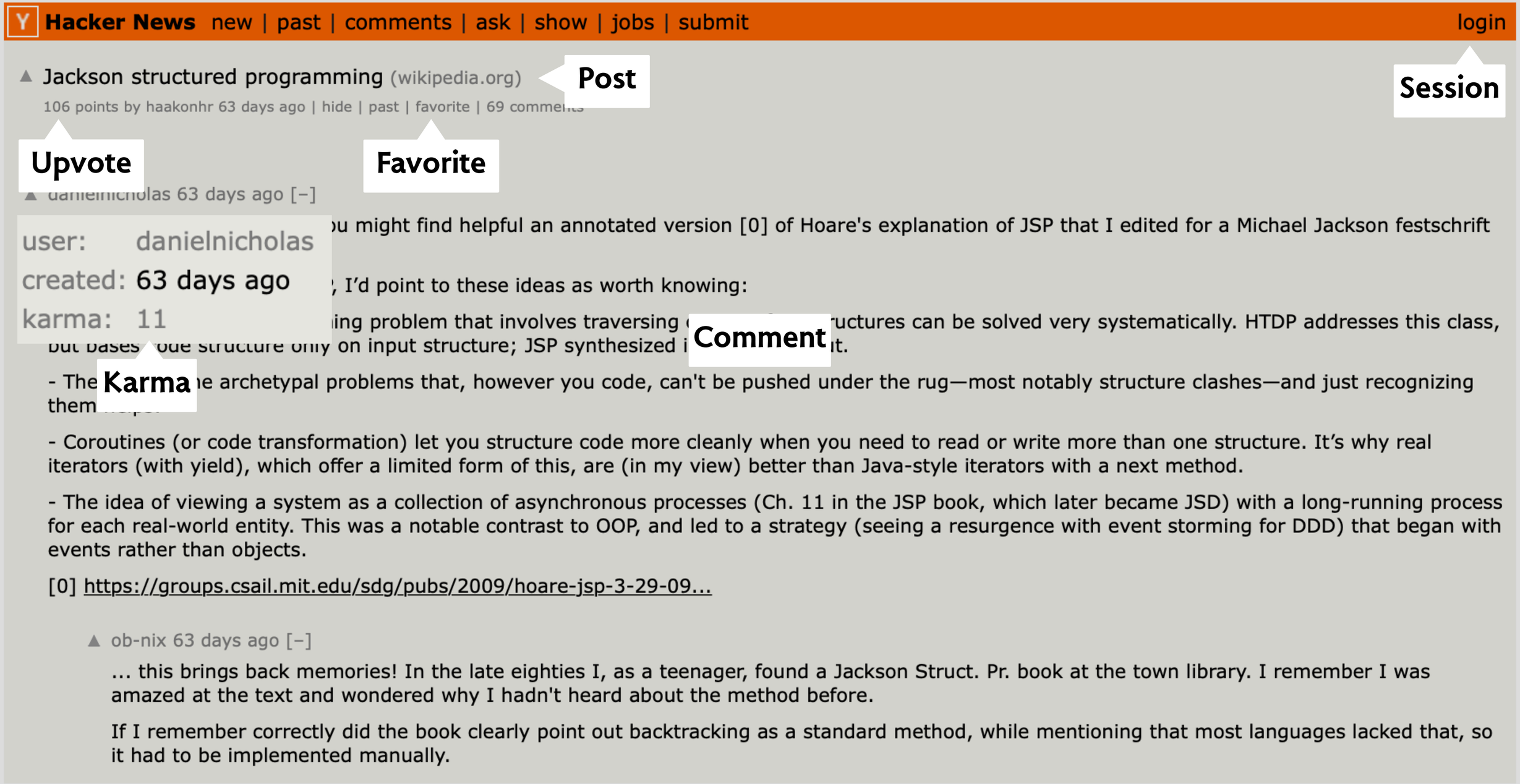
identifying concepts

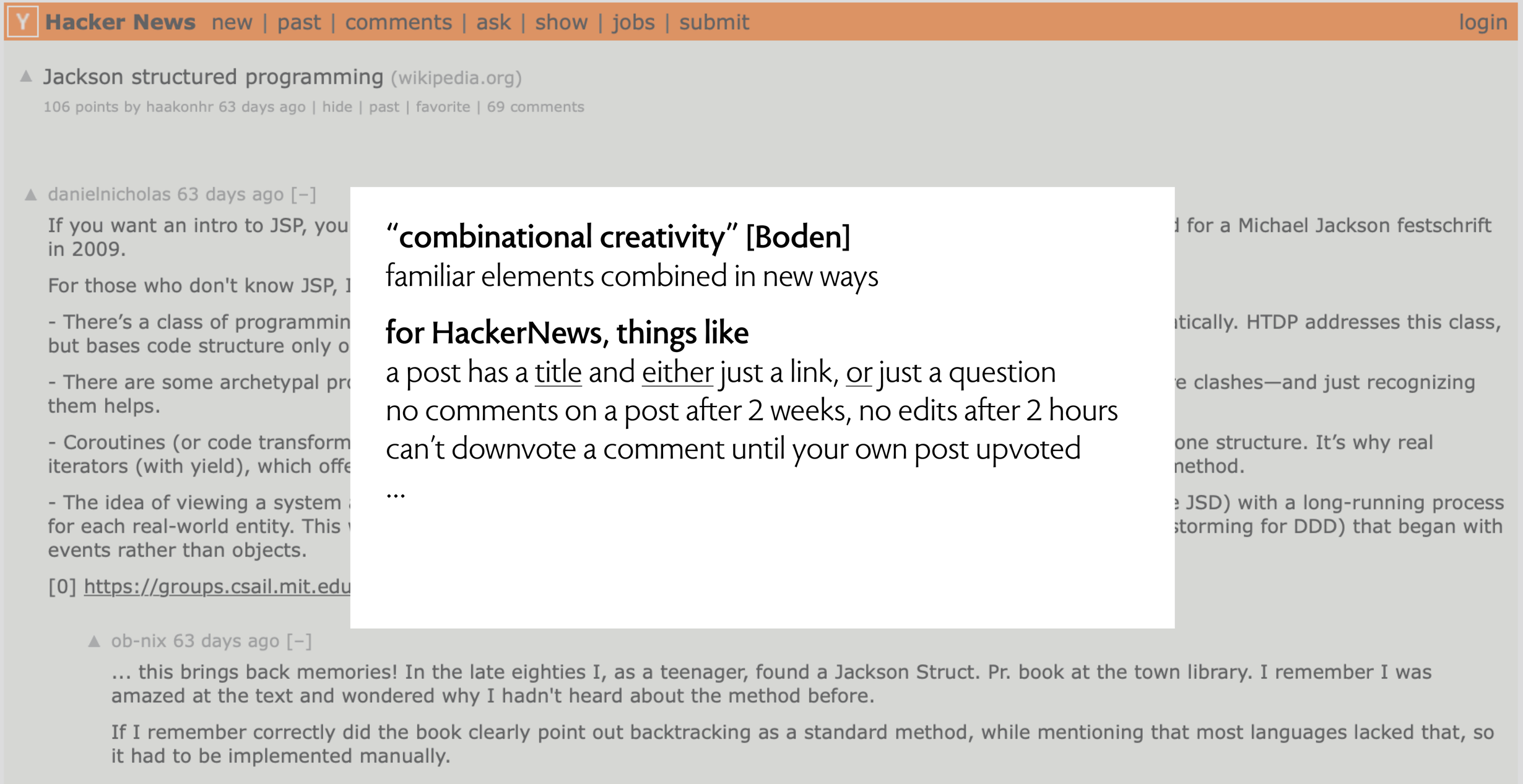
Daniel Jackson · Autodesk, Boston · March 17-18, 2025

an example: HackerNews

what are the concepts of Hacker News?



familiar concepts with some creative variation



"combinational creativity" [Boden]

familiar elements combined in new ways

for HackerNews, things like

a post has a title and either just a link, or just a question

no comments on a post after 2 weeks, no edits after 2 hours

can't downvote a comment until your own post upvoted

...

