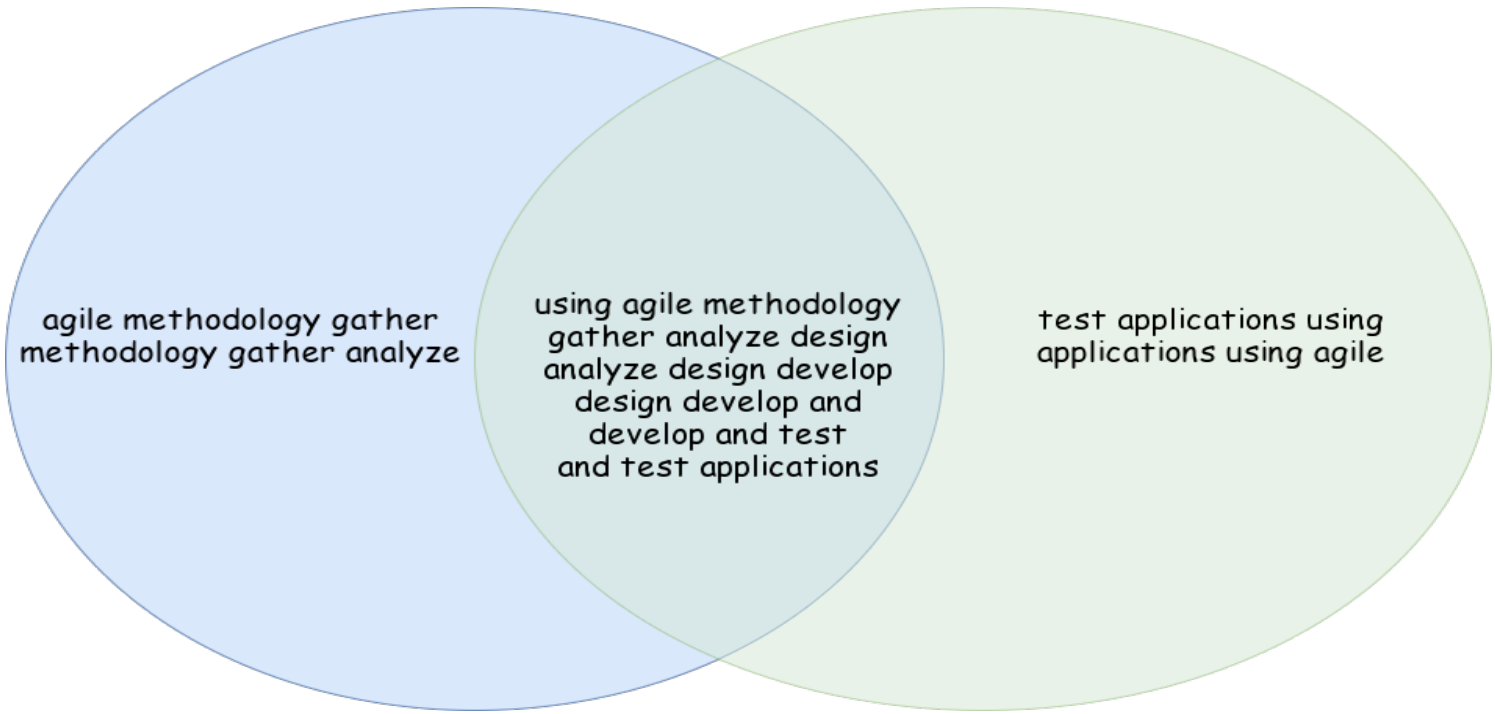

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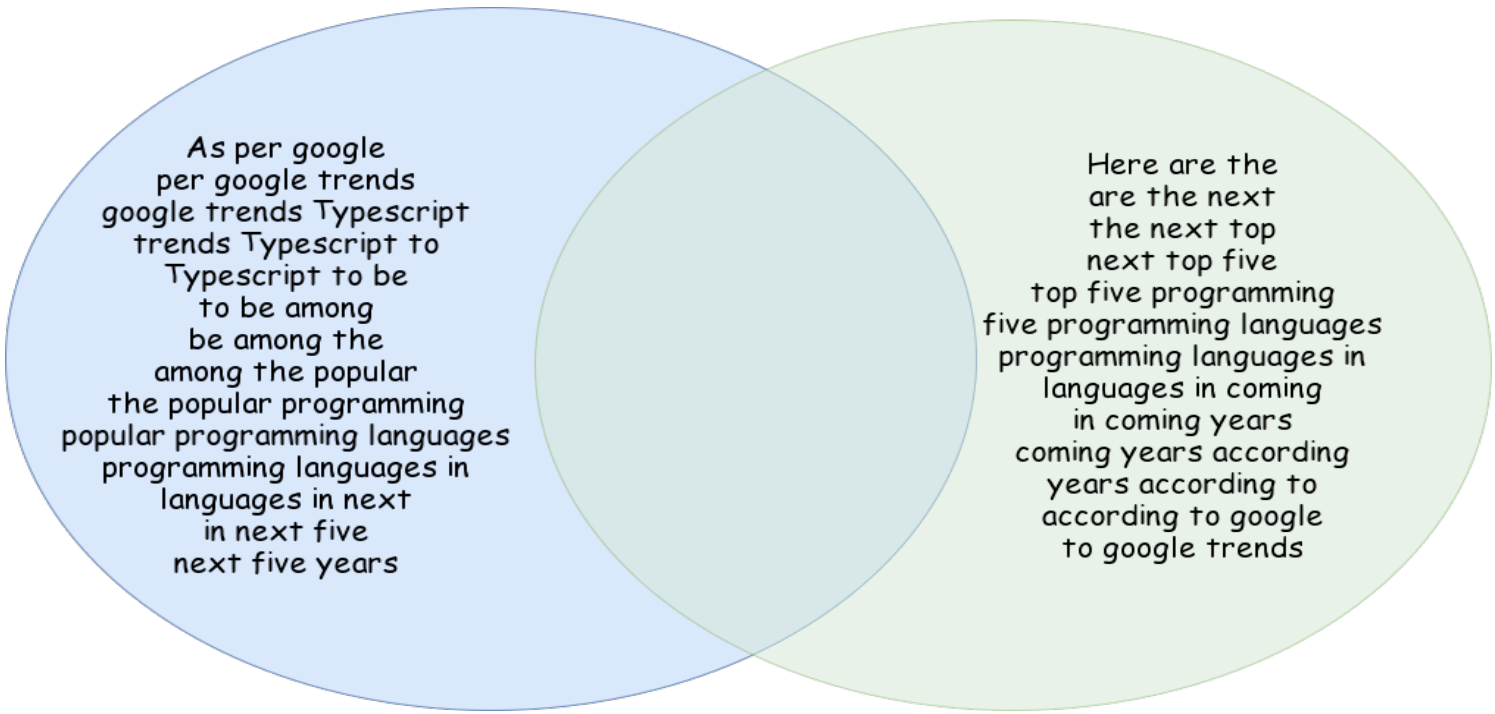


Shingling: Near Deduplication

monster.com

simhash_a	simhash_b	jaccard index	hamming weight
-1571308417	1314365132	0.04	0.52
1314365132	-1906275206	0.15	0.39
-1571308417	-1906275206	0.03	0.48

simplyhired.com

simhash_a	simhash_b	jaccard index	hamming weight
25104594	-897371832	0.1	0.19
-897371832	-880463811	0.72	0.5
25104594	-880463811	0.01	0.22

dice.com

simhash_a	simhash_b	jaccard index	hamming weight
-656343461	-660545702	0.9	0.8
-660545702	1749346824	0.1	0.35
-656343461	1749346824	0.1	0.43

