Activity Feeds Architecture

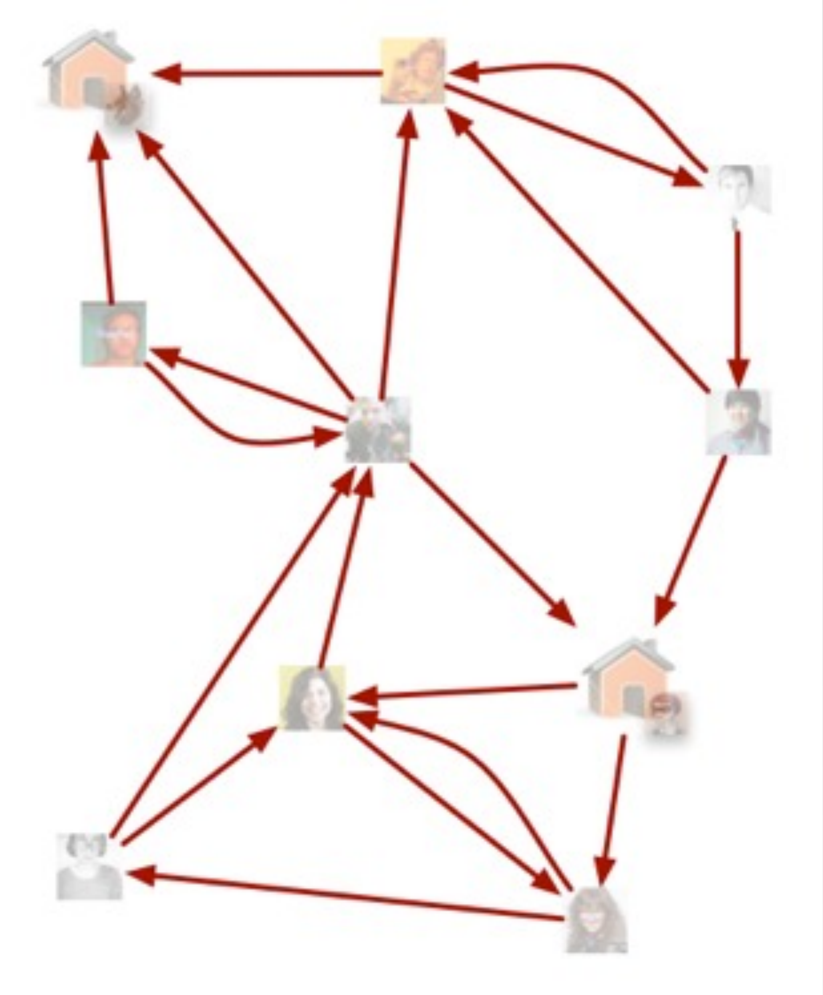
January, 2011

To Be Covered:

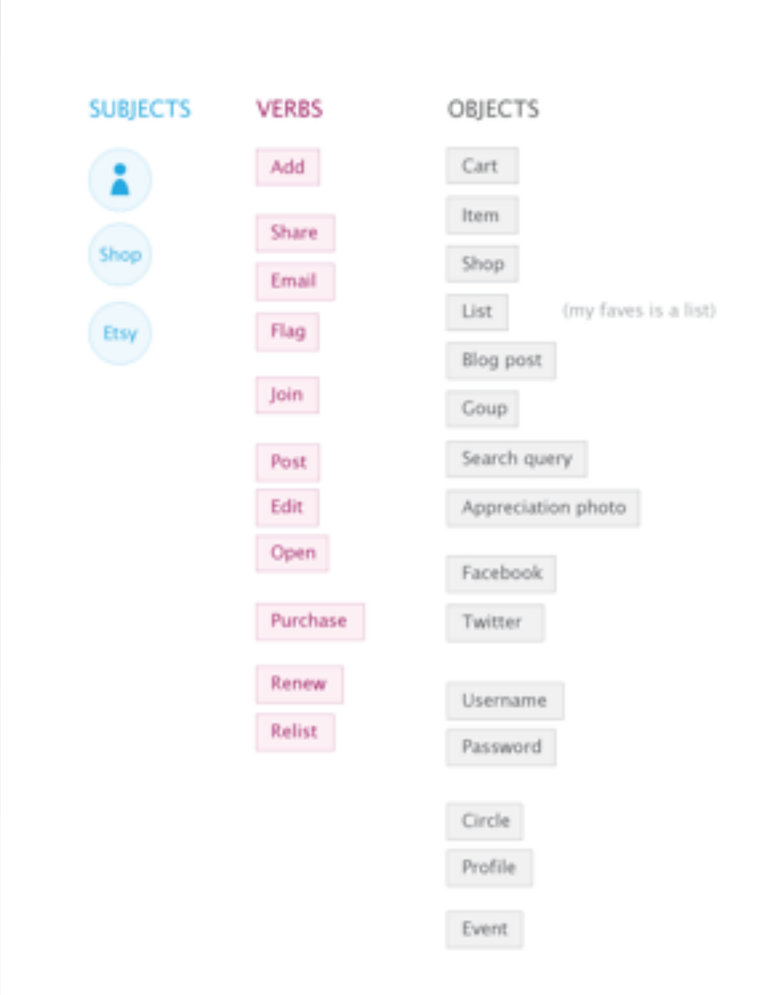
- Data model
- Where feeds come from
- How feeds are displayed
- Optimizations

Fundamental Entities

Connections



Activities



SUBJECTS

- Shop
- Etsy

VERBS

- Add
- Share
- Email
- Flag
- Join
- Post
- Edit
- Open
- Purchase
- Renew
- Relist

OBJECTS

- Cart
- Item
- Shop
- List (my faves is a list)
- Blog post
- Goup
- Search query
- Appreciation photo
- Facebook
- Twitter
- Username
- Password
- Circle
- Profile
- Event

There are two fundamental building blocks for feeds: connections and activities.
Activities form a log of what some entity on the site has done, or had done to it.
Connections express relationships between entities.
I will explain the data model for connections first.

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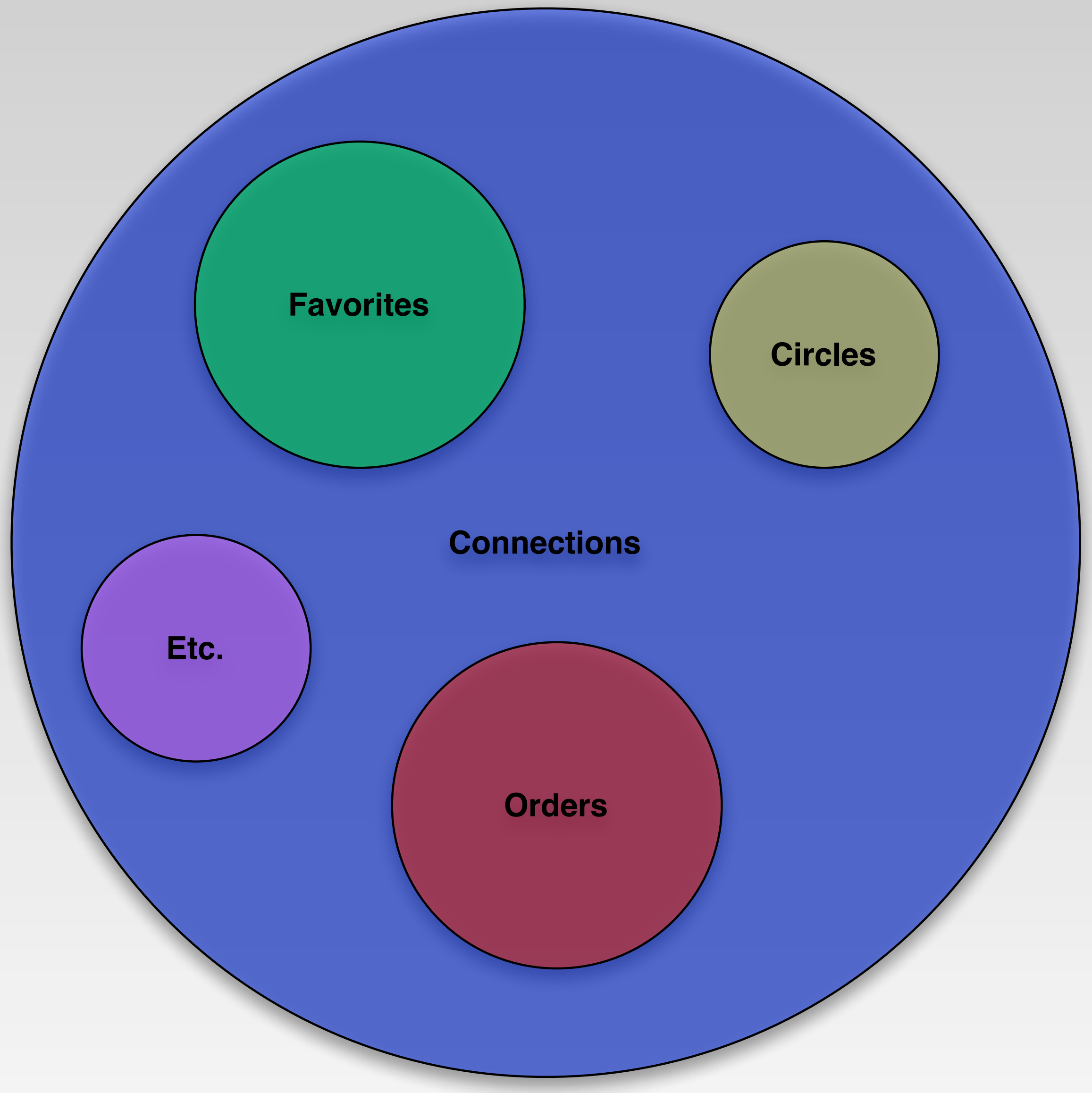
Activity Feeds Architecture

Connections



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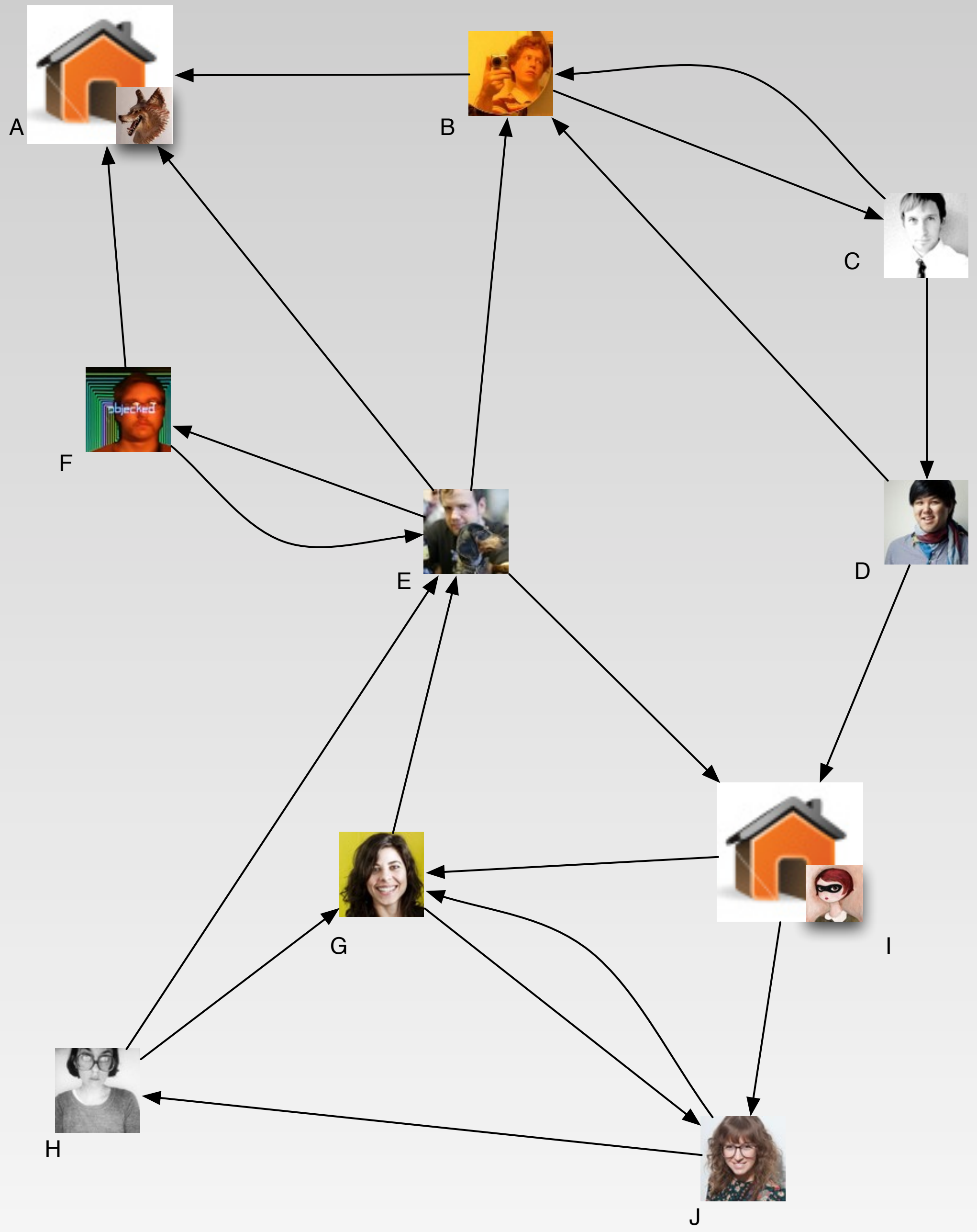
Connections are a superset of Circles, Favorites, Orders, and other relationships between entities on the site.

Connections



Connections are implemented as a directed graph.
Currently, the nodes can be people or shops. (In principle they can be other objects.)

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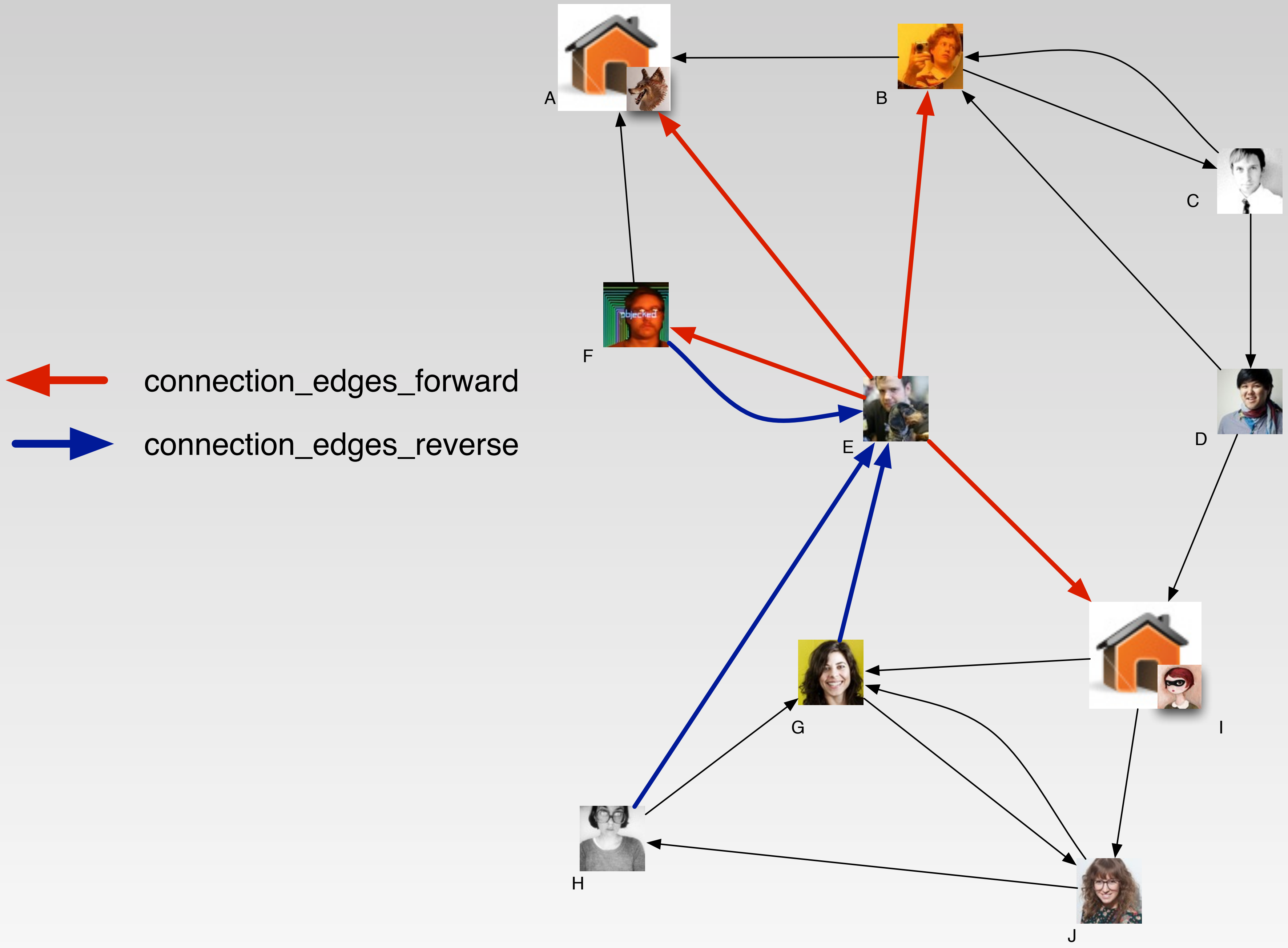
Activity Feeds Architecture

Connections



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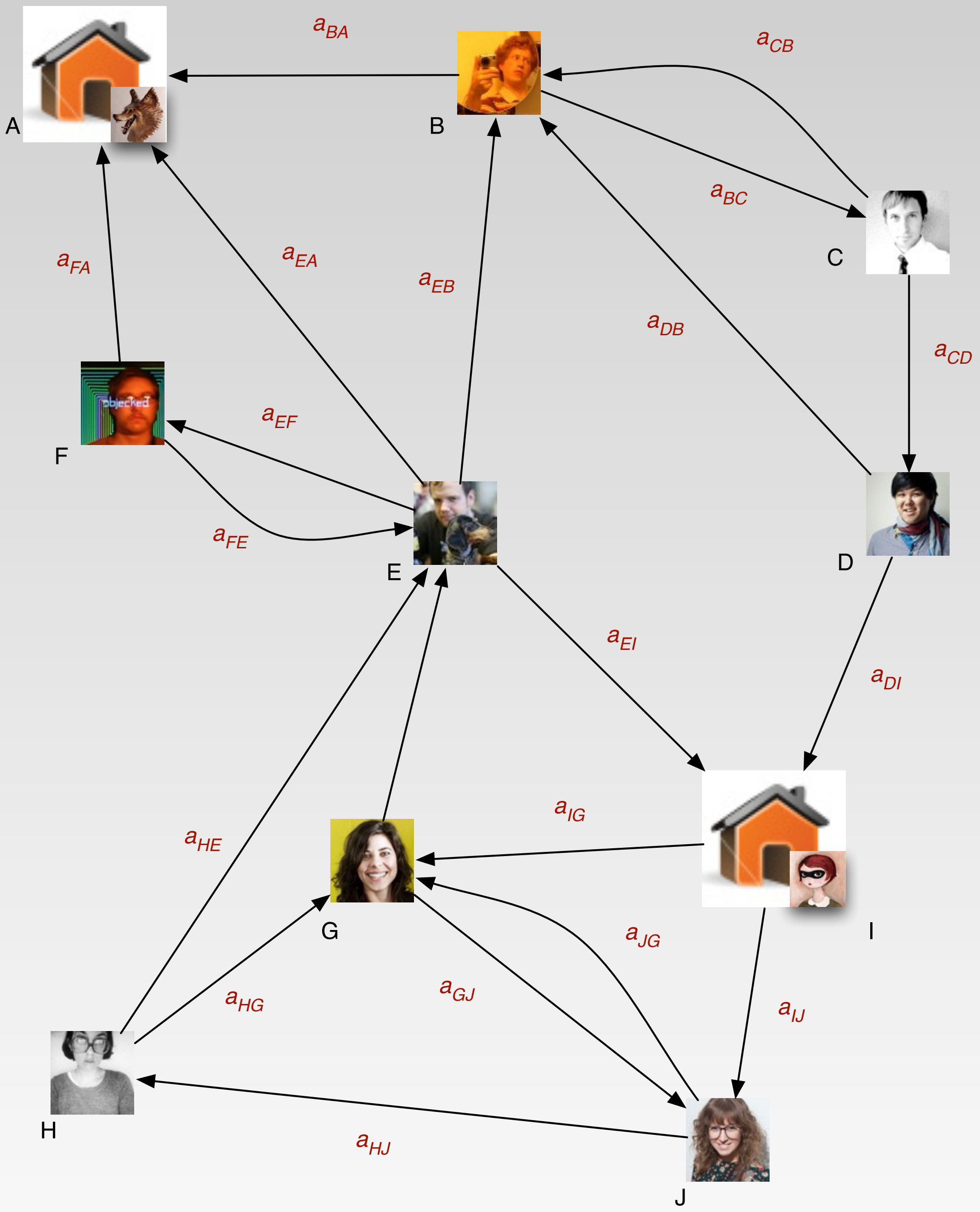
The edges of the graph are stored in two tables.
For any node, connection_edges_forward lists outgoing edges and connection_edges_reverse lists the incoming edges.
In other words, we store each edge twice.

