

BUILDING AND USING A KNOWLEDGE GRAPH TO COMBAT HUMAN TRAFFICKING

PEDRO SZEKELY

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INFORMATION SCIENCES INSTITUTE, UNIVERSITY OF SOUTHERN CALIFORNIA

COLUMBIA UNIVERSITY, INFERLINK, NEXT CENTURY, NASA JPL

LOOK BENEATH THE SURFACE

HUMAN TRAFFICKING IS
MODERN-DAY SLAVERY

A victim of trafficking may look like many of the people you see everyday.

Ask the right questions and look for clues. You are vital because you may be the only outsider with the opportunity to speak with a victim.

There are safe housing, health, immigration, food, income, employment, legal and interpretation services available to victims, but first they must be found.

If you think someone is a victim of trafficking, call **1.888.3737.888**

For more information about human trafficking visit www.acf.hhs.gov/trafficking.



LOOK
BELOW THE SURFACE
HUMAN TRAFFICKING IS
MODERN-DAY SLAVERY

PROFITS PER YEAR: \$32 BILLION

AVERAGE AGE OF ENTRY TO PROSTITUTION IN THE US: 14

PIMP'S PROFIT PER VICTIM PER YEAR: \$150,000

ADVERTISING BUDGET ON THE WEB: \$45 MILLION

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LOOK BELOW

TH
HUM
MODERN-DAY SLAVERY

Find the locations where a potential victim of human trafficking was advertised

A victim of trafficking may look like many of the people you see everyday.

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jessica blue eyes red hair swedish escort



Web

Videos

Images

Shopping

News

More ▾

Search tools

About 1,200,000 results (0.66 seconds)

[Jessica Sweden Independent San Diego Fiery Red Escort](#)

san-diego.date-check.com/Ashow-escort-pub.asp?ProID=js2101f ▾

Nice to meet you. My name is Jessica. I am from Sweden currently living in San Diego. I am 33 years old, fiery red hair and ocean blue eyes. Petite 130 pounds ...

[Highly reviewed Swedish redhead. Upscale incall. - San ...](#)

sandiego.backpage.com › ... › San Diego escorts ▾ Backpage ▾

Aug 6, 2013 - My name is Jessica. I am from Sweden currently living in San Diego. I am 34 years old, fiery red hair and ocean blue eyes. Petite 130 pounds ...

[Jessica Swedish GFE | San Diego Escort Massage Directory](#)

sandiego.sugarnights.com/escorts/jessica-swedish-gfe ▾

I am from Sweden, currently living in San Diego, 33 years old, fiery red hair and

San Diego, where else?

san-diego.south-coast.classivox.com/...escorts/-...jessica...sweden.../1192... ▾

May 14, 2012 - I have fiery red hair and ocean blue eyes, slim 120 lbs and 5'5 tall w perky D ... Hi , my name is Je - san diego female escorts ... xoxo Jessica.

Example: Find the locations where a potential victim of human trafficking was advertised

Highly reviewed Swedish Escort visiting Santa Barbara 16-18th April - 34

Posted: Saturday, April 19, 2014 8:23 AM

[Reply](#)

I am from Sweden. M.Sc. in engineering. Great reviews! Red hair and blue eyes. Perky D breasts and nice nipples.

I am visiting Santa Barbara 16-18th April.

Please check my website www.swedishpleasure.com

Incall
1 hour \$250.00

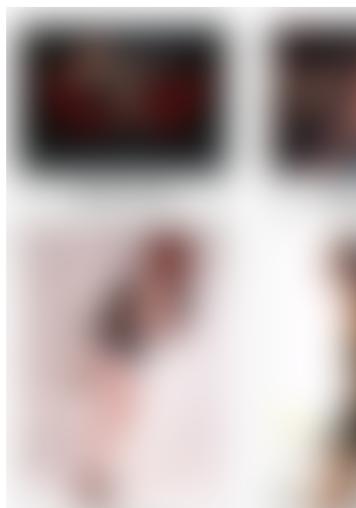
(Get \$50 off with proof of purchase of any item from www.redheadtoys.com My toys store has over 15 000 different items.)

Call or text me at:
1 619 319 7315

<http://www.adultsearch.com/classifieds/look?id=163535>

Poster's age: 34

- Location: Santa Barbara
- Post ID: 3948285 santabarbara



619-319-7315

in DC > Escorts • 619-319-7315 • 5184450

[**<< Previous Post**](#)

[**Next Post >>**](#)

Post ID: 5184450

619-319-7315 • Washington DC Female Escort

Highly reviewed Swedish provider visiting, Tysons Corner Washington DC 28th May-3rd June! - 34

[Share/Save](#) • [Send](#) • [Problems](#) • [Spam](#)
[MPReviews](#) • [TRAReview](#) • [TheEroticReview](#) • [BigDoggle](#) • [EPR](#)



Created: Monday, May 20th, 2013

Phone: **619-319-7315**

I am from Sweden. M.Sc. in engineering. Great reviews! Red hair and blue eyes. Perky D breasts and nice nipples.

Upscale incall with free parking.

Please check my website www.swedishpleasure.com

[Click for QR Code](#)

Incall

> 100 million pages advertising adult services

Highly reviewed Swedish Escort visiting Santa Barbara 16-18th April - 34

Posted: Saturday, April 19, 2014 8:23 AM

2014-12-07

Reply

I am from Sweden. [M.Sc.](#) in engineering. Great reviews! Red hair and blue eyes. Perky D breasts and nice nipples.

I am visiting Santa Barbara 16-18th April.

Please check my website www.swedishpleasure.com

Inca
Santa Barbara
1 hour \$250.00

(Get \$50 off with proof of purchase of any item from www.redheadtoys.com My toys store has over 15 000 different items.)

Call or text me at:
1 619 319 7315

<http://www.adz.com/classifieds/look?id=163535>

Poster's age: 34

• **619-319-7315**

• Post ID: 3948285 santabarbara



619-319-7315

on DC > Escorts > 619-319-7315 • 5184450

2014-05-28

<< Previous Post

2014-12-07

619-319-7315 - Washington DC Female Escort

Next Post >>

250/hour

Post ID: 5184450

Highly reviewed Swedish Provider visiting, Tysons Corner Washington DC
28th May-3rd June! -34

Share/Send
availableAt
MPReviews • TnAReview • TzeroticReview • BigDong • EPR

Santa Barbara
Collage

Offer-1

seller

250/hour
price

Person-1

phone

Created: Monday, May 20th, 2012

Phone: 619-319-7315

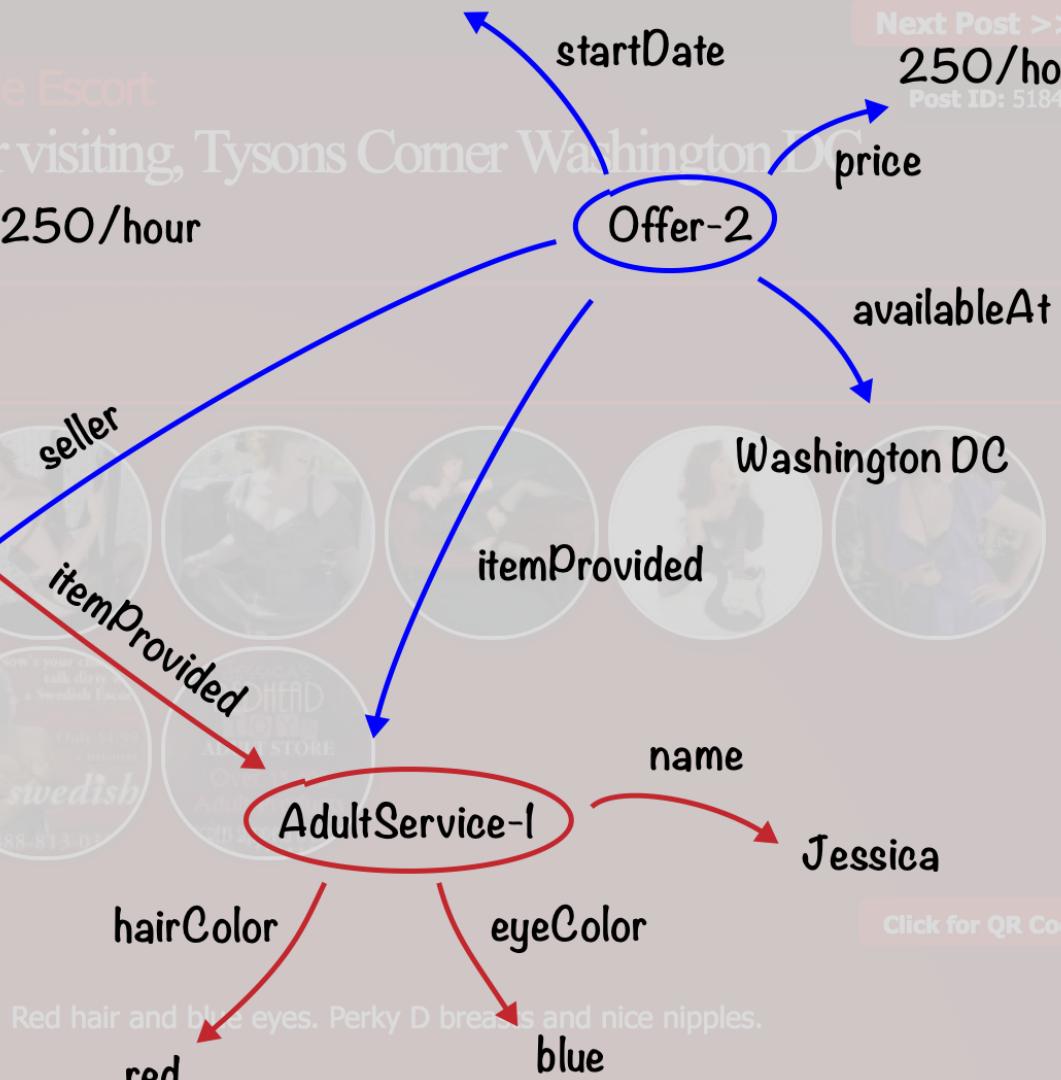
I am from Sweden. M.Sc. in engineering. Great reviews! Red hair and blue eyes. Perky D breasts and nice nipples.

