Customer Behaviour Analytics: Billions of Events to one Customer-Product Graph

Budapest BI Forum, 6th November 2013

Presented by Paul Lam

About Paul Lam

Joined uSwitch.com as first Data Scientist in 2010

- developed internal data products
- built distributed data architecture
- team of 3 with a developer and a statistician

Code contributor to various open source tools

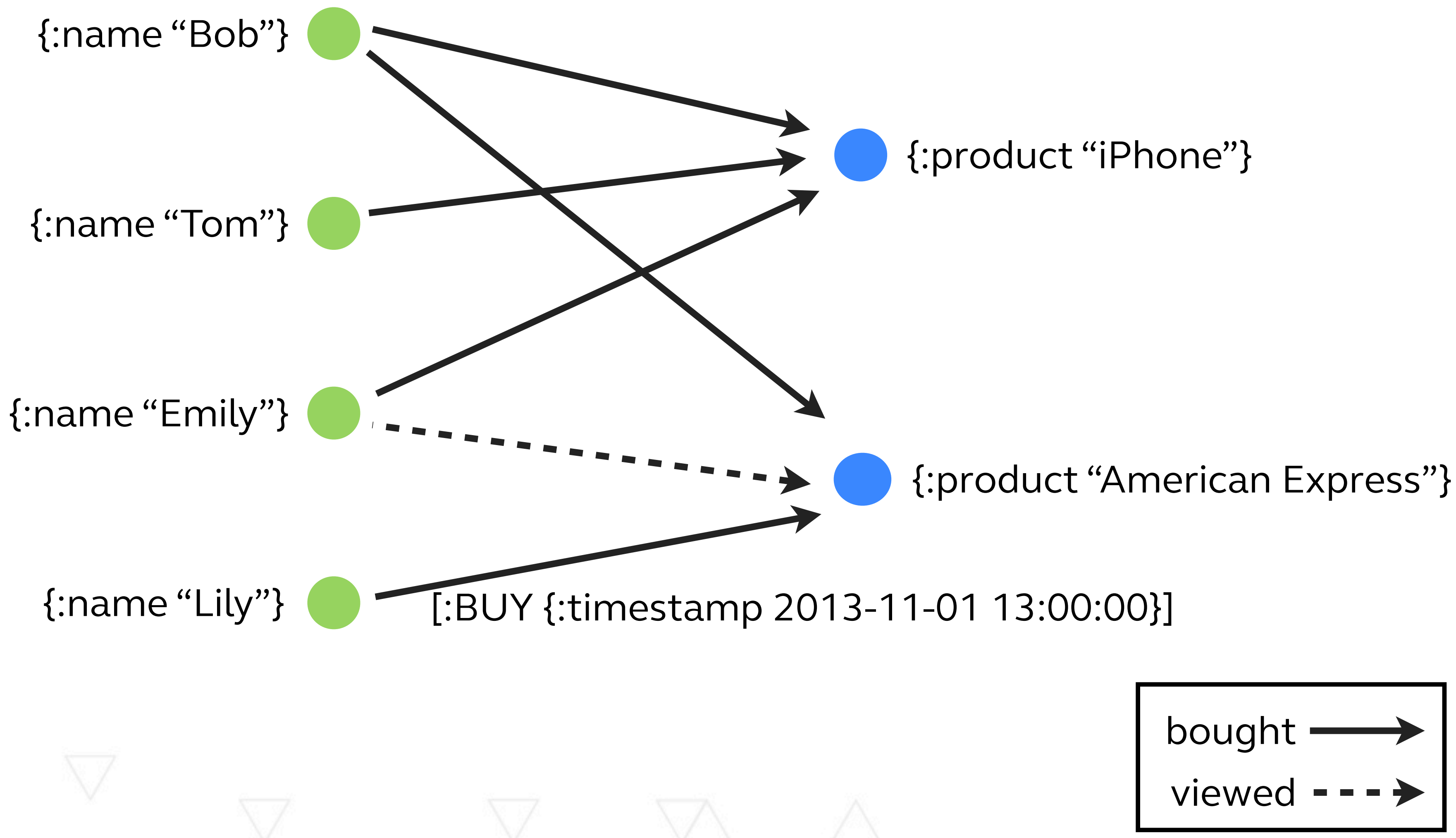
- Cascalog, a big data processing library built on top of Cascading (comparable to Apache Pig)
- Incanter, a statistical computing platform in Clojure

Author of *Web Usage Mining: Data Mining Visitor Patterns From Web Server Logs** to be published in late 2014

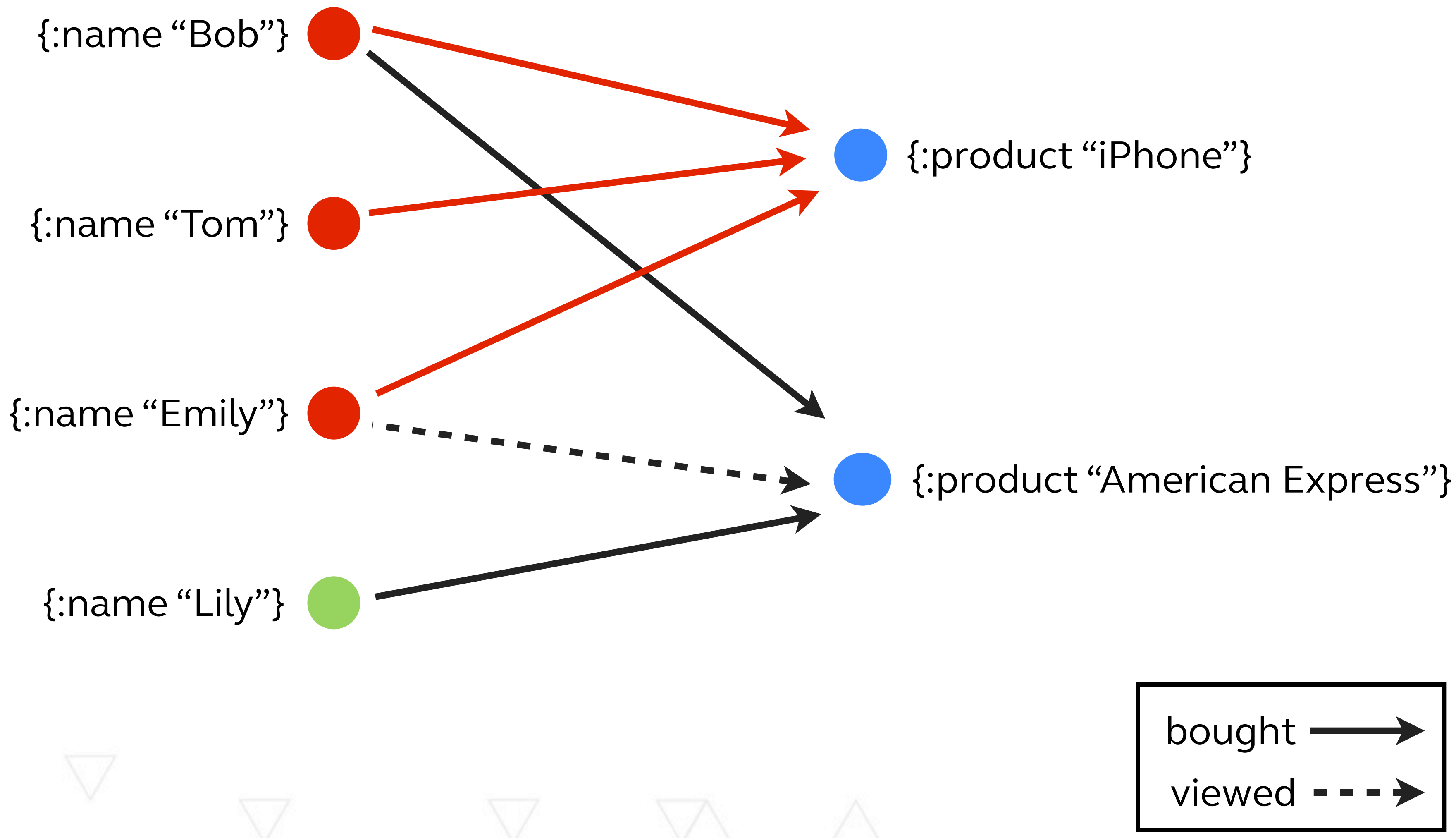
* tentative title

What is it

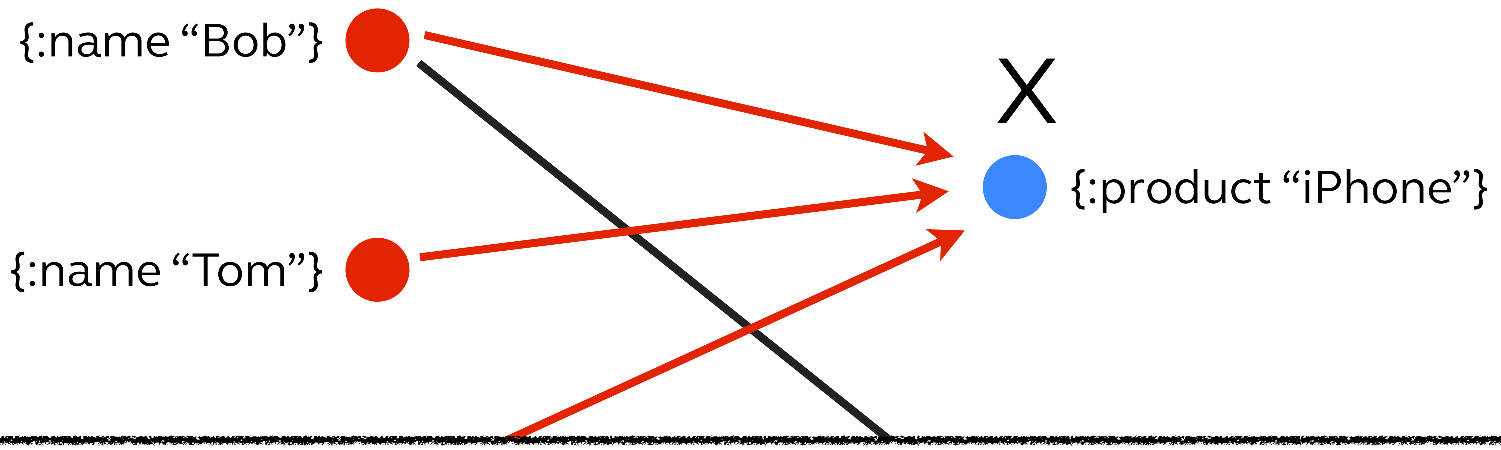
Customer-Product Graph



Question: Who bought an iPhone?