Connections



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We also assign each edge a weight, known as affinity.

Connections

On *H’s* shard

connection_edges_forward

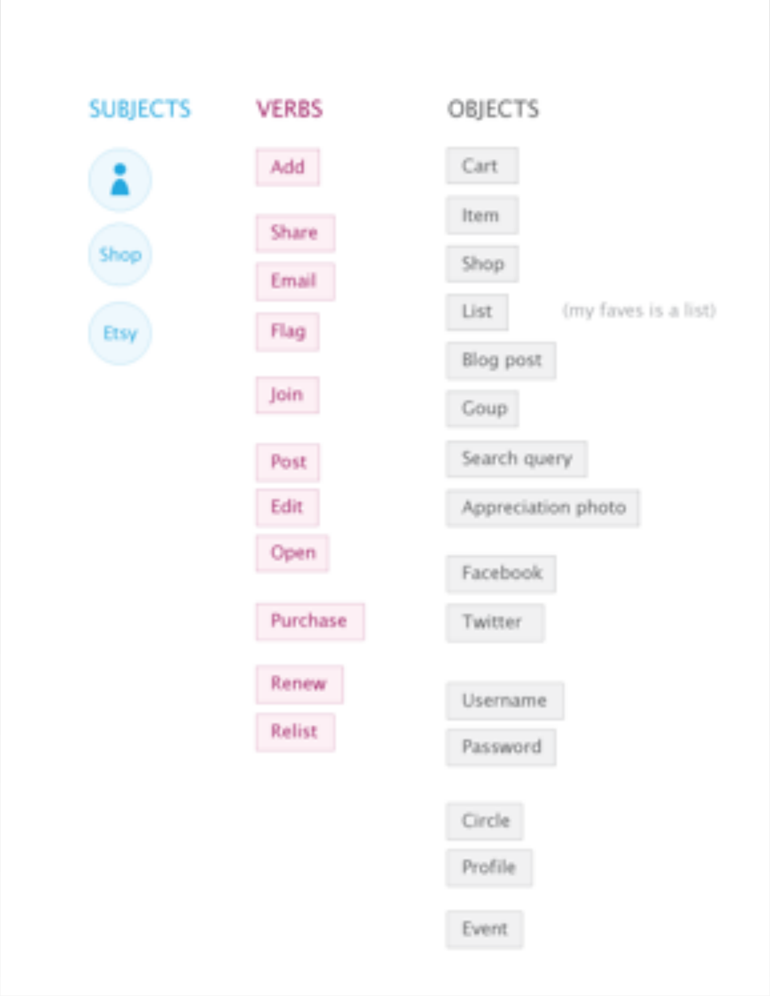
from	to	affinity
H	E	0.3
H	G	0.7

connection_edges_reverse

from	to	affinity
J	H	0.75

Here we see the data for Anda’s connections on her shard.
She has two entries in the forward connections table for the people in her circle.
She has one entry in the reverse connections so that she can see everyone following her.

Activities



SUBJECTS

Shop

Etsy

VERBS

Add

Share

Email

Flag

Join

Post

Edit

Open

Purchase

Renew

Relist

OBJECTS

Cart

Item

Shop

List (my faves is a list)

Blog post

Goup

Search query

Appreciation photo

Facebook

Twitter

Username

Password

Circle

Profile

Event

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Activities are the other database entity important to activity feeds.

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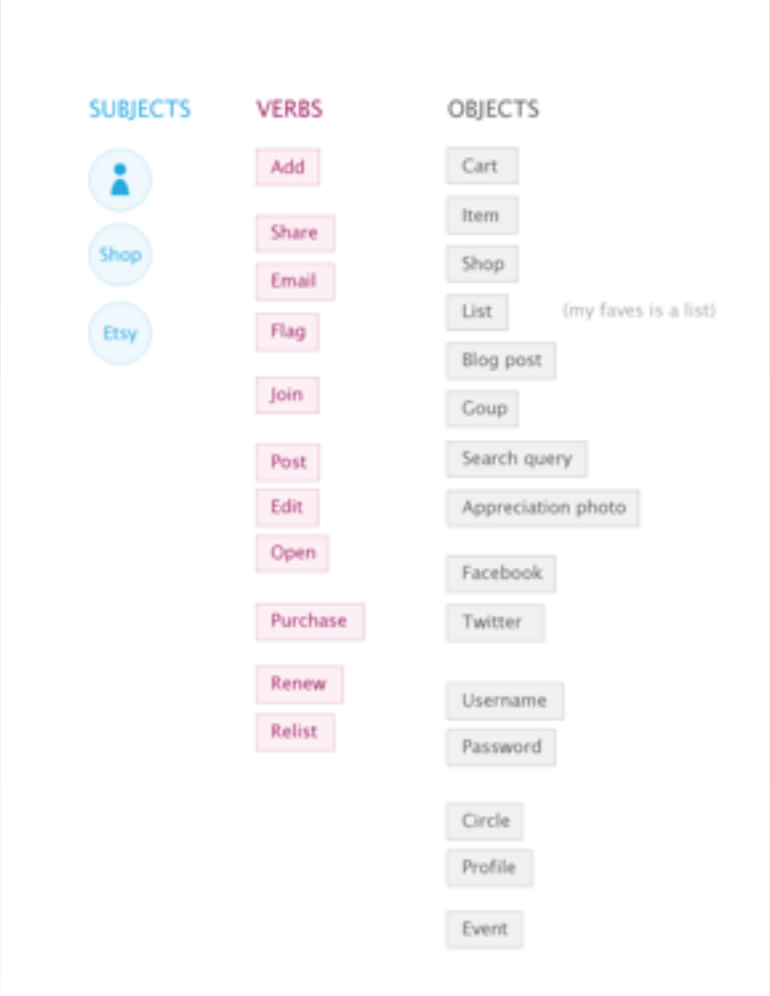
Activity Feeds Architecture

activity := (subject, verb, object)



SUBJECTS

- ●
- Shop
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VERBS

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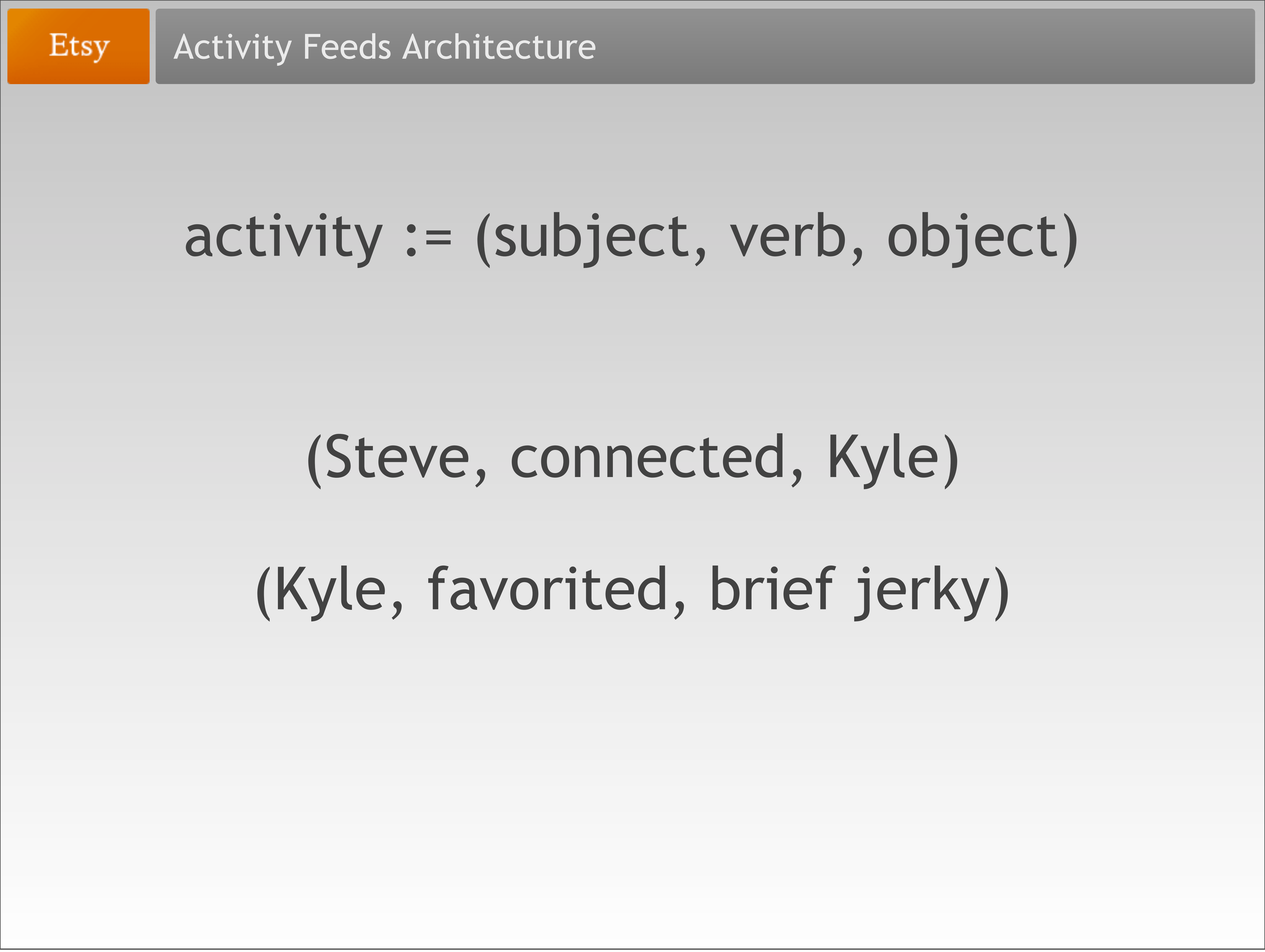
- Facebook
- Twitter
- Username
- Password
- Circle
- Profile
- Event

As you can see in Rob’s magnetic poetry diagram, activities are a description of an event on Etsy boiled down to a subject (“who did it”), a verb (“what they did”), and an object (“what they did it to”).



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Activity Feeds Architecture

activity := (subject, verb, object)

(Steve, connected, Kyle)

(Kyle, favorited, brief jerky)

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Here are some examples of activities.
The first one describes Steve adding Kyle to his circle.
The second one describes Kyle favoriting an item.
In each of these cases note that there are probably several parties interested in these events [examples]. The problem (the main one we're trying to solve with activity feeds) is how to notify all of them about it. In order to achieve that goal, as usual we copy the data all over the place.

~~activity := (subject, verb, object)~~

activity := [owner,(subject, verb, object)]

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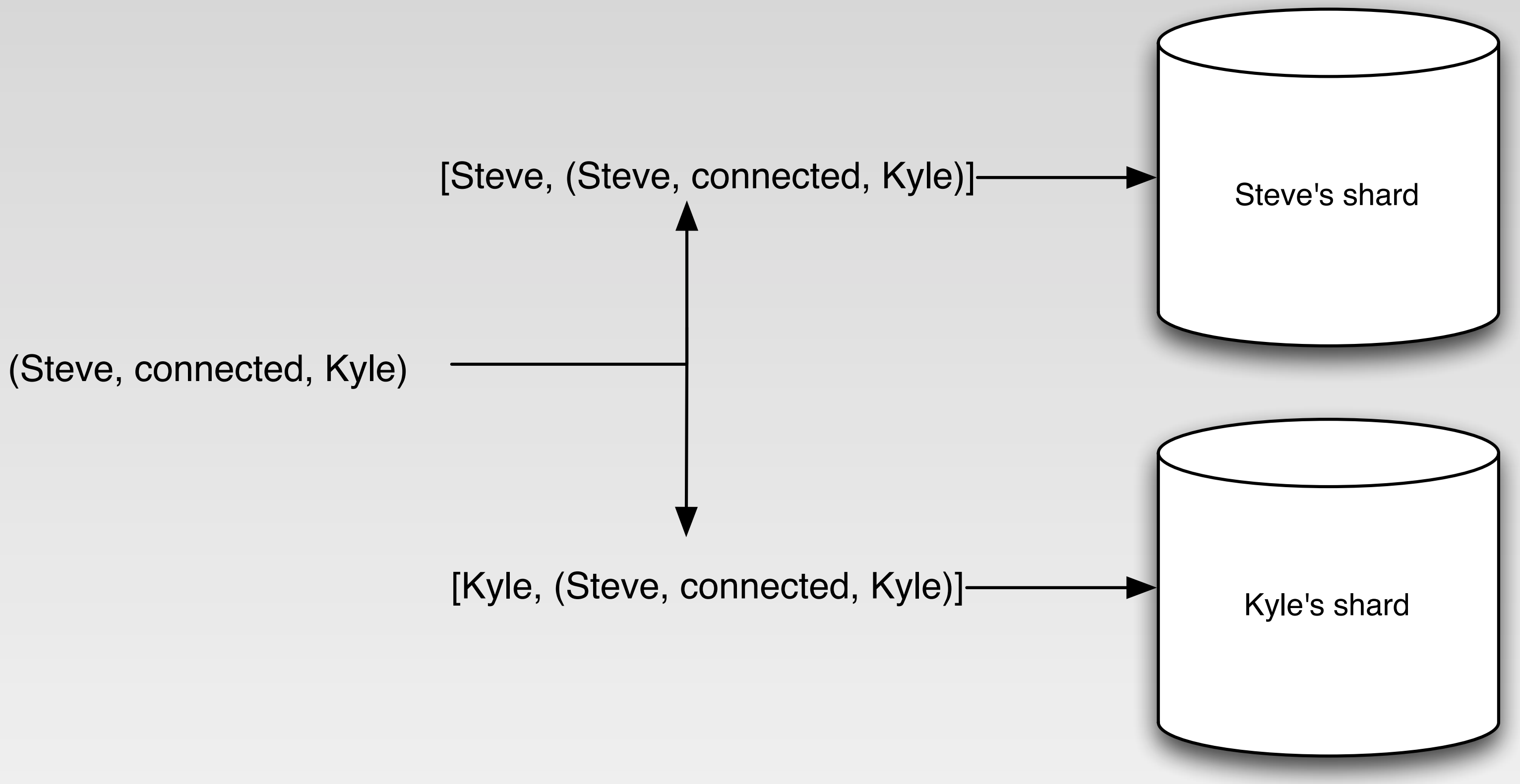
So what we do is duplicate the S,V,O combinations with different owners.
Steve will have his record that he connected to Kyle, and Kyle will be given his own record that Steve connected to him.

activity := [owner,(subject, verb, object)]


[Steve, (Steve, connected, Kyle)]
Steve's shard
(Steve, connected, Kyle)
[Kyle, (Steve, connected, Kyle)]
Kyle's shard

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This is what that looks like.

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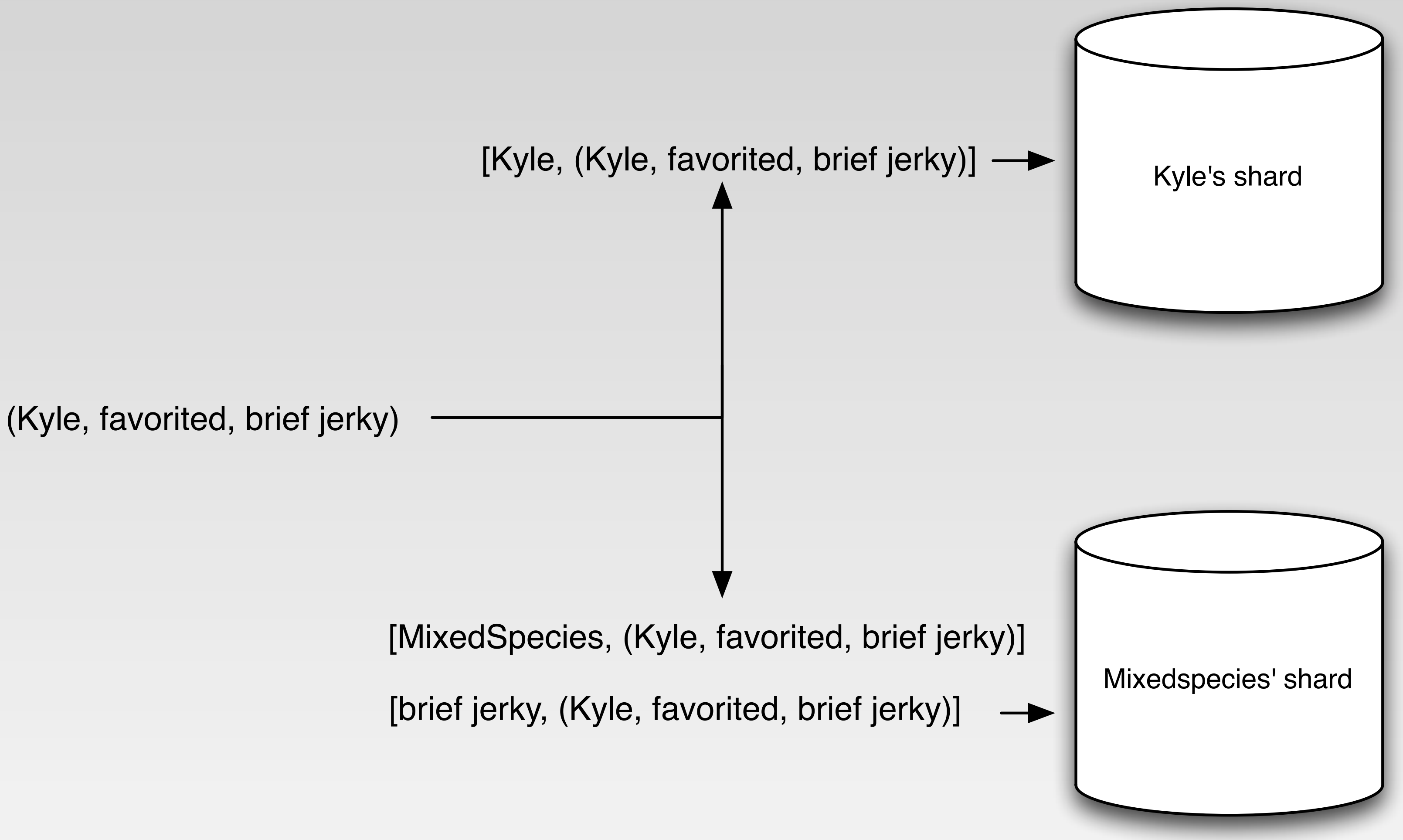
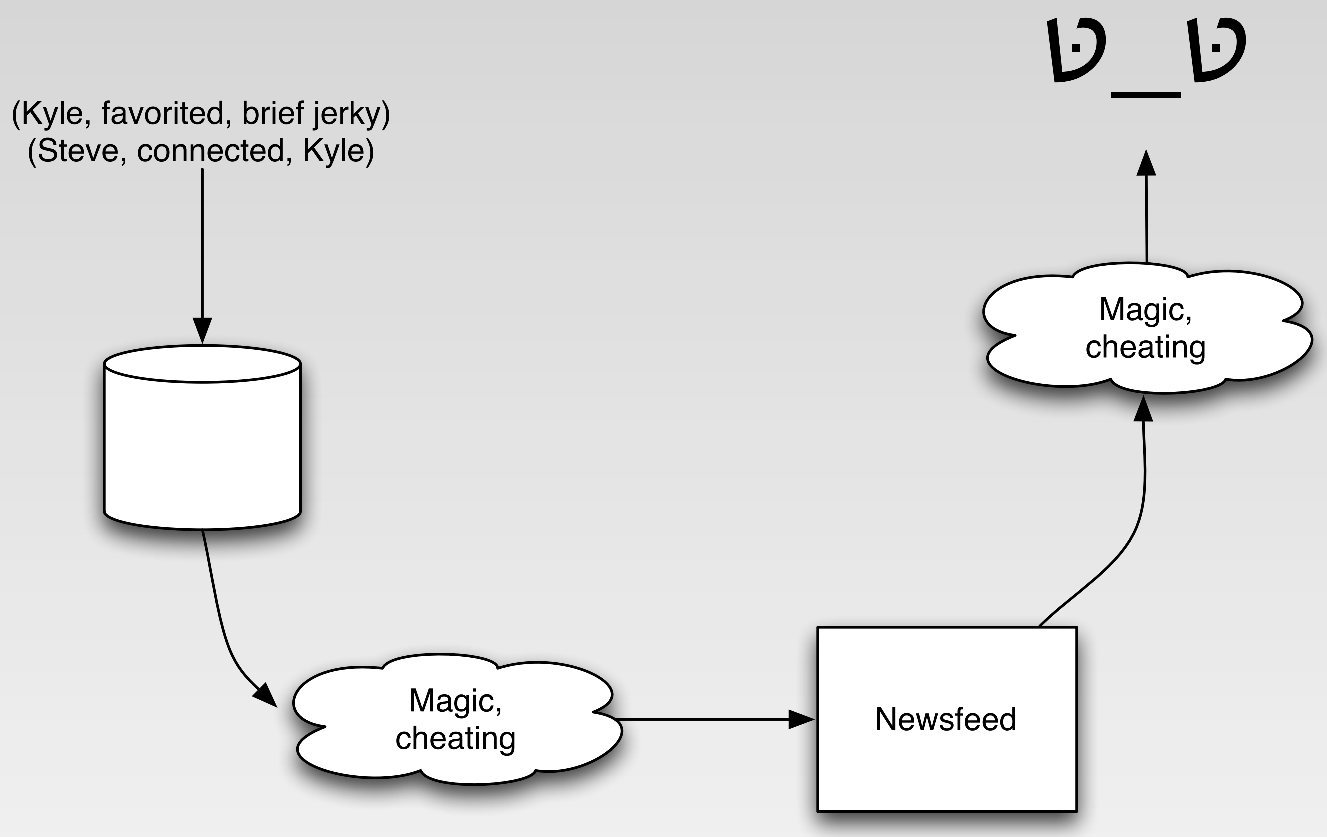
Activity Feeds Architecture

activity := [owner,(subject, verb, object)]


[Kyle, (Kyle, favorited, brief jerky)]
Kyle's shard
(Kyle, favorited, brief jerky)
[MixedSpecies, (Kyle, favorited, brief jerky)]
[brief jerky, (Kyle, favorited, brief jerky)]
Mixedspecies' shard

In more complicated examples there could be more than two owners.
You could envision people being interested in Kyle, people being interested in MixedSpecies, or people being interested in brief jerky.
In cases where there are this many writes, we will generally perform them with Gearman.
Again, in order for interested parties to find the activities, we copy the activities all over the place.