defining a concept in detail

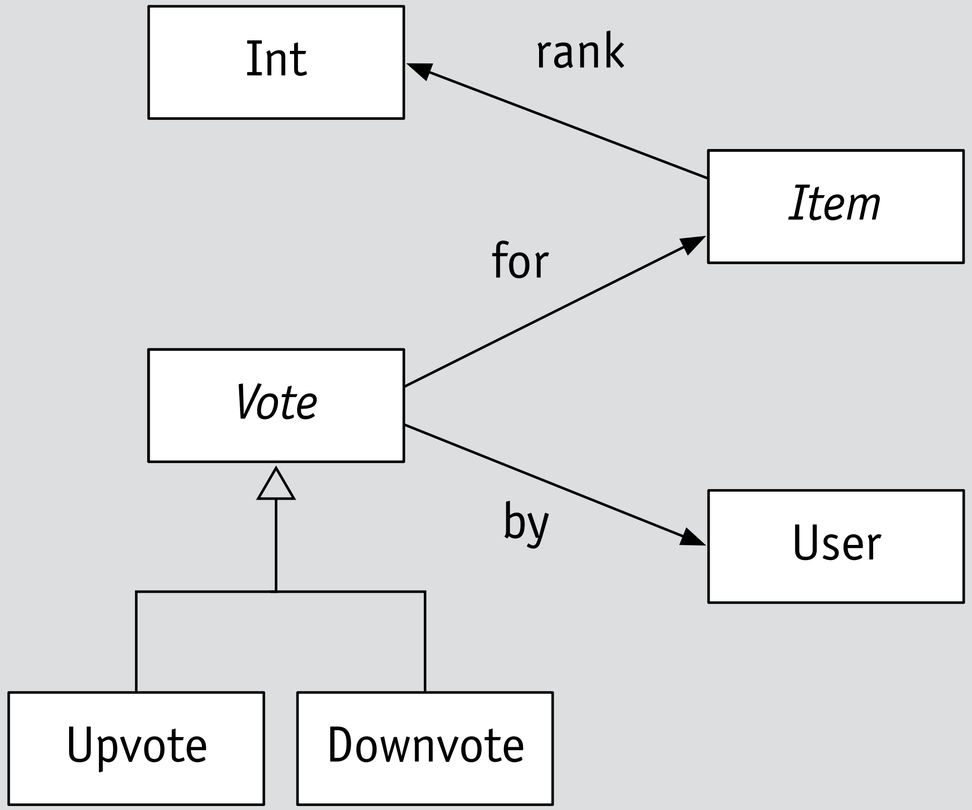
concept Upvote

purpose rank items by popularity

principle after series of upvotes of items, the items are ranked by their number of upvotes

state
by: Vote -> one User
for: Vote -> one Item
Upvote, Downvote: set Vote
rank: Item -> one Int

actions
upvote (u: User, i: Item)
downvote (u: User, i: Item)
unvote (u: User, i: Item)



downvote (i: Item, u: User)
no downvote exists for i by u
remove all upvotes for i by u
add a downvote for i by u
update the rank of i

concepts as carriers of design knowledge

concept: Upvote

related concepts
Rating, Recommendation, Reaction, ...

design variants
downvote as unvote
use age in ranking
weigh downvotes more
various identity tactics
freezing old posts

known issues
high votes can promote old content
feedback favors early upvotes
upvoting encourages echo chamber
preventing double votes

typical uses
social media posts
comments on articles
Q&A responses

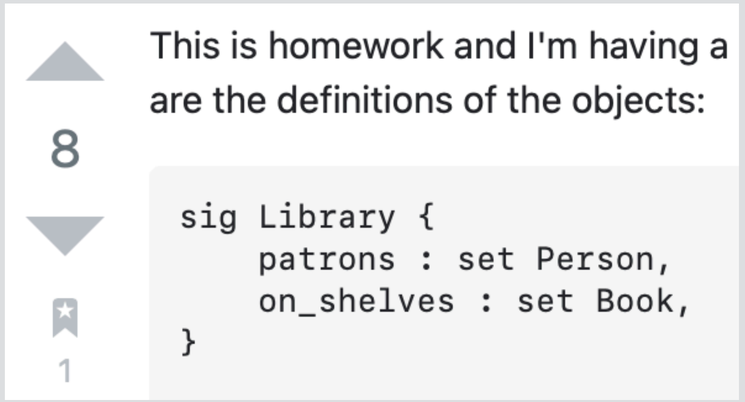
often used with
Karma, Auth, ...

concepts are about semantics, not user interface

concept Upvote

purpose rank items by popularity

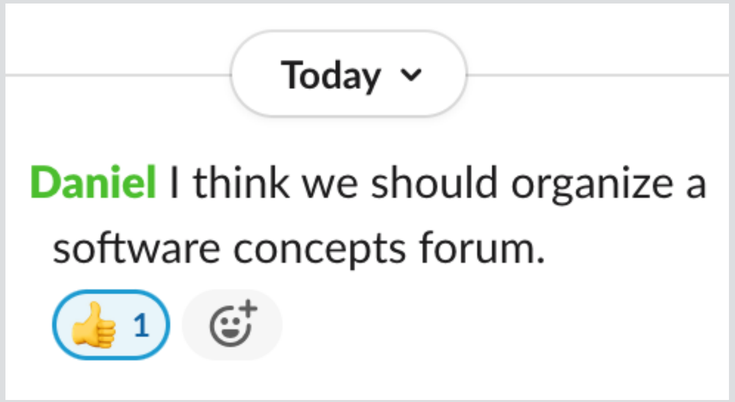
principle after series of upvotes of items, the items are ranked by their number of upvotes



concept Reaction

purpose support quick responses

principle when user selects reaction, it's shown to the author (often in aggregated form)



concept Recommendation

purpose infer user preferences

principle user likes lead to ranking of kinds of items, thus which items are recommended

your turn: which concepts do behaviors belong to?

Upvote **Favorite** **Session**

Karma **Comment** **Post**

concepts of Hacker News

reward points only go up

some behaviors belong to one concept

you can't like a post twice

you need to login every two hours

posts contain just URLs

you can comment on a post or a comment

favorite lists are unbounded

some behaviors involve more than one

you can't downvote a post until your own post is upvoted

you can't edit a post unless you're logged in as author

behaviors that involve >1 concept

concept Upvote

purpose rank items by popularity

actions
upvote (u: User, i: Item)
downvote (u: User, i: Item)
unvote (u: User, i: Item)

suppose I want this behavior:
you can't downvote an item
until you've received
an upvote on your own post

define a new concept!
a hint: not just used by Upvote

concept Karma

purpose privilege good users

state
karma: User -> one Int

actions
reward (u: User, r: Int)
permit (u: User, r: Int)

concept Post

purpose share content

state
author: Post -> one User
body: Post -> one Text

actions
create (u: User, t: Text): Post
delete (p: Post)
edit (p: Post, t: Text)
get_author (p: Post): User

composition by synchronization

when
Web.request (upvote, u, i)
Post.get_author (i) = u'
Karma.reward (u', 10)
then
Upvote.upvote (u, i)

concept Karma

actions
reward (u: User, r: Int)
permit (u: User, r: Int)