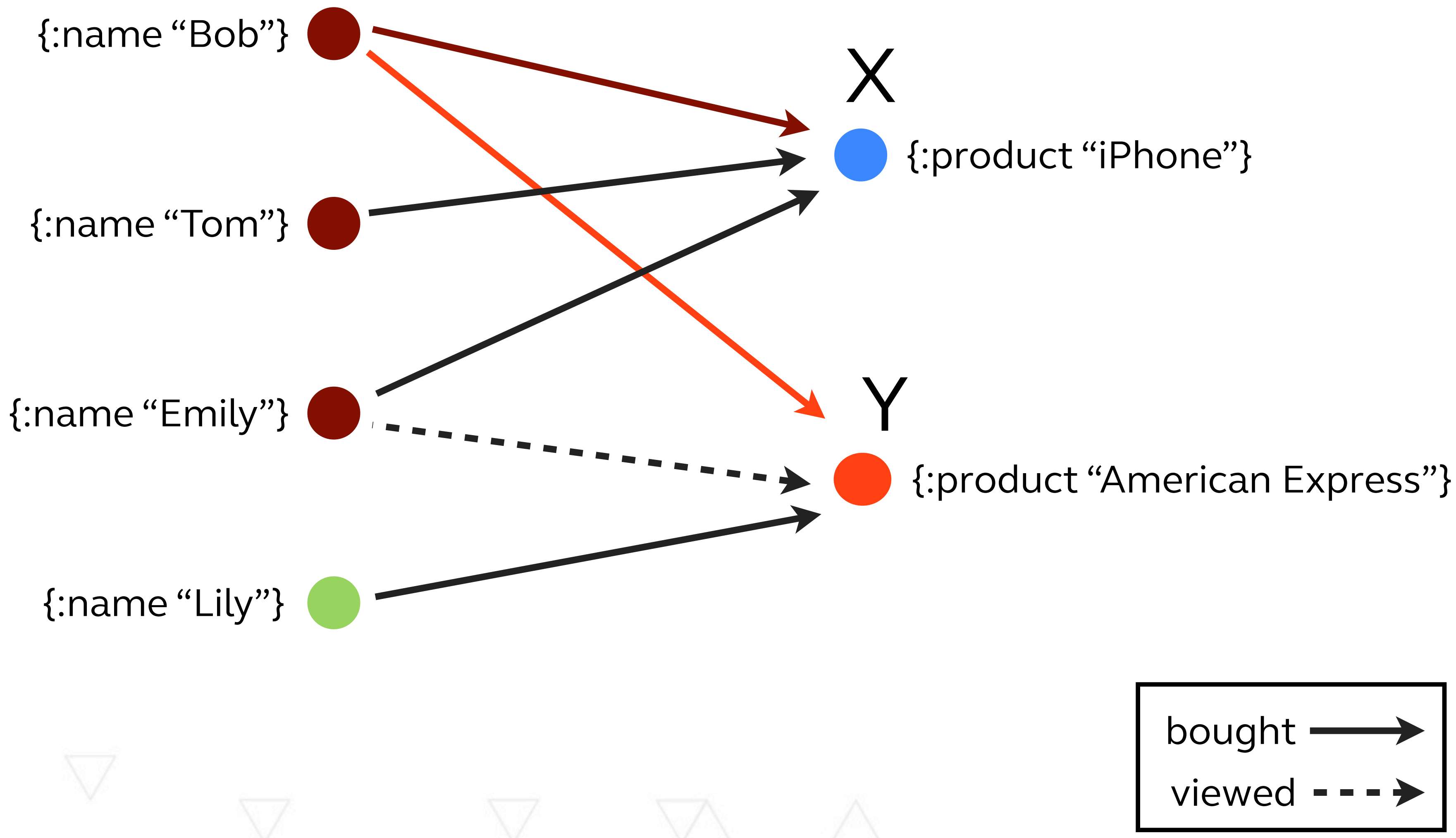


Query: Who bought an iPhone?

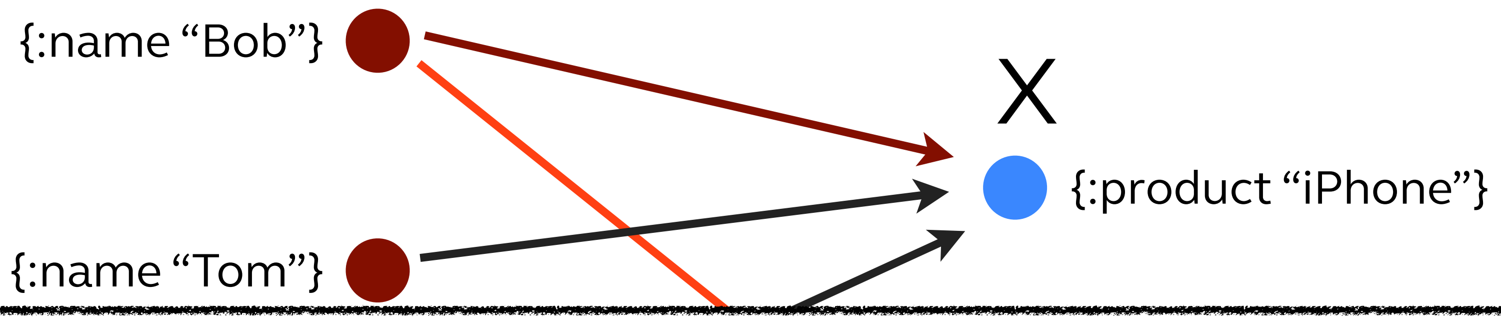


```
START
x=node:node_auto_index(product='iPhone')

MATCH (person)-[:BUY]->(x)


RETURN person
```

Question: What else did they buy?

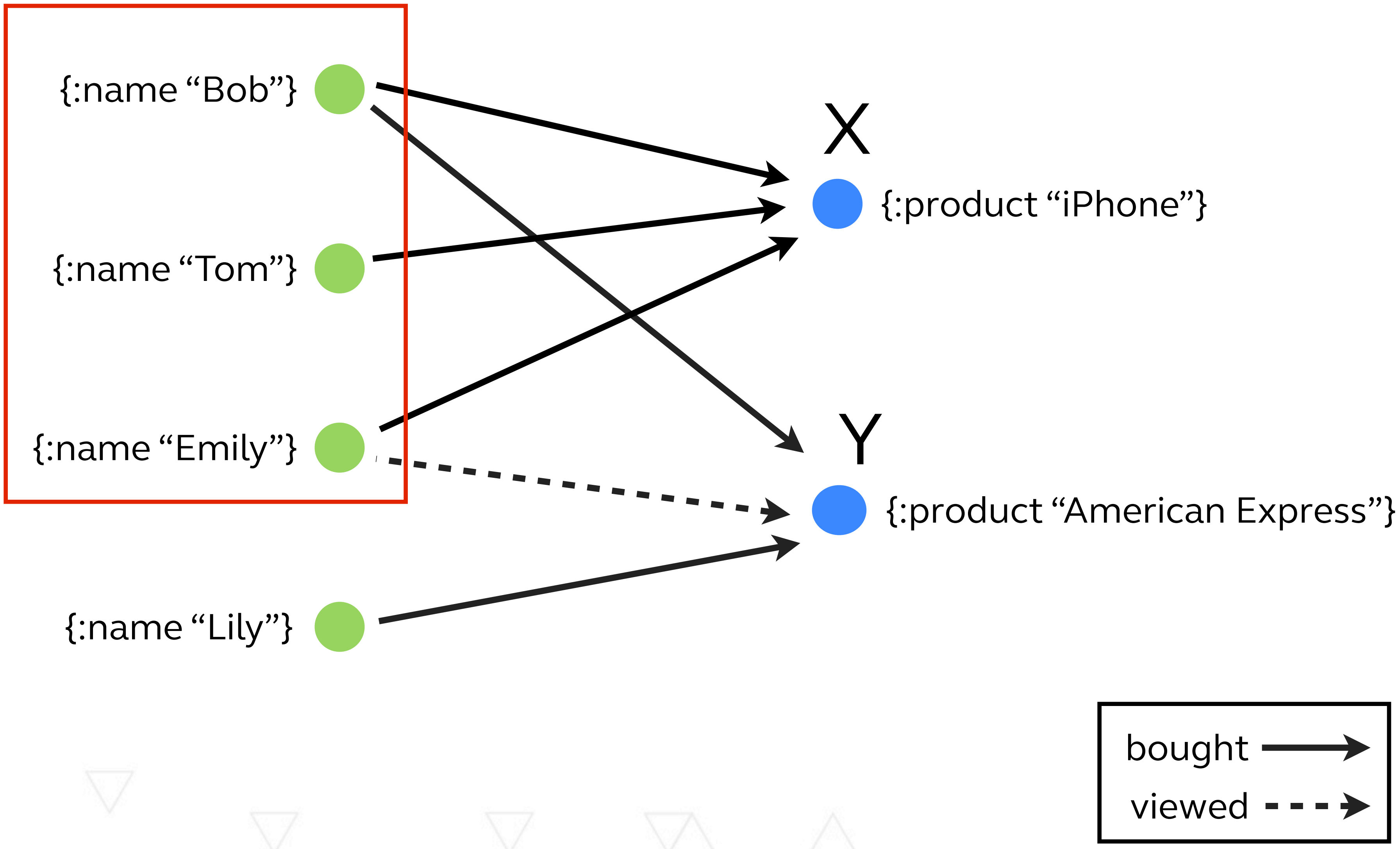


Query: What else did they buy?