Building a Feed



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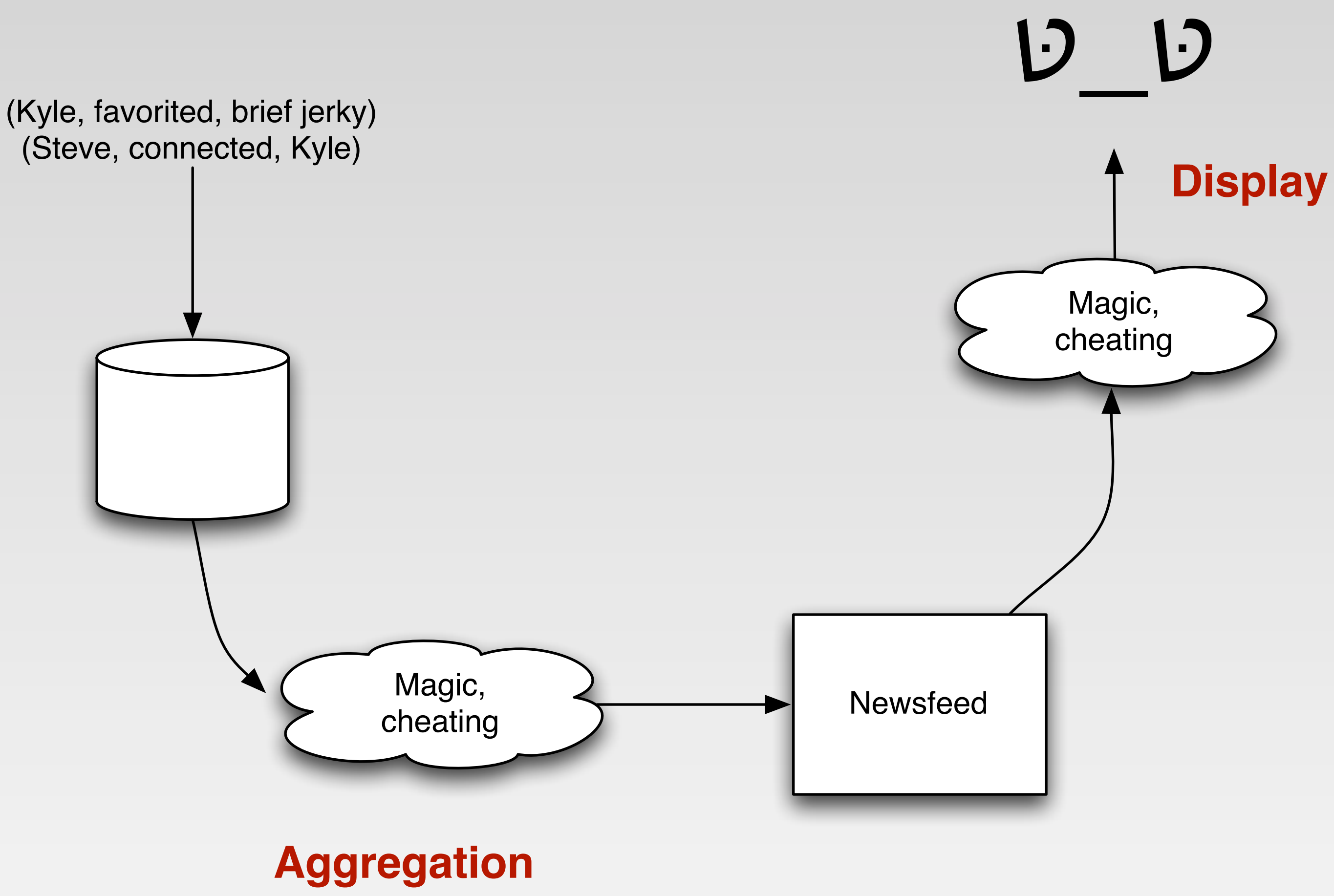
Now that we know about connections and activities, we can talk about how activities are turned into Newsfeeds and how those wind up being displayed to end users.

Building a Feed



ಠ_ಠ

Display

(Kyle, favorited, brief jerky)
(Steve, connected, Kyle)

Magic, cheating

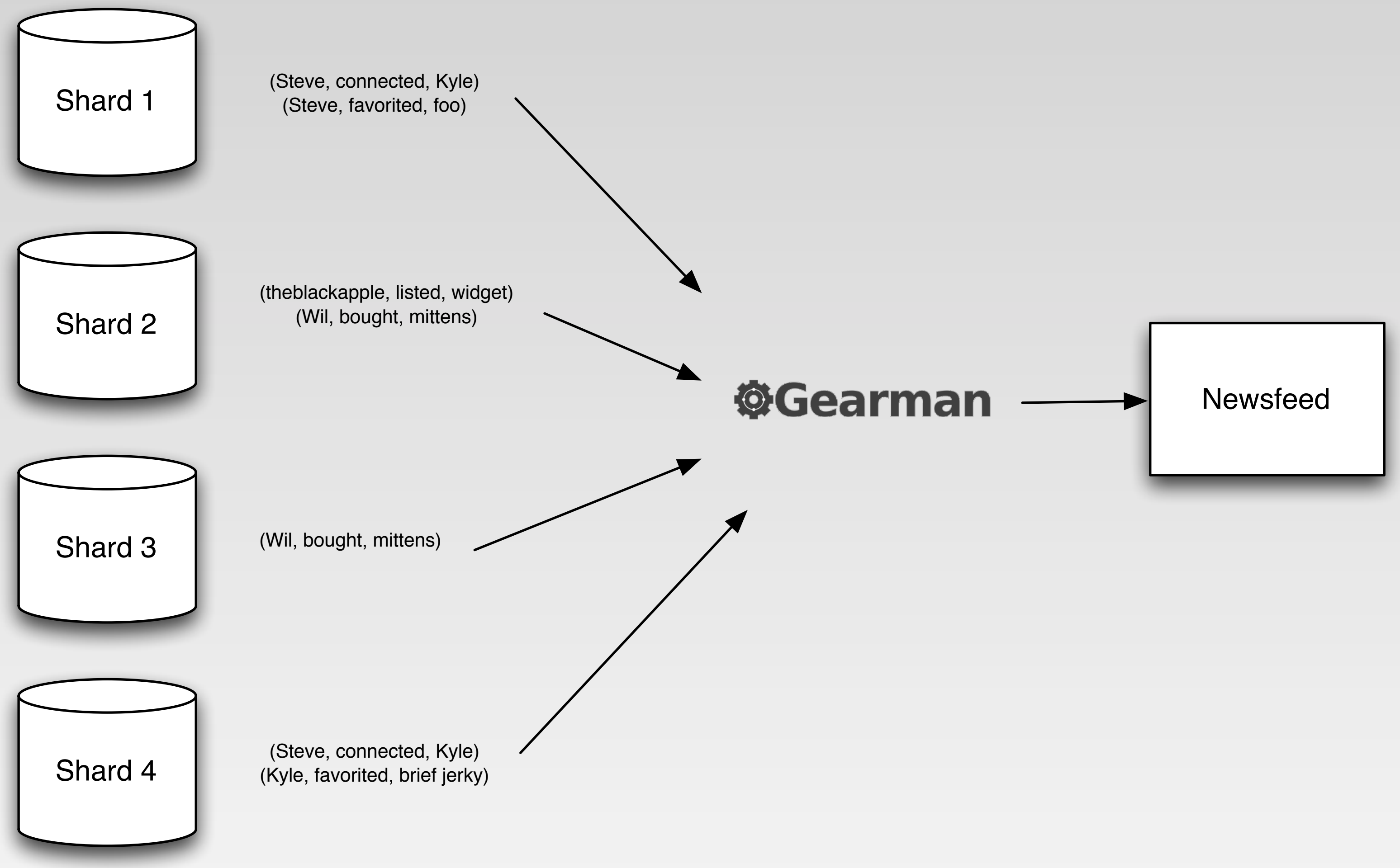
Magic, cheating

Newsfeed

Aggregation

Getting to the end result (the activity feed page) has two distinct phases: aggregation and display.

Aggregation



Shard 1

(Steve, connected, Kyle)
(Steve, favorited, foo)

Shard 2

(theblackapple, listed, widget)
(Wil, bought, mittens)

Shard 3

(Wil, bought, mittens)

Shard 4

(Steve, connected, Kyle)
(Kyle, favorited, brief jerky)

Gearman

Newsfeed

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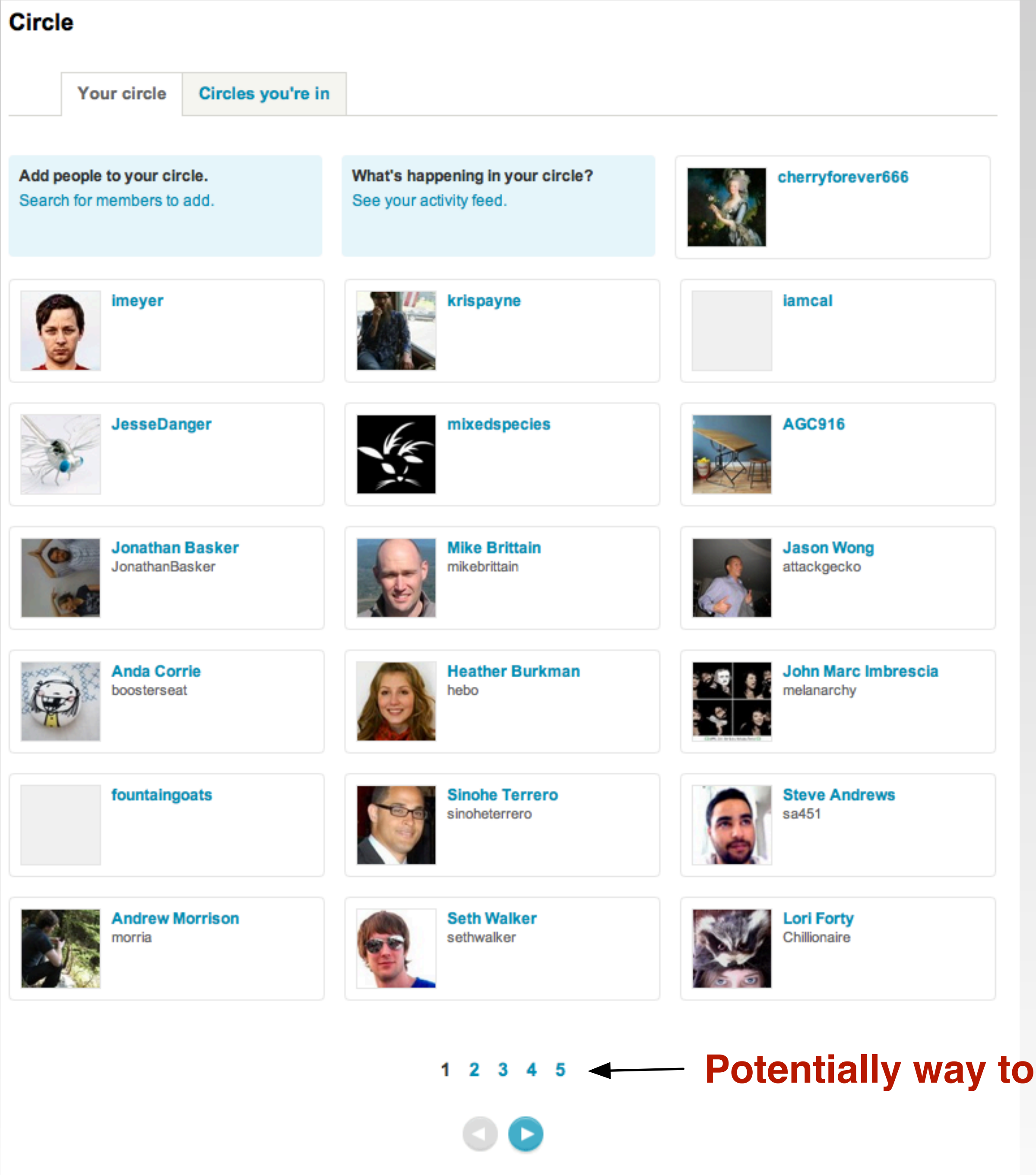
I am going to talk about aggregation first.
Aggregation turns activities (in the database) into a Newsfeed (in memcache).
Aggregation typically occurs offline, with Gearman.

Aggregation, Step 1: Choosing Connections



Circle

Your circle | Circles you're in

Add people to your circle.
Search for members to add.

What's happening in your circle?
See your activity feed.

cherryforever666

imeyer

krispayne

lamcal

JesseDanger

mixedspecies

AGC916

Jonathan Basker
JonathanBasker

Mike Brittain
mikebrittain

Jason Wong
attackgecko

Anda Corrie
boosterseat

Heather Burkman
hebo

John Marc Imbrescia
melanarchy

fountaingoats

Sinohe Terrero
sinoheterrero

Steve Andrews
sa451

Andrew Morrison
morria

Seth Walker
sethwalker

Lori Forty
Chillionaire

1 2 3 4 5

Potentially way too many

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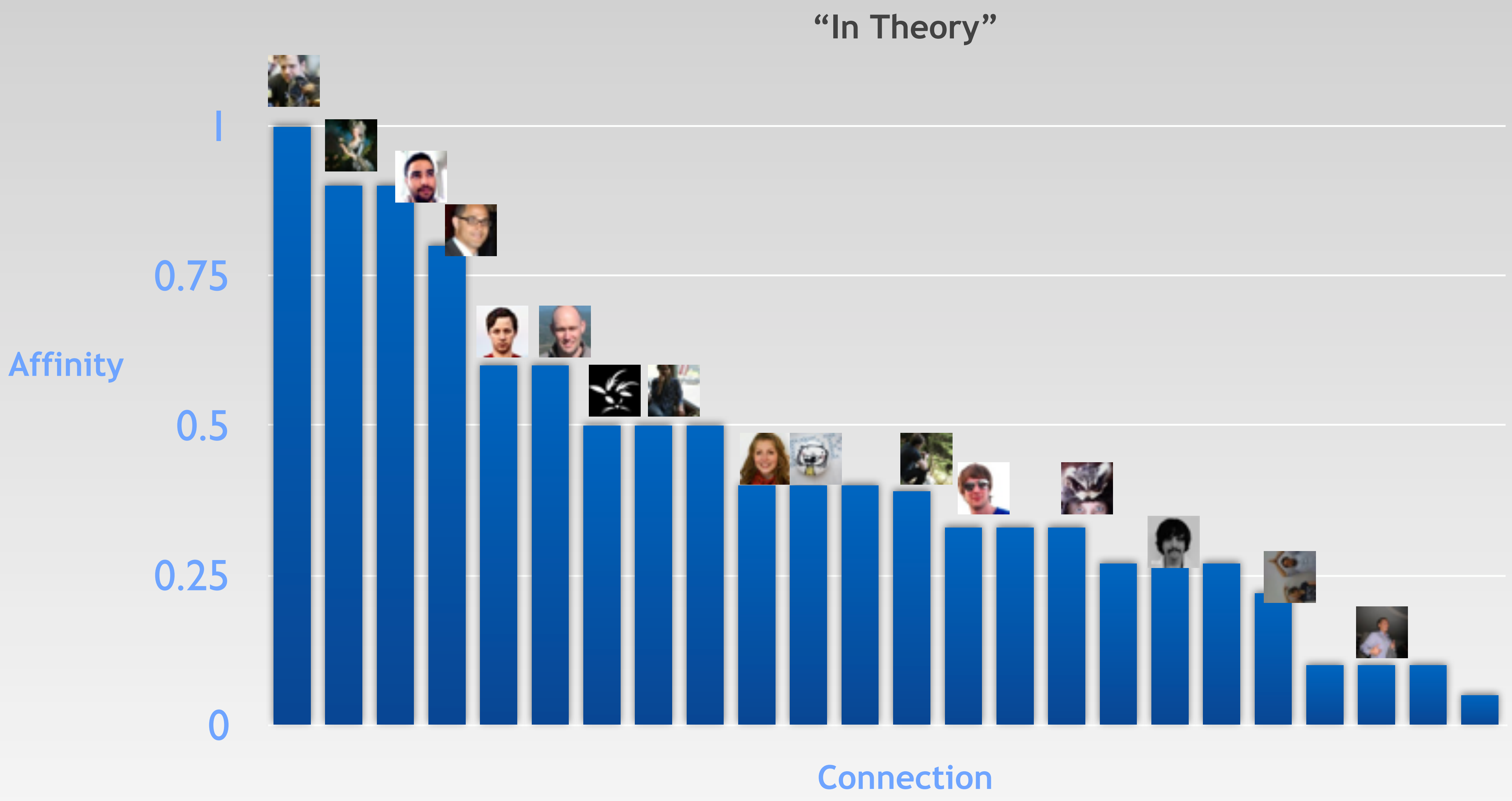
We already allow people to have more connections than would make sense on a single feed, or could be practically aggregated all at once.

The first step in aggregation is to turn the list of people you are connected to into the list of people we're actually going to go seek out activities for.

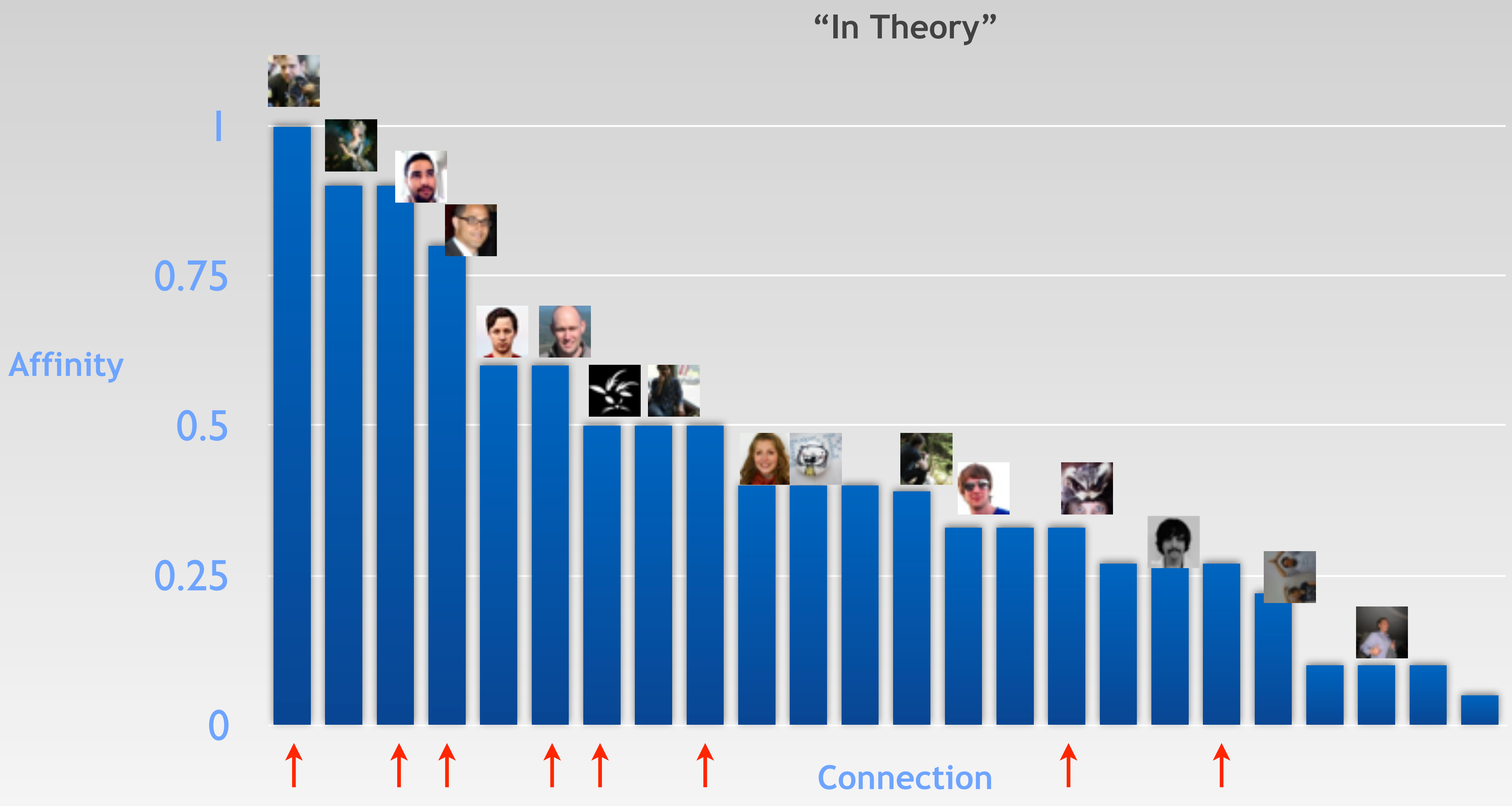
Aggregation, Step 1: Choosing Connections



$choose_connection = mt_rand() < $affinity;

In theory, the way we would do this is rank the connections by affinity and then treat the affinity as the probability that we'll pick it.