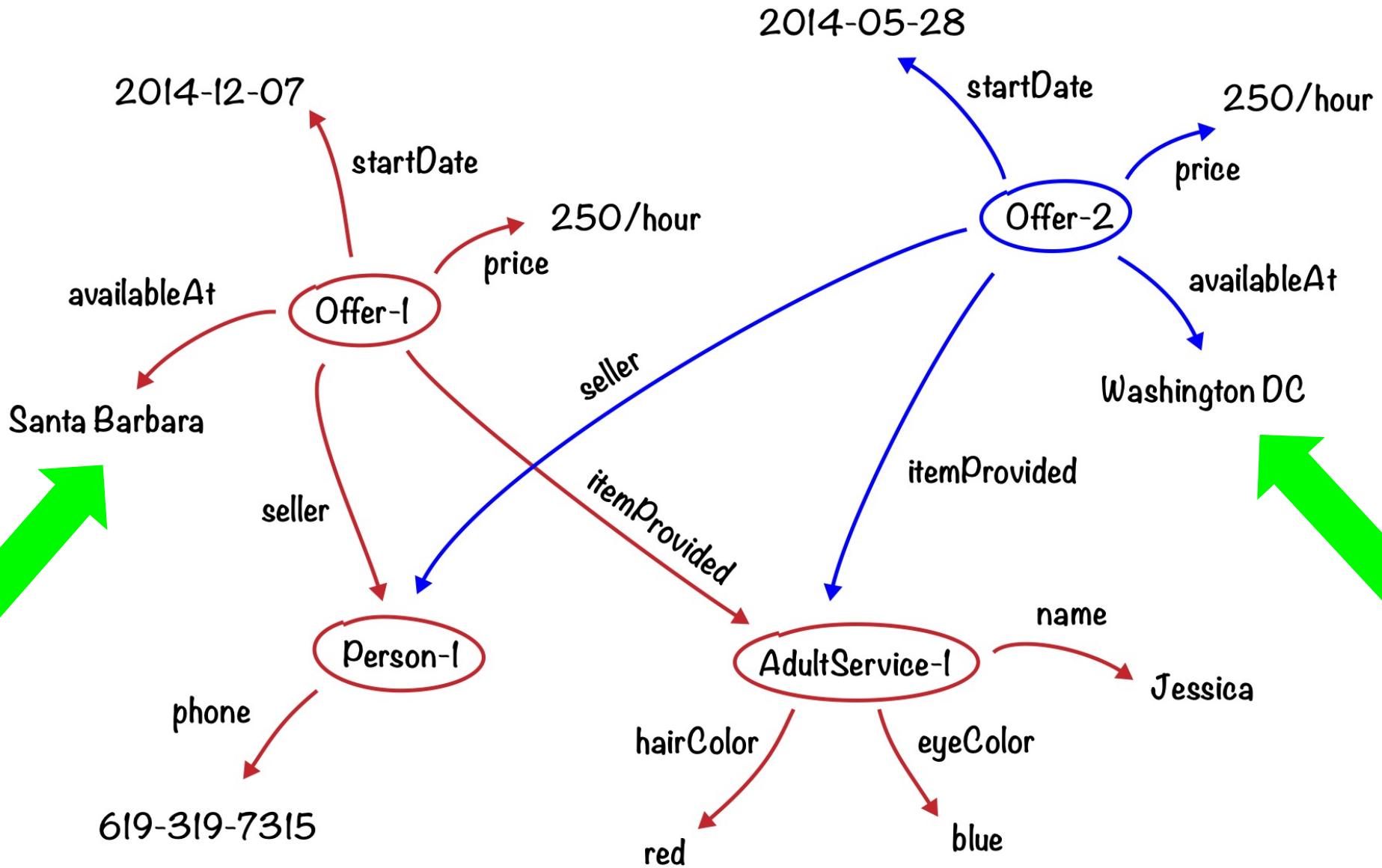
619-319-7315

Upscale incall with free parking.

Please check my website www.swedishpleasure.com

Incall







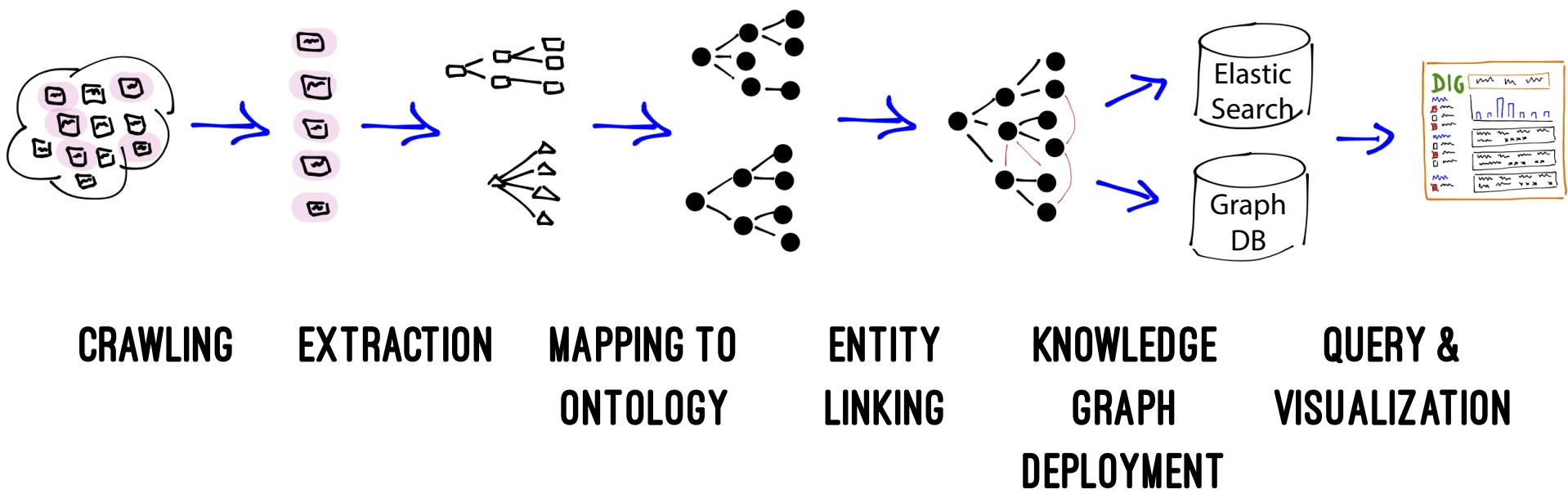
DAVID KARGER,
KEYNOTE ESWC 2013

"... SHOWING HOW THE SEMANTIC WEB CAN SOLVE
PROBLEMS THAT END USERS HAVE RIGHT NOW"

"A SEMANTIC WEB APPLICATION IS ONE WHOSE
SCHEMA IS EXPECTED TO CHANGE"



REUSABLE TECHNOLOGY FOR BUILDING DOMAIN-SPECIFIC SEARCH



WEB CRAWLING

24/7

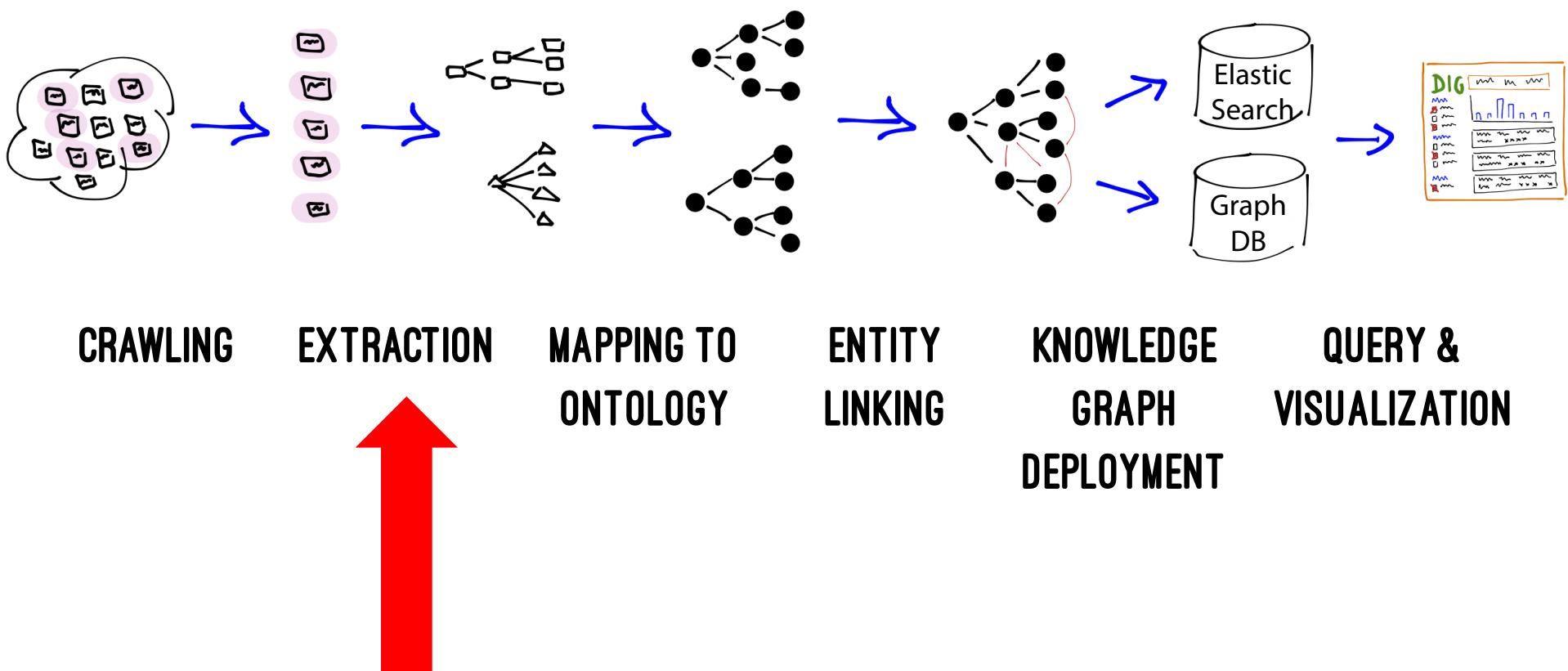
2.000 PAGES/HOUR

68.000.000 PAGES TOTAL

Backpage	26257125
Live Escort Reviews	15781909
EroticMugshots	9356957
Escortphonelist	3569247
Escorts In College	2843699
EscortAds.XXX	2139044
Craigslist	1622389
escortsinthe.us	1485510
Cityxguide	1393208
MyProviderGuide	1293239
Massagetroll	647875
NaughtyReviews	551454
Cityvibe	444240
Just Landed	259463
Escorts Inca	242635
SipSap	164153
Classivox	110066
Rubads	102187
AdultSearch	56773
Redbook	30674



REUSABLE TECHNOLOGY FOR BUILDING DOMAIN-SPECIFIC SEARCH



```
<article class="post">
<div class="seller" title=""></div>
<figure class="figure">
    <a href="/posts/3271529/arkansas-handguns-for-sale--diamondback-db-380c--compensated--with-avail
    <a href="/posts/3271529/arkansas-handguns-for-sale--diamondback-db-380c--com
    <div class="noship" title="">&ampnbsp</div>
    <div class="price">
        </div>
    <div class="blurb xsmall-text">WTS, DB Dimondback Micro 380c. Yes, this is one of...</div>
    <div class="location xsmall-text">Arkansas</div>
</div>
<div class="clear"></div>
</article>
```

SEMI-STRUCTURED EXTRACTION

HTML

FOR SALE: STOEGER M3500

post id: 4700468

share: [f](#) [e](#) [t](#) [p](#)

Price: \$ 500
Seller: Private Party
Account: Registered on 5/9/2013
[Listings by this user](#)

Listed On: Thursday, September 17, 2015
Listed In: Shotguns
Location: Keenesburg, Denver, Colorado [Map](#)
Shipping: No

Manufacturer: Stoeger
Caliber: 12 Gauge
Action: Semi-automatic
Firearm Type: Shotgun

I have a Stoeger m3500. It is a year old. It has 200 rounds through it from clay shooting. Its in perfect condition. If you have any questions email or text me. 9703427061. I'm asking 500



[Flag](#) | [Edit](#) | [Favorites](#)

Contact Seller

JSON

```
{
    "id": "4189129",
    "parent": "4189129",
    "label": "UserListedOn",
    "value": "Listings by this user",
    "label2": "Listed On",
    "value2": "Saturday, May 23, 2015",
    "label3": "Listed In"
},
{
    "value": "Universal Firearms",
    "label": "Listed In"
},
{
    "value": "Bulah, Northern Lower Peninsula, Michigan",
    "label": "Location"
},
{
    "value": "No",
    "label": "Shipping"
},
{
    "value": "Universal Firearms",
    "label": "Manufacturer"
},
{
    "value": ".30 Carbine",
    "label": "Caliber"
},
{
    "value": "Semi-automatic",
    "label": "Action"
},
{
    "value": "Rifle",
    "label": "Firearm Type"
},
{
    "team": "...",
    "version": "...",
    "ticketdata": {
        "Content-Type": [
            "text/html; charset=UTF-8"
        ],
        "Content-Encoding": [
            "UTF-8"
        ],
        "X-Parsed-By": [
            "org.apache.tika.parser.DefaultParser",
            "org.apache.tika.parser.html.HtmlParser"
        ],
        "Document-URI": [
            "ARMSLIST - For Sale/Trade: Universal M1 .30 carbine"
        ],
        "Title": [
            "ARMSLIST - For Sale/Trade: Universal M1 .30 carbine"
        ],
        "Page-Number": "443442744000",
        "Page-Count": "1",
        "Page-Size": "http://www.armslist.com/sites/armslist/content/page-size"
    }
}
```