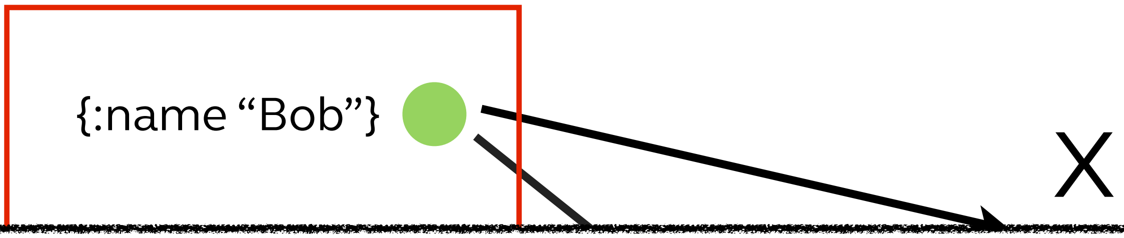


```
START x=node:node_auto_index(product='iPhone')

MATCH
   (x)<-[:BUY]-(person)-[:BUY]->(y)

RETURN y
```

Hypothesis: People that buy X has interest in Y



Query: Who to recommend Y



```
START
x=node:node_auto_index(product='iPhone'),
y=node:node_auto_index(product='American
Express')

MATCH (p)-[:BUY]->(x),
      (p)-[:VIEW]->(y)
WHERE NOT (p)-[:BUY]->(y)

RETURN p
```

Looked at AE

Haven't bought AE

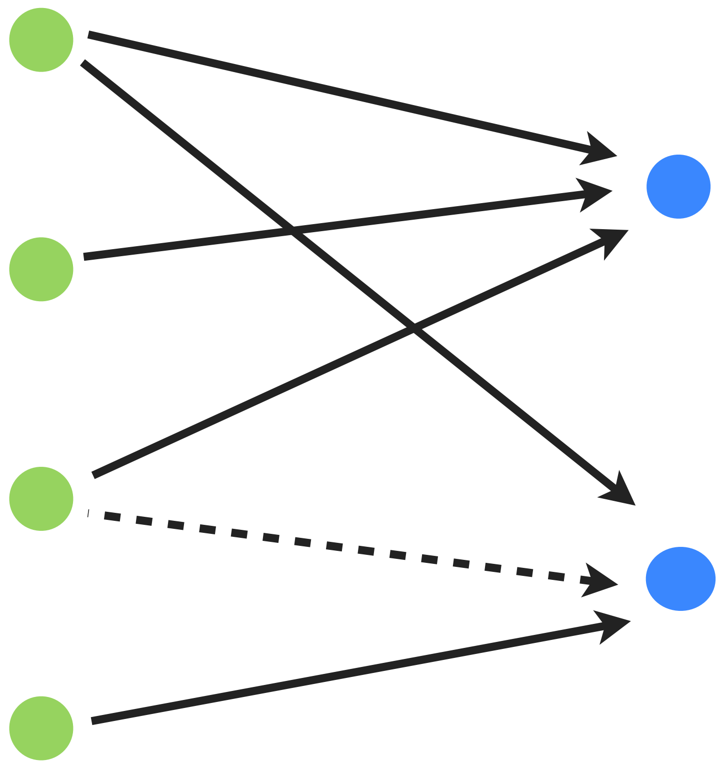
Product Recommendation by Reasoning Example

Interactive demo at http://bit.ly/customer_graph

1. Start with an idea
2. Trace to connected nodes
3. Identify patterns from viewpoint of those nodes
4. Repeat from #1 until discovering actionable item
5. Apply pattern

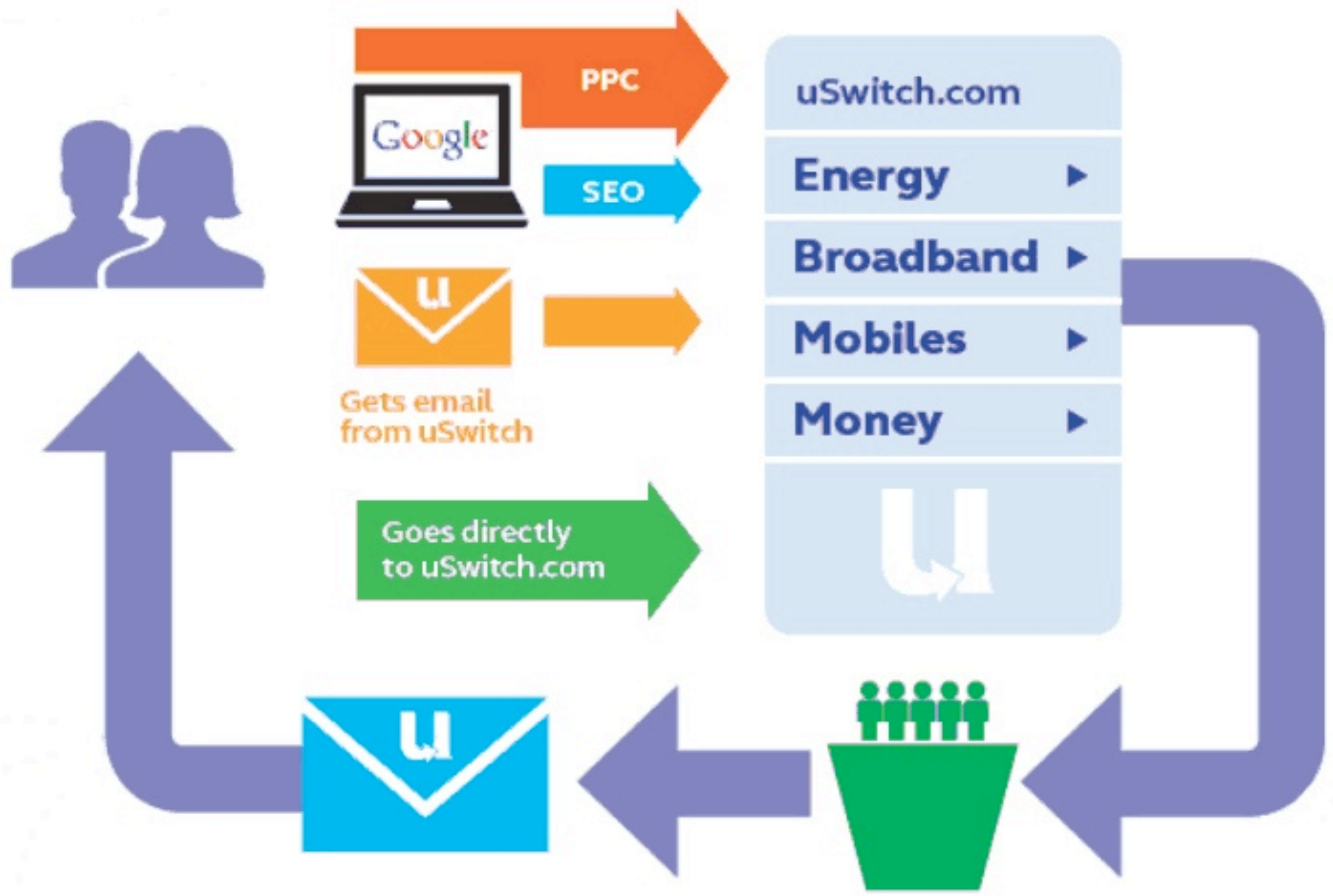
Challenge: Event Data to Graph Data

User ID	Product ID	Action
Bob	iPhone	Bought
Tom	iPhone	Bought
Emily	iPhone	Bought
Bob	AE	Bought
Emily	AE	Viewed
Lily	AE	Bought