Aggregation, Step 1: Choosing Connections



$choose_connection = mt_rand() < $affinity;

So then we'd be more likely to pick the close connections, but leaving the possibility that we will pick the distant ones.

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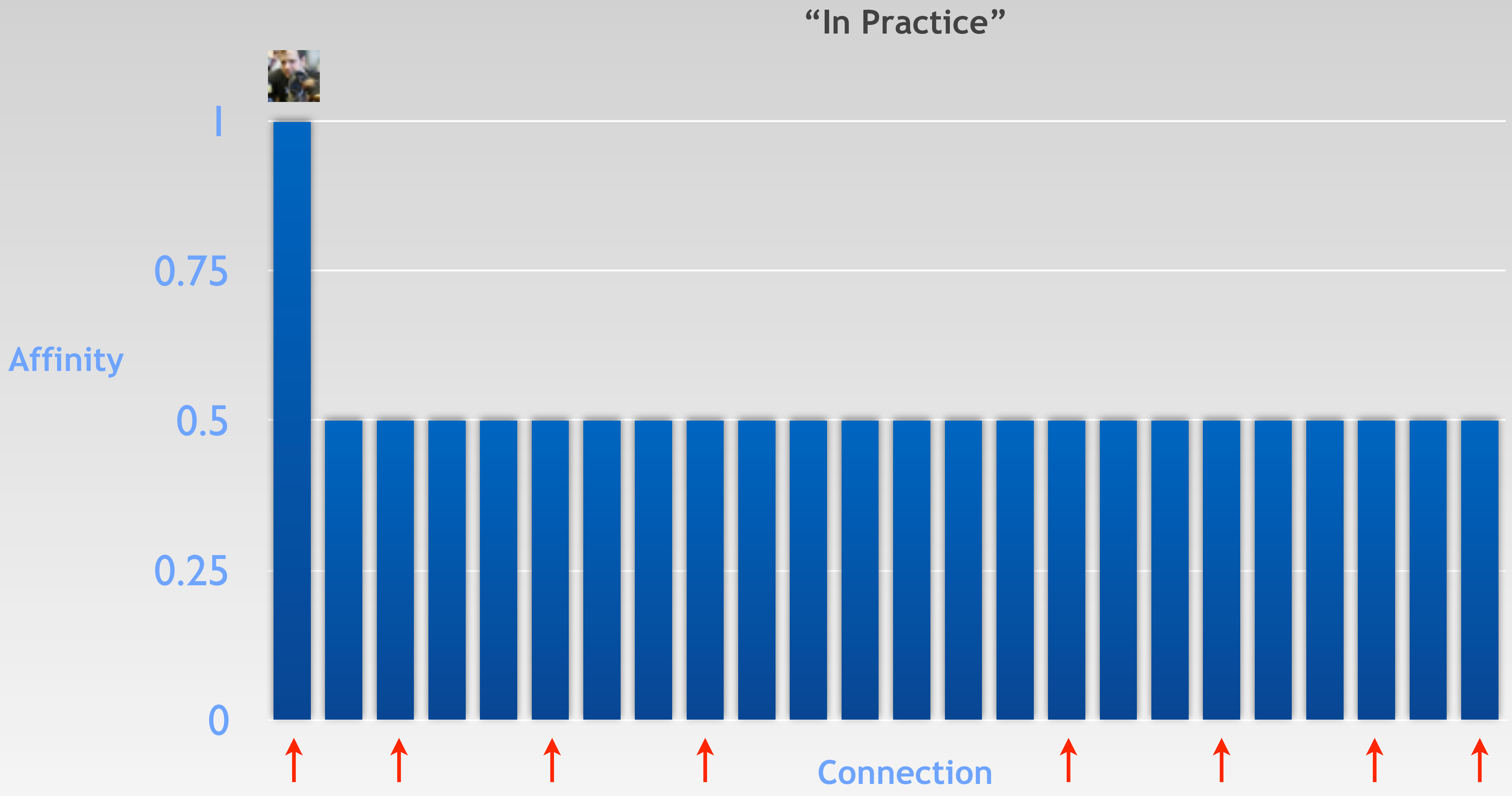
Activity Feeds Architecture

Aggregation, Step 1: Choosing Connections



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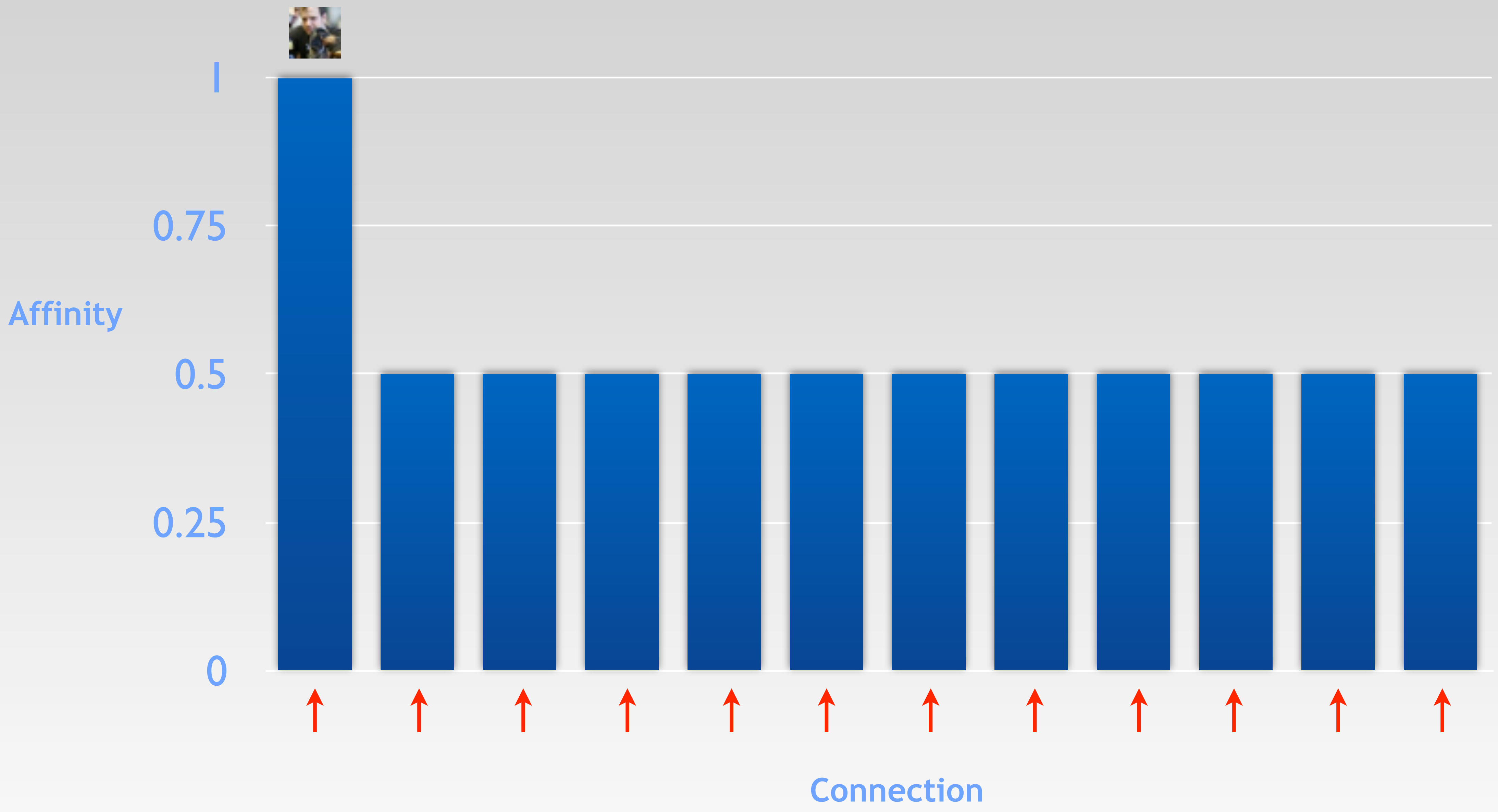
In practice we don’t really handle affinity yet.

Aggregation, Step 1: Choosing Connections

“*Even More* In Practice”



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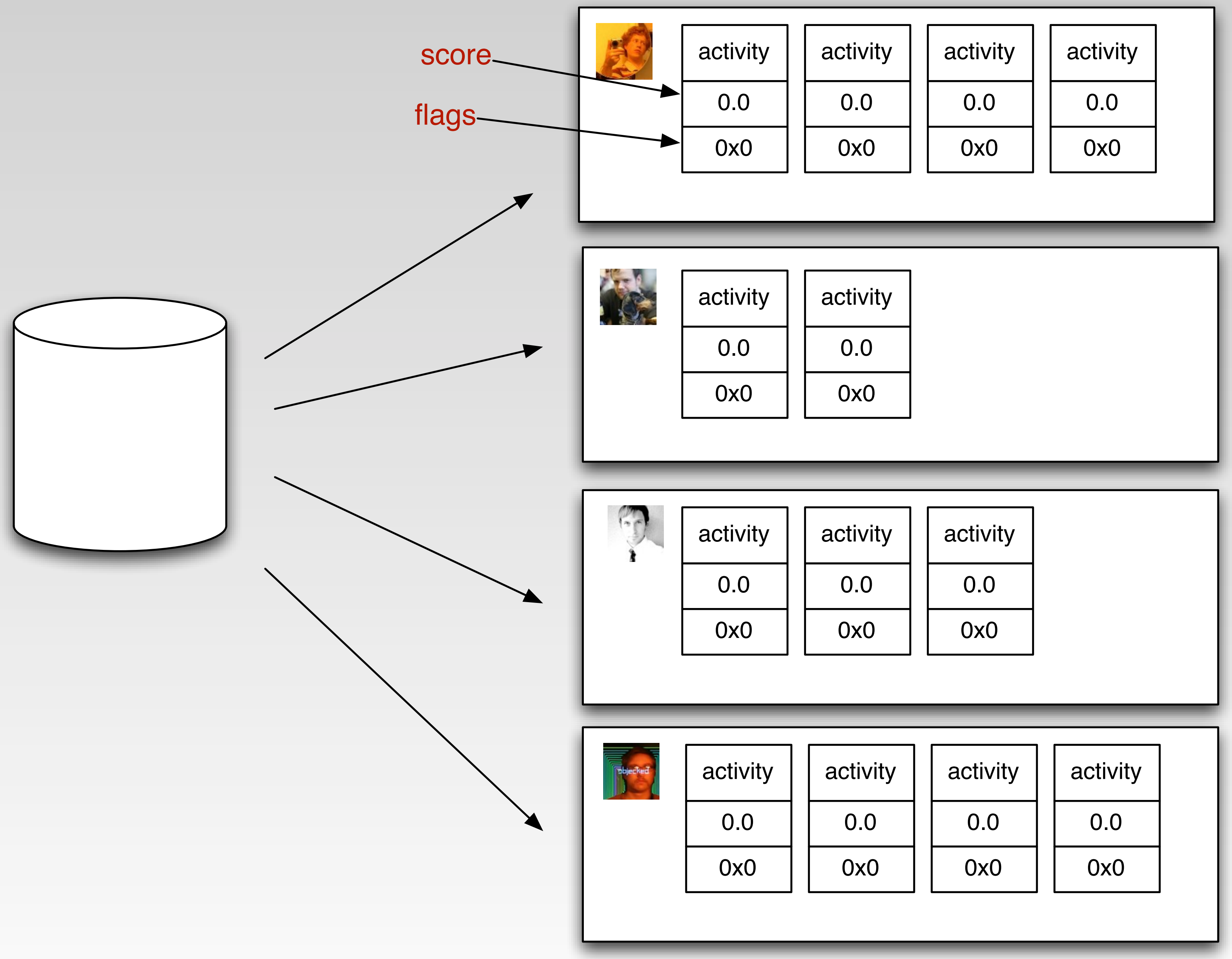
And most people don’t currently have enough connections for this to matter at all. (Mean connections is around a dozen.)

Aggregation, Step 2: Making Activity Sets

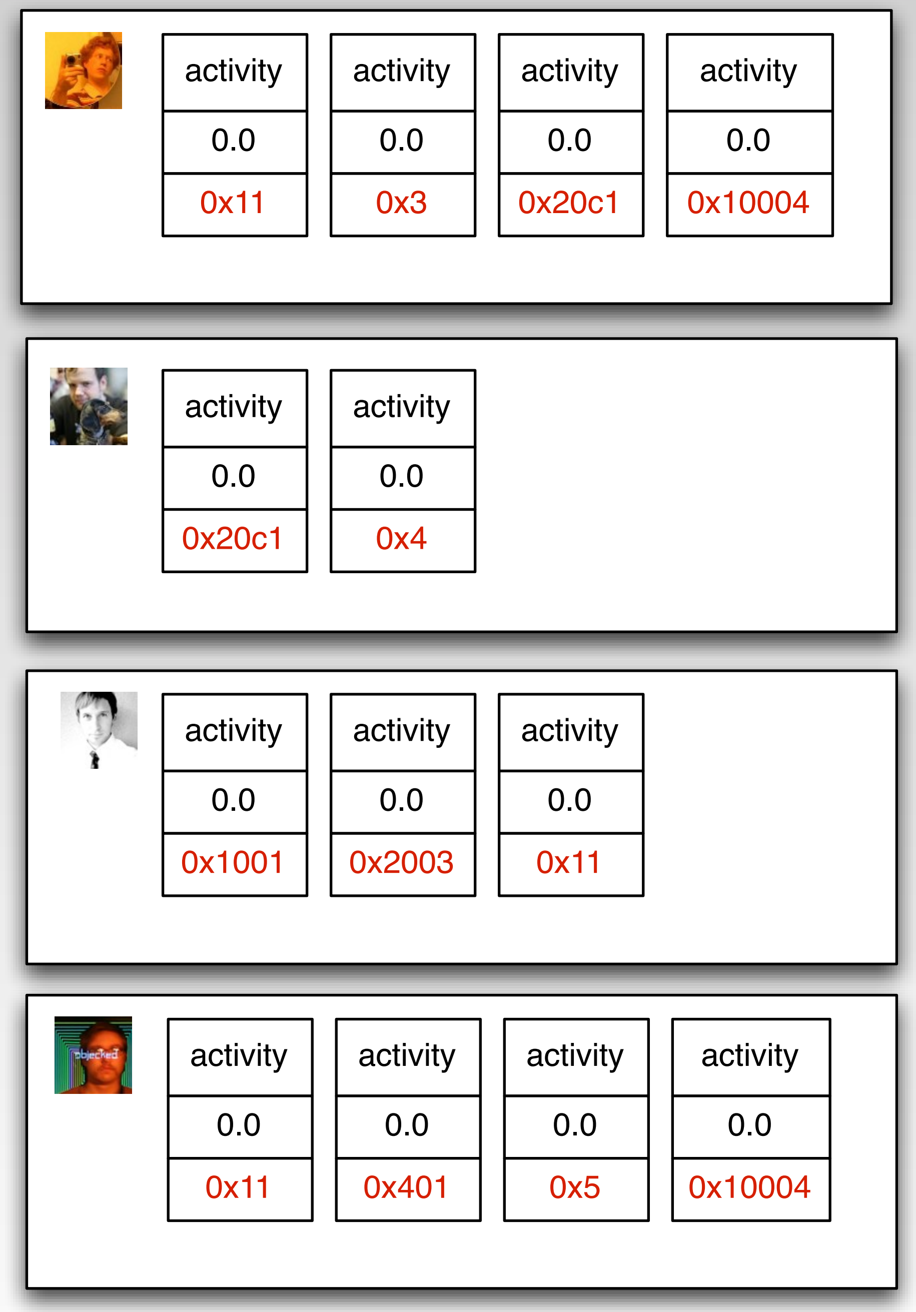


Once the connections are chosen, we then select historical activity for them and convert them into in-memory structures called activity sets.

These are just the activities grouped by connection, with a score and flags field for each.

The next few phases of aggregation operate on these.

Aggregation, Step 3: Classification



activity	activity	activity	activity
0.0	0.0	0.0	0.0
0x11	0x3	0x20c1	0x10004

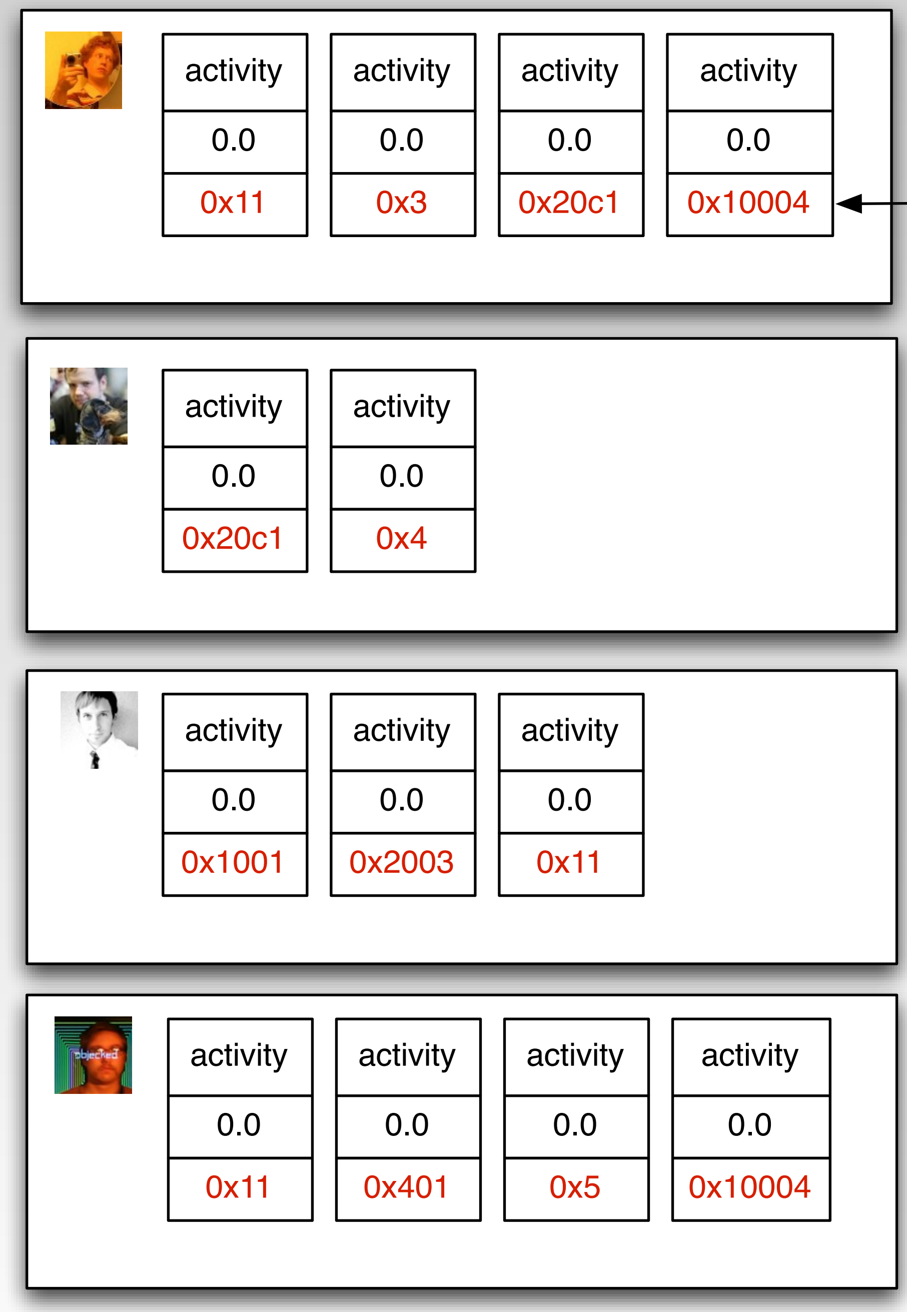
activity	activity
0.0	0.0
0x20c1	0x4

activity	activity	activity
0.0	0.0	0.0
0x1001	0x2003	0x11

activity	activity	activity	activity
0.0	0.0	0.0	0.0
0x11	0x401	0x5	0x10004

The next thing that happens is that we iterate through all of the activities in all of the sets and classify them.