TEXT EXTRACTION

“YOU don't wanna miss out
on ME :) Perfect lil booty
Green eyes Long curly black
hair Im a Irish,Armenian and
Filipino mixed princess :) ❤
Kim ❤ 7o7~7two7~7four77
❤ HH 80 roses ❤ Hour 120
roses ❤ 15 mins 60 roses”

NAME: KIM

EYE-COLOR: GREEN

HAIR-COLOR: BLACK

PHONE: 707-727-7477

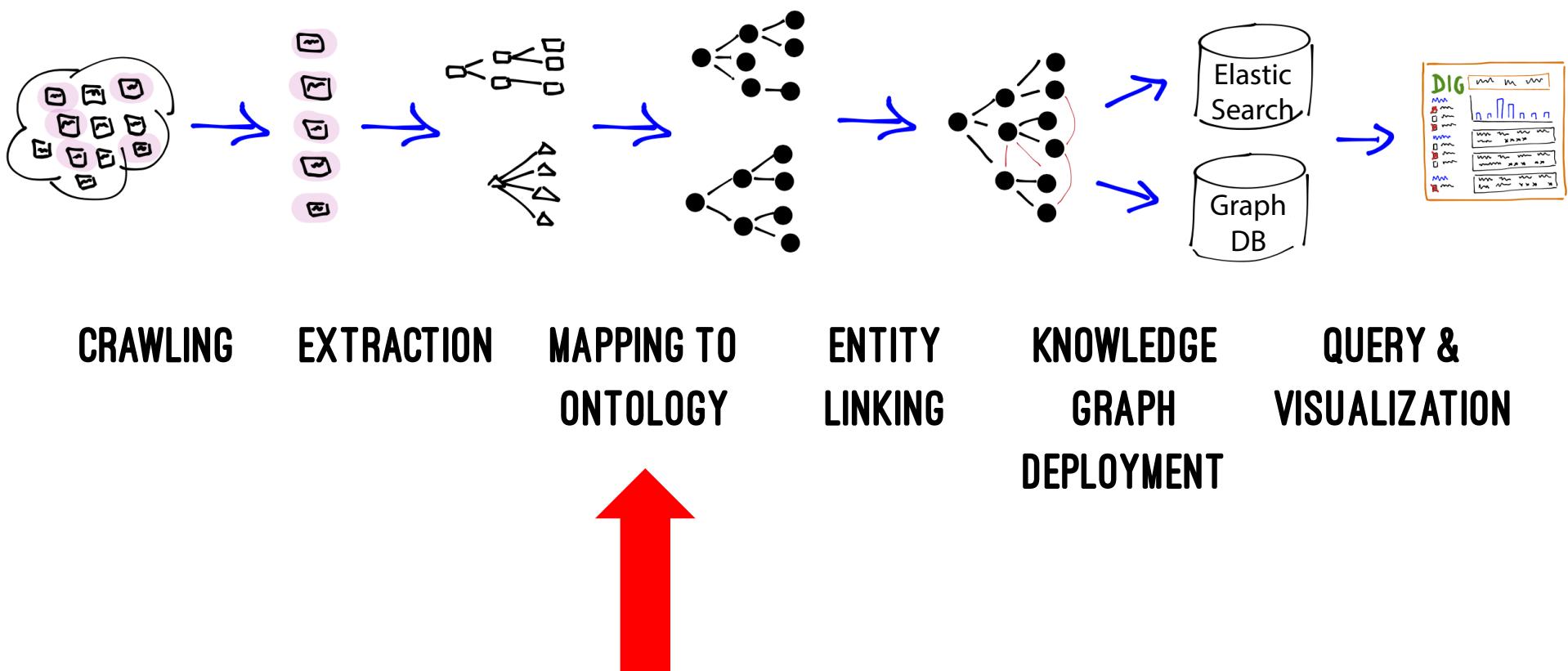
RATE: \$60/15MIN

\$80/30MIN

\$120/60MIN

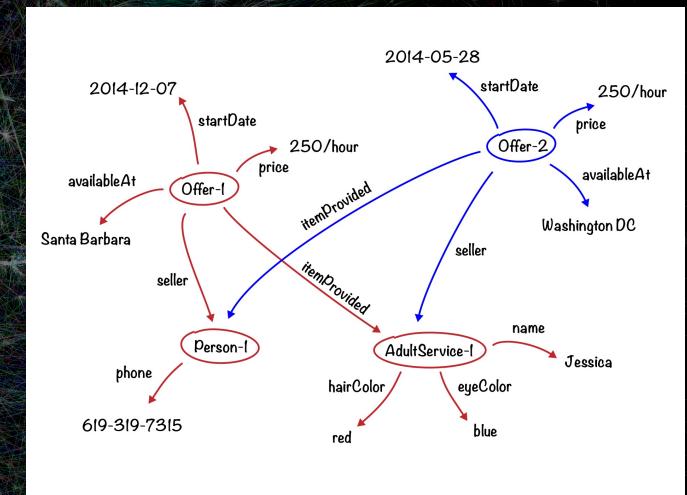


REUSABLE TECHNOLOGY FOR BUILDING DOMAIN-SPECIFIC SEARCH



MAPPING TO ONTOLOGY

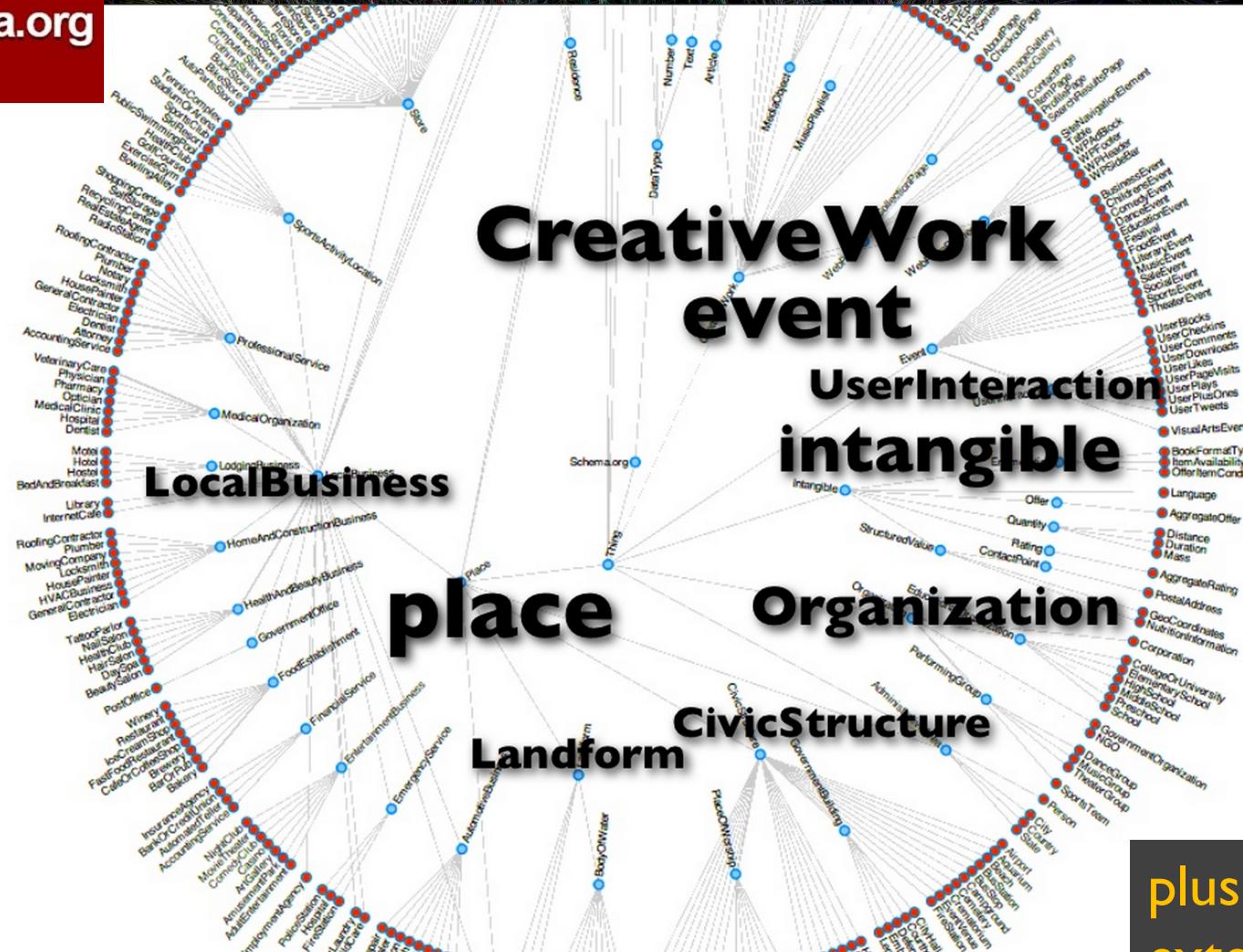
Many schemas



One ontology

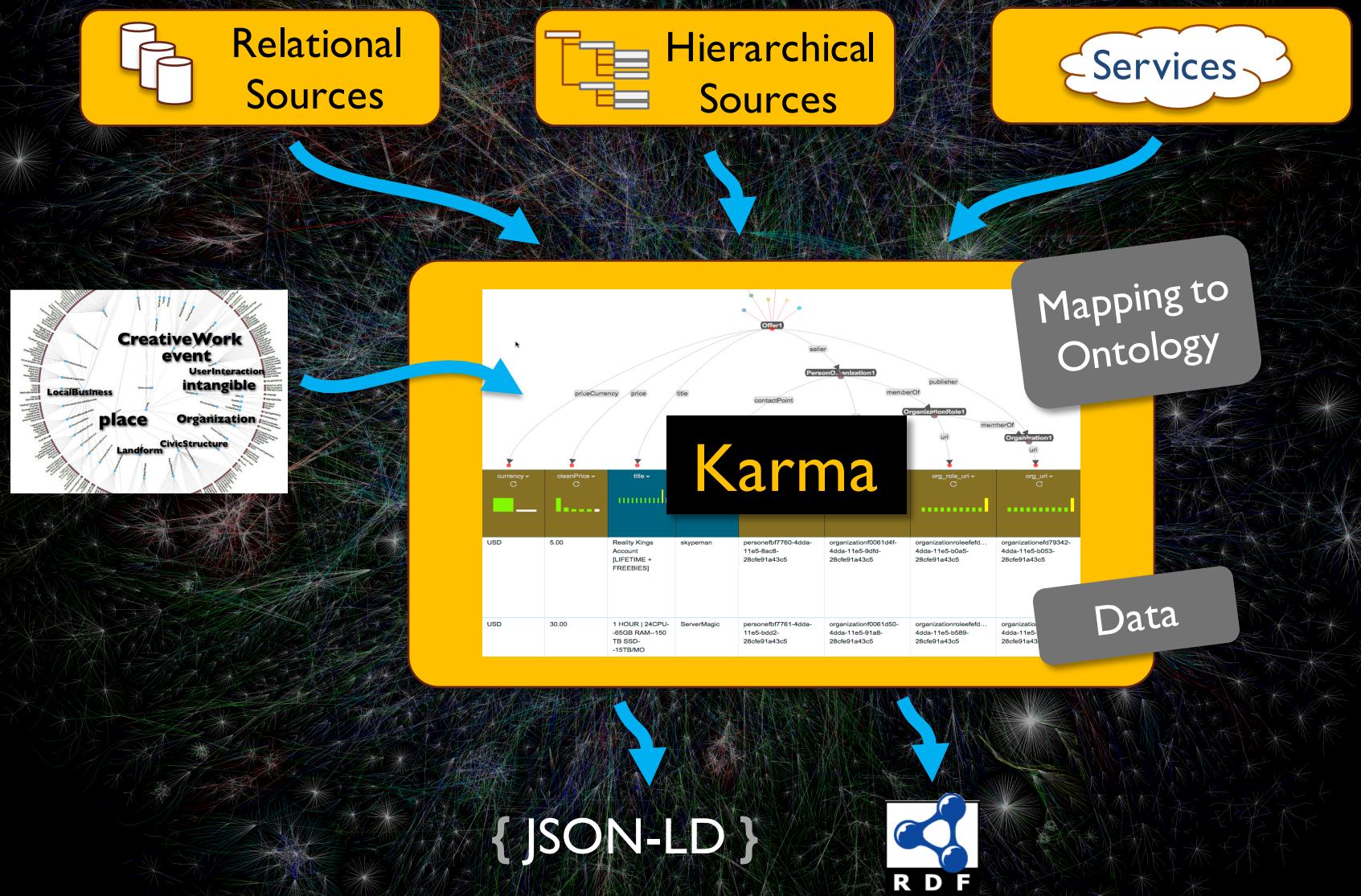
ONTOLOGY

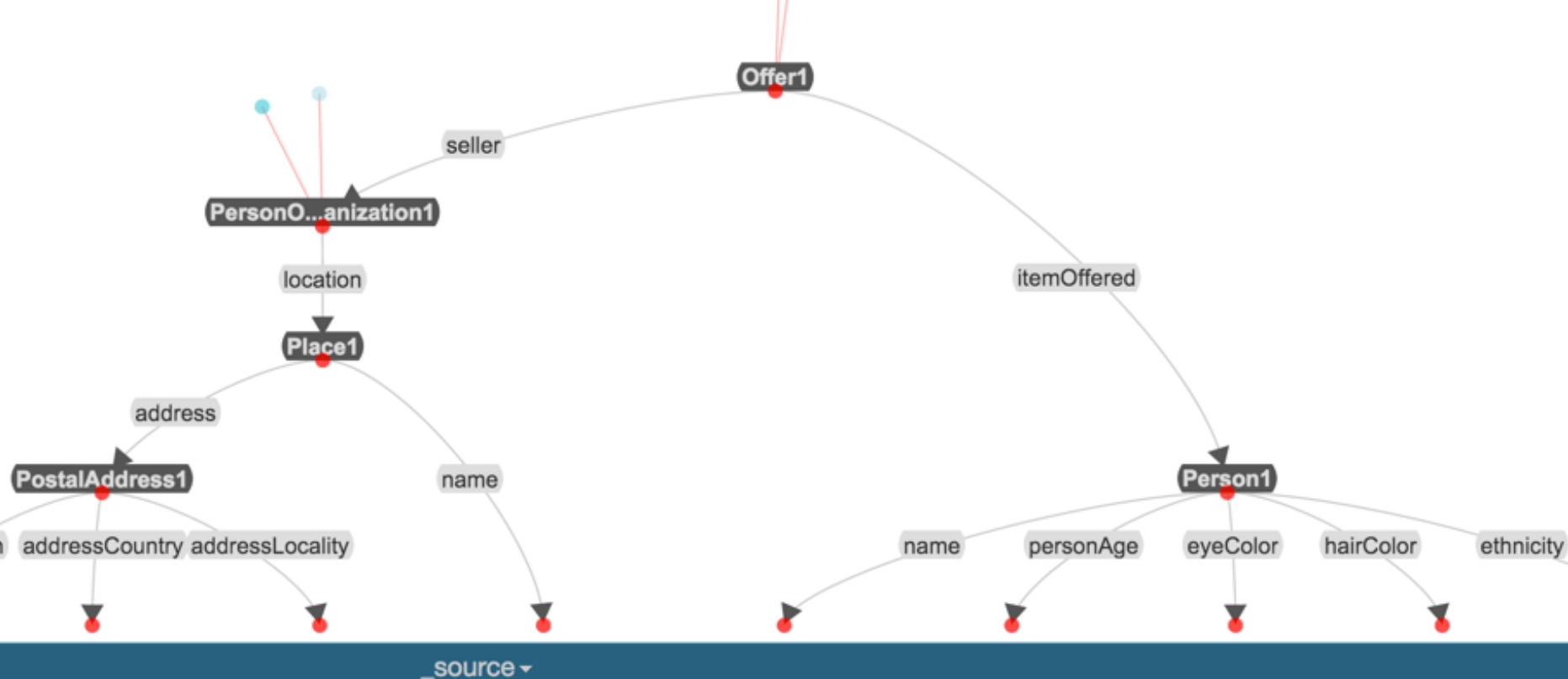
schema.org



plus some
extensions

KARMA: MAPPING DATA TO ONTOLOGIES



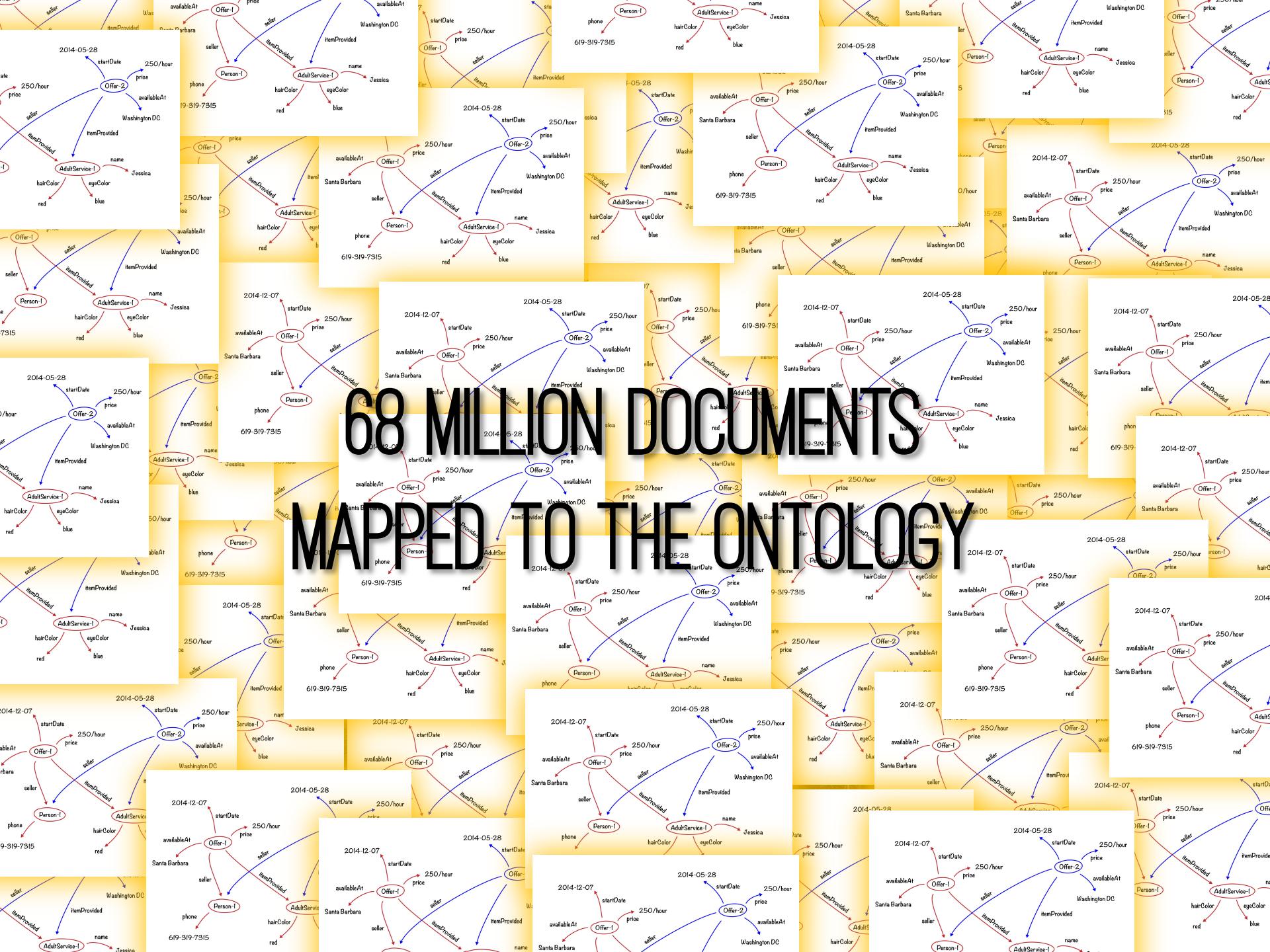


_source▼

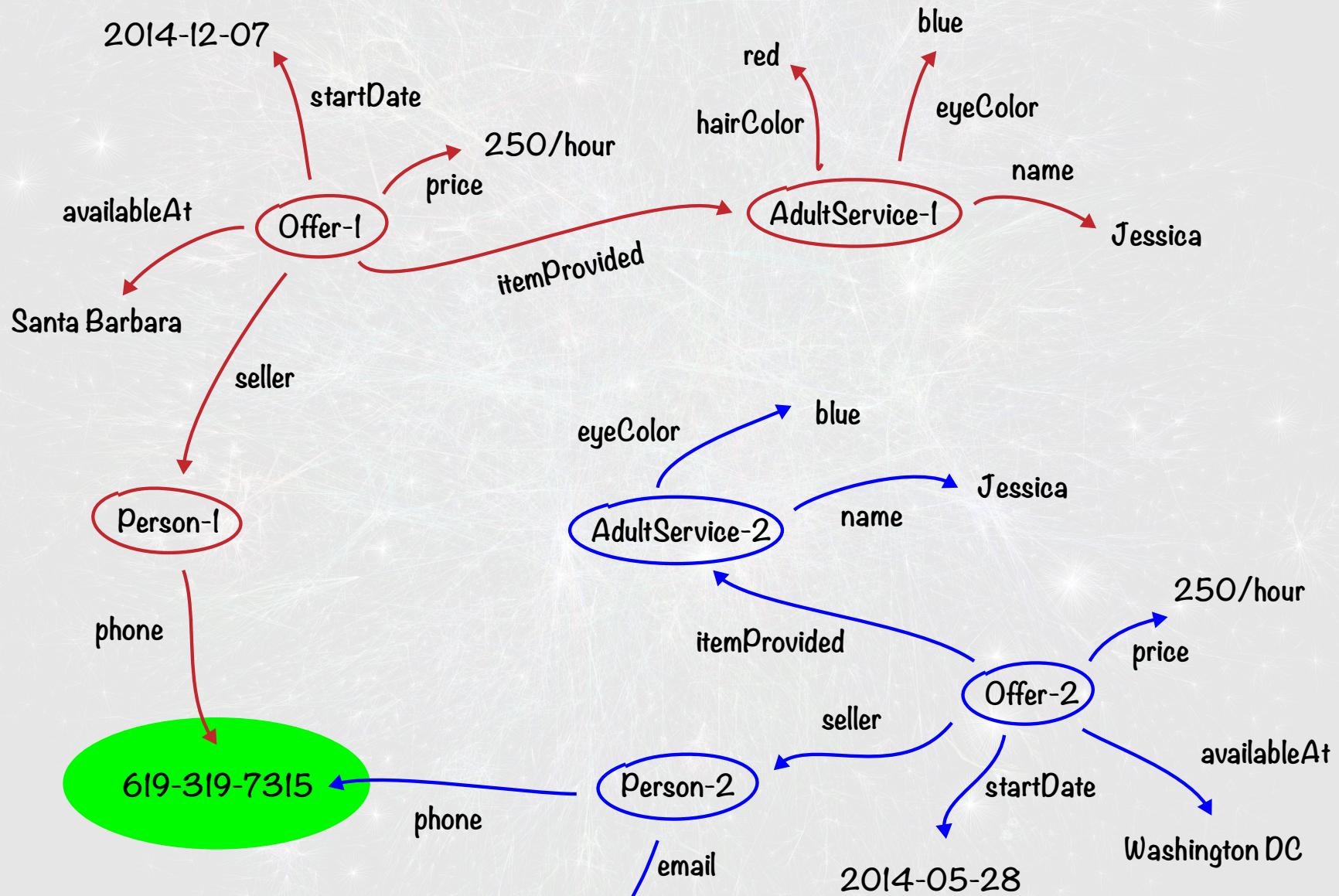
country ▾	city ▾	name ▾	age ▾	eyes ▾	hair ▾
United States of America	lawrence	lawrence, kansas, United States of America	Empty	Empty	Empty
Canada	british colu...	british columbia, British Columbia	emily	22	Empty

```
{  
    "@context": "http://localhost:8080/publish/JSON/WSP1WS1-escorts_json-context.json",  
    "itemOffered": {  
        "personAge": "26",  
        "name": "reika",  
        "a": "Person",  
        "ethnicity": "asian"  
    },  
    "a": "Offer",  
    "identifier": "14558690",  
    "seller": {  
        "location": {  
            "geo": {  
                "a": "GeoCoordinates",  
                "longitude": "-73.9597",  
                "latitude": "40.7903"  
            },  
            "address": {  
                "addressLocality": "manhattan",  
                "a": "PostalAddress"  
            },  
            "name": "manhattan, , ",  
            "a": "Place"  
        },  
        "a": "PersonOrOrganization",  
        "telephone": "9178087930"  
    },  
    "mainEntityOfPage": {  
        "text": "<i>HELLO Gentlemen!\nMy name is Reika 26years old, 5'8\" 105lbs, and I  
        "name": "***Sexy Asian model from Tokyo ~~ UPSCALE & ELEGANT&EROTIC BODY RUB ~ ~  
        "a": "WebPage",  
        "dateCreated": "2014-05-20T11:43:00",  
        "url": "http://manhattan.backpage.com/BodyRubs/sexy-asian-model-from-tokyo-upsc  
    }  
}
```