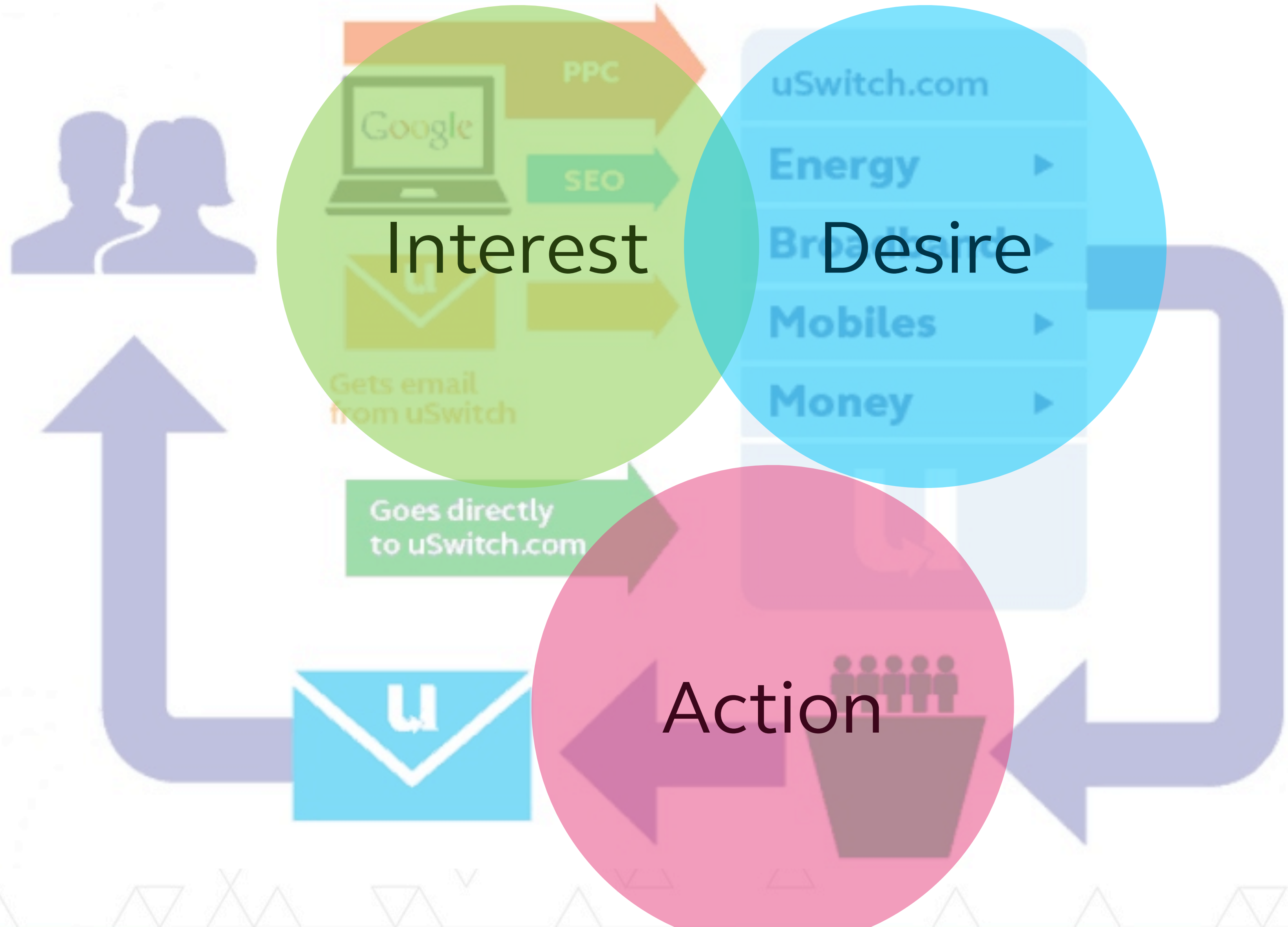


Why should you care

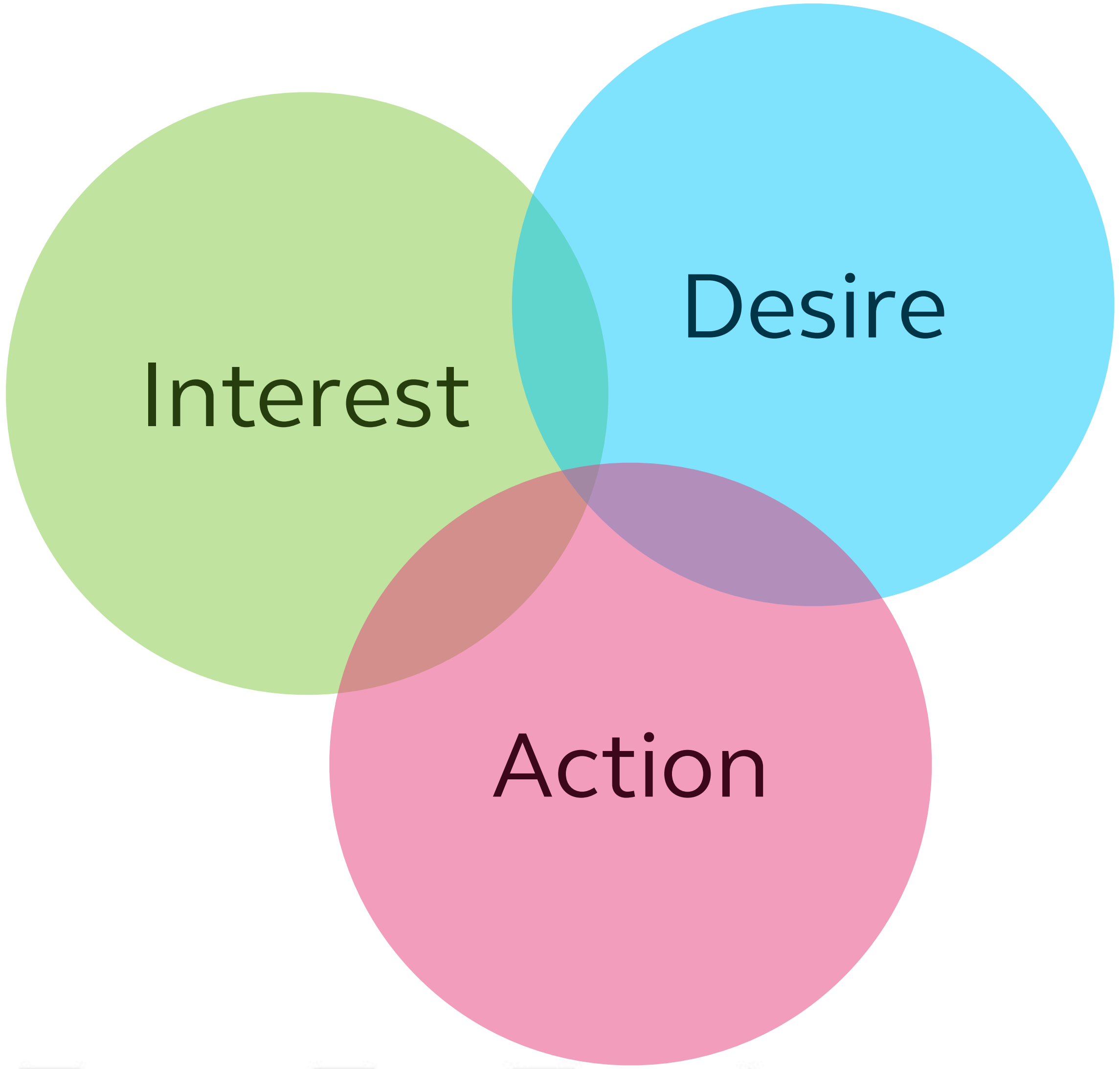
Customer Journey



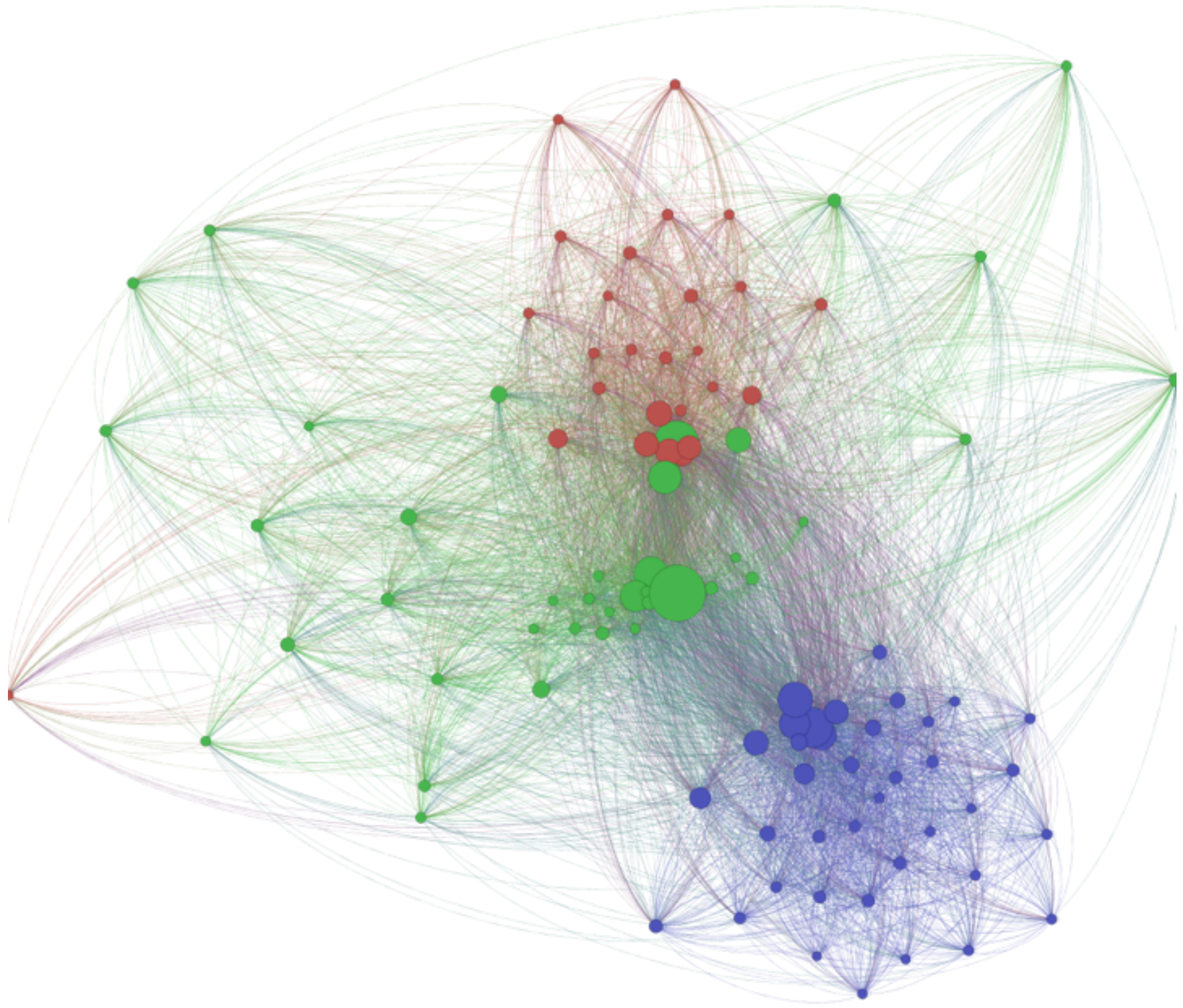
Customer Journey



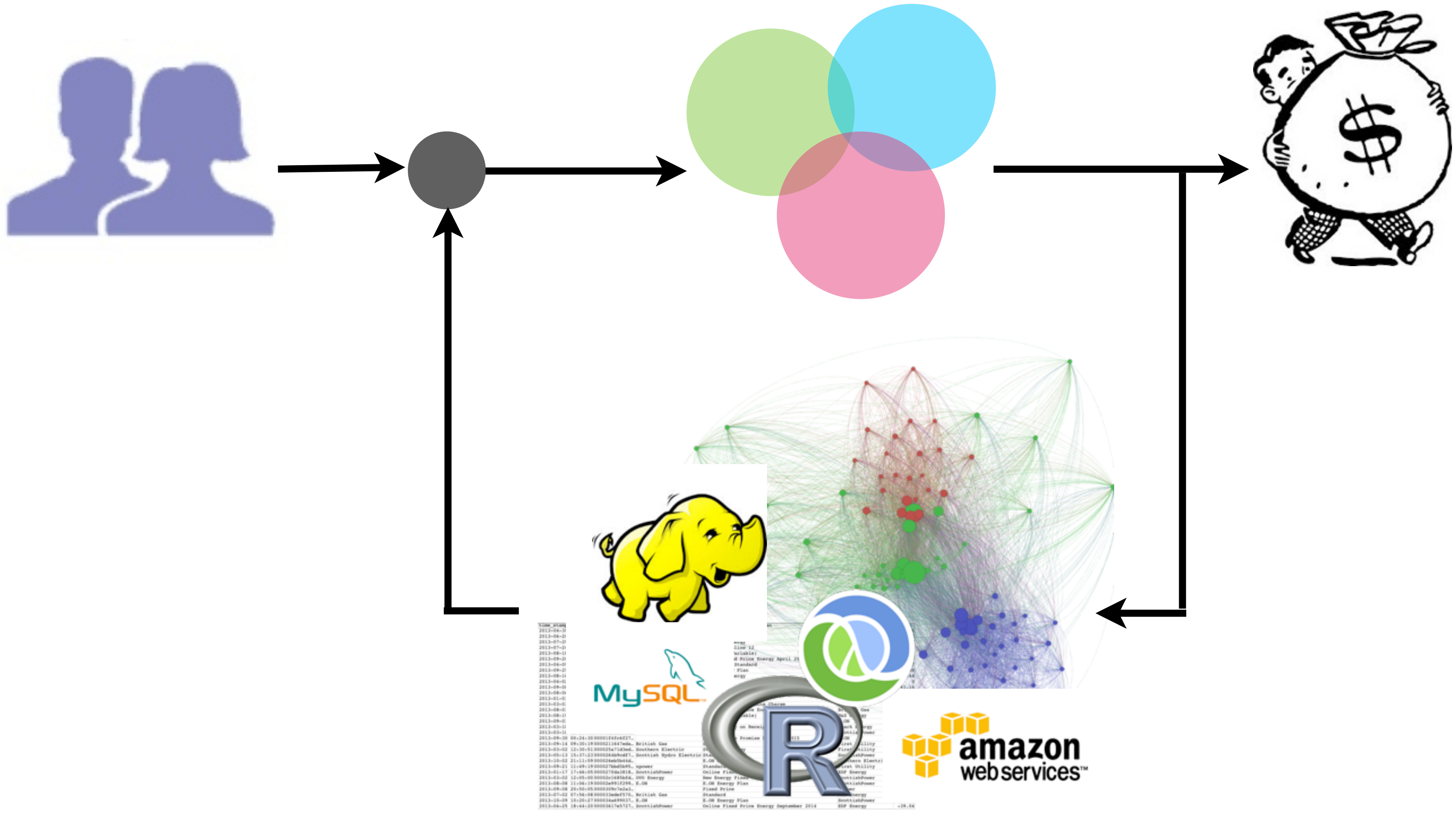
Understanding Stages of Customer



Customer Experience as a Graph



A Feedback System



Minimise effort between Q & A

$$\begin{tikzcd}
& \text{Question} \arrow[dr] & \\
\text{Answer} \arrow[ur] & & \text{Data Interrogation} \arrow[ll]
\end{tikzcd}$$

One Approach: Make data querying easier

Query = Function(Data) [1]

~ Function(Data Structure)