Aggregation, Step 3: Classification



activity	activity	activity	activity
0.0	0.0	0.0	0.0
0x11	0x3	0x20c1	0x10004

activity	activity
0.0	0.0
0x20c1	0x4

activity	activity	activity
0.0	0.0	0.0
0x1001	0x2003	0x11

activity	activity	activity	activity
0.0	0.0	0.0	0.0
0x11	0x401	0x5	0x10004

about_owner_shop | user_created_treasury

Rob created a treasury featuring
the feed owner's shop.

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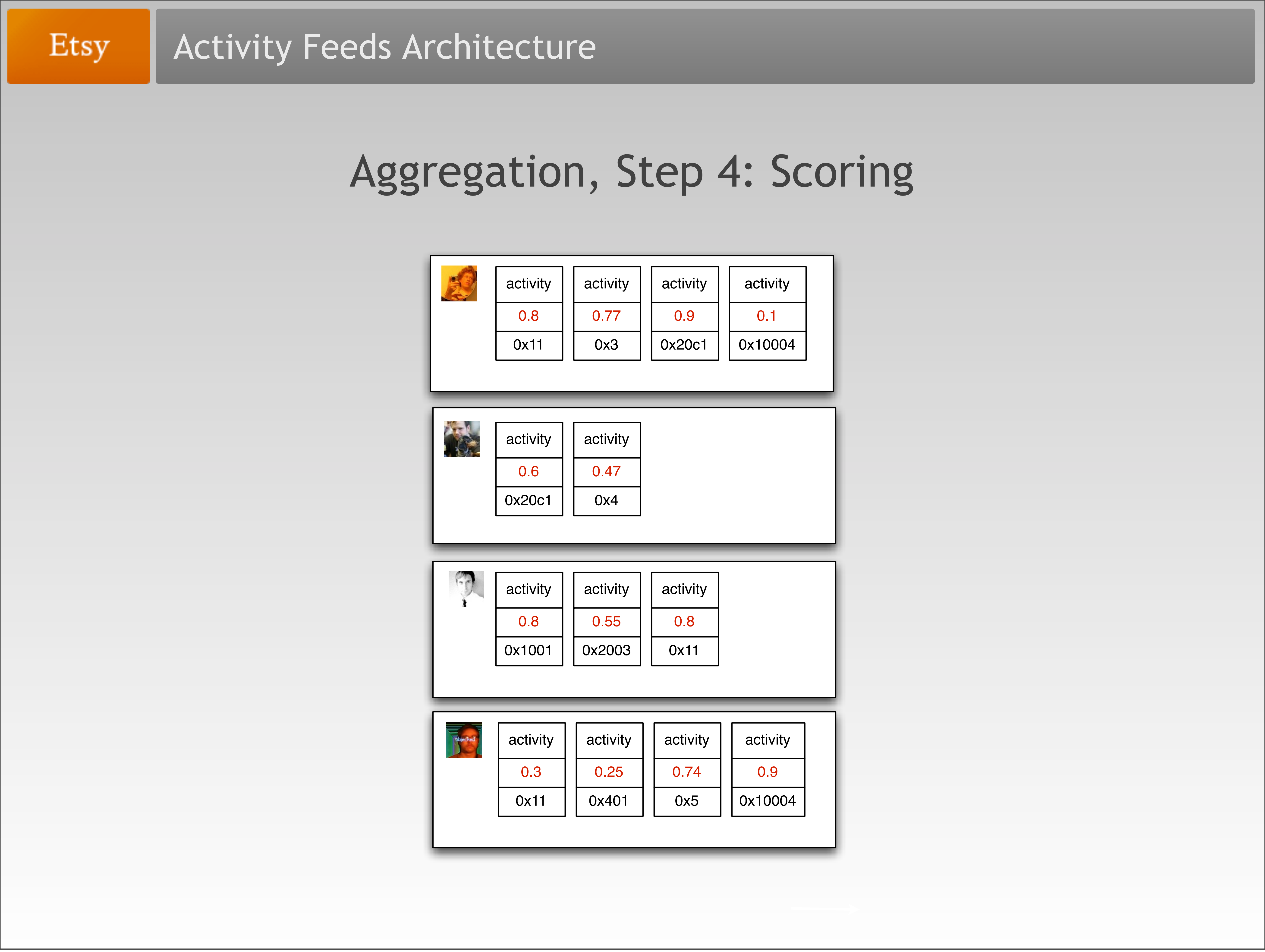
The flags are a bit field.
They are all from the point of view of the feed owner.
So the same activities on another person’s feed would be assigned different flags.



Aggregation, Step 4: Scoring

activity	activity	activity	activity
0.8	0.77	0.9	0.1
0x11	0x3	0x20c1	0x10004

activity	activity
0.6	0.47
0x20c1	0x4

activity	activity	activity
0.8	0.55	0.8
0x1001	0x2003	0x11

activity	activity	activity	activity
0.3	0.25	0.74	0.9
0x11	0x401	0x5	0x10004

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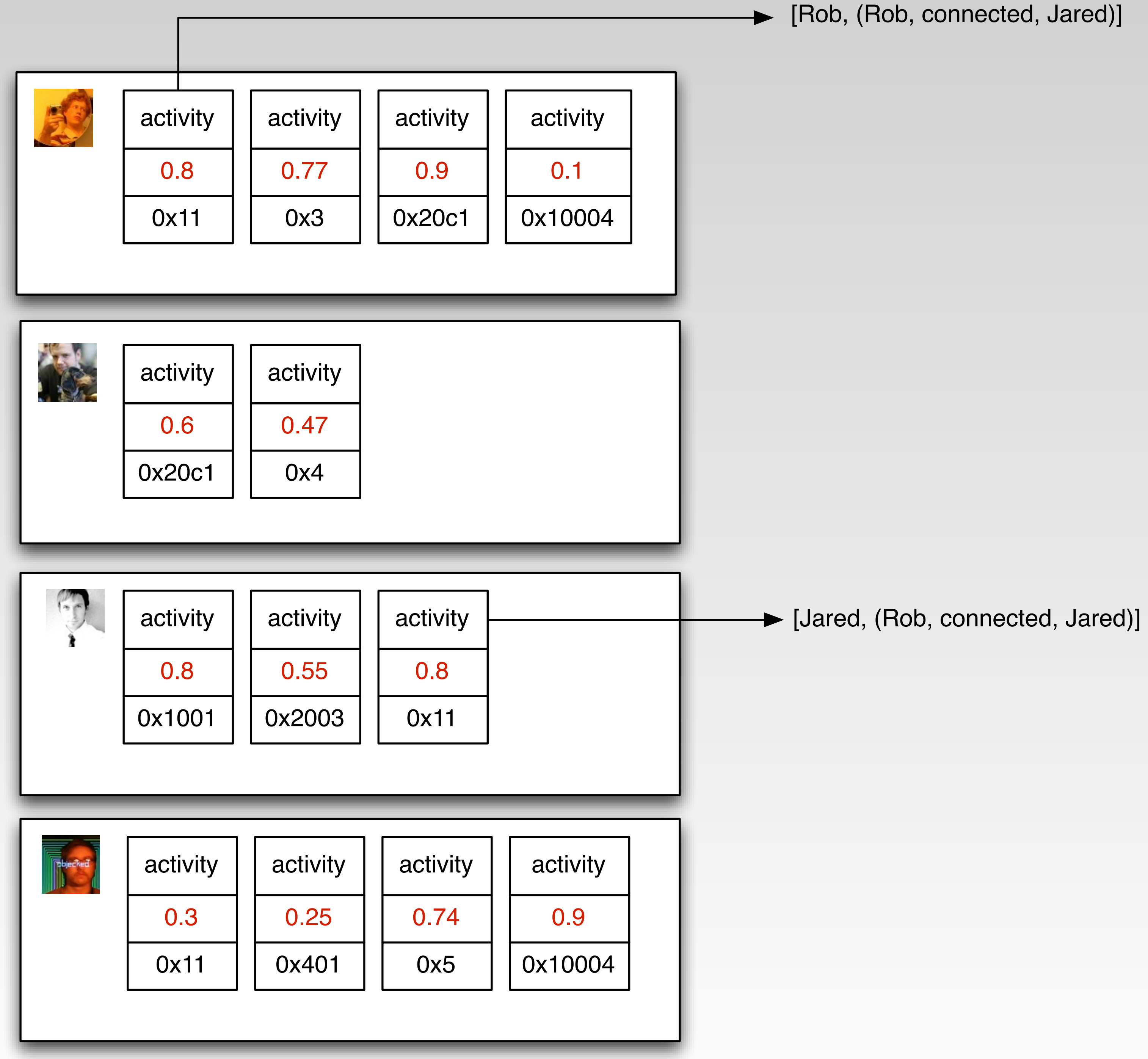
Next we fill in the score fields.

At this point the score is just a simple time decay function (older activities always score lower than new ones).

Aggregation, Step 5: Pruning



activity	activity	activity	activity
0.8	0.77	0.9	0.1
0x11	0x3	0x20c1	0x10004

activity	activity
0.6	0.47
0x20c1	0x4

activity	activity	activity
0.8	0.55	0.8
0x1001	0x2003	0x11

activity	activity	activity	activity
0.3	0.25	0.74	0.9
0x11	0x401	0x5	0x10004

[Rob, (Rob, connected, Jared)]
[Jared, (Rob, connected, Jared)]

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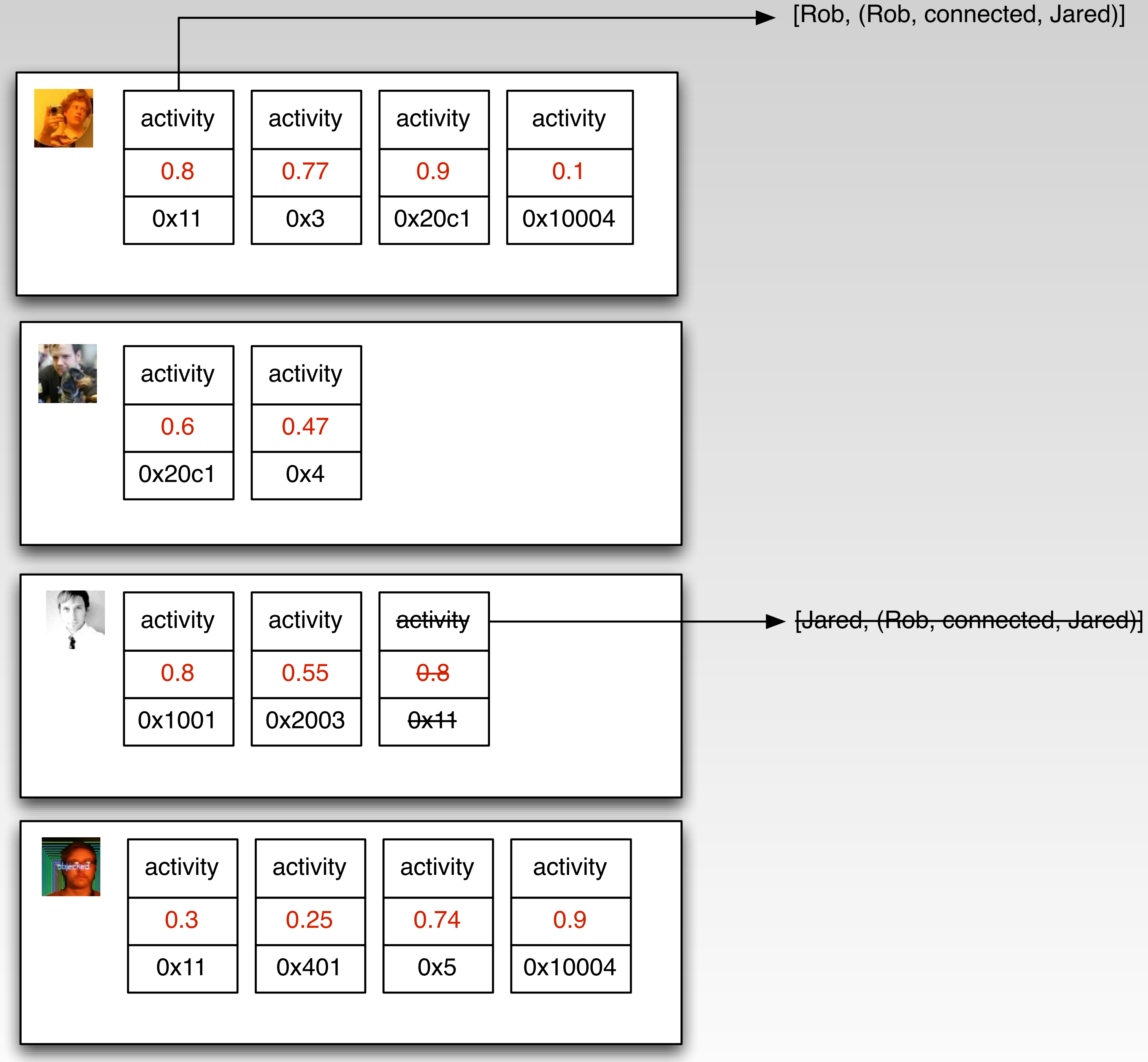
As we noted before it’s possible to wind up seeing the same event as two or more activities. The next stage of aggregation detects these situations.

Aggregation, Step 5: Pruning



[Rob, (Rob, connected, Jared)]

activity	activity	activity	activity
0.8	0.77	0.9	0.1
0x11	0x3	0x20c1	0x10004

activity	activity
0.6	0.47
0x20c1	0x4

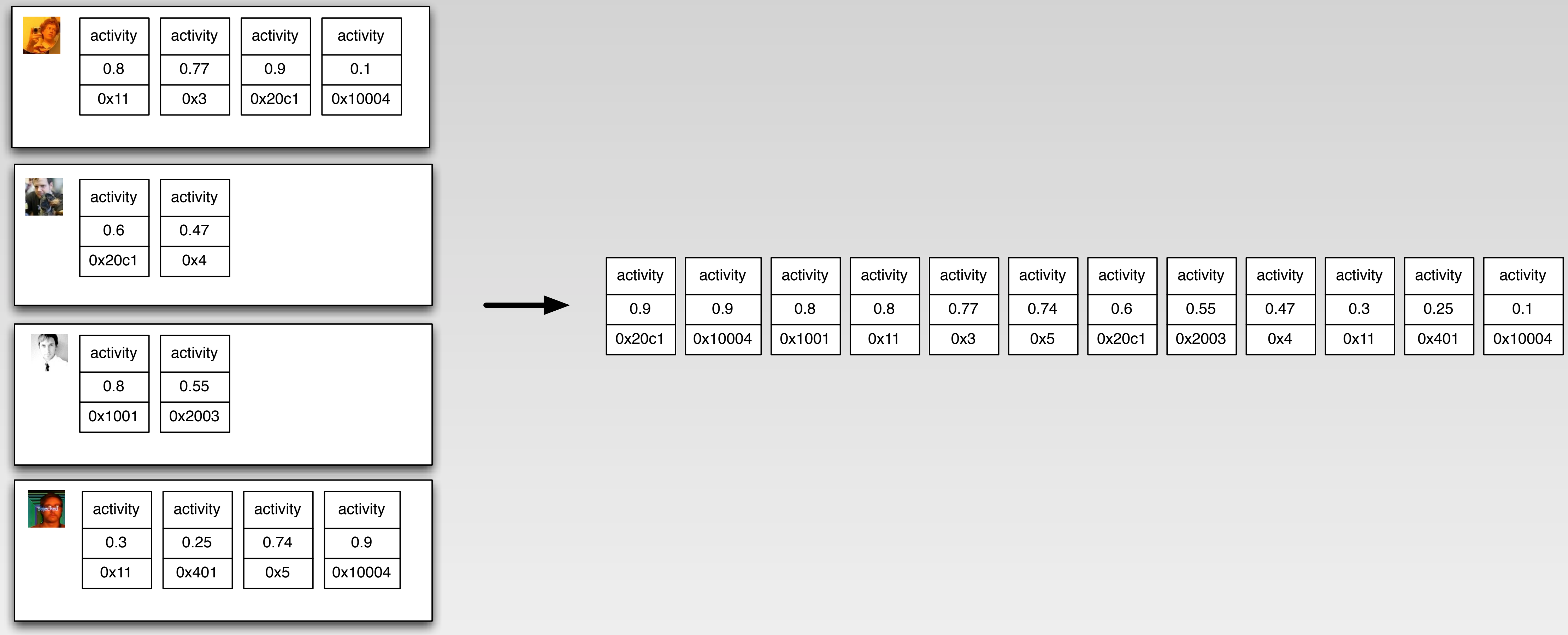
activity	activity	~~activity~~
0.8	0.55	~~0.8~~
0x1001	0x2003	~~0x11~~

~~[Jared, (Rob, connected, Jared)]~~

activity	activity	activity	activity
0.3	0.25	0.74	0.9
0x11	0x401	0x5	0x10004

We iterate through the activity sets and remove the duplicates.
Right now we can just cross off the second instance of the SVO pair; once we have comments this will be more complicated.

Aggregation, Step 6: Sort & Merge



activity	activity	activity	activity
0.8	0.77	0.9	0.1
0x11	0x3	0x20c1	0x10004

activity	activity
0.6	0.47
0x20c1	0x4

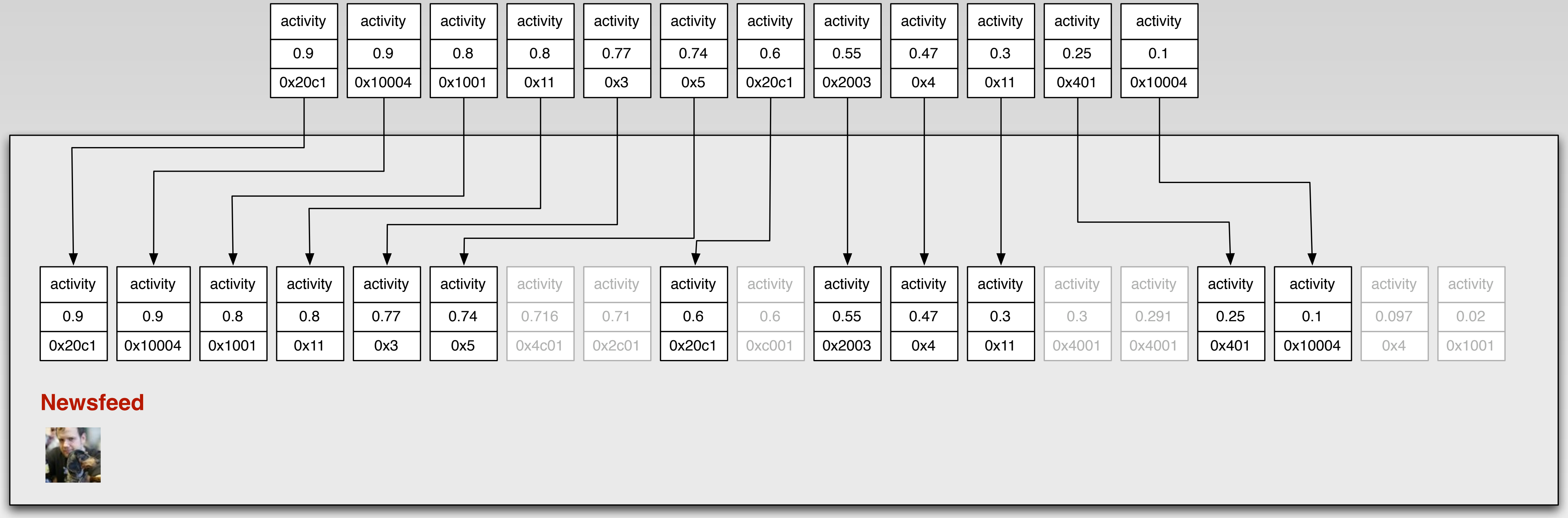
activity	activity
0.8	0.55
0x1001	0x2003

activity	activity	activity	activity
0.3	0.25	0.74	0.9
0x11	0x401	0x5	0x10004

activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity
0.9	0.9	0.8	0.8	0.77	0.74	0.6	0.55	0.47	0.3	0.25	0.1
0x20c1	0x10004	0x1001	0x11	0x3	0x5	0x20c1	0x2003	0x4	0x11	0x401	0x10004

Once everything is scored, classified, and de-duped we can flatten the whole thing and sort it by score.