concept Upvote

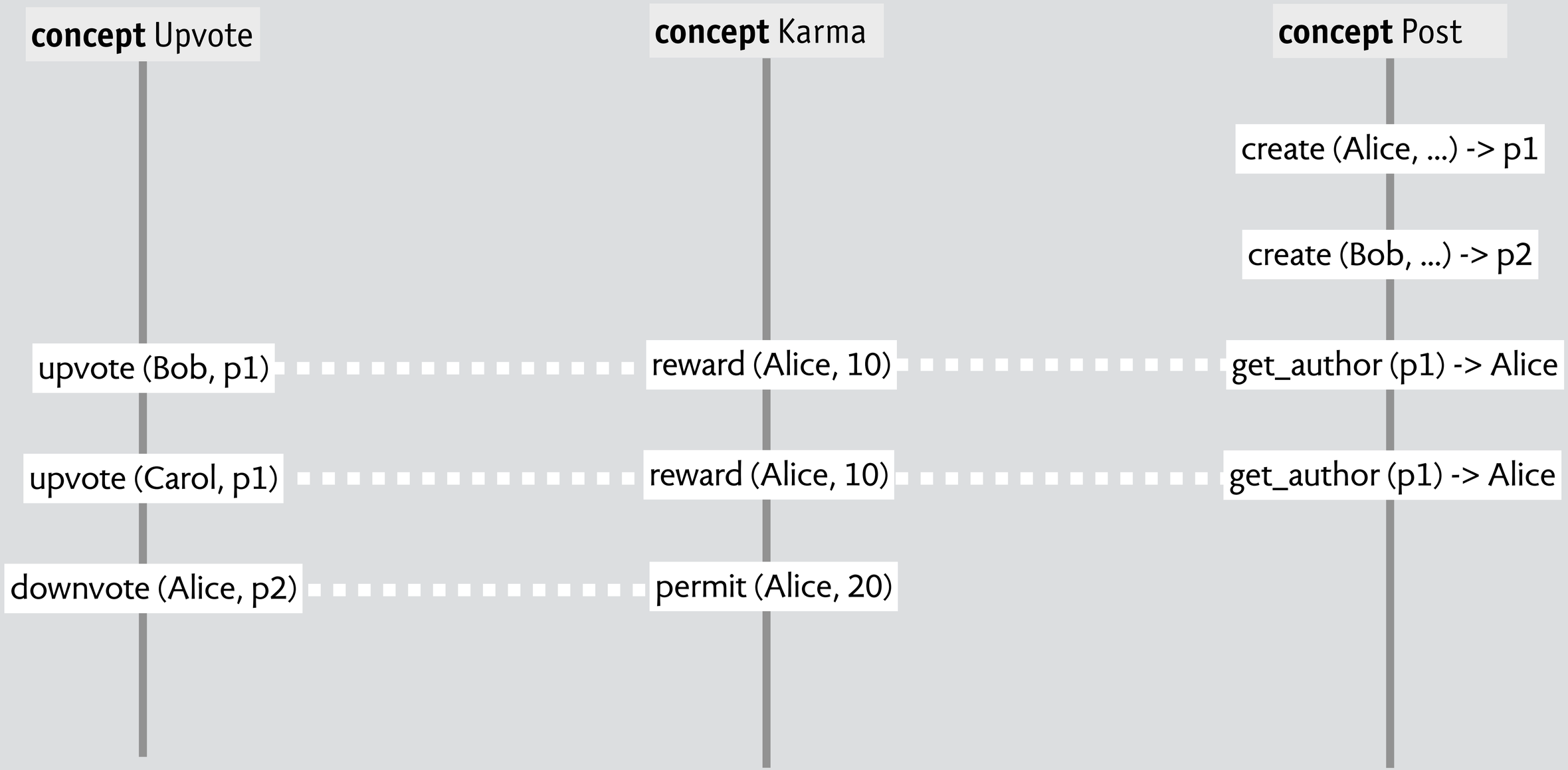
actions
upvote (u: User, i: Item)
downvote (u: User, i: Item)
unvote (u: User, i: Item)

when
Web.request (downvote, u, i)
Karma.permit (u, 20)
then Upvote.downvote (u, i)

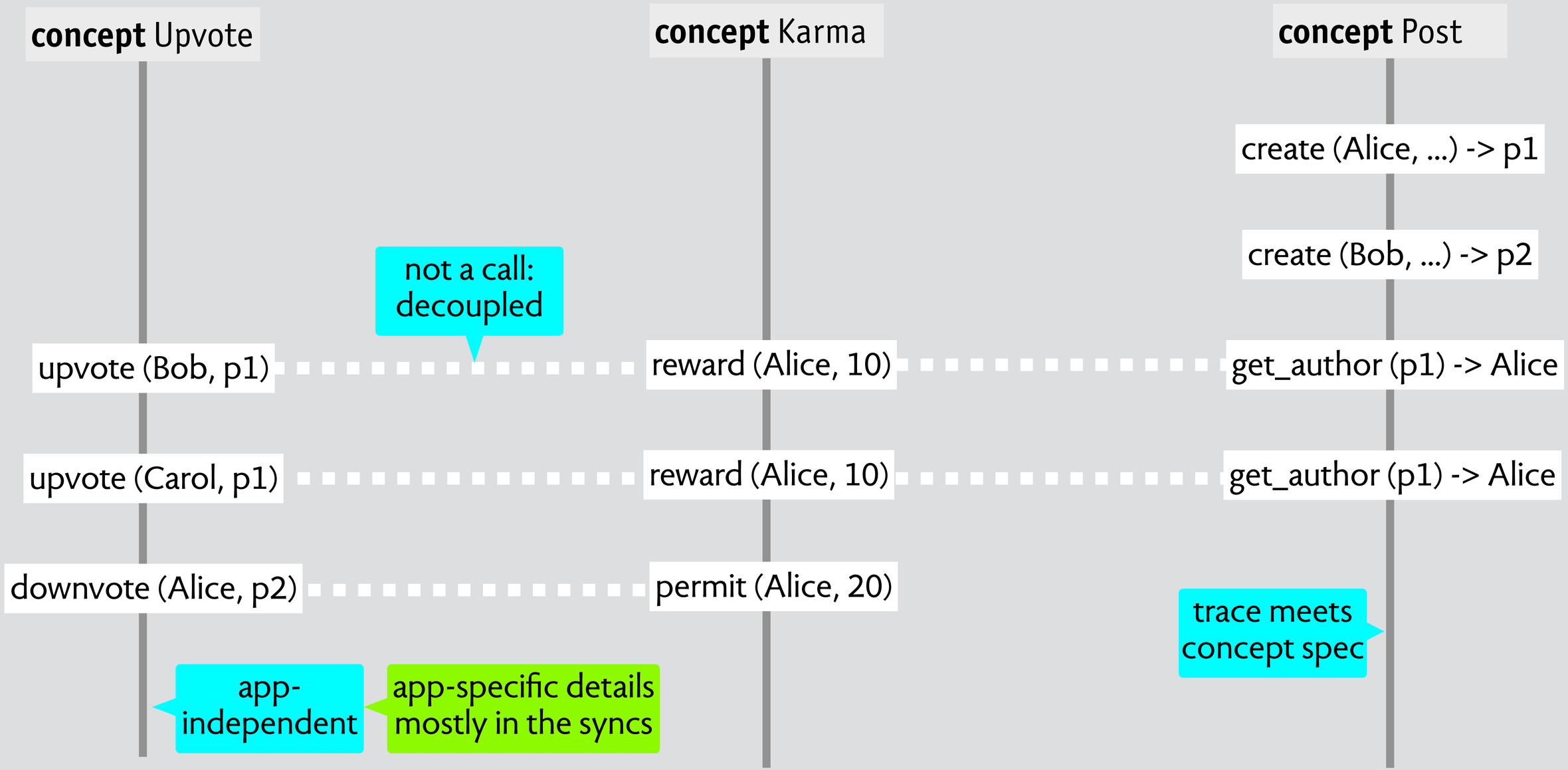
concept Post

actions
create (u: User, t: Text): Post
delete (p: Post)
edit (p: Post, t: Text)
get_author (p: Post): User

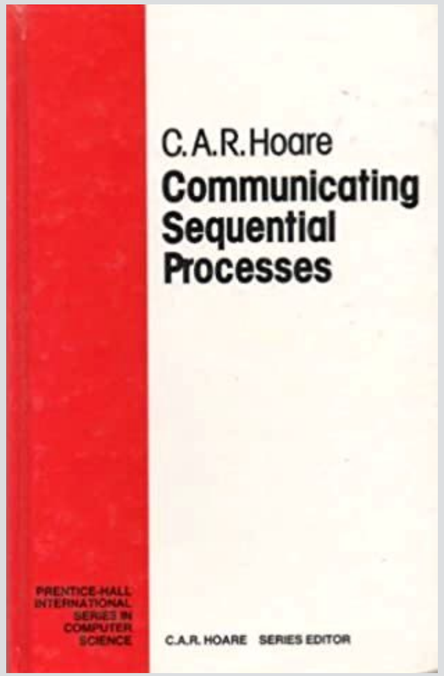
synchronizations at runtime



key properties



not a new idea



shared events
Hoare's CSP (1978)
occam (1983-1994)