68 MILLION DOCUMENTS MAPPED TO THE ONTOLOGY

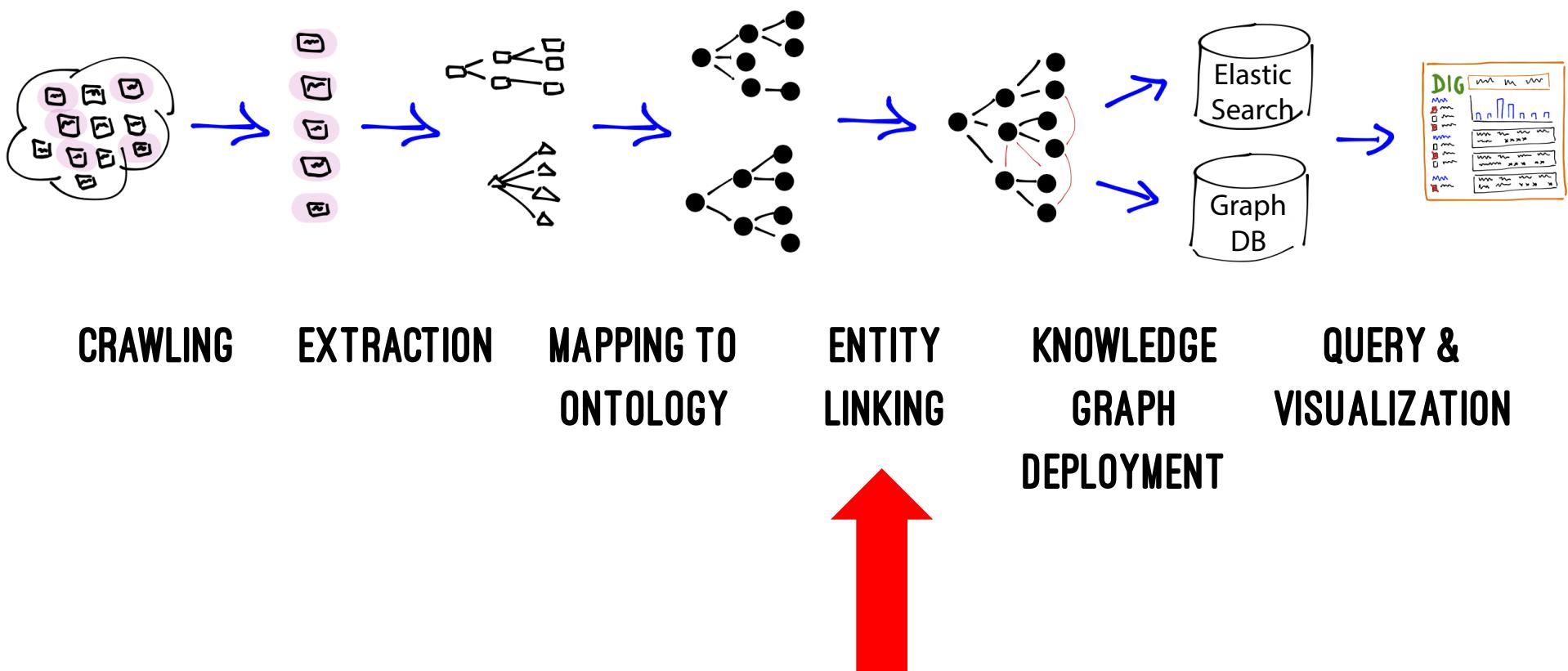


KARMA CONNECTS GRAPHS ON STRONG ATTRIBUTES





REUSABLE TECHNOLOGY FOR BUILDING DOMAIN-SPECIFIC SEARCH



USING TEXT SIMILARITY TO CONNECT THE DOTS

EMILY SEXY. ** wHiTe/|ATin girl ** bUsTy SWEET. LoTs Of fUn. Call Me.

O_U_T_C_A_L_L_S

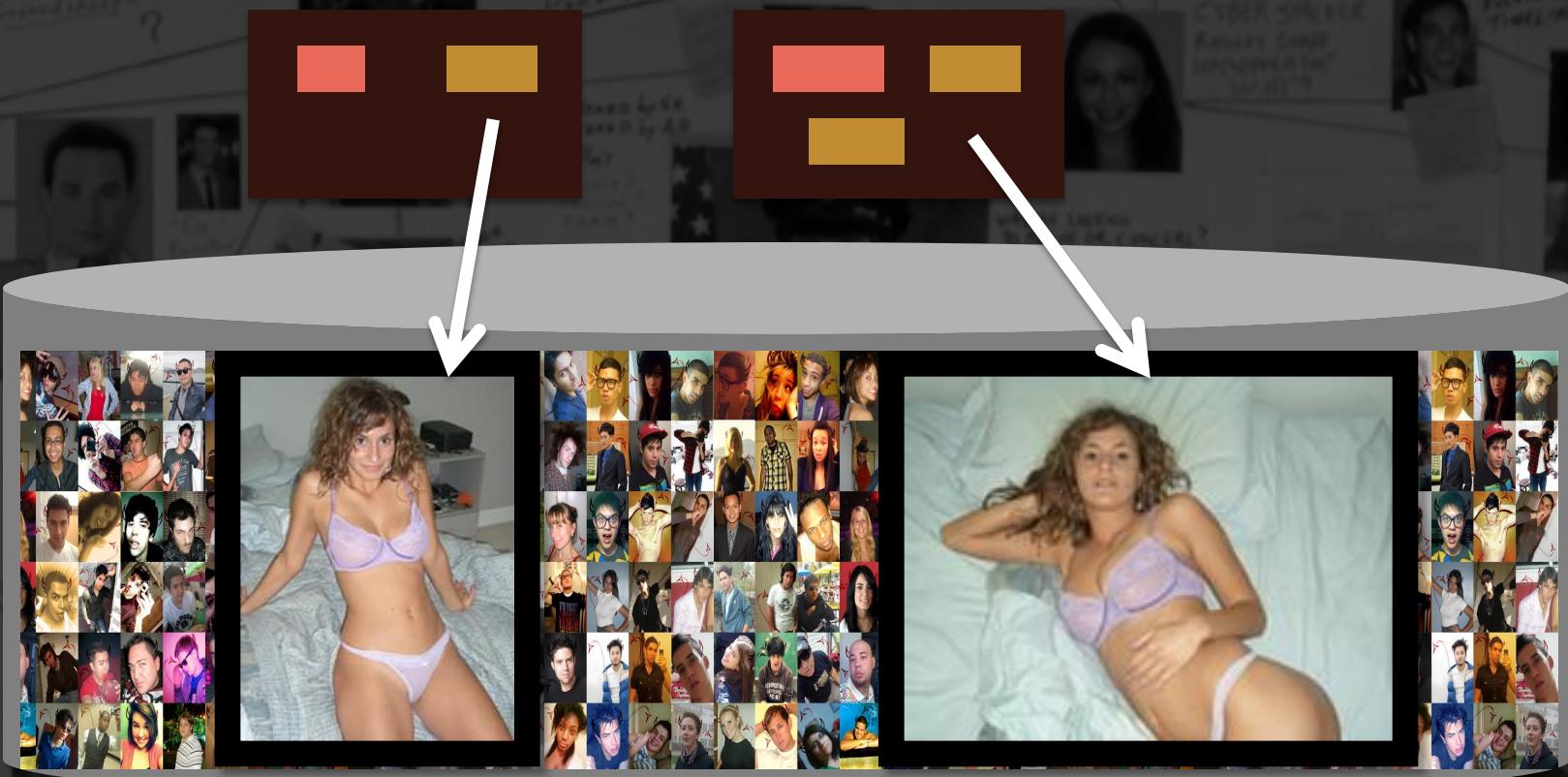
LAYLA SEXY. ** wHiTe girl ** bUsTy SWEET. LoTs Of fUn. Call Me.

O_U_T_C_A_L_L_S

LILA SEXY. ** WhiTe girl ** bUsTy SWEET. LoTs Of fUn. Call Me.

O_U_T_C_A_L_L_S

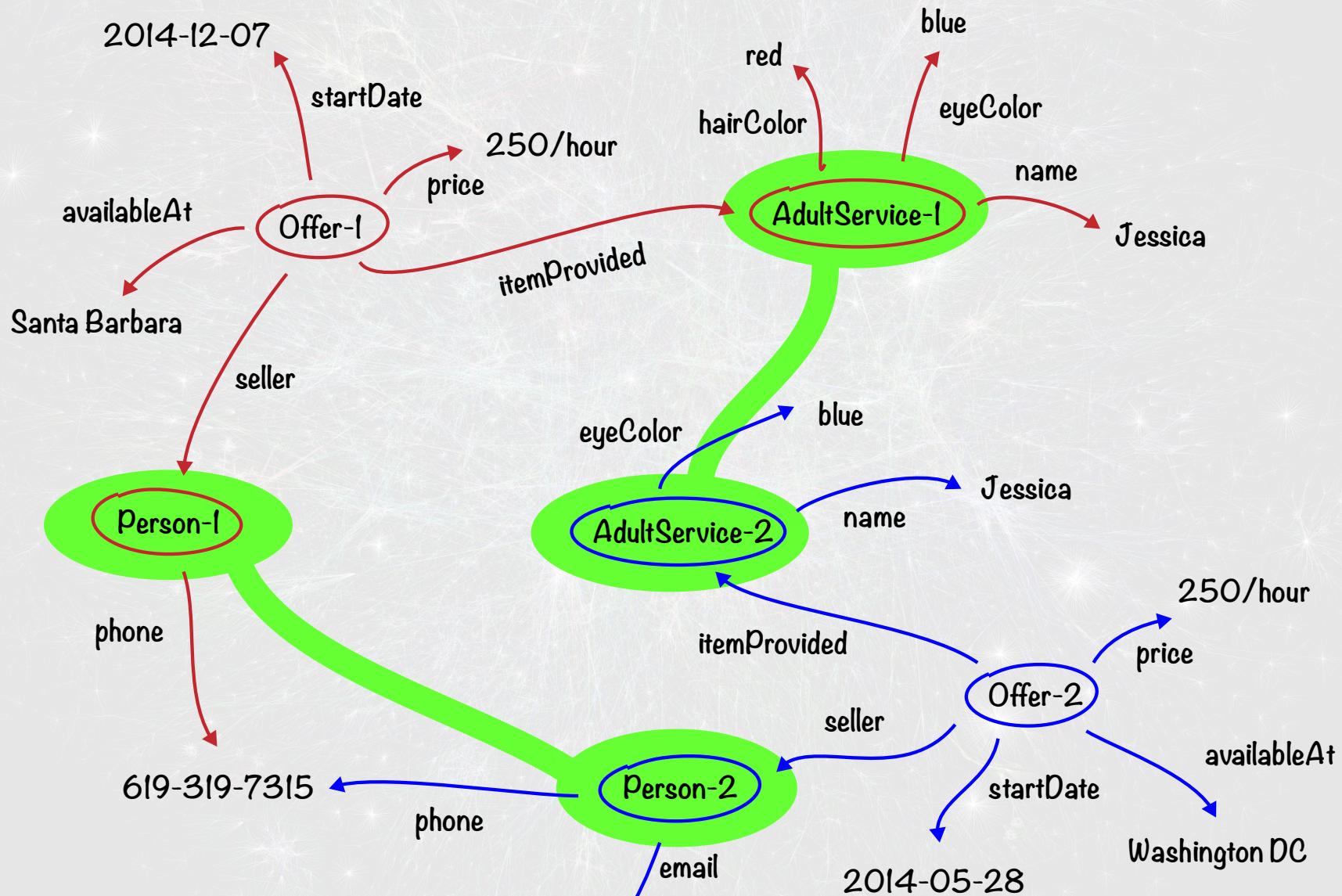
USING IMAGE SIMILARITY TO CONNECT THE DOTS