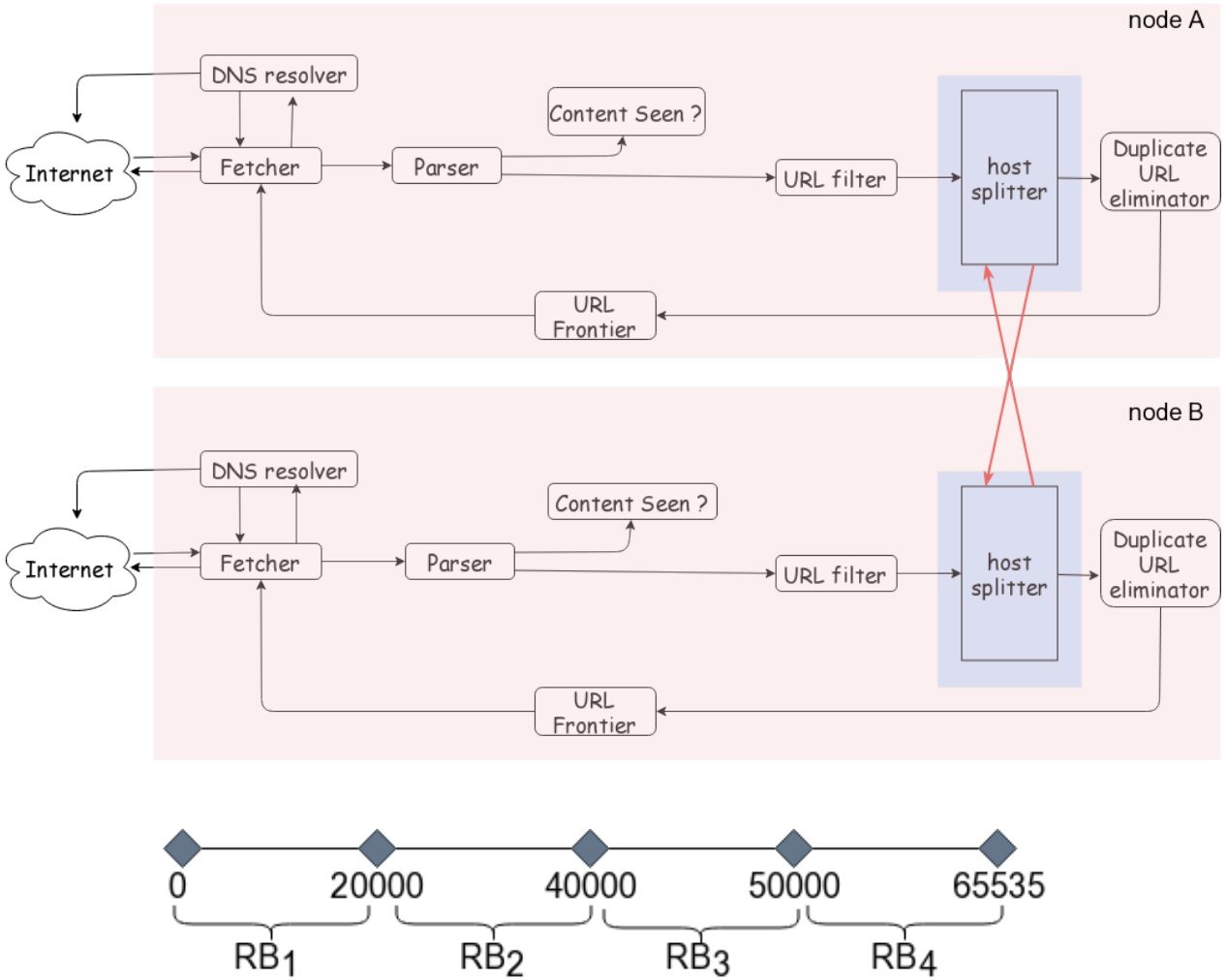
Shingling: Near Deduplication

id [PK] integer	page_fp character varying (255)	page_type character varying (255)	whirlpool_page_id character varying (255)	domain character varying (255)	fp_alg character varying (255)	content_page_id character varying (255)
32	-656343461	nc	5da2785cd410370044b269a4	www.dice.com	simhash	5da27972d410370044b269a5
33	-660545702	nc	5da28b327f2d693fe92077aa	www.dice.com	simhash	[null]
34	1749346824	nc	5da28e0c1244bc30edf4026f	www.dice.com	simhash	5da28e0c1244bcd4eef40270
35	25104594	nc	5da2961ef31b193ffb426bca	www.simplyhired.com	simhash	5da2961ef31b194674426bcb
36	-897371832	nc	5da2966b3c81d51360729b22	www.simplyhired.com	simhash	5da2966b3c81d52104729b23
37	-880463811	nc	5da296cf153a6c17cac78e8f	www.simplyhired.com	simhash	[null]
38	-1571308417	nc	5da298c6dd568b9a7fa681dd	www.jobs-openings.monster.c...	simhash	5da298c6dd568bf87ba681de
39	1314365132	nc	5da299011cd38e47840c4f50	www.jobs-openings.monster.c...	simhash	5da299011cd38e27210c4f51
40	-1906275206	nc	5da29924d66cd79ec310c1da	www.jobs-openings.monster.c...	simhash	5da29924d66cd783c610c1db