Mediators:
Easing the Design and Evolution of Integrated Systems

Kevin J. Sullivan

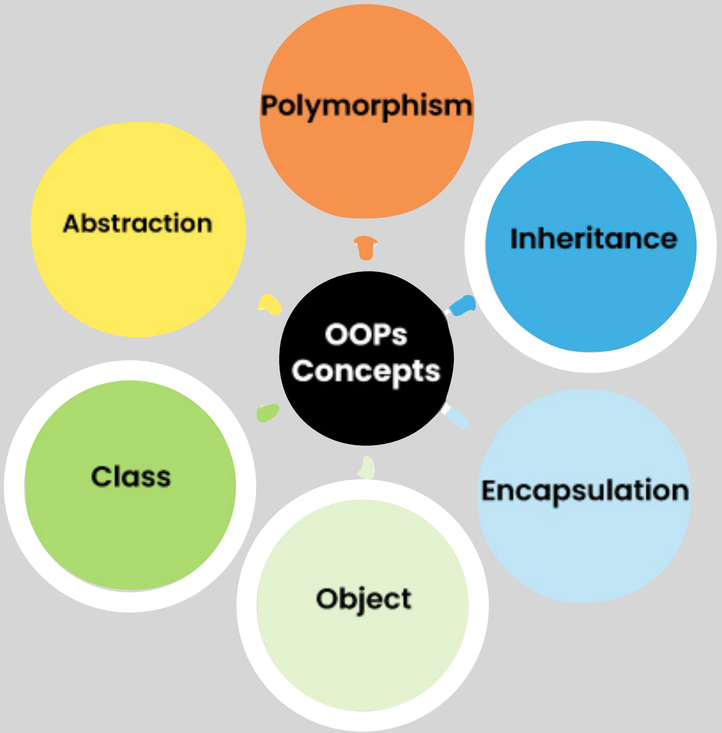
Technical Report 94-08-01

Department of Computer Science and Engineering
University of Washington

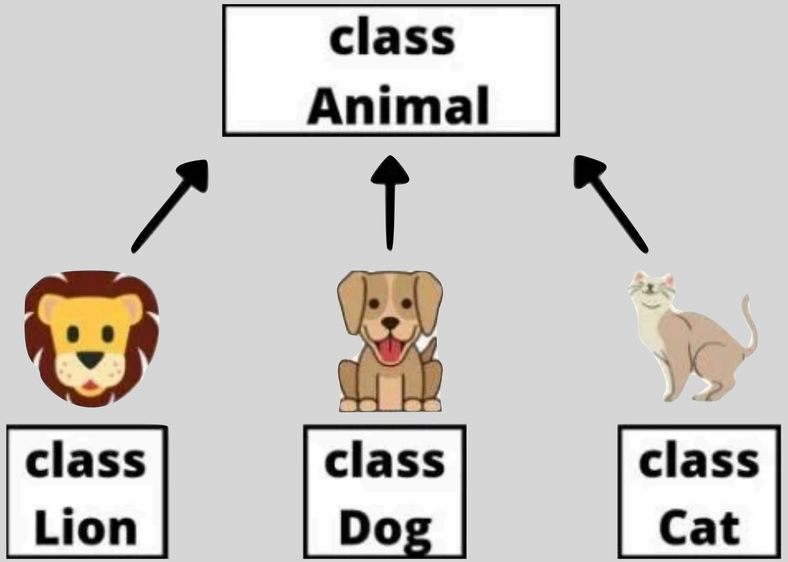
mediator pattern
Kevin Sullivan (1994)
Gang of Four (1994)

concepts vs. objects (a coding detour)

concepts are not classes



object-oriented programming
a dominant coding paradigm
good for implementing concepts



object-oriented development
objects correspond to real world entities
embody *all* of their behavior

let's build HN with objects

```
class User {
  String name;
  String password;
  User register (n, p) { ... }
  User authenticate (n, p) { ... }
}
```

```
class Post {
  User author;
  String body;
  Post new (a, b) { ... }
}
```

adding upvoting

```
class User {
  String name;
  String password;
  User register (n, p) { ... }
  User authenticate (n, p) { ... }
}
```

```
class Post {
  User author;
  String body;
  Set [User] ups, downs;
  Post new (a, b) { ... }
  upvote (u) { ... }
  downvote (u) { ... }
}
```

adding karma

```
class User {
  String name;
  String password;
  int karma;
  User register (n, p) { ... }
  User authenticate (n, p) { ... }
  incKarma (i) { ... }
  bool hasKarma (i) { ... }
}
```

```
class Post {
  User author;
  String body;
  Set [User] ups, downs;
  Post new (a, b) { ... }
  upvote (u) { ... }
  downvote (u) {
    if u.hasKarma (10)  ... }
}
```

adding commenting

```
class User {
  String name;
  String password;
  int karma;
  User register (n, p) { … }
  User authenticate (n, p) { … }
  incKarma (i) { … }
  bool hasKarma (i) { … }
}
```

```
class Post {
  User author;
  String body;
  Set [User] ups, downs;
  Seq [Post] comments;
  Post new (a, b) { … }
  upvote (u) { … }
  downvote (u) {
    if u.hasKarma (10)  … }
  addComment (c) { … }
}
```

what's wrong with this code?

```
class User {
  String name;
  String password;
  int karma;
  User register (n, p) { ... }
  User authenticate (n, p) { ... }
  incKarma (i) { ... }
  bool hasKarma (i) { ... }
}
```

```
class Post {
  User author;
  String body;
  Set [User] ups, downs;
  Seq [Post] comments;
  Post new (a, b) { ... }
  upvote (u) { ... }
  downvote (u) {
    if u.hasKarma (10)  ... }
  addComment (c) { ... }
}
```

User authentication

Posting

Upvoting

Commenting

Karma

no separation of concerns
Post class contains posting, commenting, upvoting, karma

→ **classes are novel & not reusable**
Post class won't work in an app that doesn't have karma points

dependencies between files
Post class calls *User* class to get karma points

→ **can't be built independently**
to build *Post* class, need *User* class to have been built already

a different way

```
concept User {
  Map [User, String] name;
  Map [User, String] password;
  User register (n, p) { ... }
  User authenticate (n, p) { ... }
}
```

```
concept Karma [U] {
  Map [U, Int] karma;
  incKarma (u, i) { ... }
  hasKarma (u, i) { ... }
}
```

concerns now cleanly separated

coupling is gone: refs are polymorphic

```
concept Post [U] {
  Map [Post, U] author;
  Map [Post, URL] url;
  Post new (a, u) { ... }
}
```

```
concept Upvote [U, I] {
  Map [U, I] ups, downs;
  upvote (u, i) { ... }
  downvote (u, i) { ... }
}
```

```
concept Comment [U, T] {
  Map [Comment, U] author;
  Map [Comment, T] target;
  Map [Comment, String] body;
  Comment new (a, t, b) { ... }
}
```