Aggregation, Step 6: Sort & Merge



activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity
0.9	0.9	0.8	0.8	0.77	0.74	0.6	0.55	0.47	0.3	0.25	0.1
0x20c1	0x10004	0x1001	0x11	0x3	0x5	0x20c1	0x2003	0x4	0x11	0x401	0x10004

activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity
0.9	0.9	0.8	0.8	0.77	0.74	0.716	0.71	0.6	0.6	0.55	0.47	0.3	0.3	0.291	0.25	0.1	0.097	0.02
0x20c1	0x10004	0x1001	0x11	0x3	0x5	0x4c01	0x2c01	0x20c1	0xc001	0x2003	0x4	0x11	0x4001	0x4001	0x401	0x10004	0x4	0x1001

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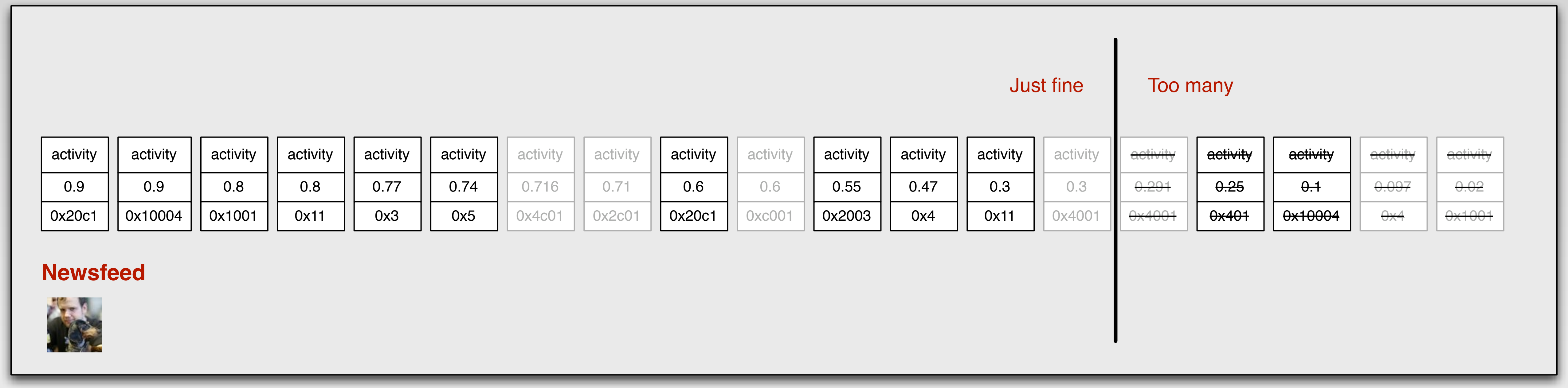
Then we take the final set of activities and merge it on to the owner's existing newsfeed. (Or we create a new newsfeed if they don't have one.)

Aggregation: Cleaning Up



Just fine

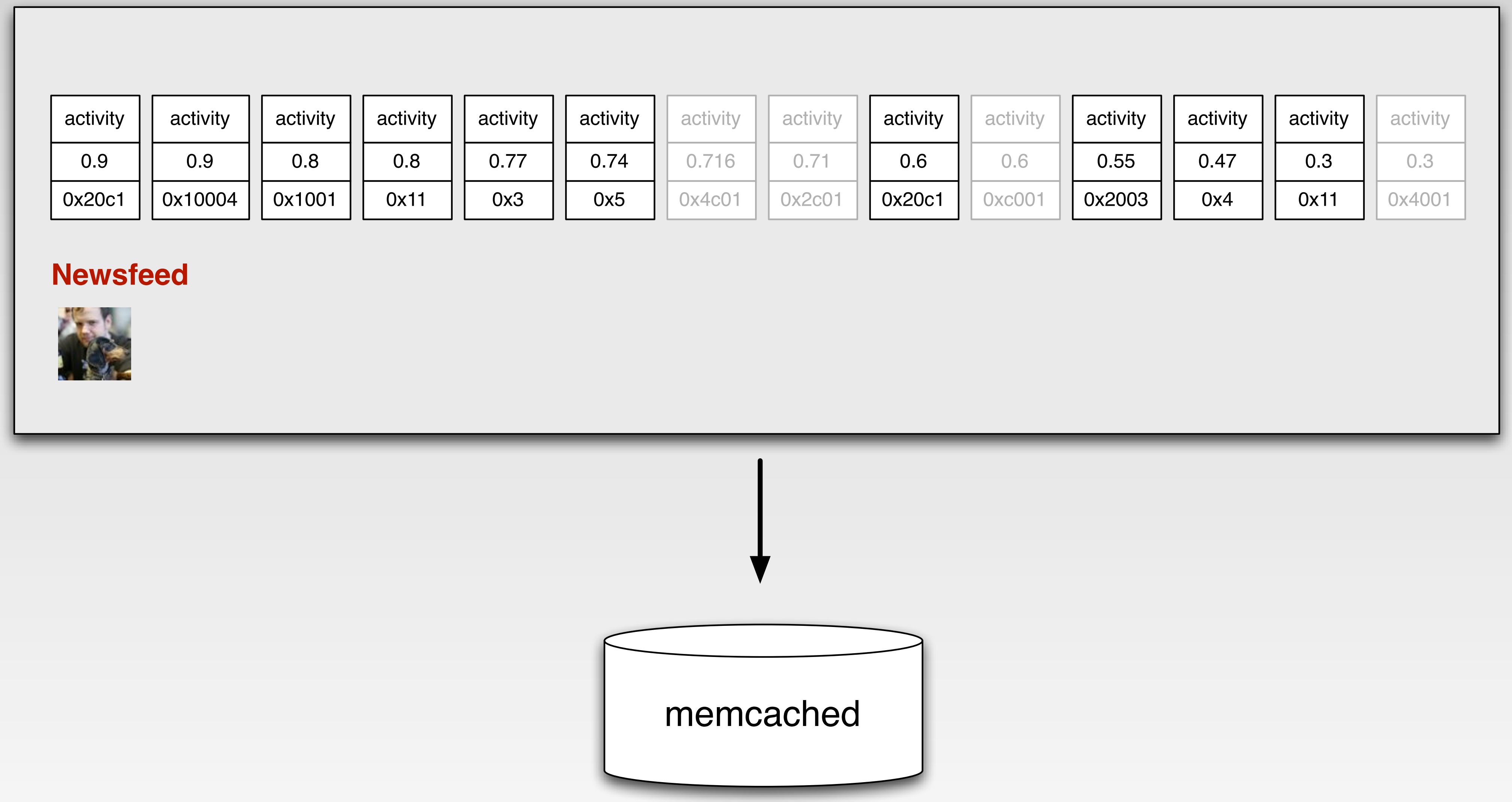
Too many

activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	~~activity~~	~~activity~~	~~activity~~	~~activity~~	~~activity~~
0.9	0.9	0.8	0.8	0.77	0.74	0.716	0.71	0.6	0.6	0.55	0.47	0.3	0.3	~~0.291~~	~~0.25~~	~~0.1~~	~~0.097~~	~~0.02~~
0x20c1	0x10004	0x1001	0x11	0x3	0x5	0x4c01	0x2c01	0x20c1	0xc001	0x2003	0x4	0x11	0x4001	~~0x4001~~	~~0x401~~	~~0x10004~~	~~0x4~~	~~0x1001~~

Newsfeed

We trim off the end of the newsfeed, so that they don’t become arbitrarily large.

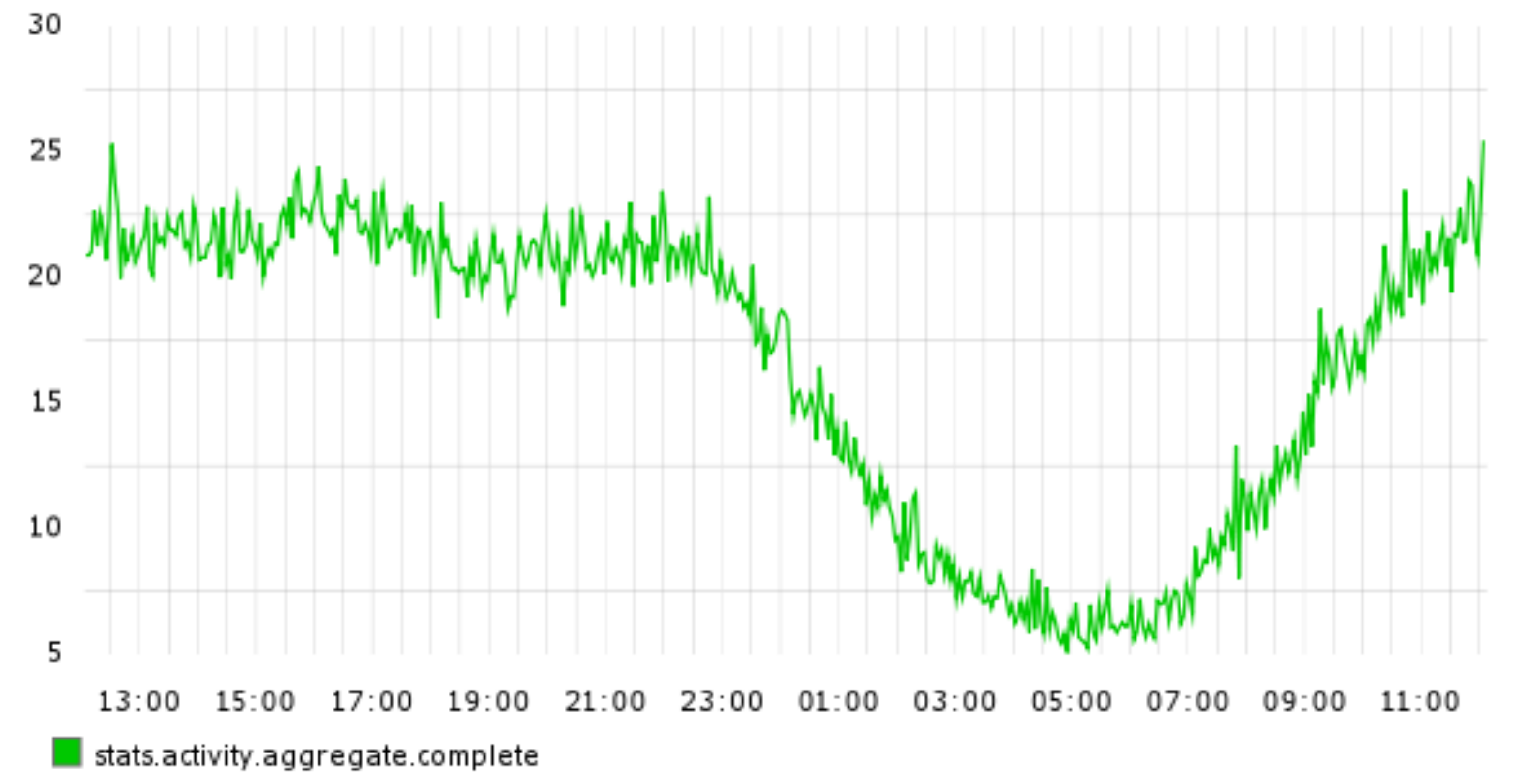
Aggregation: Cleaning Up



activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity	activity
0.9	0.9	0.8	0.8	0.77	0.74	0.716	0.71	0.6	0.6	0.55	0.47	0.3	0.3
0x20c1	0x10004	0x1001	0x11	0x3	0x5	0x4c01	0x2c01	0x20c1	0xc001	0x2003	0x4	0x11	0x4001

And then finally we stuff the feed into memcached.

Aggregation



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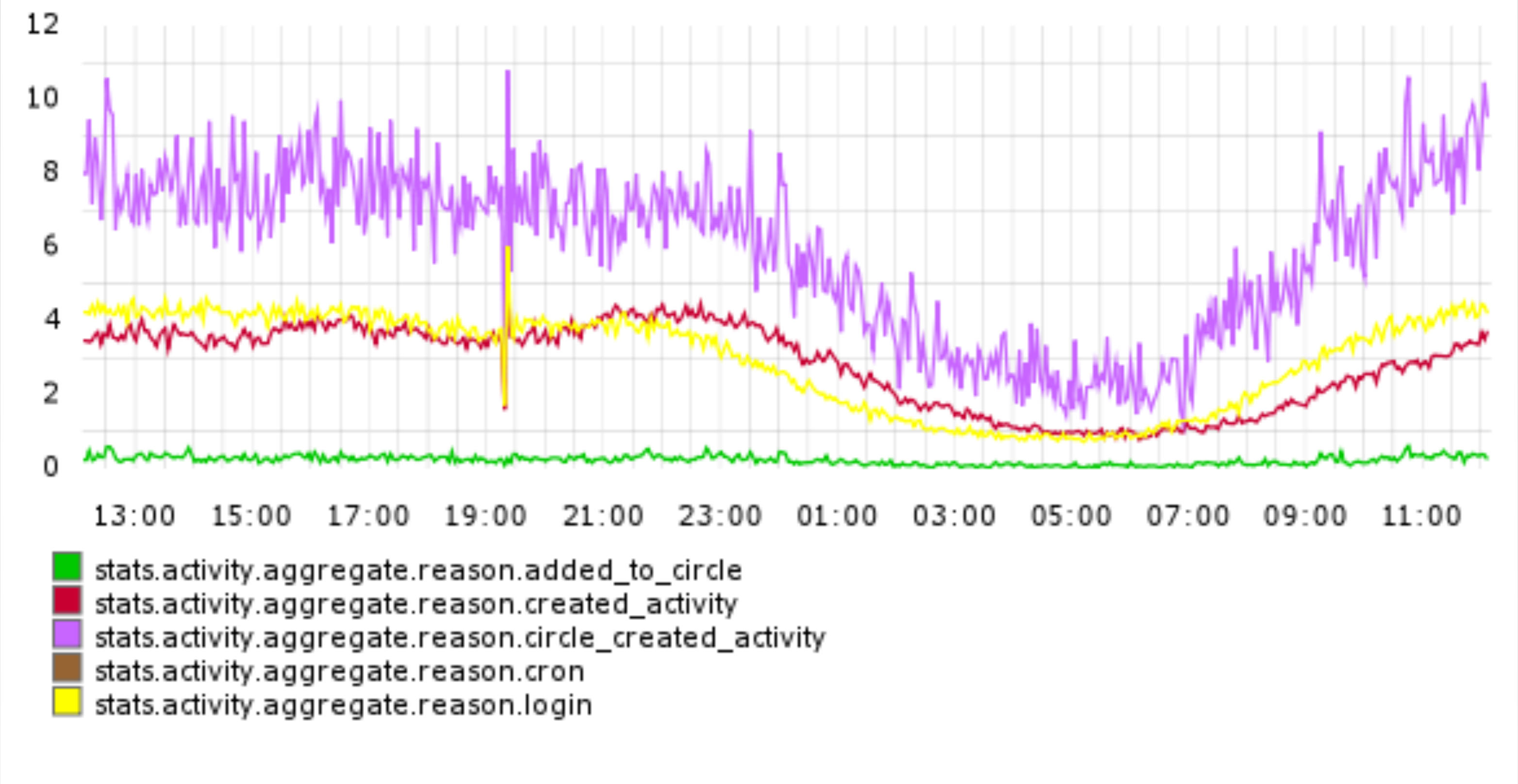
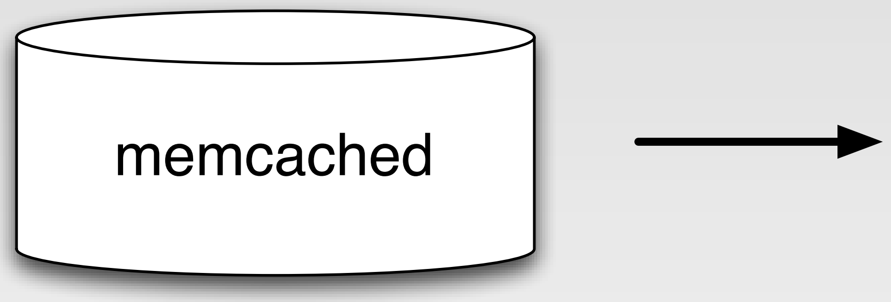
Currently we peak at doing this about 25 times per second.

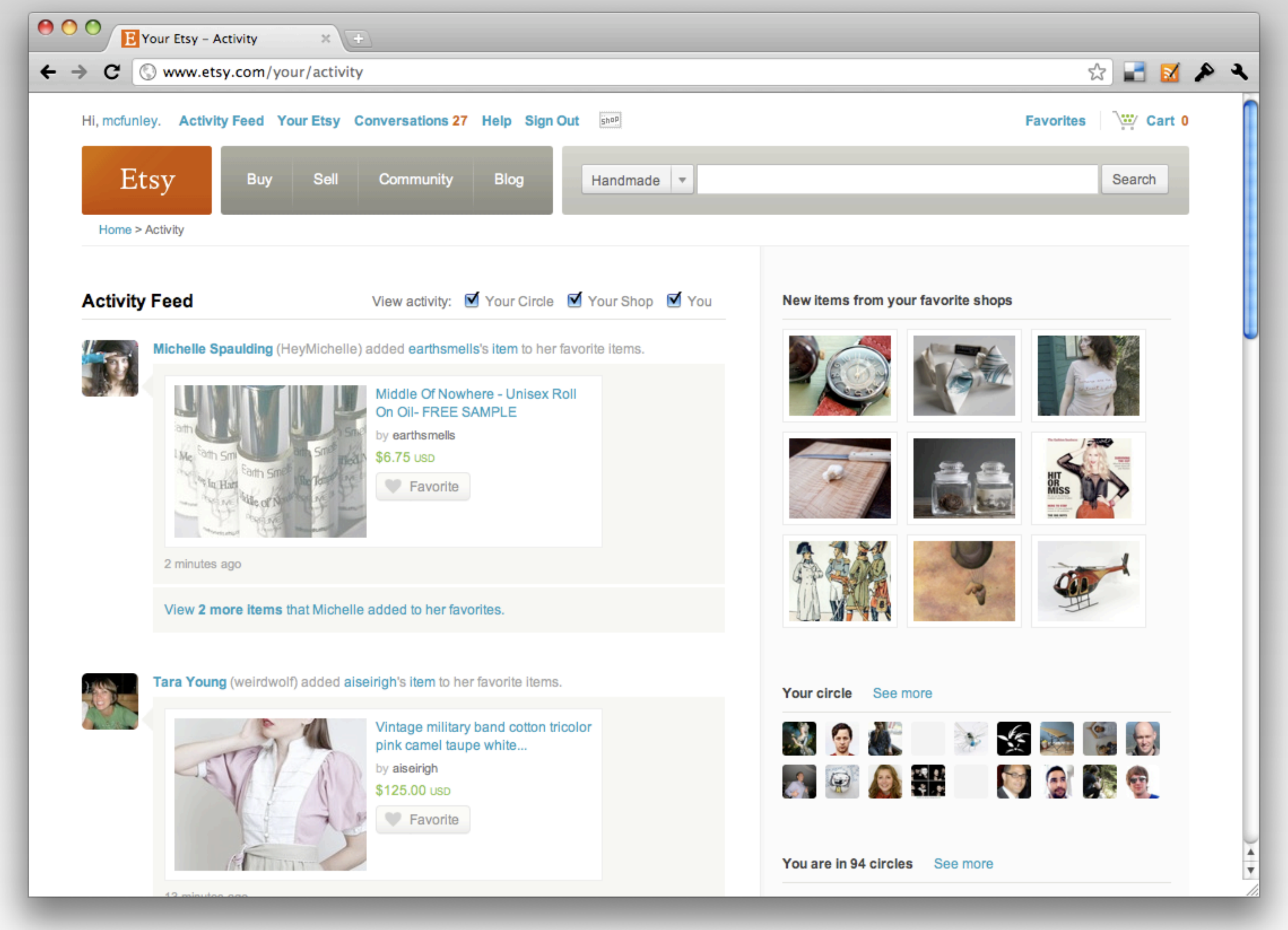
Aggregation



We do it for a lot of different reasons:
- The feed owner has done something, or logged in.
- On a schedule, with cron.
- We also aggregate for your connections when you do something (purple). This is a hack and won’t scale.

Display





Activity Feed

View activity: ☑ Your Circle ☑ Your Shop ☑ You

Michelle Spaulding (HeyMichelle) added earthsmells's item to her favorite items.

Middle Of Nowhere - Unisex Roll On Oil- FREE SAMPLE
by earthsmells
$6.75 USD
Favorite

2 minutes ago

View 2 more items that Michelle added to her favorites.

Tara Young (weirdwolf) added aiseirigh's item to her favorite items.