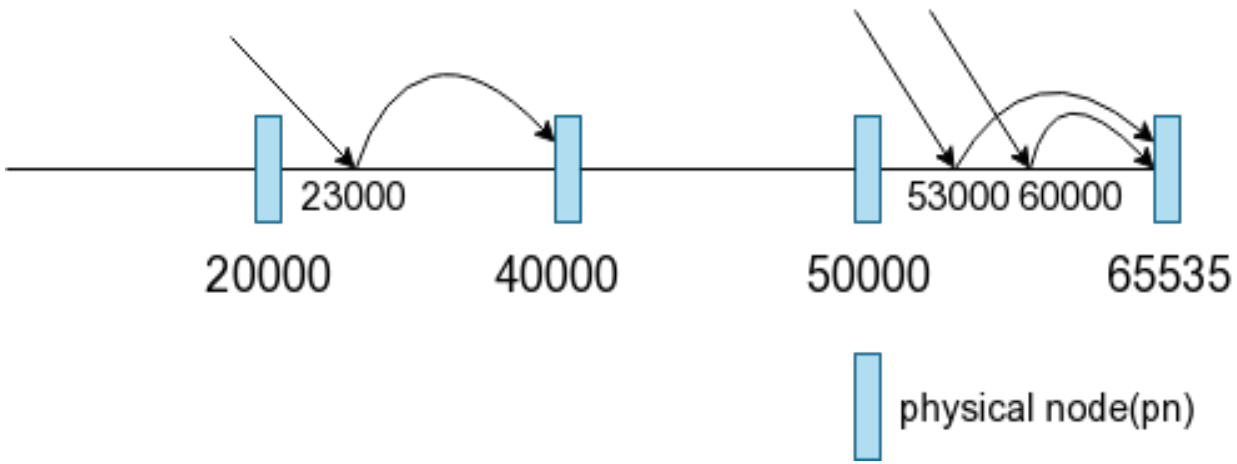
Locality Sensitive Hashing

Whirlpool: Distributed Crawling

Host splitting in Mercator



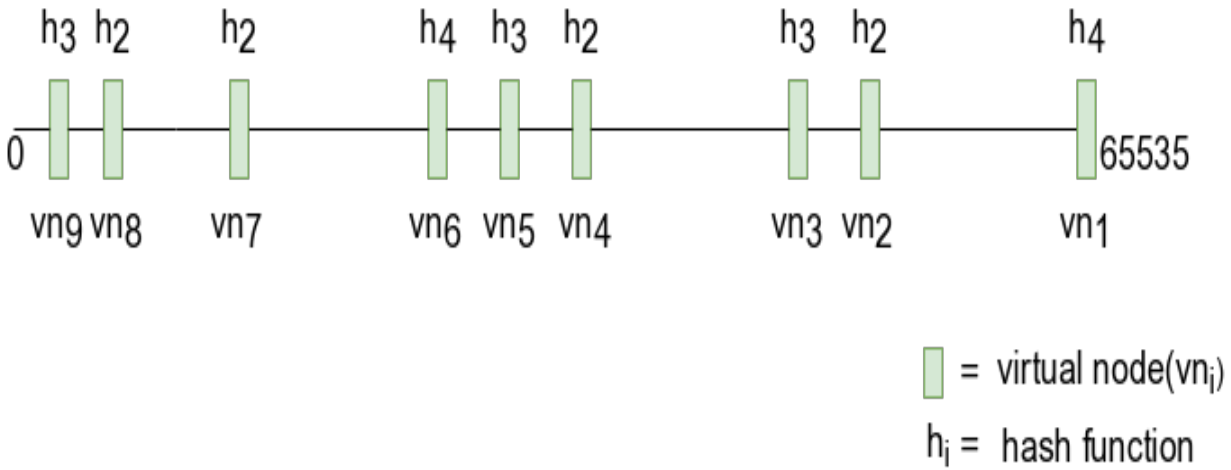
Rebalancing: mod N



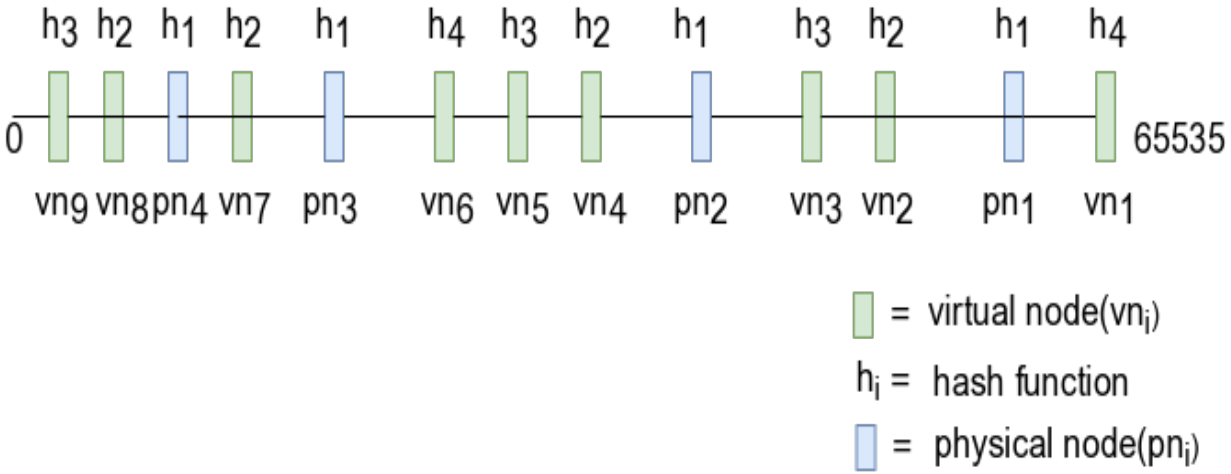
Rebalancing: mod N

absolute URL	m = hash(absolute URL)	m mod N(1)	m mod N(2)	m mod N(3)	m mod N(4)
jobs.com/browses	24	n1	n1 0	n1 0	n1 0
dice.com/browse-titles	59956	n1	n2 1	n1 1	n4 1
monster.com/categories	10090	n1	n1 0	n1 0	n3 1
simplyhired.com/find-jobs	23000	n1	n2 1	n2 0	n4 1
indeed.com/jobs/unix-admin	41103	n1	n2 1	n1 1	n4 1
glassdoor.com/hires/software-developer	35114	n1	n1 0	n3 1	n3 0
data movement		0%	50%	50%	60%