web apps have this!
called a route

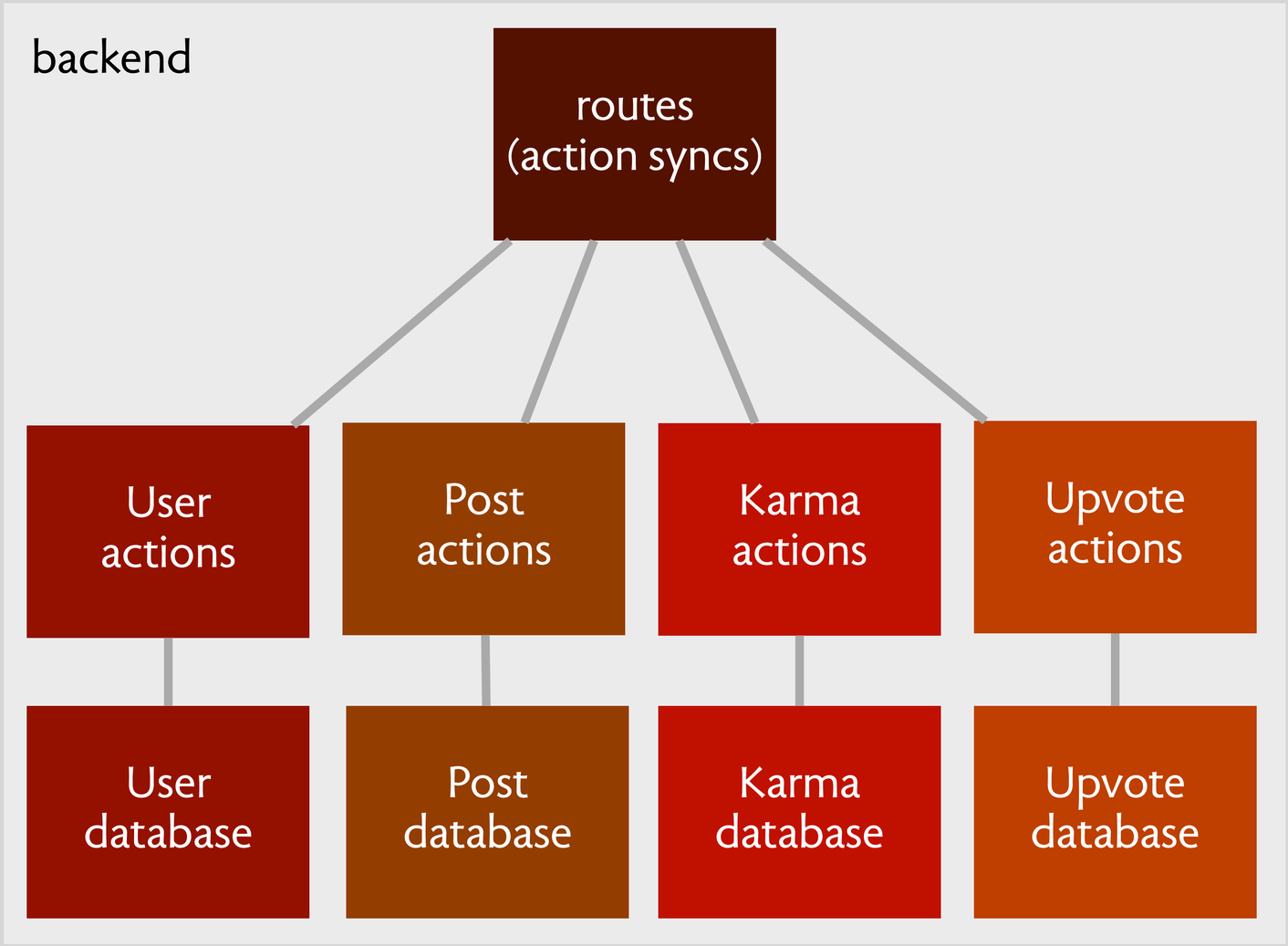
need a mediator
outside the concept

```
sync downvote (u, i) {
  Karma.hasKarma (u, 10)
  Upvote.downvote (u, i)
}
```

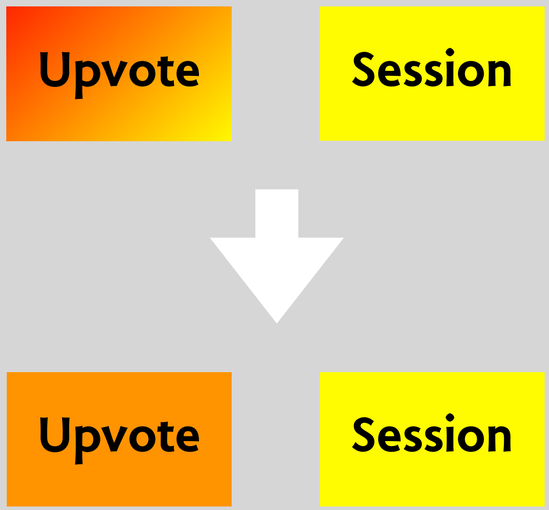
web apps have this!
called a database

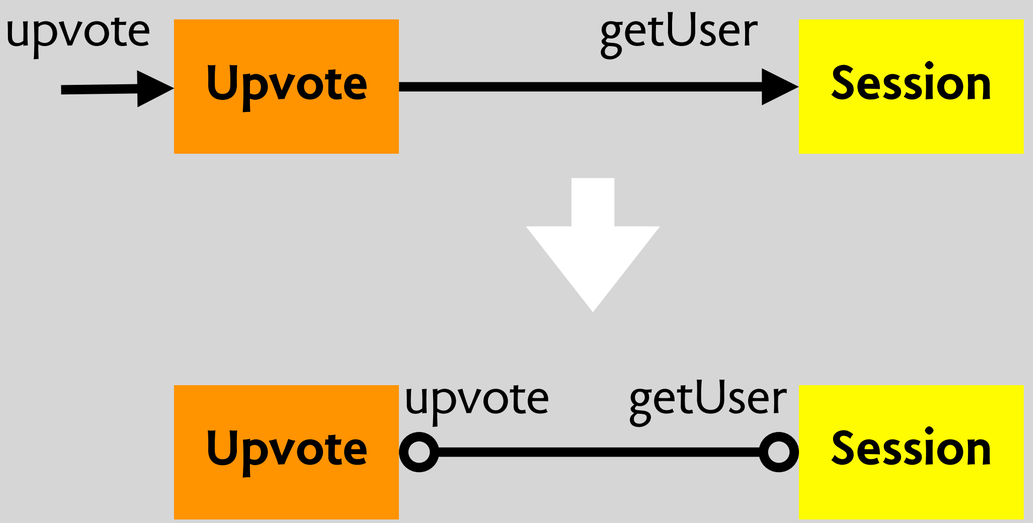
need two-way map
target to comment

a new way to structure a web app



key lessons: coherence & independence





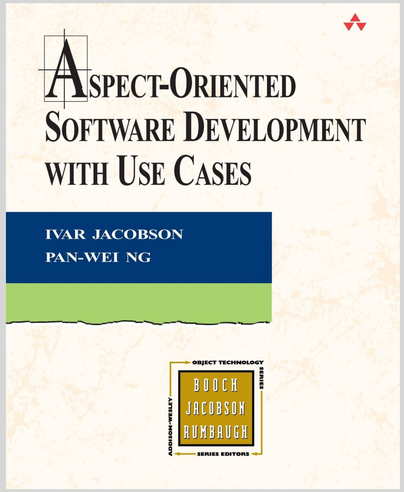
coherence
concept embodies a unit of reusable function
concept contains all and only that function

example: preventing double voting
Upvote stops 2x voting by linking voter to vote
Session ensures voter is the logged in user

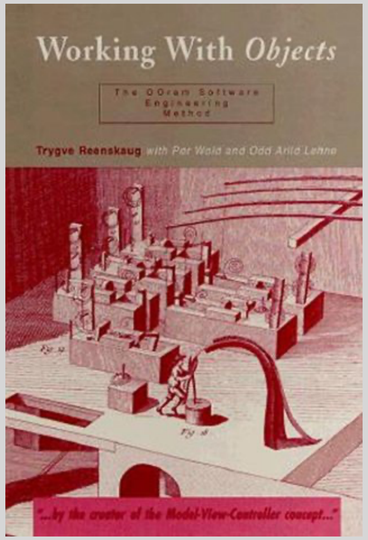
independence
each concept can be understood by itself
concepts don't refer to each other

example: preventing double voting
Upvote doesn't call Session to get user
synchronization ensures voter param is user