Vintage military band cotton tricolor pink camel taupe white...
by aiseirigh
$125.00 USD
Favorite

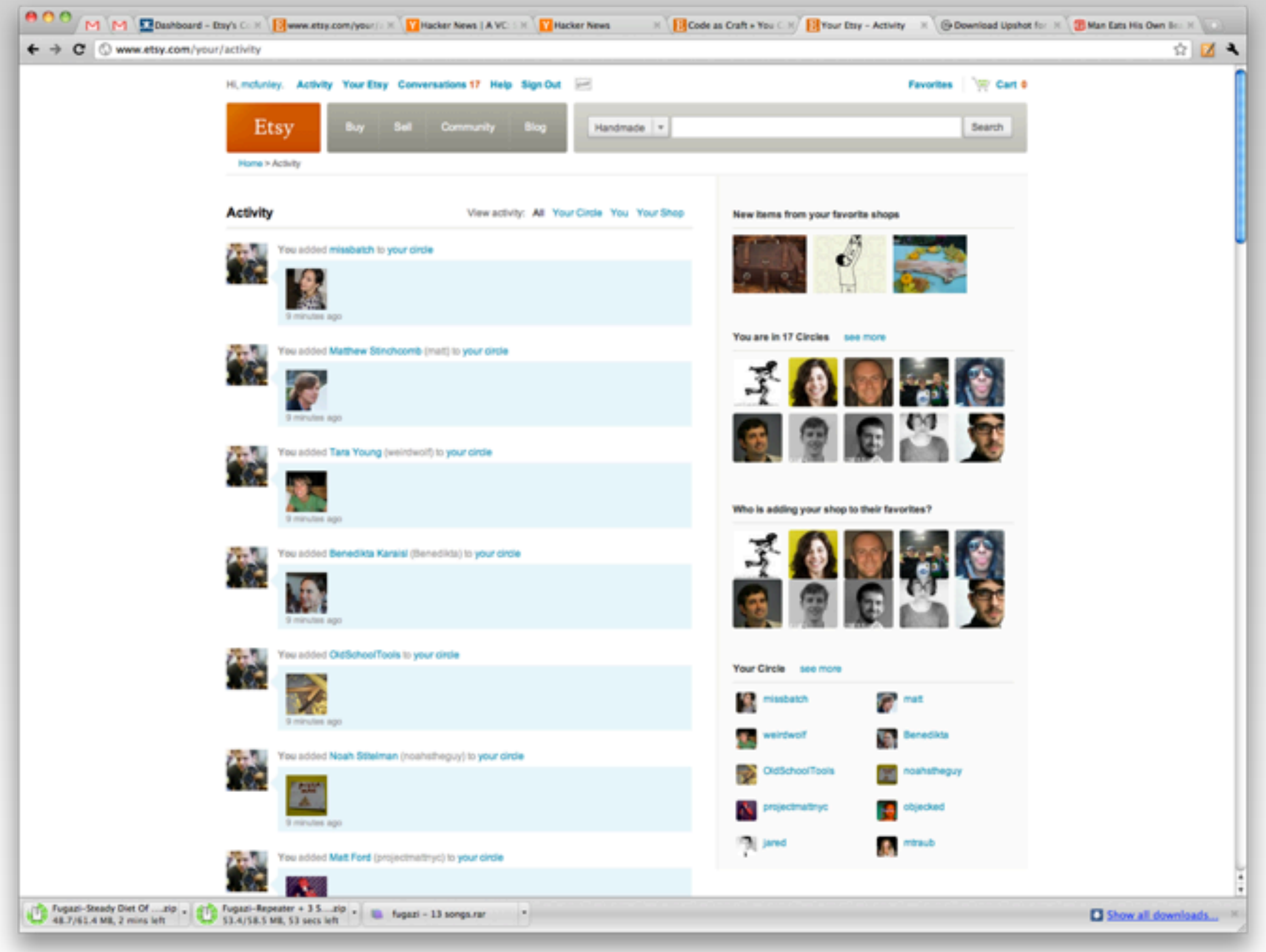
New items from your favorite shops

Your circle See more

You are in 94 circles See more

Next I'm going to talk about how we get from the memcached newsfeed to the final product.

Display: done naively, sucks


www.etsy.com/your/activity
Hi, mcfunley. Activity Your Etsy Conversations 17 Help Sign Out
Favorites Cart 0
Etsy
Buy Sell Community Blog
Handmade
Search
Home > Activity
View activity: All Your Circle You Your Shop
New items from your favorite shops
You are in 17 Circles see more
Who is adding your shop to their favorites?
Your Circle see more
missbatch matt
weirdwolf Benedikta
OldSchoolTools noahstheguy
projectmattnyc objecked
jared mtraub
Fugazi-Steady Diet Of ....zip 48.7/61.4 MB, 2 mins left
Fugazi-Repeater + 3 5....zip 53.4/58.5 MB, 53 secs left
fugazi - 13 songs.rar
Show all downloads...

Activity

You added missbatch to your circle
9 minutes ago

You added Matthew Stinchcomb (matt) to your circle
9 minutes ago

You added Tara Young (weirdwolf) to your circle
9 minutes ago

You added Benedikta Karaisl (Benedikta) to your circle
9 minutes ago

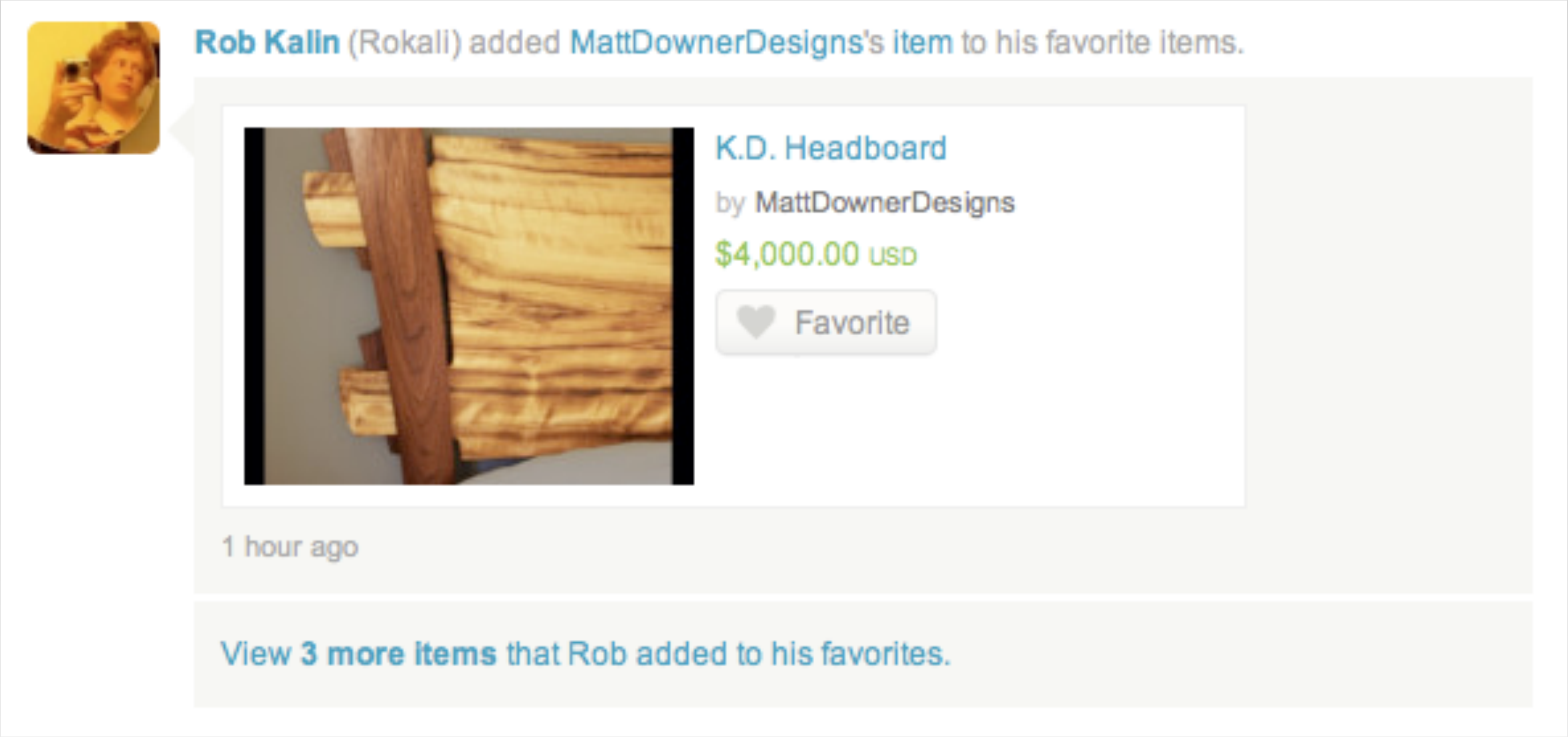
You added OldSchoolTools to your circle
9 minutes ago

You added Noah Sitelman (noahstheguy) to your circle
9 minutes ago

You added Matt Ford (projectmattnyc) to your circle

If we just showed the activities in the order that they're in on the newsfeed, it would look like this.

Display: Enter Rollups



Rob Kalin (Rokali) added MattDownerDesigns's item to his favorite items.

K.D. Headboard

by MattDownerDesigns

$4,000.00 USD

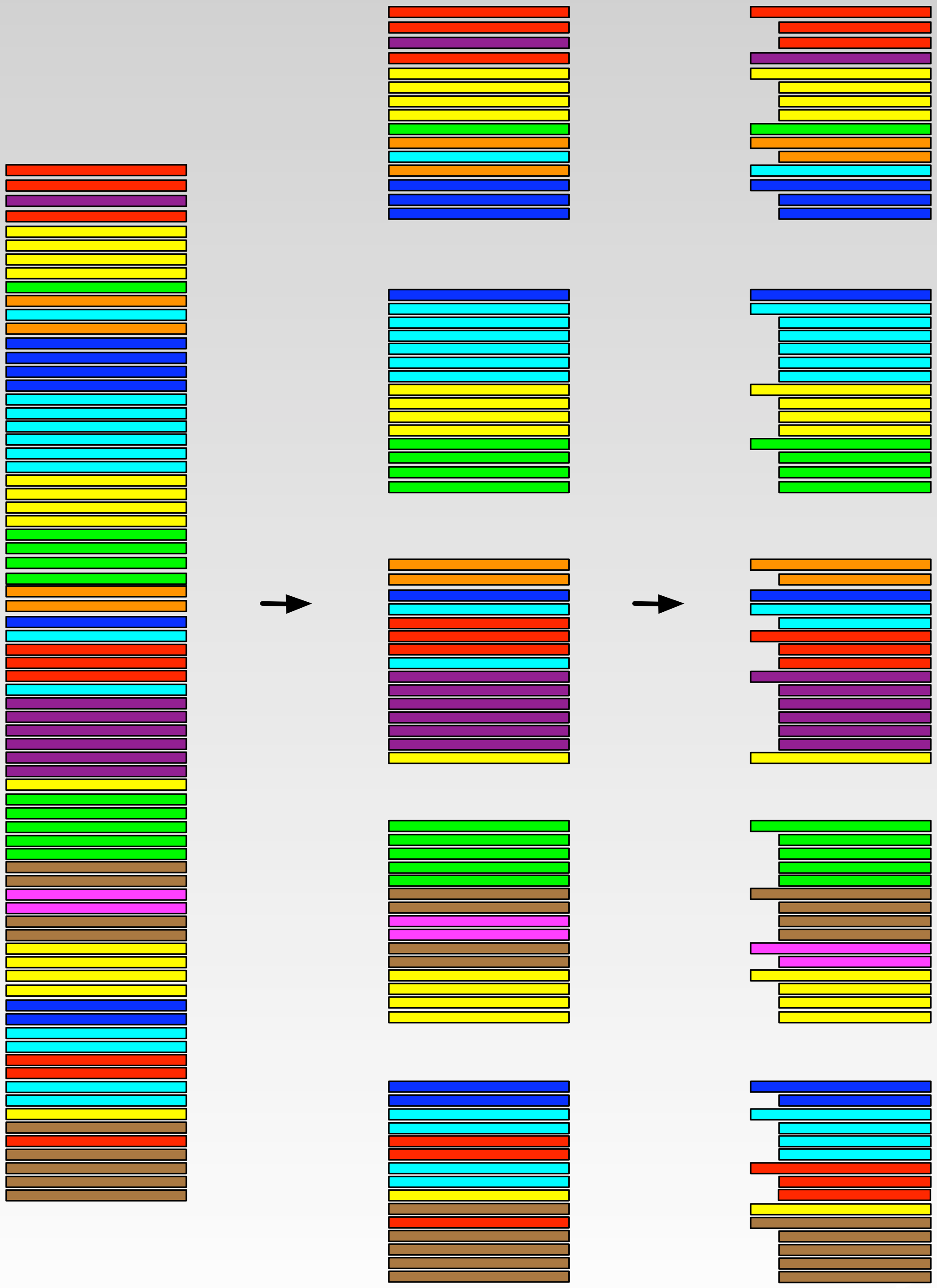
Favorite

1 hour ago

View 3 more items that Rob added to his favorites.

To solve this problem we combine similar stories into rollups.

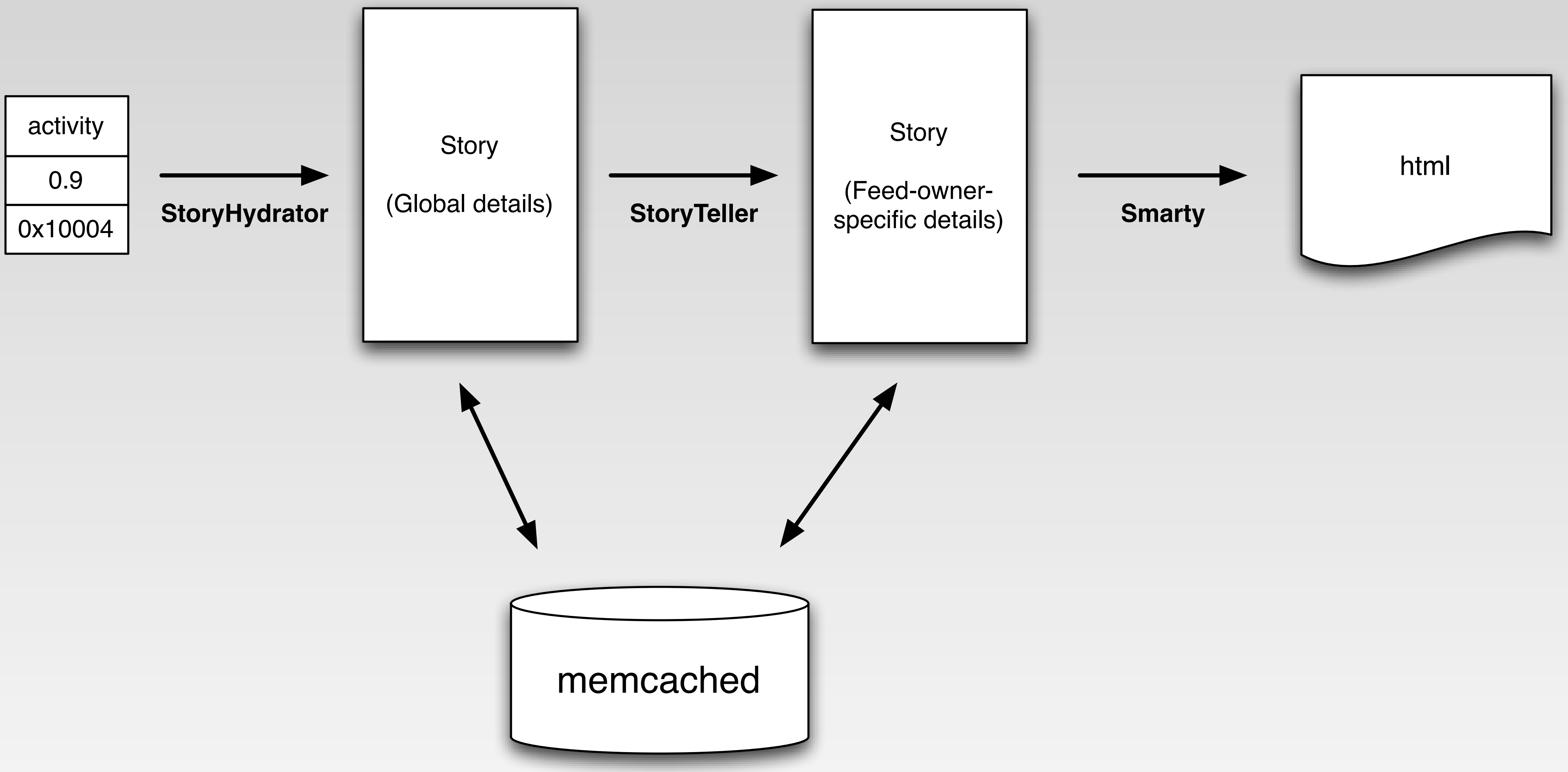
Display: Computing Rollups



Friday, January 14, 2011

Here’s an attempt at depicting how rollups are created.
The feed is divided up into sections, so that you don’t wind up seeing all of the reds, greens, etc. on the entire feed in just a few very large rollups.
Then the similar stories are grouped together within the sections.

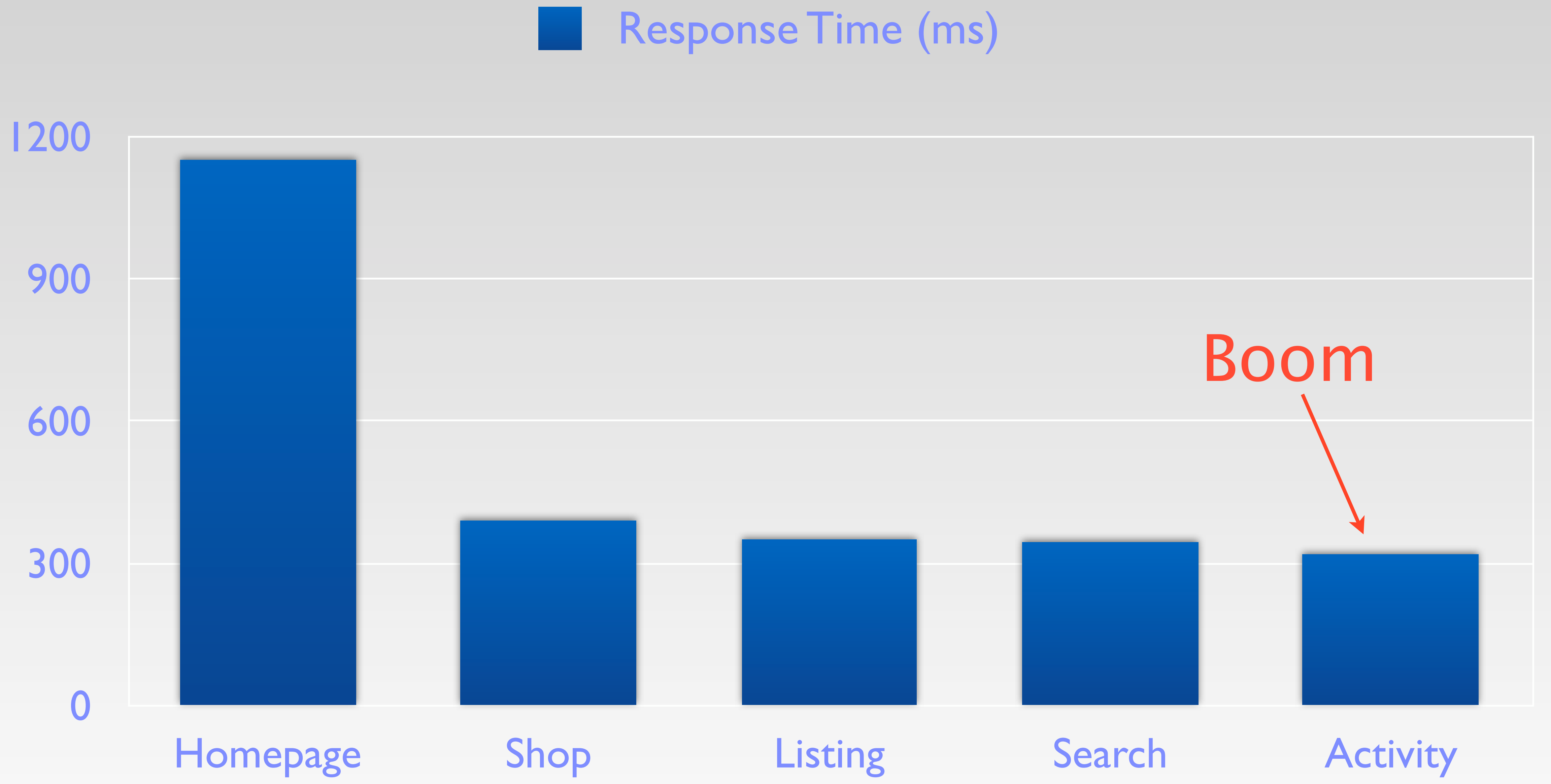
Display: Filling in Stories



Once that’s done, we can go through the rest of the display pipeline for the root story in each rollup.