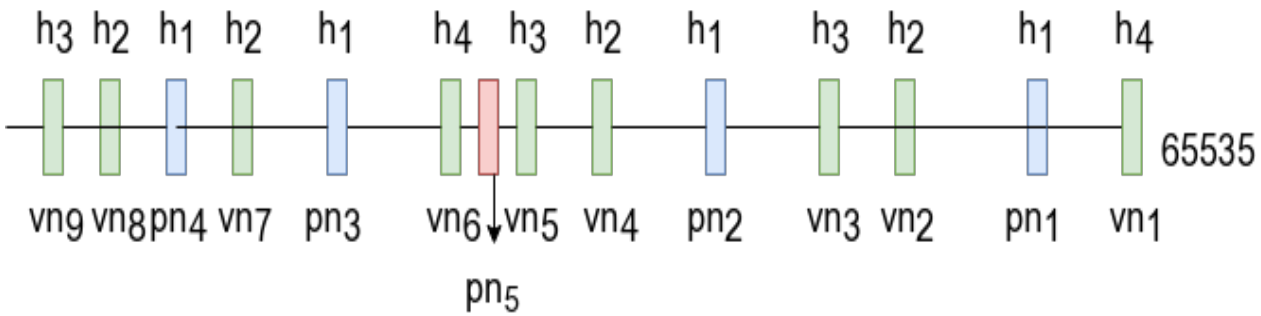
Rebalancing: virtual nodes



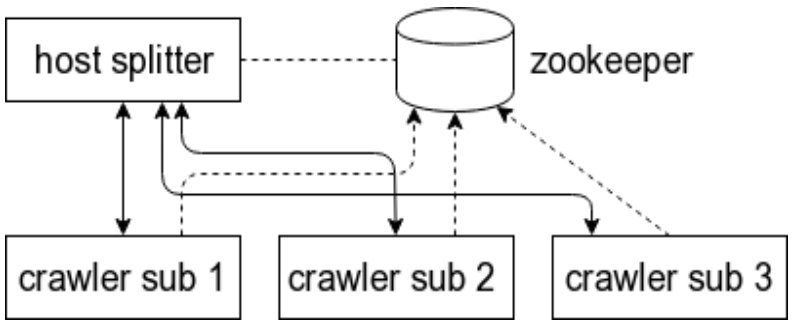
Rebalancing: virtual nodes



Rebalancing: virtual nodes



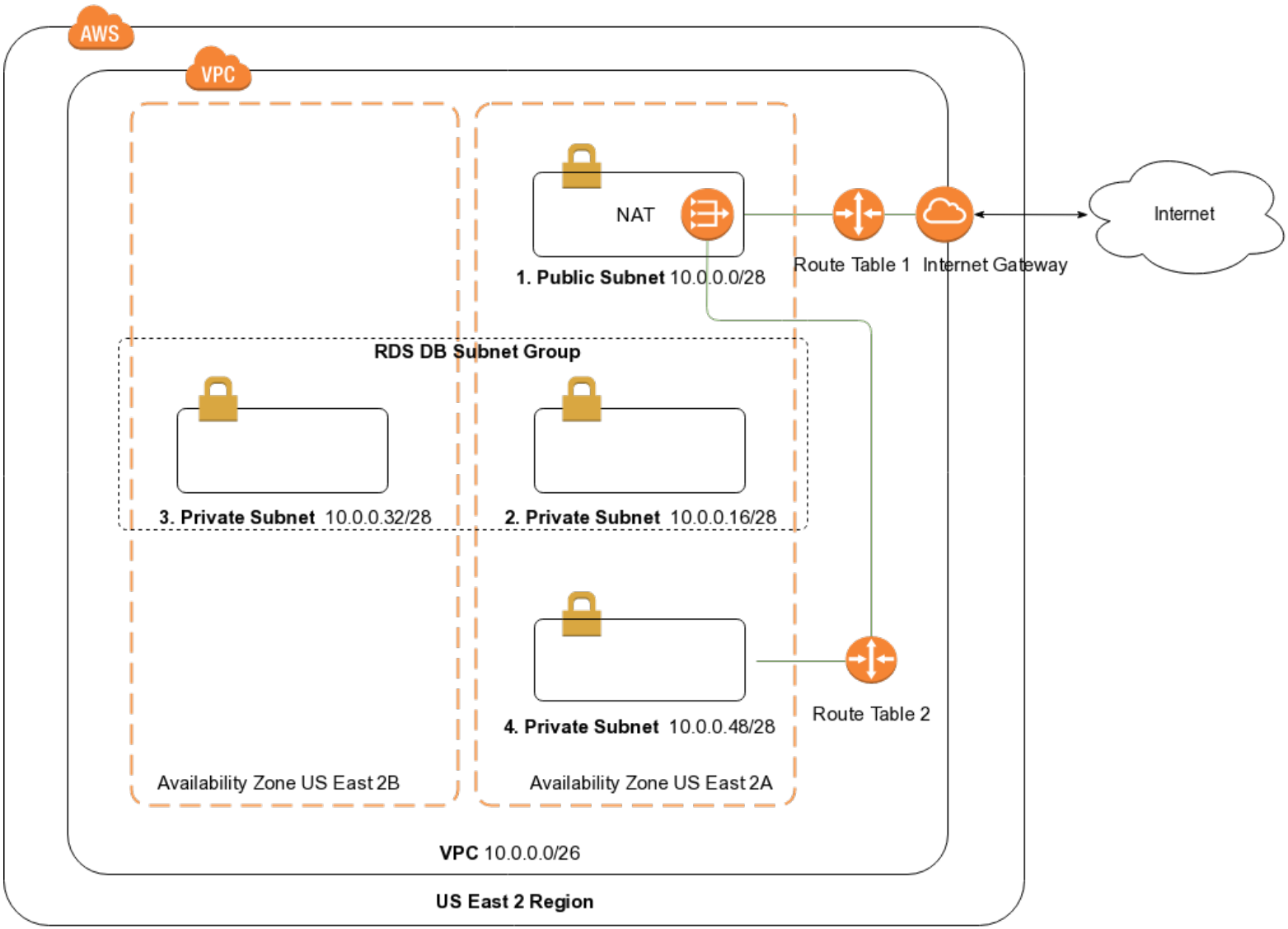
Zookeeper



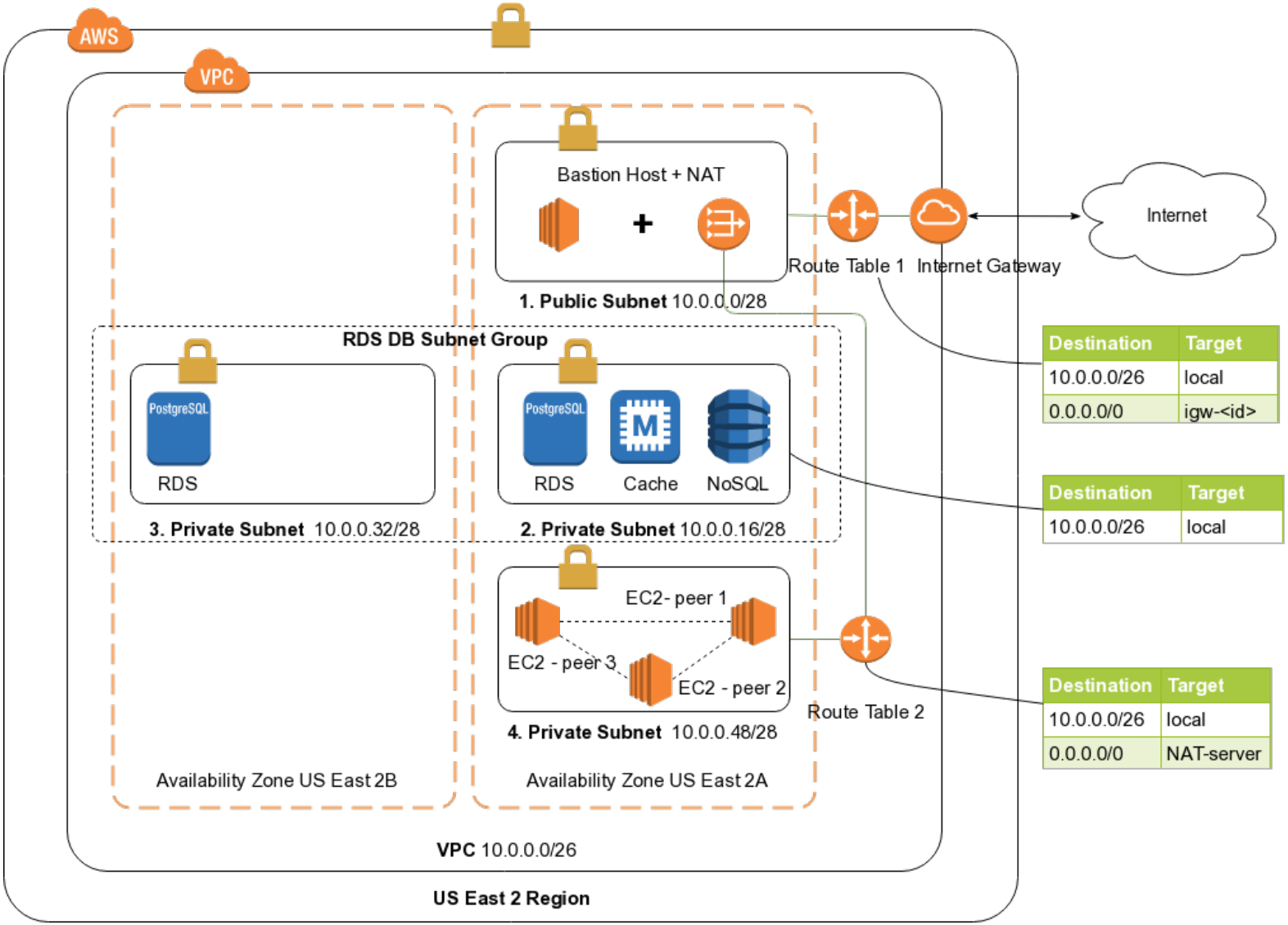
hash range	vnode(vni)	pnode(pni)	IP
0 – 3k	vn9	pn4	10.0.0.4
3k – 6k	vn8	pn4	10.0.0.4
6k – 10k	vn7	pn3	10.0.0.3
10k – 15k	vn6	pn2	10.0.0.2
15k – 20k	vn5	pn2	10.0.0.2
20k – 35k	vn4	pn2	10.0.0.2
35k – 45k	vn3	pn1	10.0.0.1
45k – 55k	vn2	pn1	10.0.0.1
55k – 65k	vn1	pn4	10.0.0.4