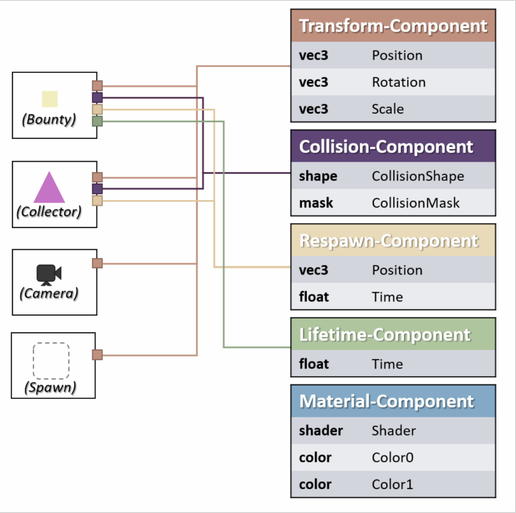
long history of attempts to fix OOP



Aspect-oriented Programming
Kiczales et al (1997)



Role-oriented Programming
Reenskaug et al (1983)



Entity-component system
Scott Bilas et al (2002)

your turn:
a Twitter/X puzzle

Andy Ostroy
@AndyOstroy

Seems the only #Wall @realDonaldTrump's built is the one between him and @FLOTUS #Melania #trump

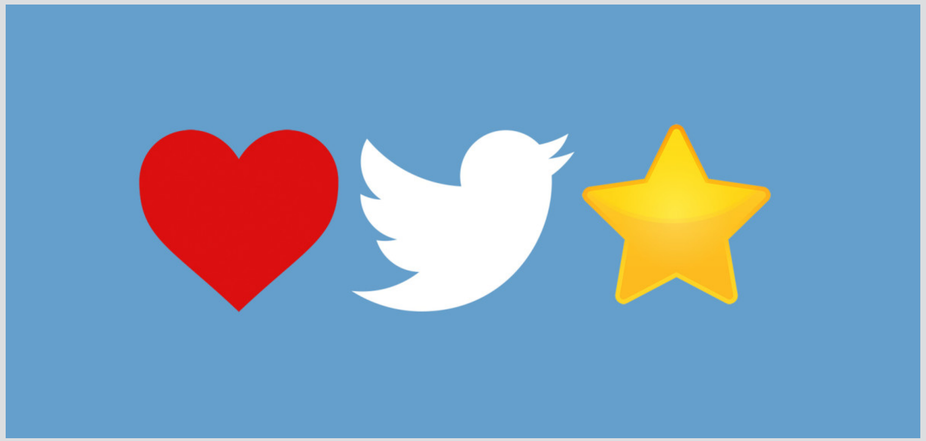
8,221 8:15 PM - May 2, 2017

4,022 people are talking about this

MELANIA TRUMP liked your Tweet

Seems the only #Wall @realDonaldTrump's built is the one between him and @FLOTUS #Melania #trump pic.twitter.com/XiNd2jiLUF

your turn: what does heart button do? and what did ML think it did?

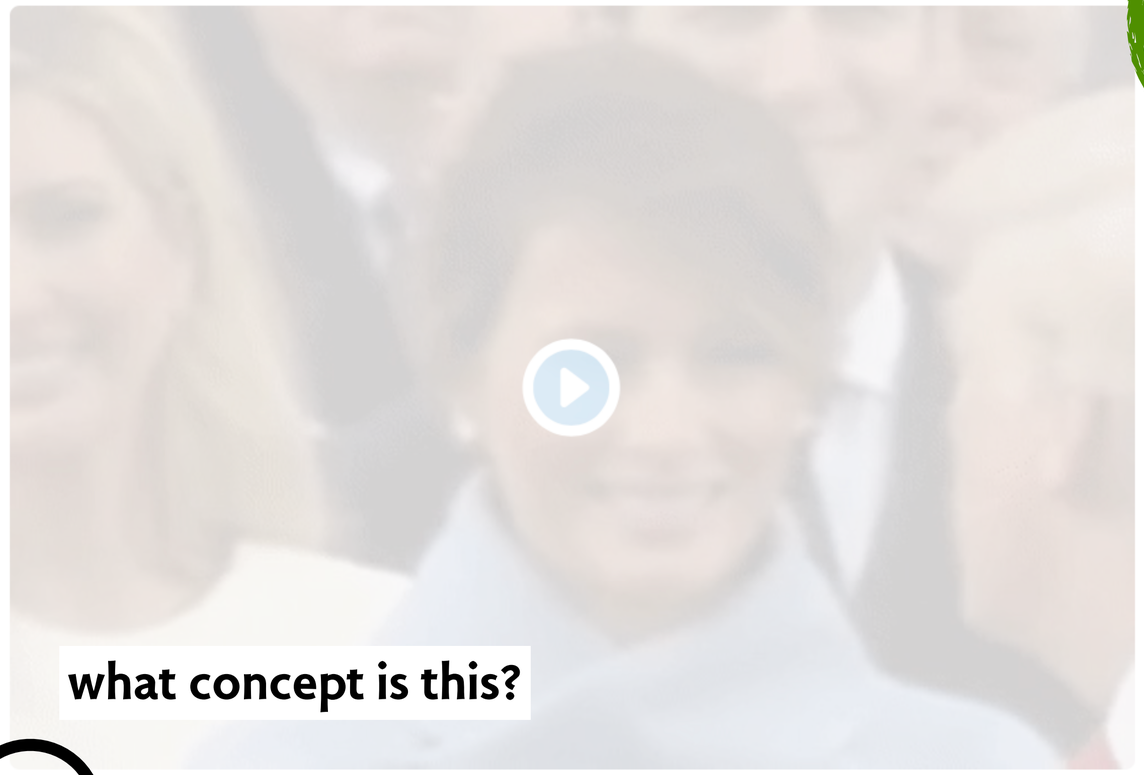


Nov 2, 2015: Twitter changes Favorite (Star) to Like (Heart)

We are changing our star icon for favorites to a heart and we'll be calling them likes... **We know that at times the star could be confusing, especially to newcomers**. You might like a lot of things, but not everything can be your favorite. *Twitter press release*

Andy Ostroy
@AndyOstroy

Seems the only #Wall @realDonaldTrump's built is the one between him and @FLOTUS #Melania #trump



what concept is this?