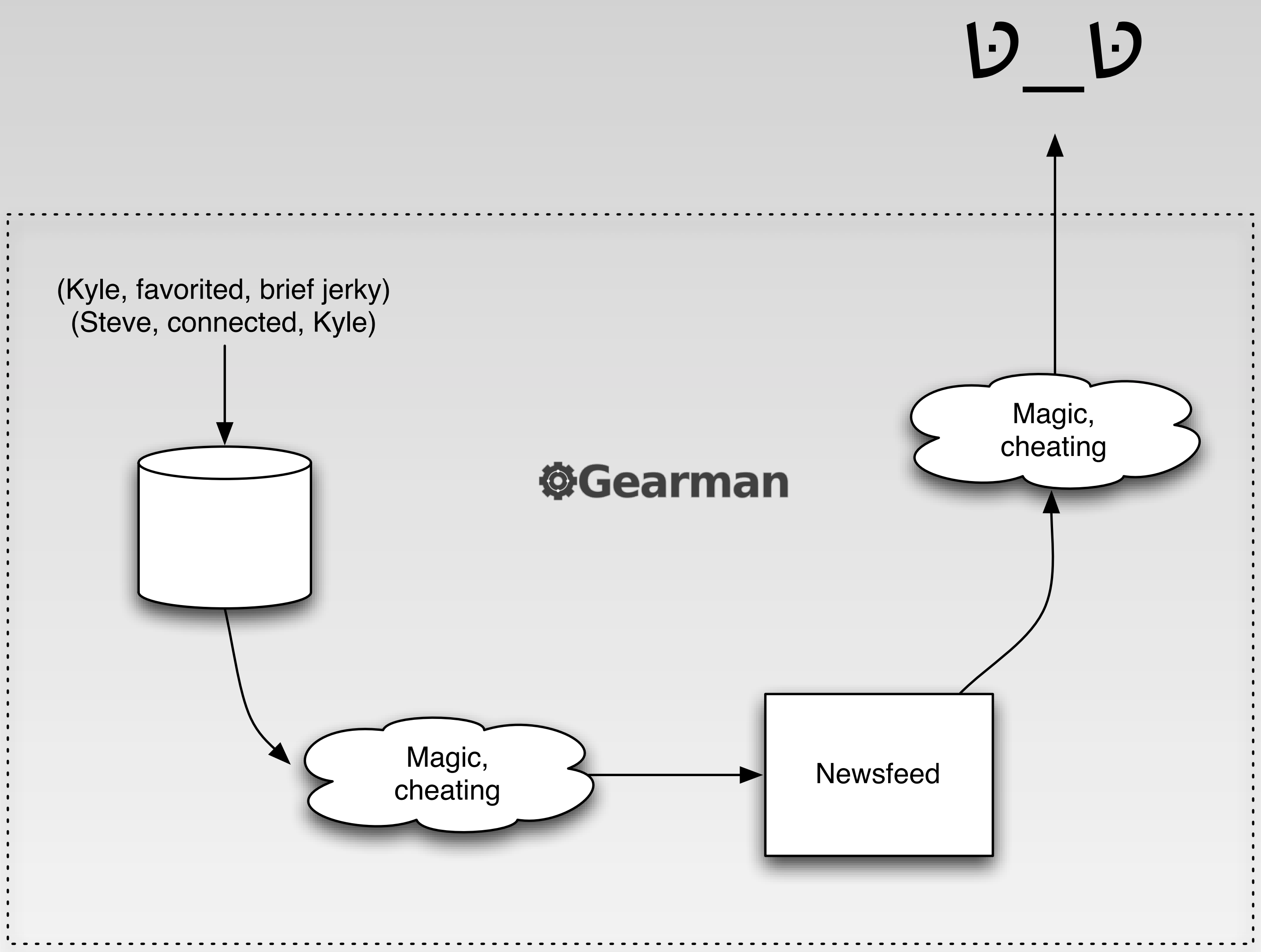
There are multiple layers of caching here. Things that are global (like the shop associated with a favorited listing) are cached separately from things that are unique to the person looking at the feed (like the exact way the story is phrased).

Making it Fast



Finally I'm going to go through a few ways that we've sped up activity, to the point where it's one of the faster pages on the site (despite being pretty complicated).

Hack #1: Cache Warming



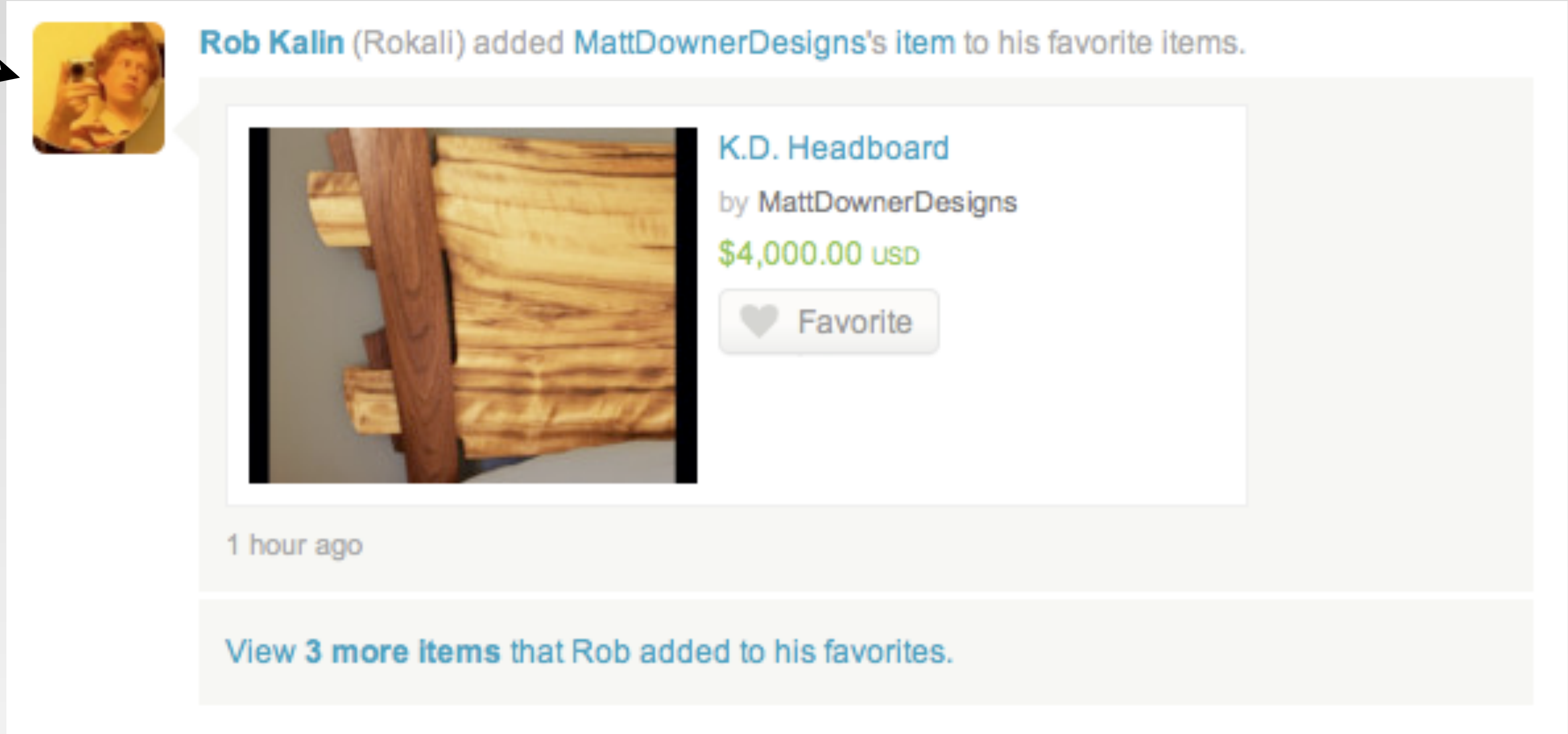
Friday, January 14, 2011

The first thing we do to speed things up is run almost the entire pipeline proactively using gearman.
So after aggregation we trigger a display run, even though nobody is there to look at the html.
The end result is that almost every pageview is against a hot cache.

Hack #2: TTL Caching

May be his avatar from 5 minutes ago.

Big f'ing deal.



Rob Kalin (Rokali) added MattDownerDesigns's item to his favorite items.

K.D. Headboard

by MattDownerDesigns

$4,000.00 USD

1 hour ago

View 3 more items that Rob added to his favorites.

The second thing we do is add bits of TTL caching where few people will notice. Straightforward but not done in many places on the site.

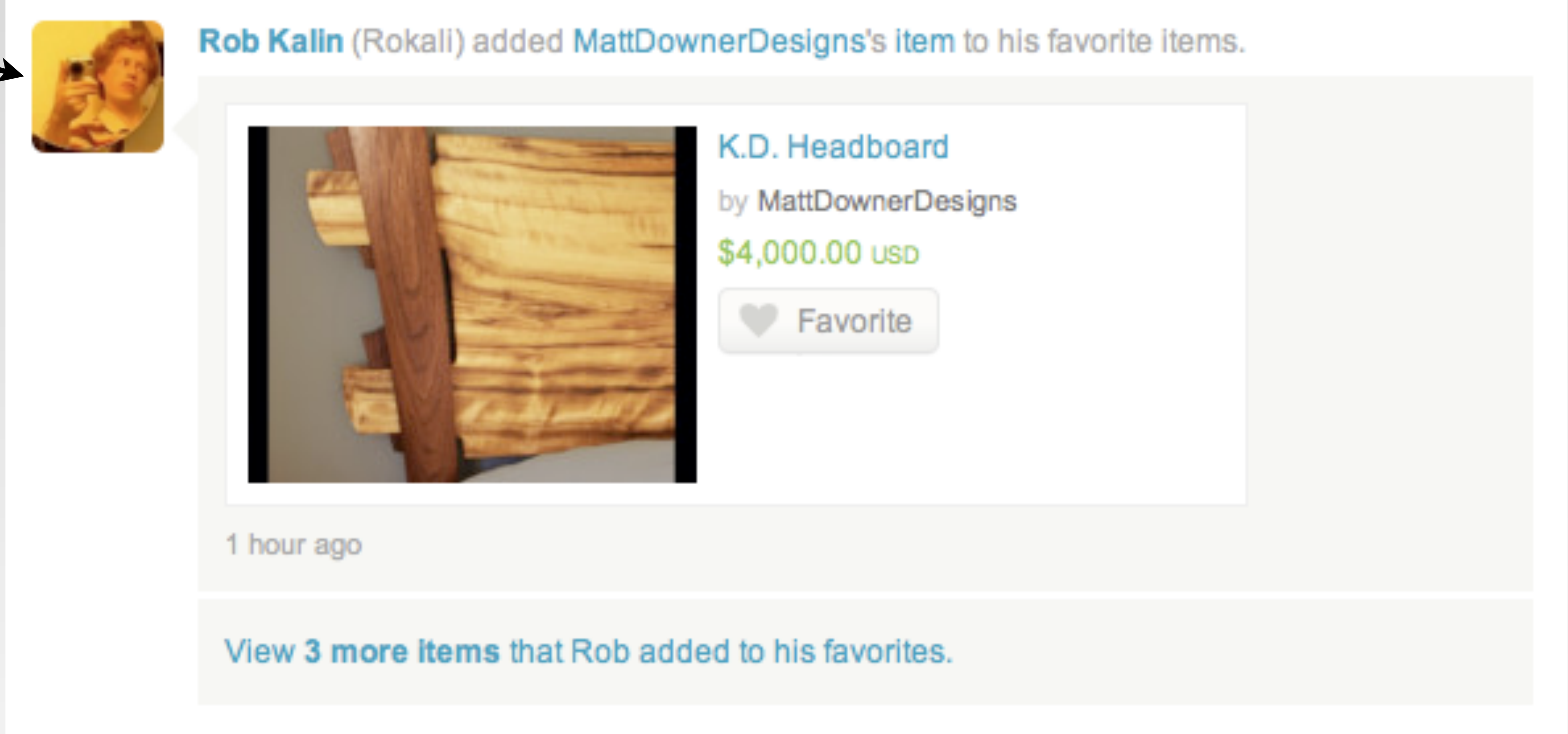
Note that his avatar here is tied to the story. If he generates new activity he'll see his new avatar.

Hack #3: Judicious Associations

getFinder("UserProfile")->find(...)

not

getFinder("User")->find(...)->Profile



Rob Kalin (Rokali) added MattDownerDesigns's item to his favorite items.

K.D. Headboard

by MattDownerDesigns

$4,000.00 USD

Favorite

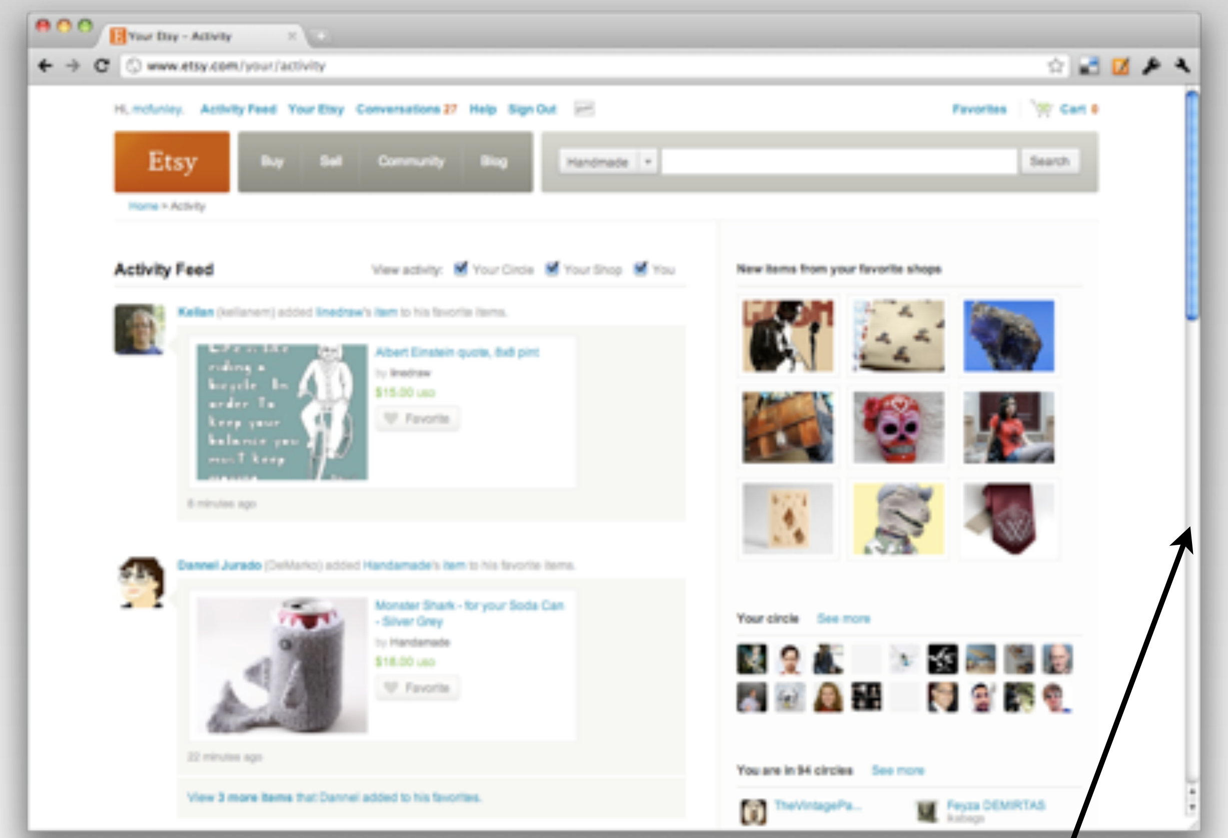
1 hour ago

View 3 more items that Rob added to his favorites.

Friday, January 14, 2011

We also profiled the pages and meticulously simplified ORM usage.
Again this sounds obvious but it's really easy to lose track of what you're doing as you hand the user off to the template. Lots of ORM calls were originally actually being made by the template.

Hack #4: Lazy Below the Fold



Your Etsy - Activity

www.etsy.com/your/activity

Hi, mcfunley. Activity Feed Your Etsy Conversations 27 Help Sign Out

Favorites Cart 0

Etsy Buy Sell Community Blog Handmade Search

Home > Activity

Activity Feed View activity: ☑ Your Circle ☑ Your Shop ☑ You

Kellan (kellanem) added linedraw's item to his favorite items.

Albert Einstein quote, 8x8 print
by linedraw
$15.00 USD
Favorite

8 minutes ago

Dannel Jurado (DeMarko) added Handamade's item to his favorite items.

Monster Shark - for your Soda Can - Silver Grey
by Handamade
$18.00 USD
Favorite

22 minutes ago

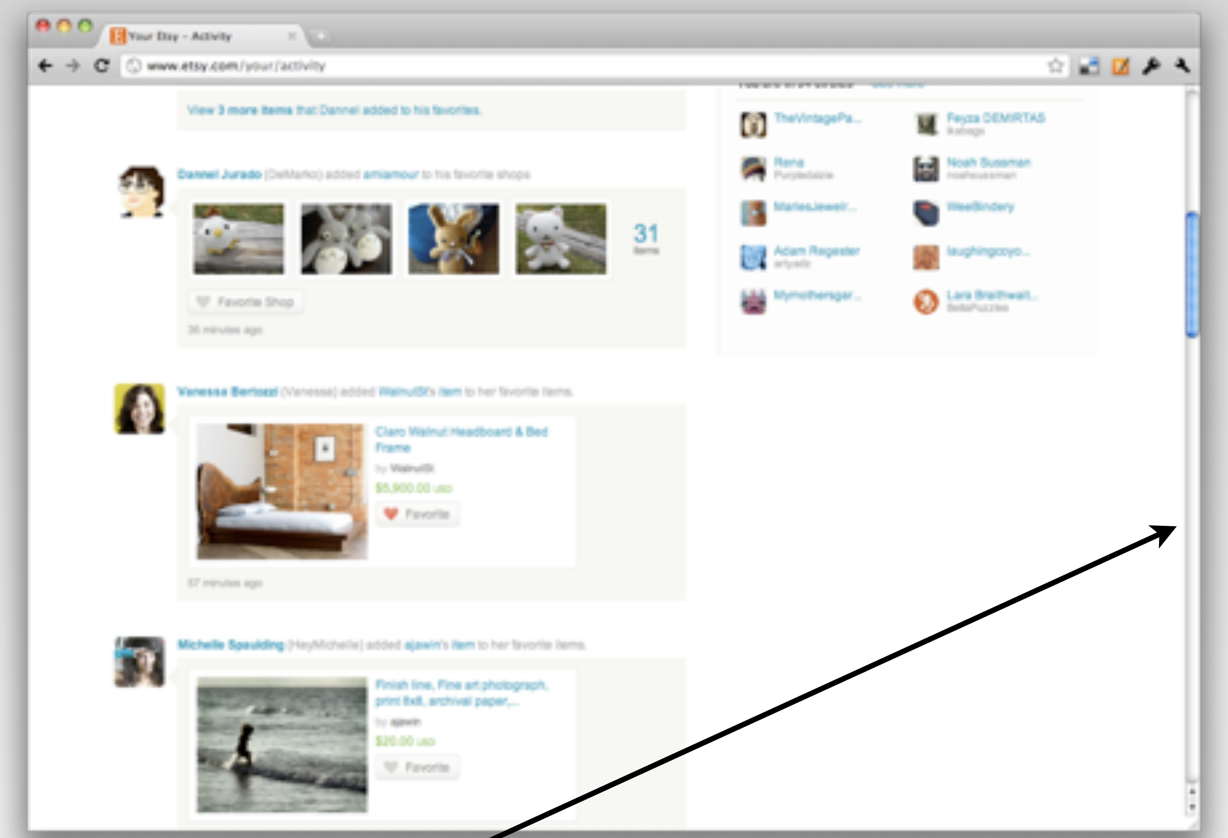
View 3 more items that Dannel added to his favorites.

New items from your favorite shops

Your circle See more

You are in 94 circles See more

TheVintagePa... Feyza DEMIRTAS



Your Etsy - Activity

www.etsy.com/your/activity

View 3 more items that Dannel added to his favorites.

Dannel Jurado (DeMarko) added amiamour to his favorite shops

31 items

Favorite Shop

36 minutes ago

Vanessa Bertozzi (Vanessa) added WalnutSt's item to her favorite items.

Claro Walnut Headboard & Bed Frame
by WalnutSt
$5,900.00 USD
Favorite

57 minutes ago

Michelle Spaulding (HeyMichelle) added ajawin's item to her favorite items.

Finish line, Fine art photograph, print 8x8, archival paper,...
by ajawin
$20.00 USD
Favorite

TheVintagePa... Feyza DEMIRTAS
Rena Noah Sussman
MarlesJewelr... WeeBindery
Adam Regester laughingcoyo...
Mymothersgar... Lara Braithwait...

We don't load much at the outset.
You get more as you scroll down
(finite scrolling).

Etsy

The End