Whirlpool: Operations

From 10,000 ft.



From 5,000 ft.


AWS
VPC
Bastion Host + NAT
1. Public Subnet 10.0.0.0/28
Route Table 1
Internet Gateway
Internet
RDS DB Subnet Group
PostgreSQL
RDS
3. Private Subnet 10.0.0.32/28
PostgreSQL
RDS
Cache
NoSQL
2. Private Subnet 10.0.0.16/28
EC2- peer 1
EC2 - peer 3
EC2 - peer 2
4. Private Subnet 10.0.0.48/28
Route Table 2
Availability Zone US East 2B
Availability Zone US East 2A
VPC 10.0.0.0/26
US East 2 Region
Destination Target
10.0.0.0/26 local
0.0.0.0/0 igw-<id>
Destination Target
10.0.0.0/26 local
Destination Target
10.0.0.0/26 local
0.0.0.0/0 NAT-server

Infrastructure as a code

Recap

- Microservices
- Load balancing
- Decoupling
- Extensible
- Distributed Systems(Partitioning)
- Logging & metrics calculation
- Fault tolerance
- Resiliency

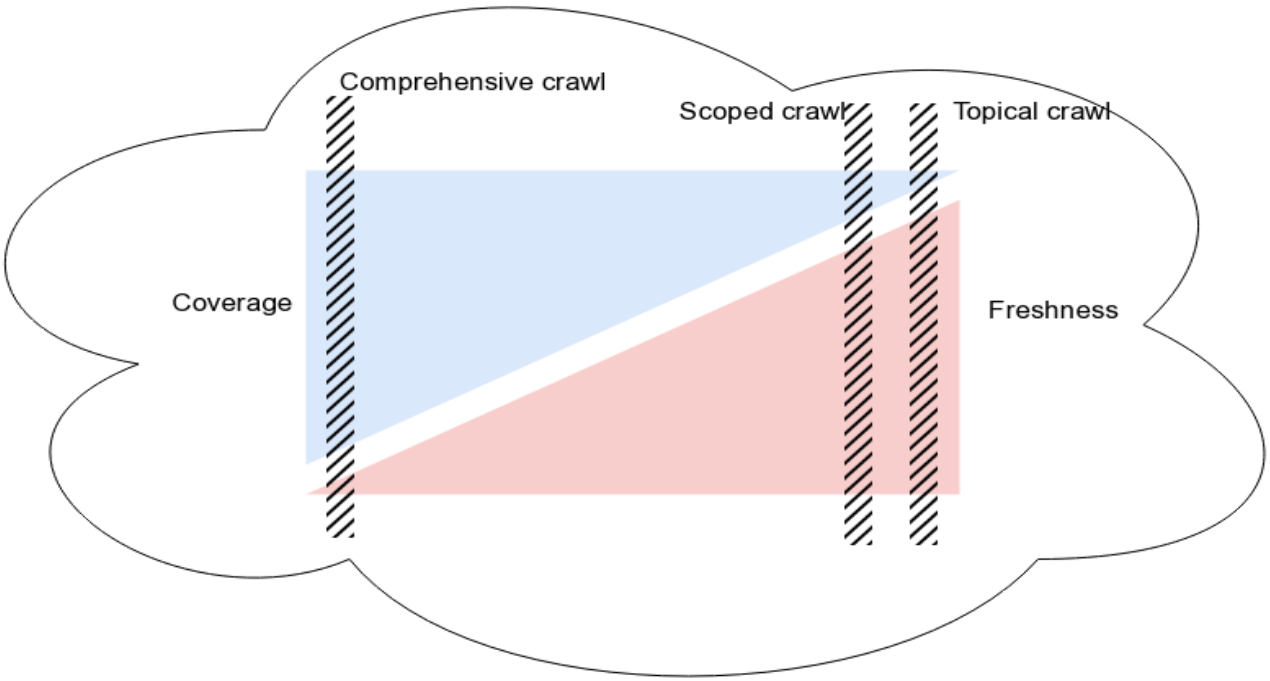
Future work

future work

Indexing crawled data & logs using Elasticsearch

future work

Adding comprehensive coverage



future work

Content Extraction

future work

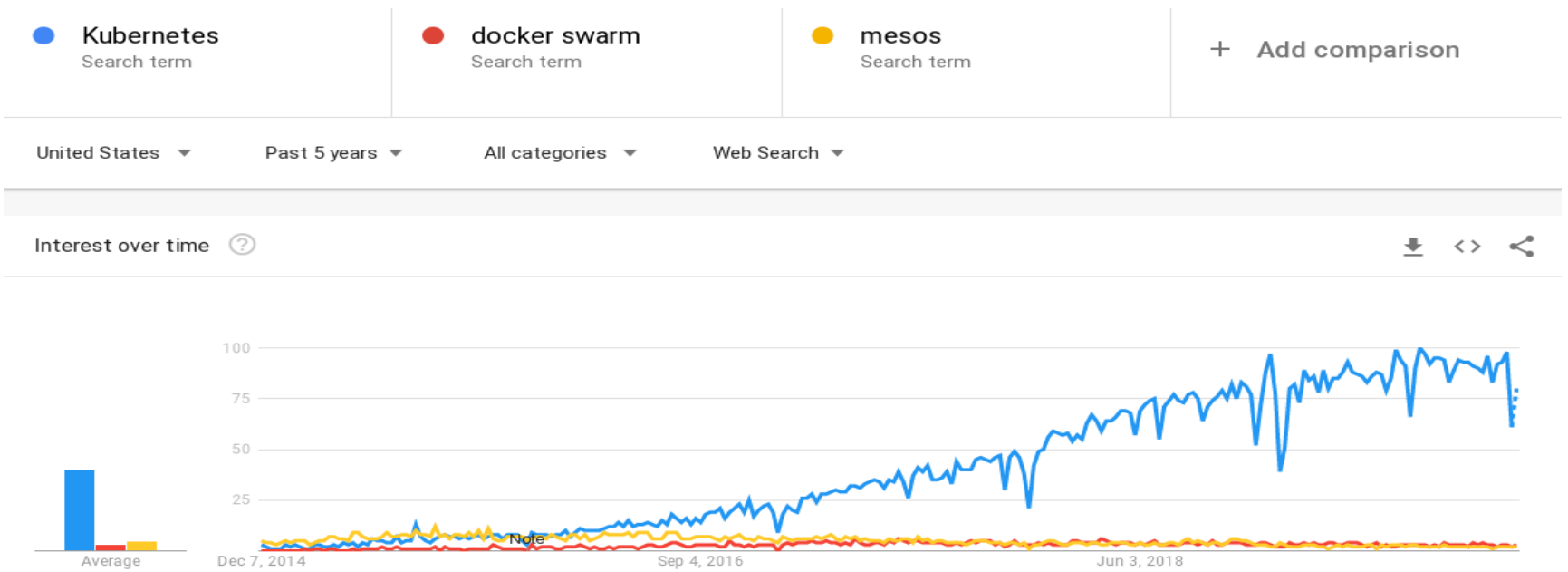
Categorizing Jobs using ML algorithm

future work

SeenTest: Inserting and Querying Simhashes using LSH

future work

Deploying whirlpool using kubernetes



Thank you! Questions ?