8,221 8:15 PM - May 2, 2017

4,022 people are talking about this

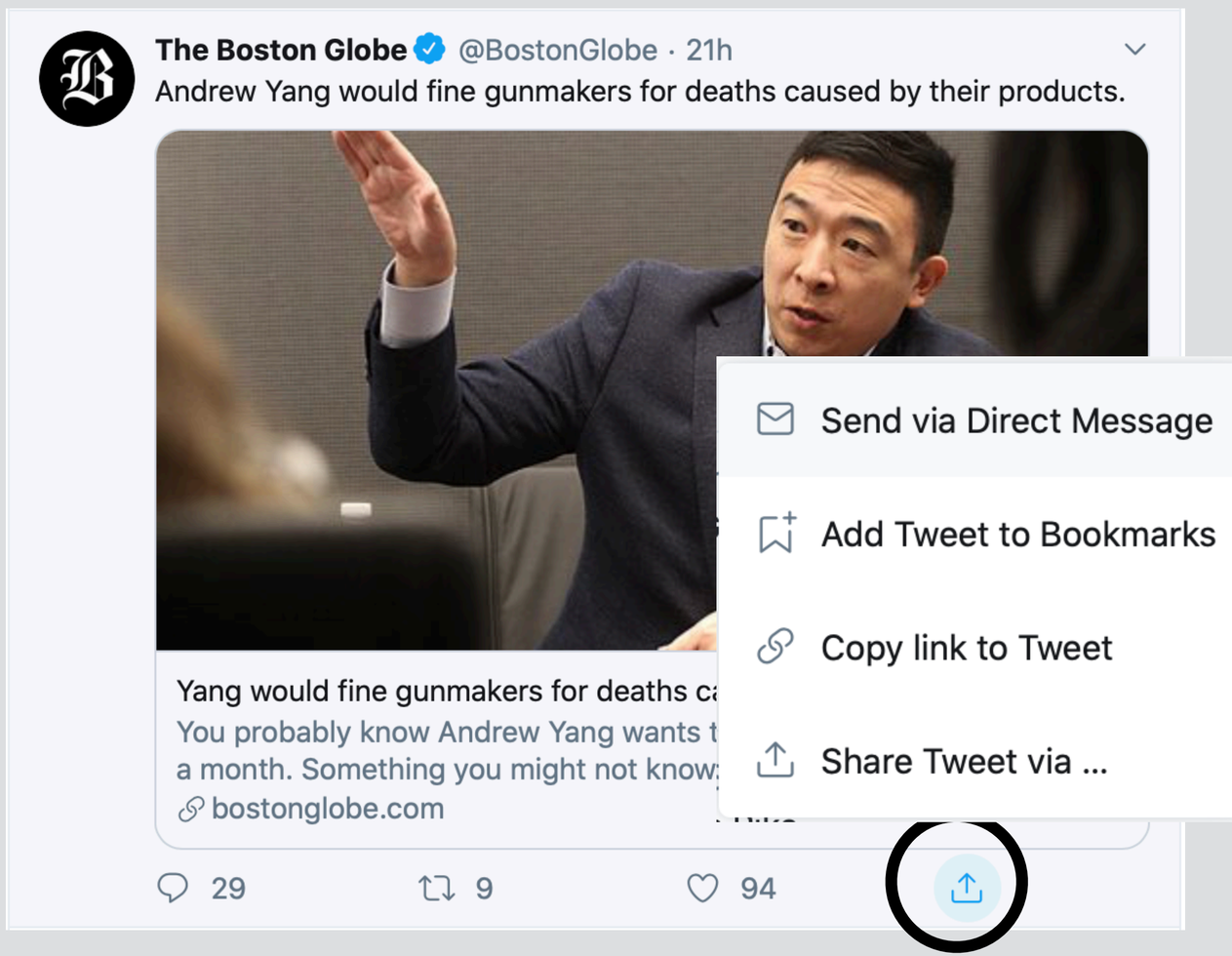
concept Upvote
purpose rank items by popularity
principle after upvotes, ranked by num upvotes

?

concept Bookmark
purpose save items to revisit
principle save then select from private list later

concept Upvote

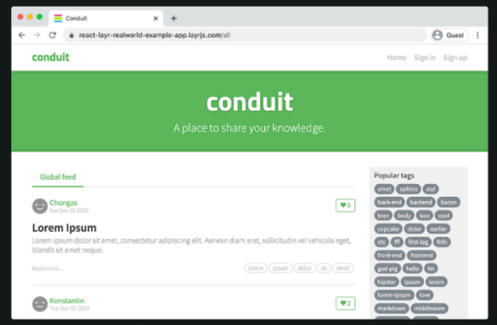
purpose rank items by popularity



concept Bookmark

purpose save items to revisit

your turn:
RealWorld API



The mother of all demo apps

See how the exact same application is built using different libraries and frameworks.

Frontend | Backend | Fullstack

LANGUAGES

All
Java
TypeScript
Go
Python
Kotlin
JavaScript
C#

.NET + Minimal API Erikvdv/realworldapiminimal	C#
ActixWeb + Diesel snamiki1212/realworld-v1-rust-actix-web-diesel	Rust
Adonis Utwo/adonis-realworld-example-app	JavaScript
Adonis	TypeScript

how many concepts can you find in this endpoint?

RealWorld

Search ⌘ K

- Implementation creation
  - Introduction
  - Features
  - Expectations
- Specifications
  - Frontend specifications
    - Templates
    - Styles
    - Routing
    - API
    - Tests
  - Backend specifications
    - Introduction
    - Endpoints
    - API response format
    - CORS
    - Error handling
    - Postman
    - Tests
  - Mobile specifications
- Community
  - Authors
  - Resources

Users (for authentication)

```
{
  "user": {
    "email": "jake@jake.jake",
    "token": "jwt.token.here",
    "username": "jake",
    "bio": "I work at statefarm",
    "image": null
  }
}
```

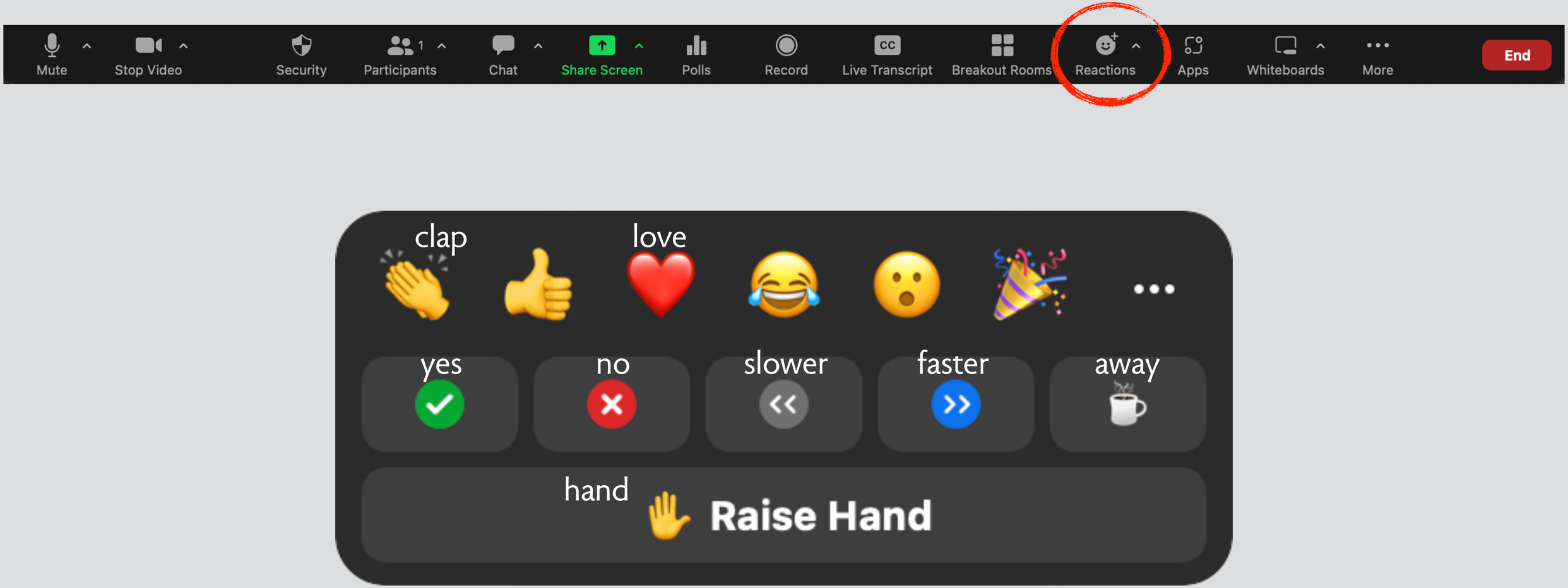
Profile

```
{
  "profile": {
    "username": "jake",
    "bio": "I work at statefarm",
    "image": "https://api.realworld.io/images/smiley-cyrus.jpg",
    "following": false
  }
}
```