[1] Figure 1.3 from *Big Data* (preview v11) by Nathan Marz and James Warren

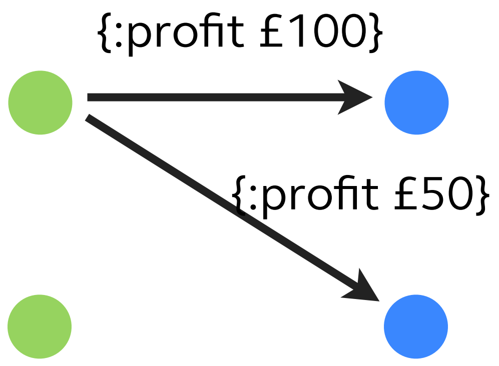
Data Structure: Relations versus Relations

aka Edges

Sale ID	User ID	Product ID	Profit
1	1	1	£100
2	1	2	£50

User ID	Name
1	Bob
2	Emily

Product ID	Name
1	iPhone
2	A.E.

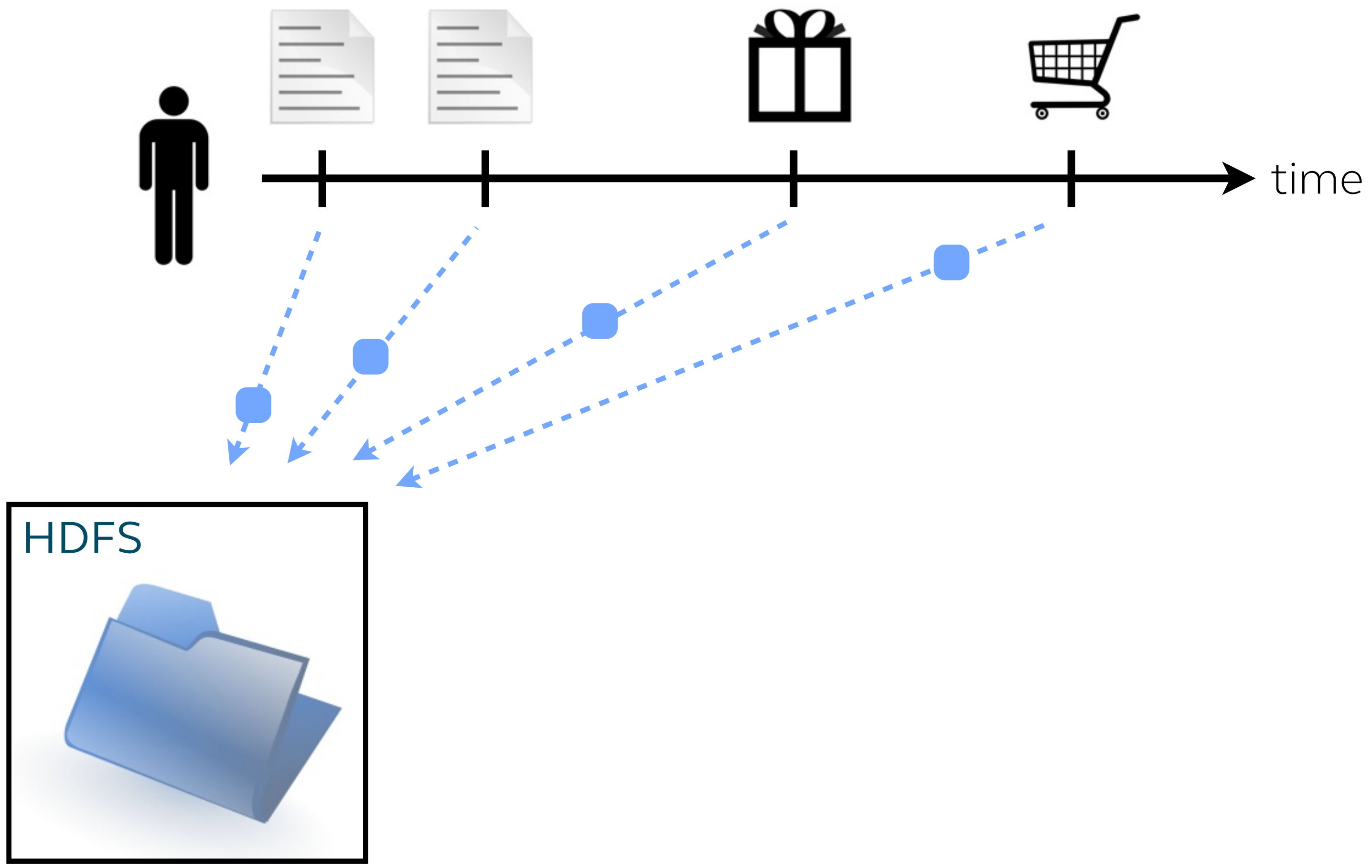


Using the right database for the right task

	RDBMS	Graph DB
Data	Attributes	Entities and relations
Model	Record-based	Associative
Relation	By-product of normalisation	First class citizen
Example use	Reporting	Reasoning