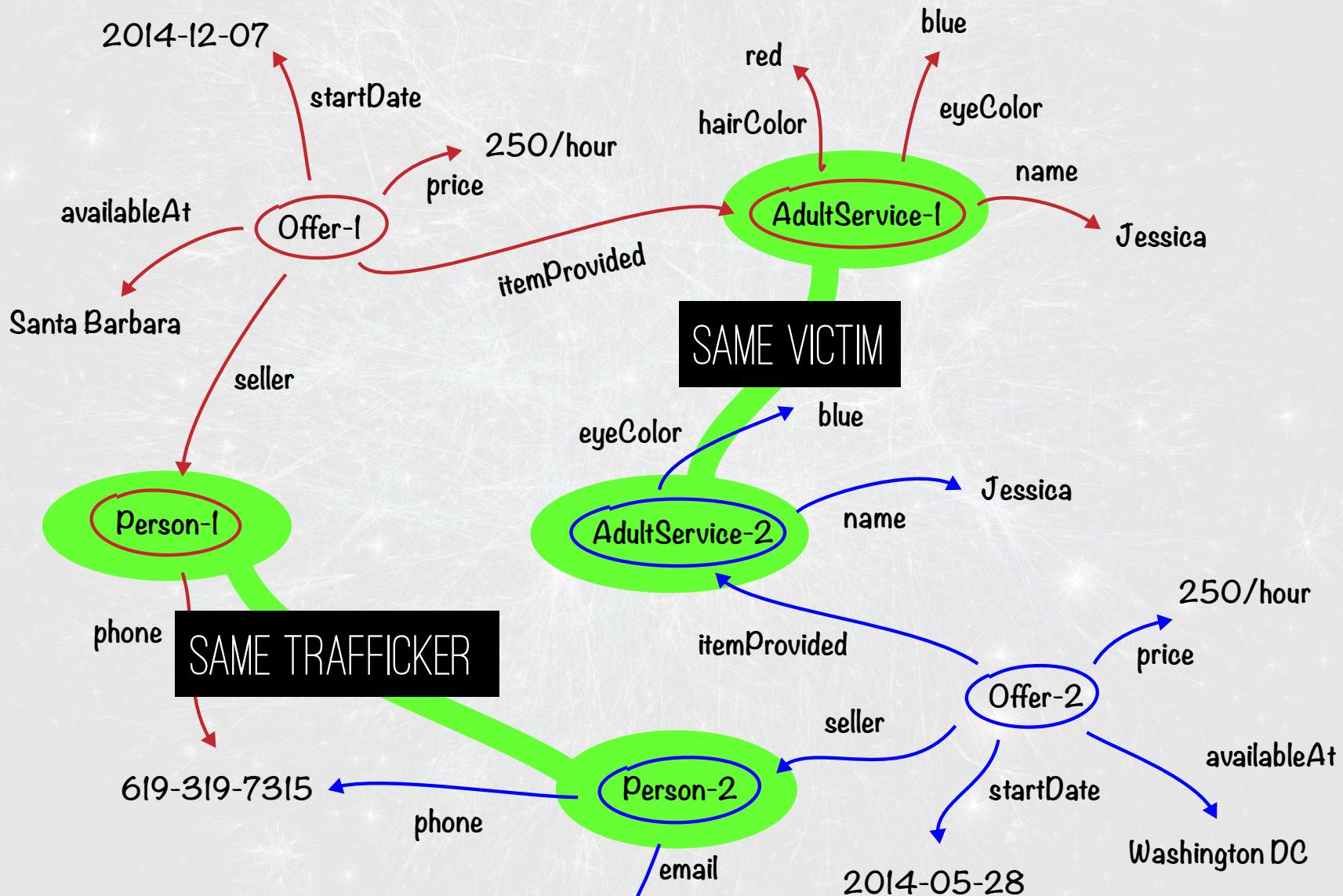
80 MILLION IMAGES

TECHNOLOGY: DEEP LEARNING

CONNECTING NODES USING ALL ATTRIBUTES

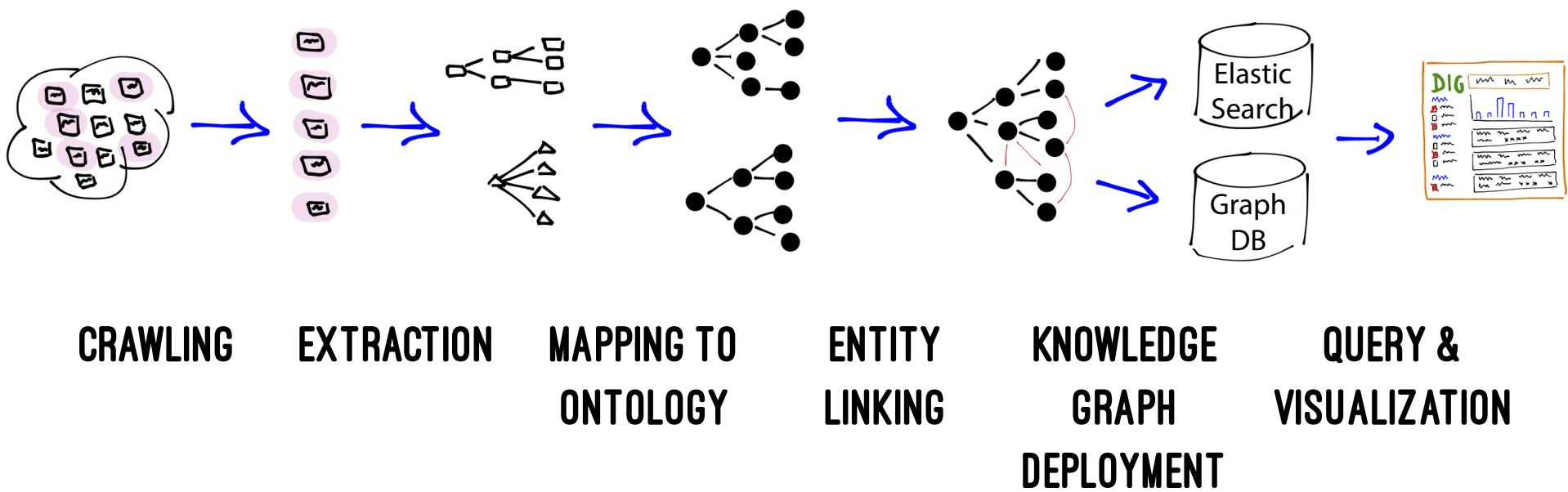


CONNECTING NODES USING ALL ATTRIBUTES





REUSABLE TECHNOLOGY FOR BUILDING DOMAIN-SPECIFIC SEARCH



SPARQL

- > 100 MILLION DOCS
- > 1 BILLION TRIPLES

TEXT +
STRUCTURED QUERY

FACETED BROWSING

FAMILIAR TO
DEVELOPERS

CHALLENGING

RESTRICTED

HARD

NO

ELASTICSEARCH

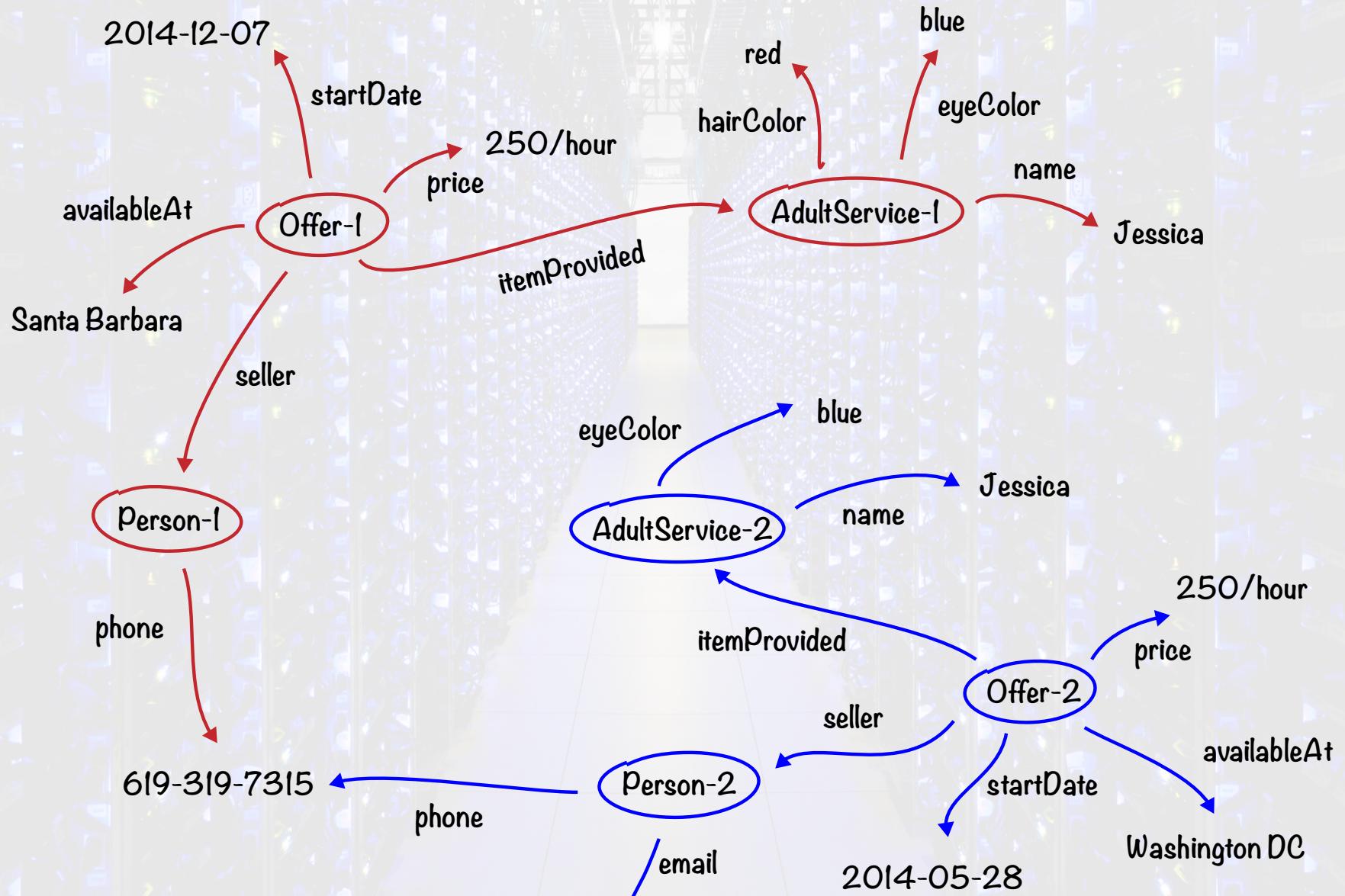
EASY

NATIVE SUPPORT

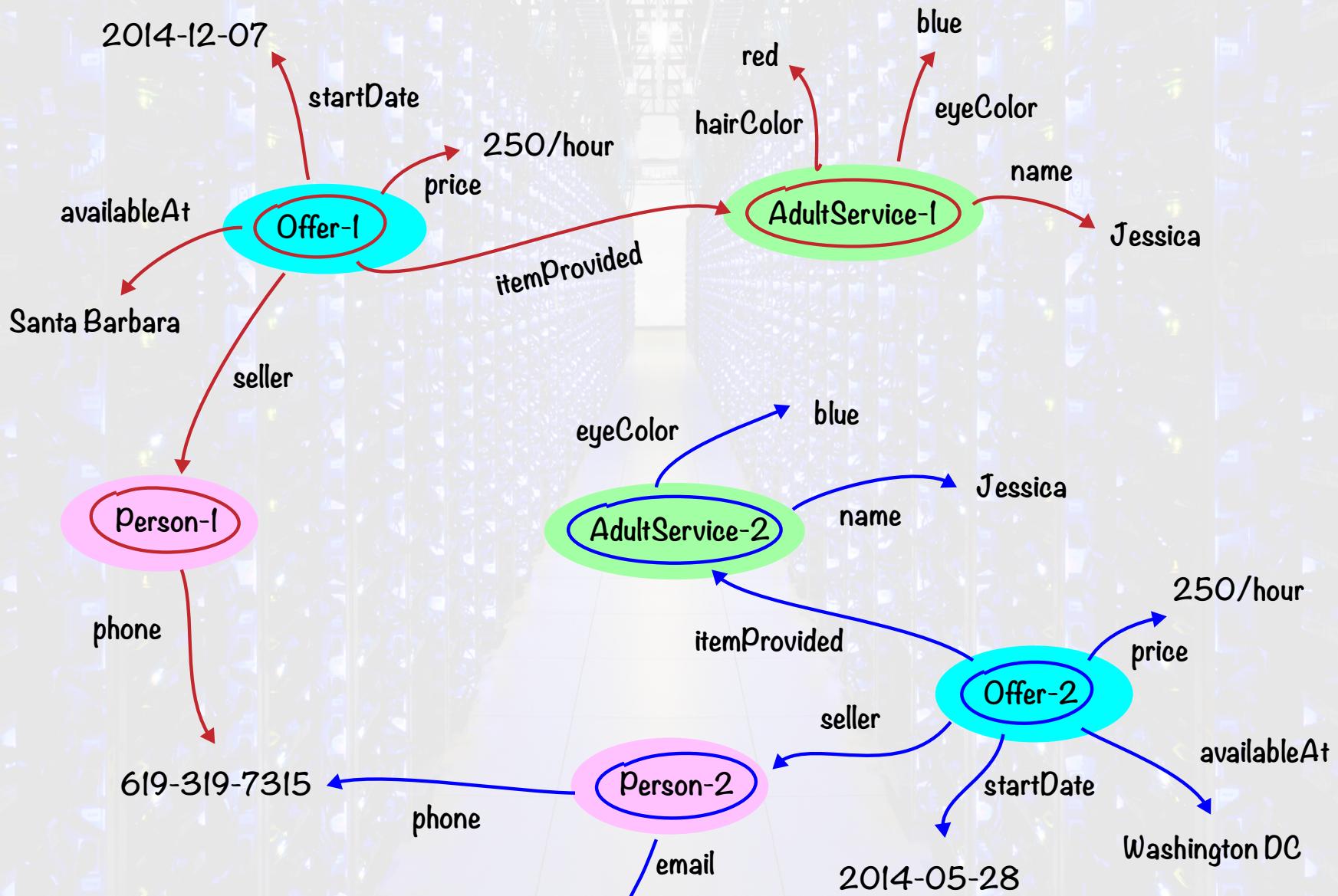
EASY

YES

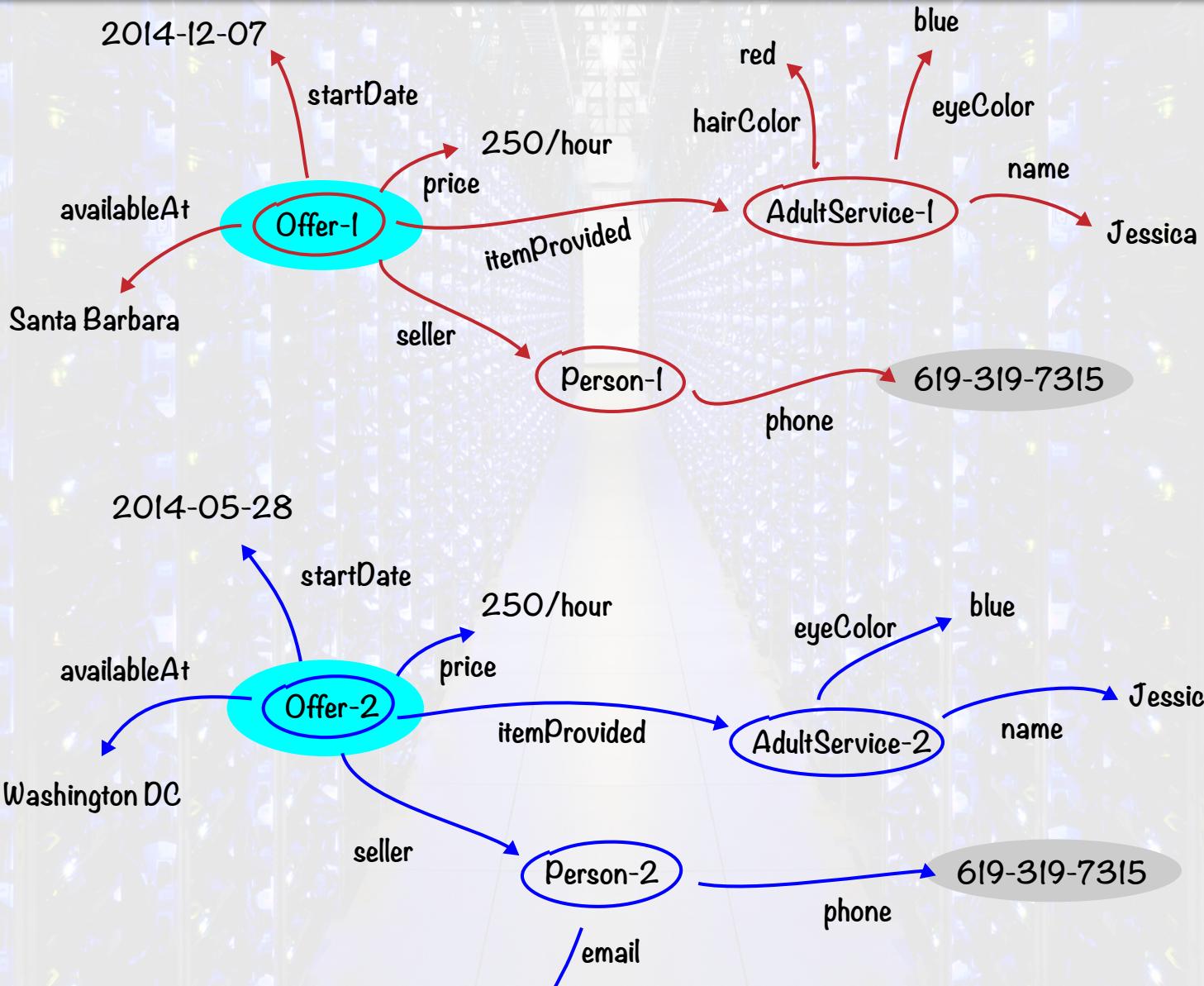
CREATE UNIFIED DATABASE



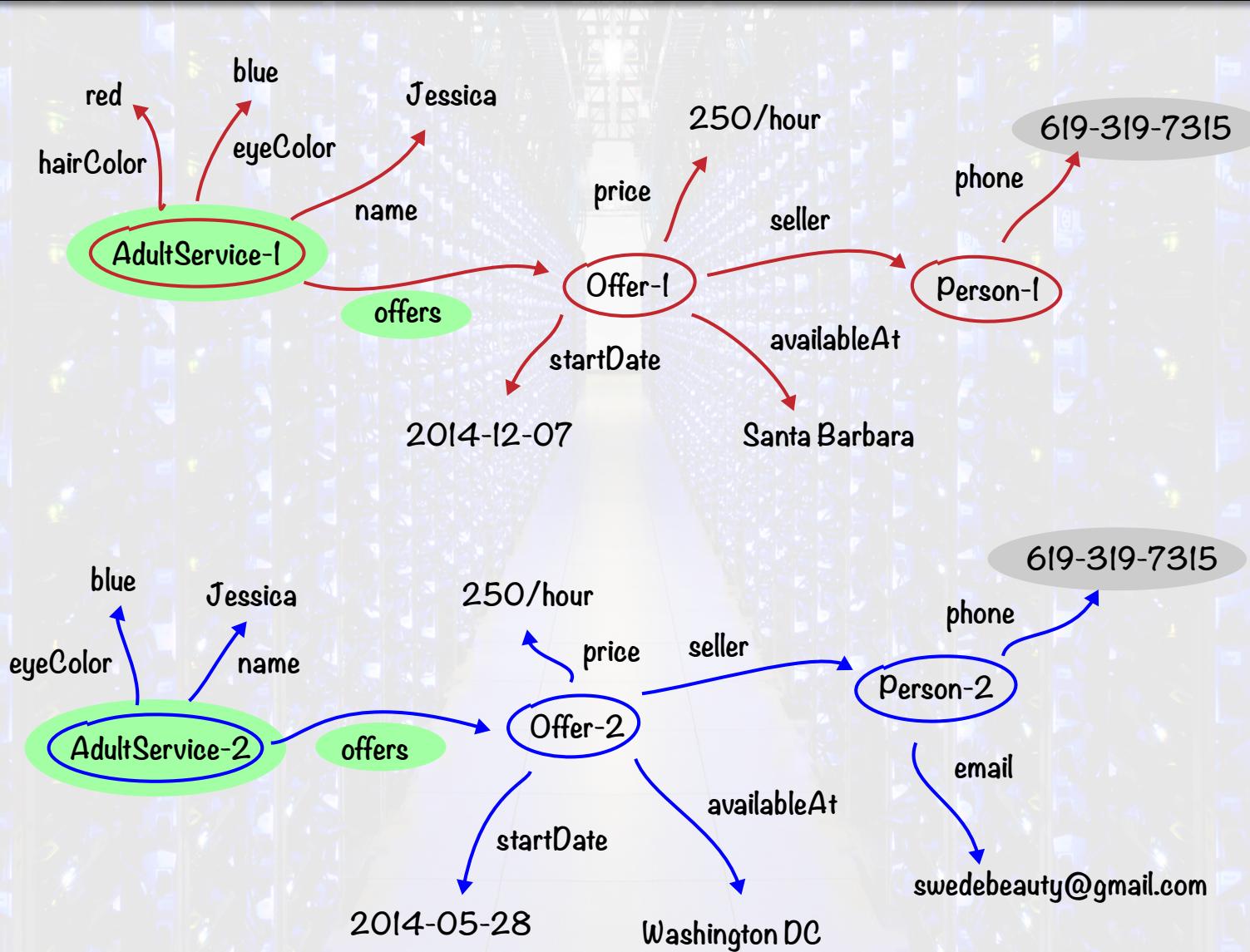
ONE INDEX PER MAIN CLASS



OFFERS AS ROOTS

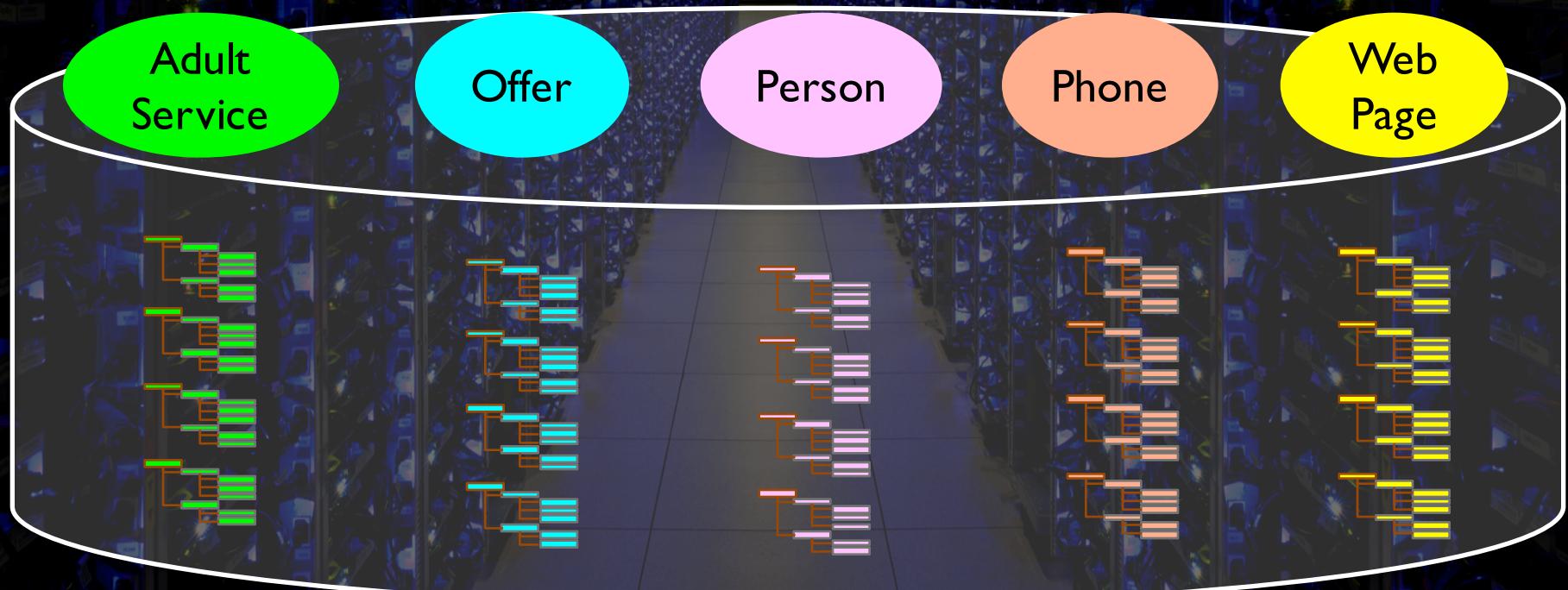


ADULT SERVICE AS ROOTS



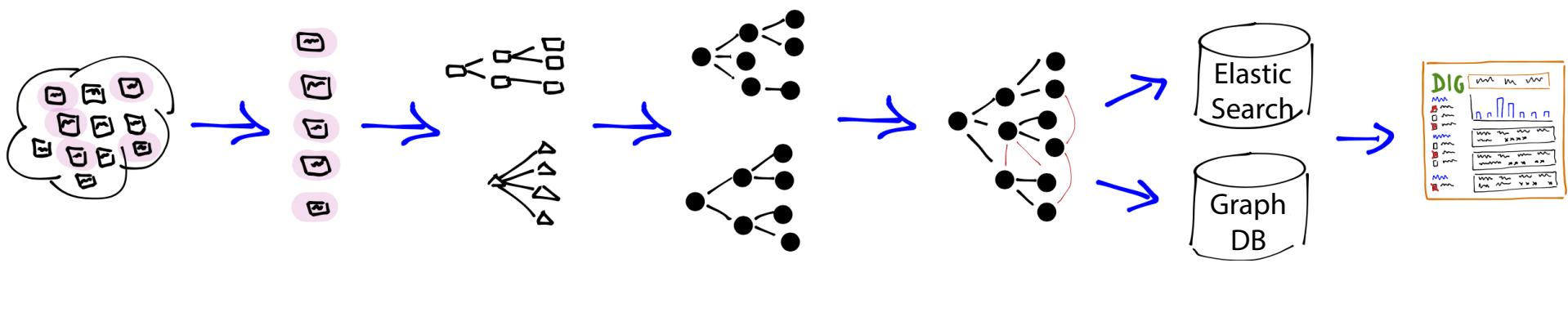
ELASTICSEARCH DATA MODEL

EFFICIENT INDEXING AND QUERY





REUSABLE TECHNOLOGY FOR BUILDING DOMAIN-SPECIFIC SEARCH



CRAWLING

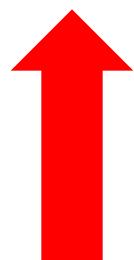
EXTRACTION

MAPPING TO
ONTOMY

ENTITY
LINKING

KNOWLEDGE
GRAPH
DEPLOYMENT

QUERY &
VISUALIZATION



Filter Folders

FROM

TO

▼ CITY/REGION

<input type="checkbox"/> Not Specified	663544
<input type="checkbox"/> Toronto	111130
<input type="checkbox"/> New York	81876
<input type="checkbox"/> Ontario	80422
<input type="checkbox"/> Los Angeles	54444
<input type="checkbox"/> Chicago	54285
<input type="checkbox"/> Phoenix	49934
<input type="checkbox"/> Montreal	48932
<input type="checkbox"/> Denver	48291
<input type="checkbox"/> Houston	47814
<input type="checkbox"/> Calgary	47480
<input type="checkbox"/> Red Deer	46936
<input type="checkbox"/> San Jose	46769
<input type="checkbox"/> Ottawa	46367
<input type="checkbox"/> Dallas	45777
<input type="checkbox"/> London	43122
<input type="checkbox"/> Orange County	43001
<input type="checkbox"/> San Diego	42382
<input type="checkbox"/> Boston	42352
<input type="checkbox"/> Edmonton	42097
<input type="checkbox"/> Atlanta	41958
	41155

Display a menu

jessica red hair blue eyes swedish



Search

Clear All

Save

With Images Only



SORT BY Best Match ▾

 0 item(s) selected

4,946,783 results

**San Diego Escorts - Elite Swedish Escort in San Diego 31 - 3518804 - My Provider Guide**created: 04/11/2011 00:00:00 UTC location: San Diego phone: +1-6193197315
name: Jessica age: 31**1-619-319-7315 - jessica @swedishgfe.com - swedishgfe - San Diego Escorts - Swedish Pleasure from a Real Swede - 3558086 - My Provider Guide**created: 01/14/2014 00:00:00 UTC location: San Diego phone: +1-6193197315
name: Jessica age: 33**1-619-319-7315 - jessica @swedishgfe.com - swedishgfe - San Diego Escorts - Swedish Pleasure from a Real Swede - 3558086 - My Provider Guide**created: 01/14/2014 00:00:00 UTC location: San Diego phone: +1-6193197315
name: Jessica age: 33**1-619-319-7315 - jessica @swedishgfe.com - swedishgfe - San Diego Escorts - Swedish Pleasure from a Real Swede - 3558086 - My Provider Guide**created: 11/01/2013 00:00:00 UTC location: San Diego phone: +1-6193197315
name: Jessica age: 33

619-319-7315 - Los Angeles Escorts - Umm... Swedish. Redhead visiting



1-619-319-7315 - jessica @swedishgfe.com - swedishgfe - San Diego
Escorts - Swedish Pleasure from a Real Swede - 3558086 - My Provider
Guide

created: 01/14/2014 00:00:00 UTC location: San Diego phone: +1-6193197315
name: Jessica age: 33



URL

http://www.myproviderguide.com/escorts/san-diego/free-posts/w4m/3558086_swedish-pleasure-from-a-real-s.html

NAME(S)

Jessica

AGE

33

CITY

San Diego

ETHNICITY

HAIR COLOR
red

PHONE NUMBER

+1-6193197315
+1-6193197315

HEIGHT
157

EMAIL

jessica@swedishgfe.com

WEIGHT
54

WEB SITE

/external/d3d3LnN3ZWRpc2hnZmUuY29t

PROVIDER

MyProviderGuide

CREATED

01/14/2014 00:00:00 UTC

[View Details](#)

+ / -

▼ PROVIDER

<input type="checkbox"/> Not Specified	2933
<input type="checkbox"/> Backpage	2954771
<input type="checkbox"/> EroticMugshots	1425744
<input type="checkbox"/> Escortphonelist	609763
<input type="checkbox"/> Escorts In College	483456
<input type="checkbox"/> NaughtyReviews	471204
<input type="checkbox"/> EscortAds.XXX	359567
<input type="checkbox"/> Cityxguide	260736
<input type="checkbox"/> Live Escort Reviews	258932
<input type="checkbox"/> MyProviderGuide	233901
<input type="checkbox"/> escortsinthe.us	221848
<input type="checkbox"/> Craigslist	130255
<input type="checkbox"/> Massagetroll	115994
<input type="checkbox"/> Cityvibe	88122
<input type="checkbox"/> Escorts Inca	79499
<input type="checkbox"/> SipSap	23699
<input type="checkbox"/> Rubads	19165
<input type="checkbox"/> Classivox	13197
<input type="checkbox"/> Just Landed	9004
<input type="checkbox"/> Redbook	8742
<input type="checkbox"/> AdultSearch	7361
<input type="checkbox"/> Alibaba	48
<input type="checkbox"/> Gmdu	8

HIPS TYPE

32

CUP SIZE

d

WAIST SIZE

76

BUST BAND SIZE

34

BUILD

slender

IN CALL/OUT CALL

incalloutcall

USERNAME

swedishgfe

PROVIDER

MyProviderGuide