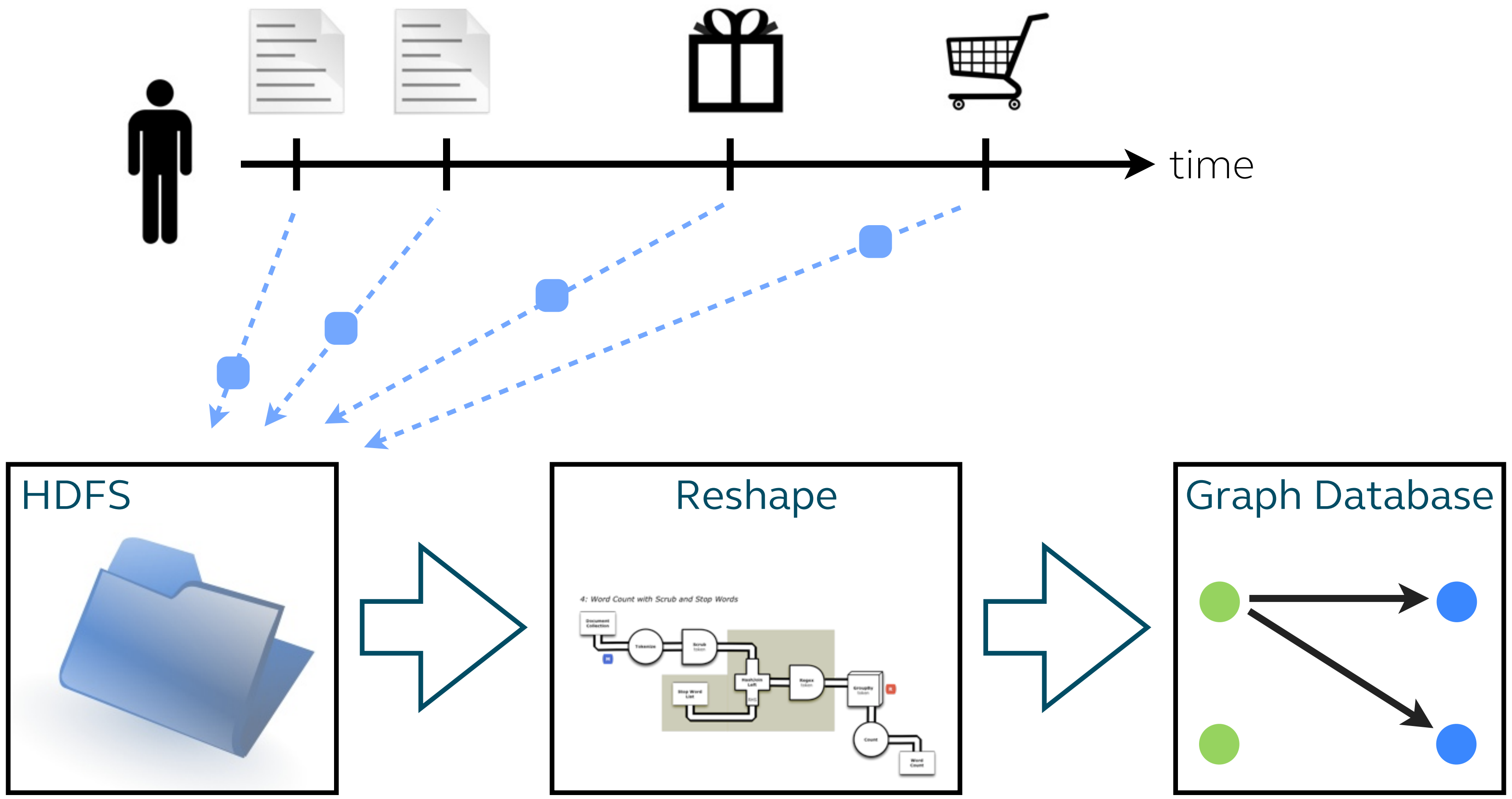
How does it work

User actions as time-stamped records

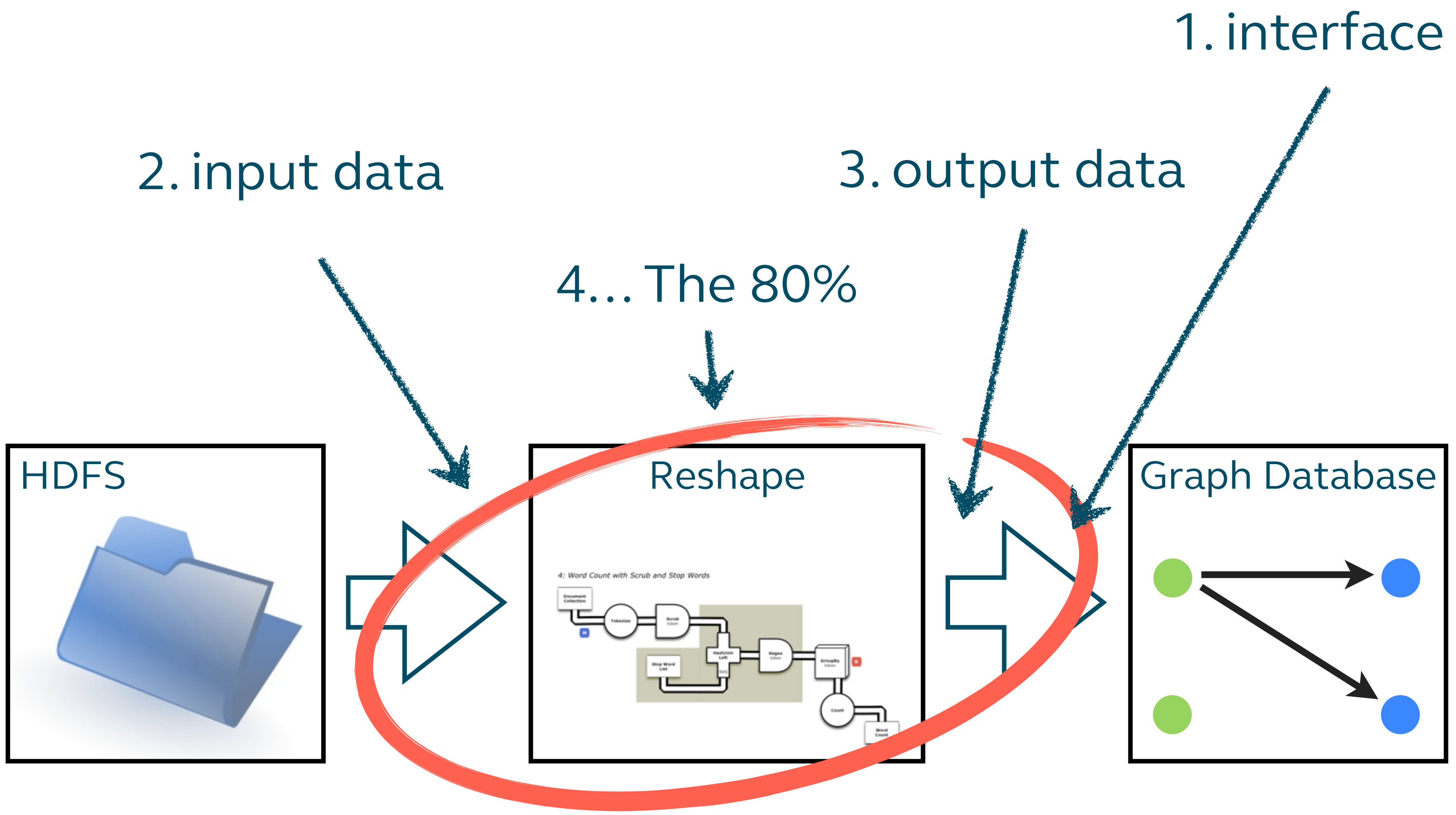


Paul Ingles, “User as Data”, Euroclojure 2012

Our User Event to Graph Data Pipeline



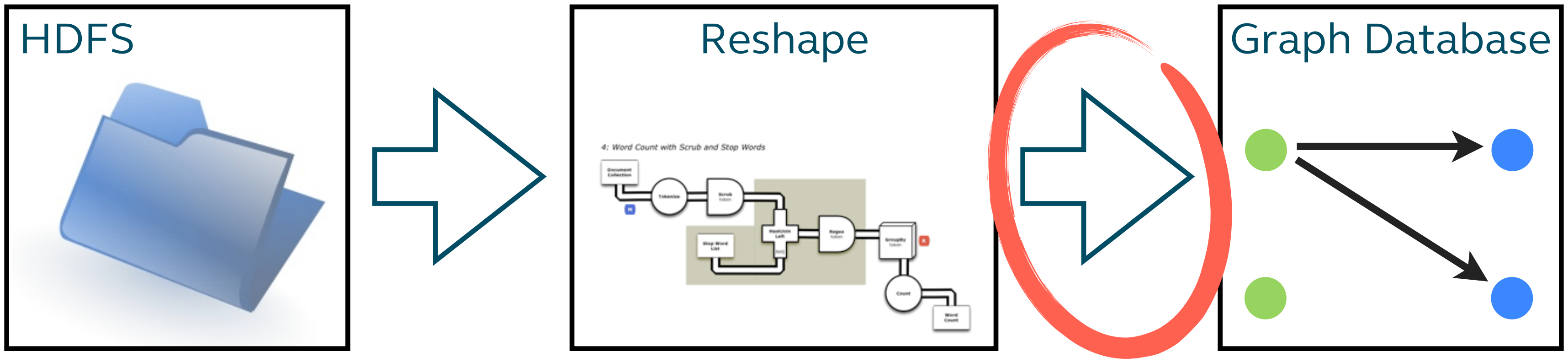
From Input to Output with Hadoop, aka ETL step



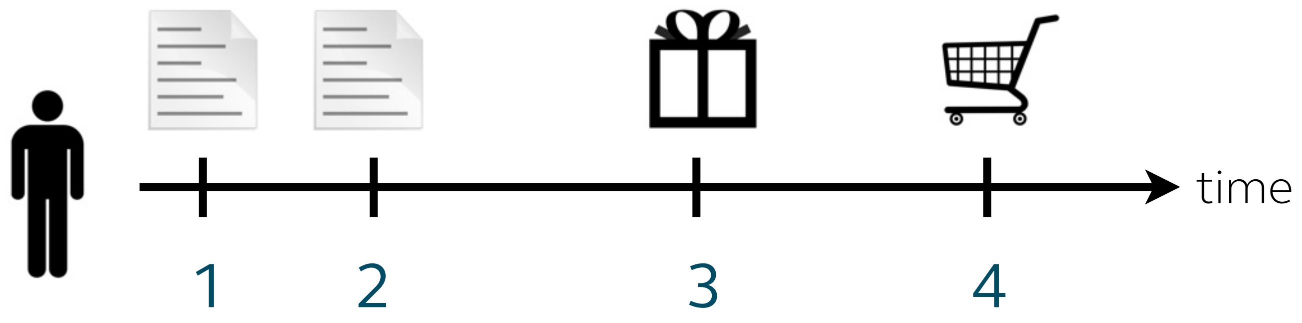
Hadoop interface to Neo4J

- Cascading-Neo4j tap [1]
- Faunus Hadoop binaries [2]
- CSV files*
- etc.

[1] http://github.com/pingles/cascading.neo4j
[2] http://thinkaurelius.github.io/faunus/



Input data stored on HDFS



	User	Timestamp	Viewed Page	Referrer
1	Paul	2013-11-01 13:00	/homepage/	google.com
2	Paul	2013-11-01 13:01	/blog/	/homepage/

	User	Timestamp	Viewed Product	Price	Referrer
3	Paul	2013-11-01 13:04	iPhone	£500	/blog/

	User	Timestamp	Purchased	Paid	Attrib.
4	Paul	2013-11-01 13:05	iPhone	£500	google.com

User	Landed	Referral	Email
Paul	2013-11-01 13:00	google.com	paul.lam@uswitch.com

Nodes and Edges CSVs to go into a property graph

Node ID	Properties
1	{:name "Paul", email: "paul.lam@uswitch.com"}
2	{:domain "google.com"}
3	{:page "/homepage/"}
…	…
5	{:product "iPhone"}

From	To	Type	Properties
1	2	:SOURCE	{:timestamp "2013-11-01 13:00"}
1	3	:VIEWED	{:timestamp "2013-11-01 13:00"}
…	…	…	…
1	5	:BOUGHT	{:timestamp "2013-11-01 13:05"}