Hi, my name is Jessica and I am from Sweden now living in San Diego. I am 33 years old, fiery red hair and ocean blue eyes; slim 120 pounds and 5'5" tall with nice firm breasts. I have an M.Sc (Masters Degree) in Engineering from Sweden. I am a great companion and I speak five languages. I care about our time together and I offer unrushed encounters with pleasure for both of us. I love to laugh, smile, cuddle, kiss and spend quality time, enough for us to connect. If you would like to see more pictures of me and get to know more about me, please check my website www.swedishgfe.com Look at my video: <http://vimeo.com/20795643> Rates: Incall 1 hour \$250.00 2 hours \$400.00 (Get \$50 off with the purchase of any item from my new website: www.redheadtoys.com, show/print receipt) Call or text me at: 1-619-319-7315 I look forward to seeing you soon. xoxo Jessica PS. If you rather talk dirty please call my chat line. Look at www.swedishredhead.com Also, don't forget to check out my new adult sex toy website! www.redheadtoys.com - Great selection of adult sex toys!!

TO

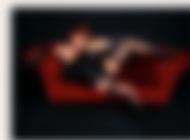
Find the locations where a potential victim of human trafficking was advertised

IMAGE



CITY/REGION

- Not Specified
- San Diego
- Santa Barbara
- Palmdale
- Los Angeles
- Washington Dc
- Chicago
- East Bay
- Oakland

 0 item(s) selected [619-319-7315 - Sa](#)[32 - 3620011 - My](#)

created: 08/04/2011 0

name: Jessica age:

21

254

56

42

10

8

5

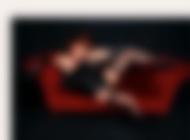
3

1

[619-319-7315 - Sa](#)[32 - 3620011 - My](#)

created: 08/04/2011 0

name: Jessica age:

[619-319-7315 - Lo](#)[on March 7 10th 32](#)

created: 02/27/2012 0

name: Jessica age:

+ / -

A dramatic image of a meteor impact over Earth's horizon. A bright, yellow-orange fireball erupts from a long, luminous orange-tinted streak that cuts across the dark sky. This streak originates from a point just above the Earth's horizon, where the planet's blue and white cloud-covered surface meets the black void of space. The fireball is highly intense, with bright sparks trailing off to the left.

IMPACT

A large, diverse group of people of various ages, ethnicities, and genders are shown from the waist up or full body. They are all smiling and have their right hands raised high in the air, palm facing forward. The background is a soft, out-of-focus white.

**DEPLOYED TO LAW
ENFORCEMENT AND NGOS**

CONCLUSIONS

- Using an ontology to integrate data
- Continuous schema evolution
- ElasticSearch as an RDF store
- Using a JSON-based tool chain
- Deployment of large SemanticWeb app

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