Records to Graph in 3 Steps

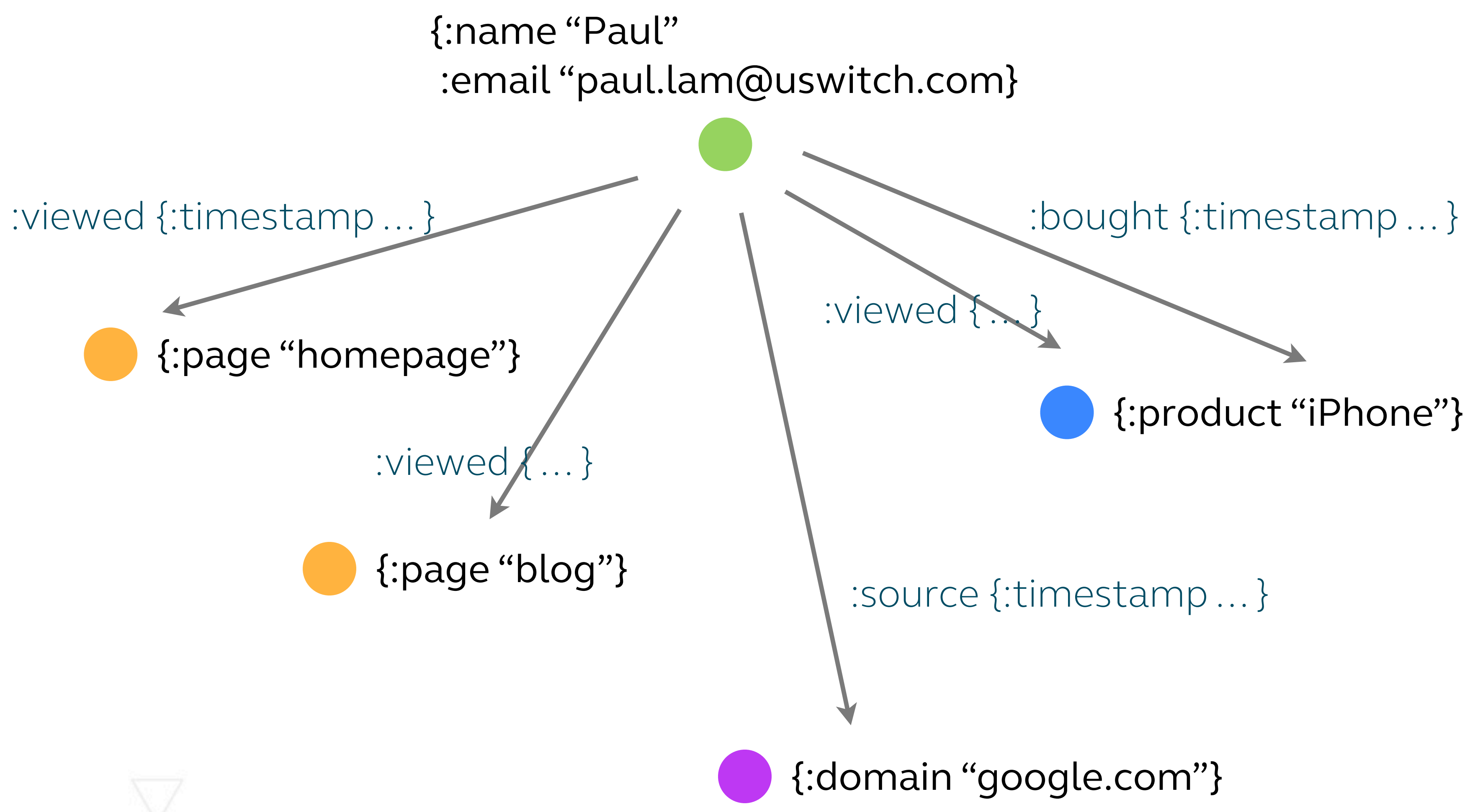
^ importable CSV

1. Design graph

2. Extract Nodes

3. Build Relations

Step 1: Designing your graph



Step 2: Extract list of entity nodes

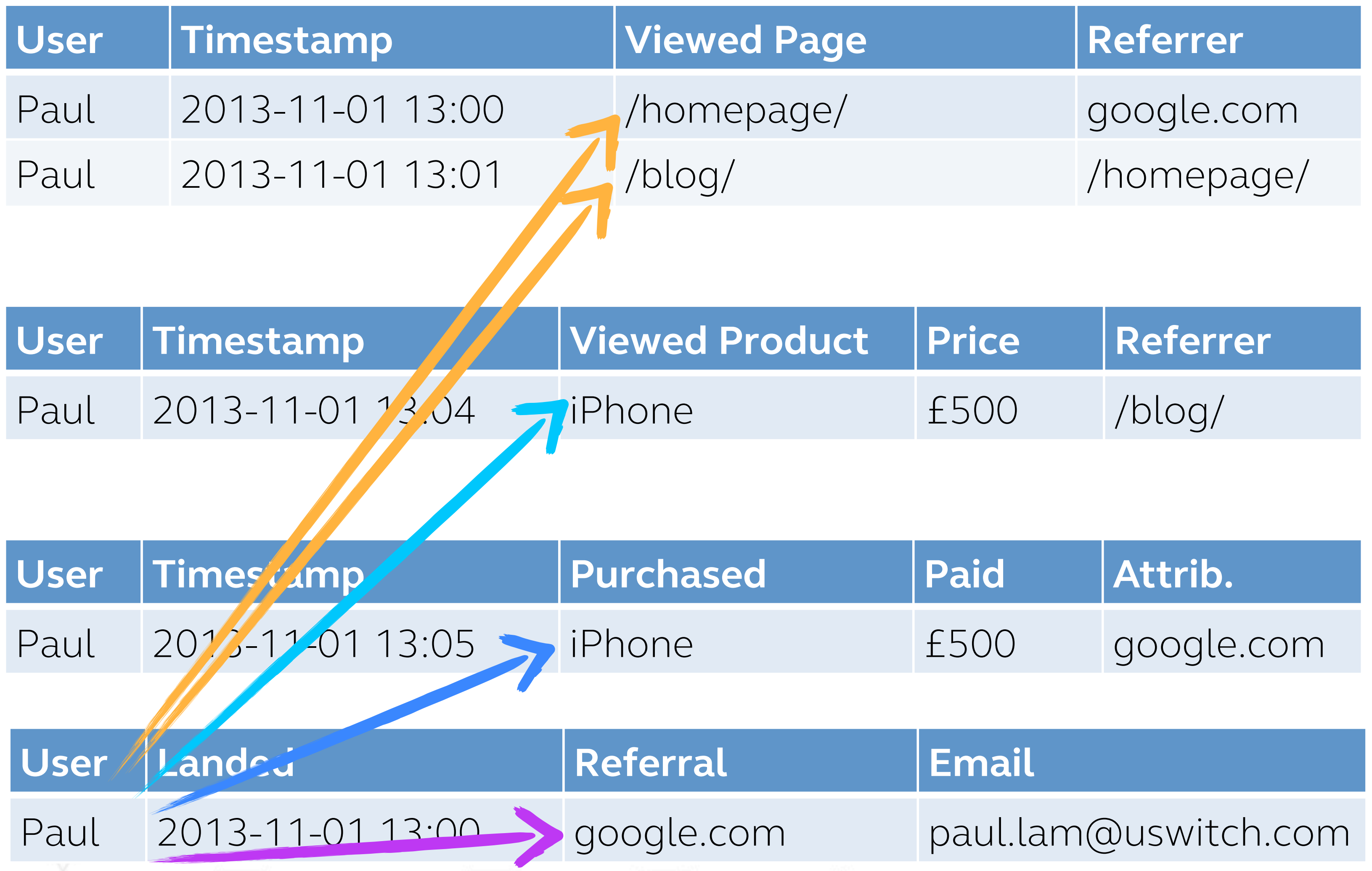
User	Timestamp	Viewed Page	Referrer
Paul	2013-11-01 13:00	/homepage/	google.com
Paul	2013-11-01 13:01	/blog/	/homepage/

User	Timestamp	Viewed Product	Price	Referrer
Paul	2013-11-01 13:04	iPhone	£500	/blog/

User	Timestamp	Purchased	Paid	Attrib.
Paul	2013-11-01 13:05	iPhone	£500	google.com

User	Landed	Referral	Email
Paul	2013-11-01 13:00	google.com	paul.lam@uswitch.com

Step 3: Building node-to-node relations



User	Timestamp	Viewed Page	Referrer
Paul	2013-11-01 13:00	/homepage/	google.com
Paul	2013-11-01 13:01	/blog/	/homepage/

User	Timestamp	Viewed Product	Price	Referrer
Paul	2013-11-01 13:04	iPhone	£500	/blog/

User	Timestamp	Purchased	Paid	Attrib.
Paul	2013-11-01 13:05	iPhone	£500	google.com

User	Landed	Referral	Email
Paul	2013-11-01 13:00	google.com	paul.lam@uswitch.com

Do this across all customers and products

Use your data processing tool of choice:

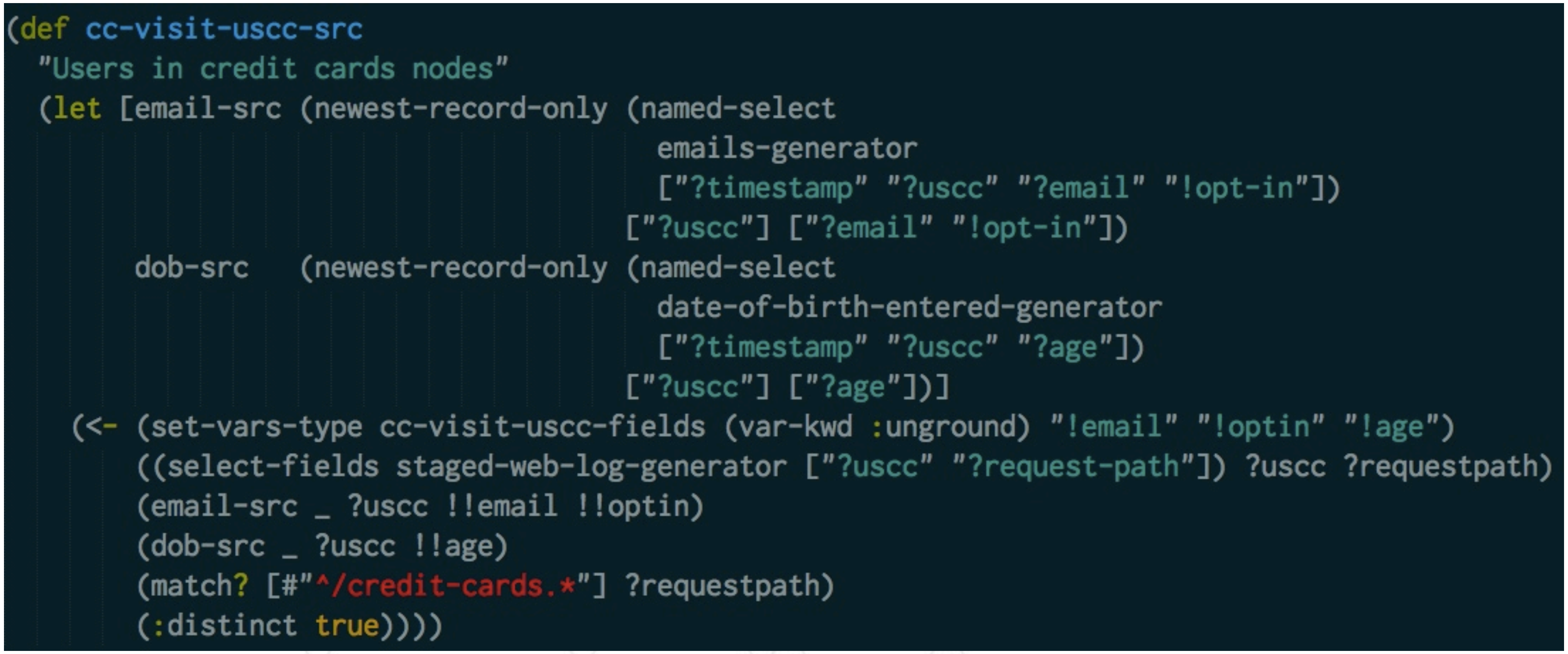
- Apache Hive
- Apache Pig
- Cascading
    - Scalding
    - Cascalog
- Spark
- your favourite programming language

and more …

Paco Nathan, "The Workflow Abstraction", Strata SC, 2013.

Cascalog code to build user nodes

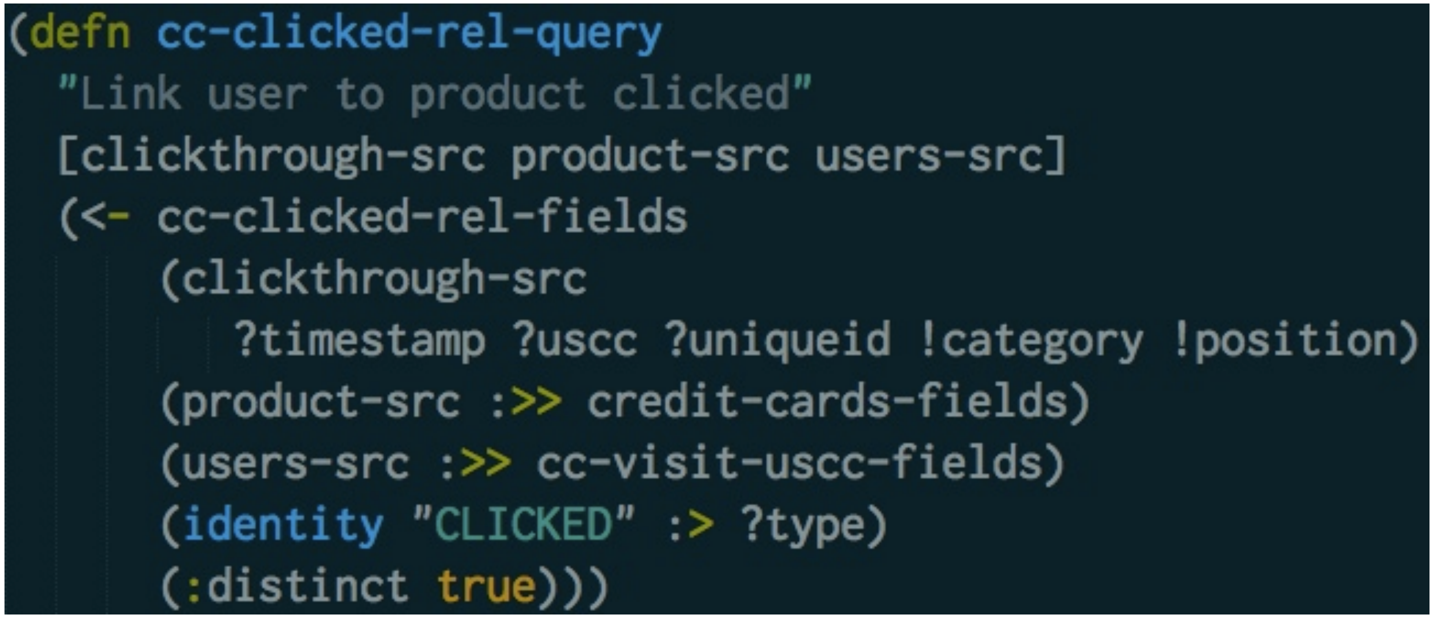
- 145 lines of Cascalog code in production
- a couple hundred lines more of utility functions
- build entity nodes and meta nodes
- sink data into database with Cascading-Neo4j Tap



```
(def cc-visit-uscc-src
  "Users in credit cards nodes"
  (let [email-src (newest-record-only (named-select
                                        emails-generator
                                        ["?timestamp" "?uscc" "?email" "!opt-in"])
                                      ["?uscc"] ["?email" "!opt-in"])
        dob-src   (newest-record-only (named-select
                                        date-of-birth-entered-generator
                                        ["?timestamp" "?uscc" "?age"])
                                      ["?uscc"] ["?age"])]
    (<- (set-vars-type cc-visit-uscc-fields (var-kwd :unground) "!email" "!optin" "!age")
        ((select-fields staged-web-log-generator ["?uscc" "?request-path"]) ?uscc ?requestpath)
        (email-src _ ?uscc !!email !!optin)
        (dob-src _ ?uscc !!age)
        (match? [#"^/credit-cards.*"] ?requestpath)
        (:distinct true))))
```

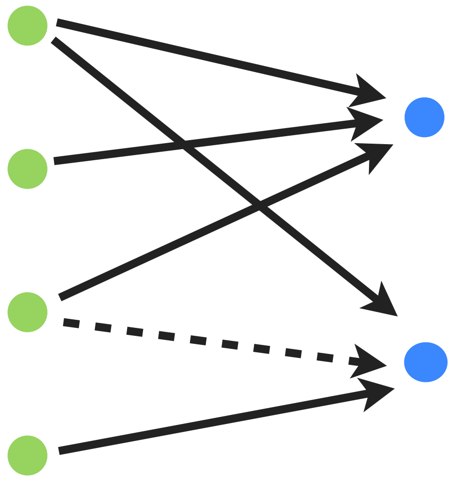
Code to build user to product click relations

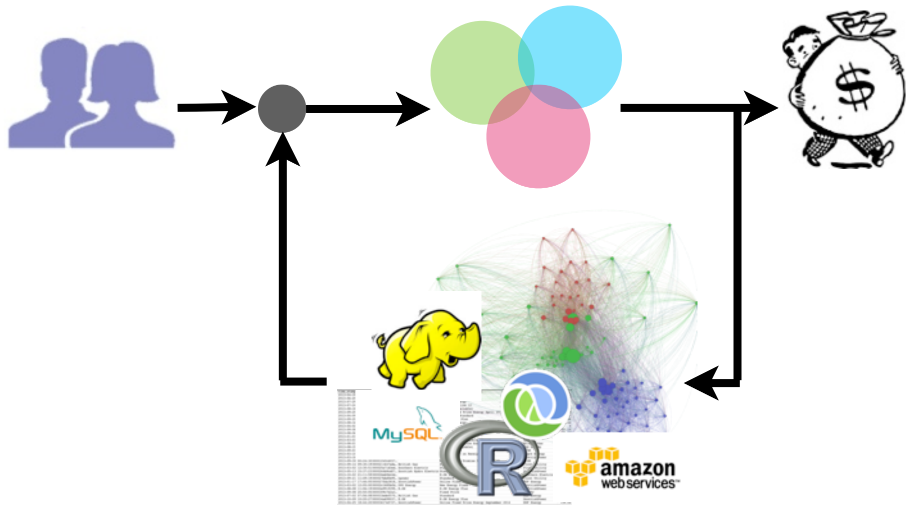
- 160 lines of Cascalog code in production
- + utility functions
- build direct and categoric relations
- sink data with Cascading-Neo4j Tap

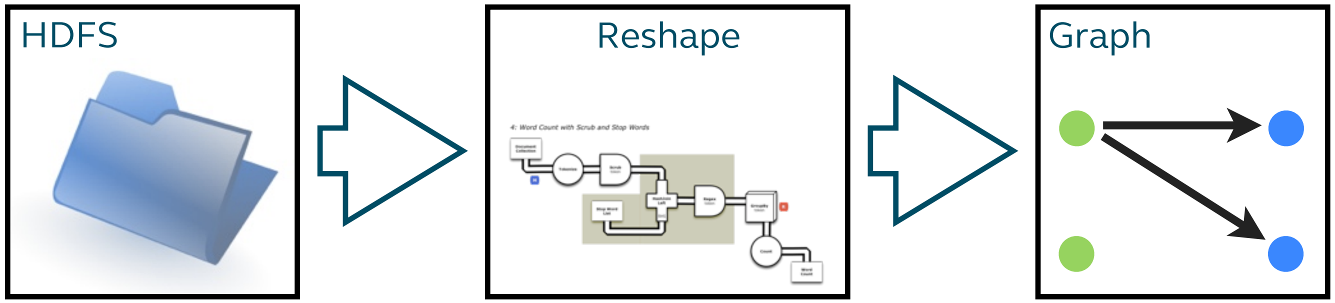


```
(defn cc-clicked-rel-query
  "Link user to product clicked"
  [clickthrough-src product-src users-src]
  (<- cc-clicked-rel-fields
      (clickthrough-src
        ?timestamp ?uscc ?uniqueid !category !position)
      (product-src :>> credit-cards-fields)
      (users-src :>> cc-visit-uscc-fields)
      (identity "CLICKED" :> ?type)
      (:distinct true)))
```

Summary







Contact

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