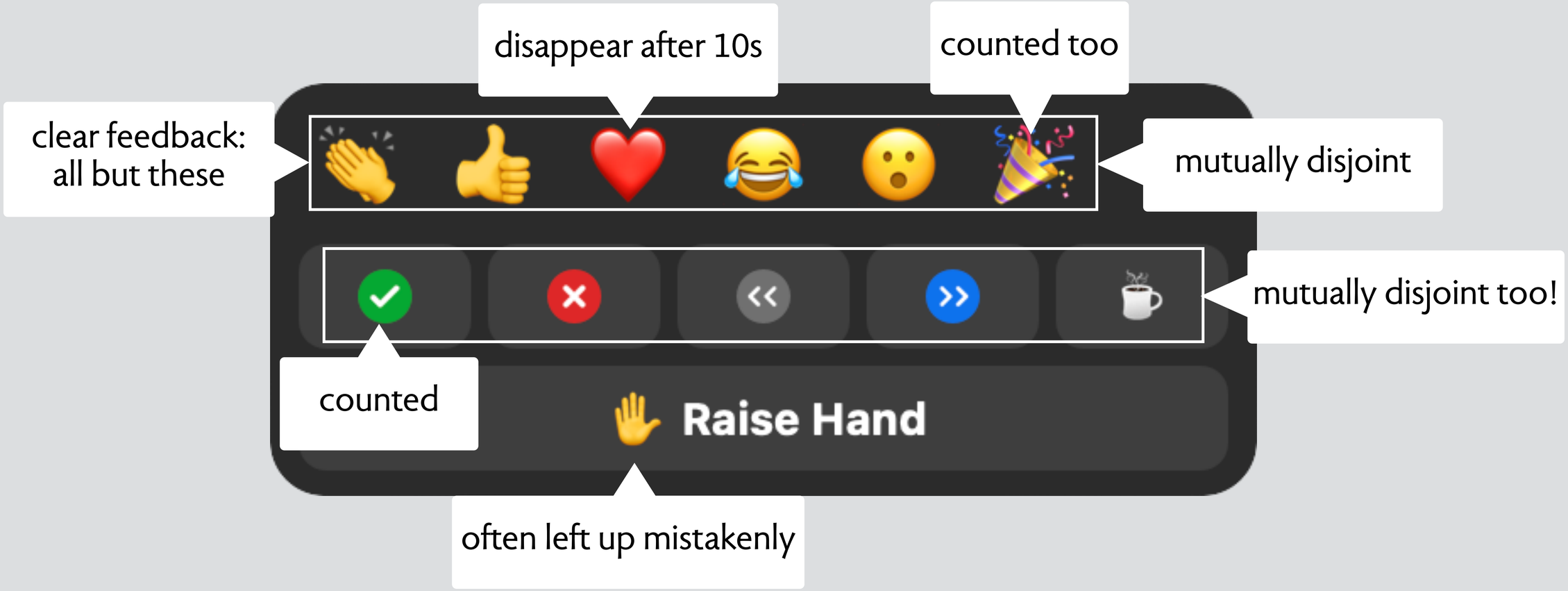
On this page

exercise:
Zoom reactions

Zoom's reactions



anomalous behaviors



functions by reaction type

Reaction	Disappears	Counted	Cancel by host
Emojis	✔	(✔)	
Yes/no		✔	✔
Slow/speed		✔	✔
Away		(✔)	(✔)
Hand		(✔)	✔

✔ yes

(✔) yes, but should probably be no

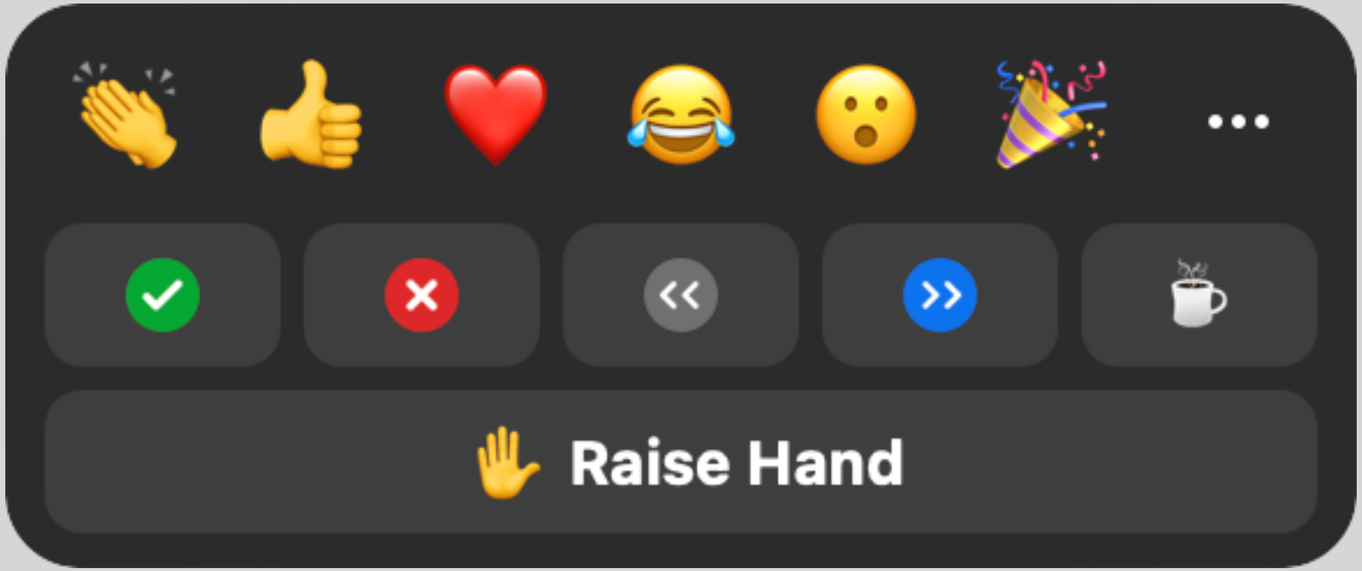
disjointness of reaction types: my take

Reaction	Emojis	Yes/no	Slow/speed	Away	Hand
Emojis	✔				
Yes/no		✔	(✔)	(✔)	(✔)
Slow/speed		(✔)	✔	(✔)	(✔)
Away		(✔)	(✔)	✔	(✔)
Hand		(✔)	(✔)	(✔)	✔

✔ yes

(✔) yes, but should probably be no

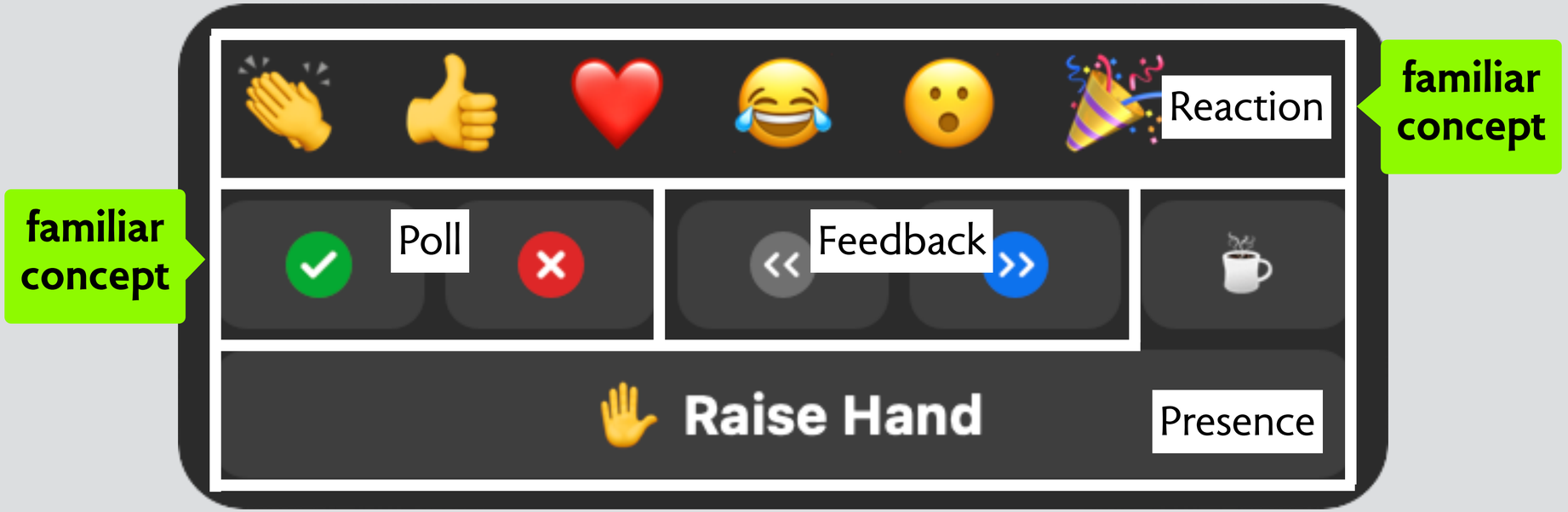
redesigning Zoom

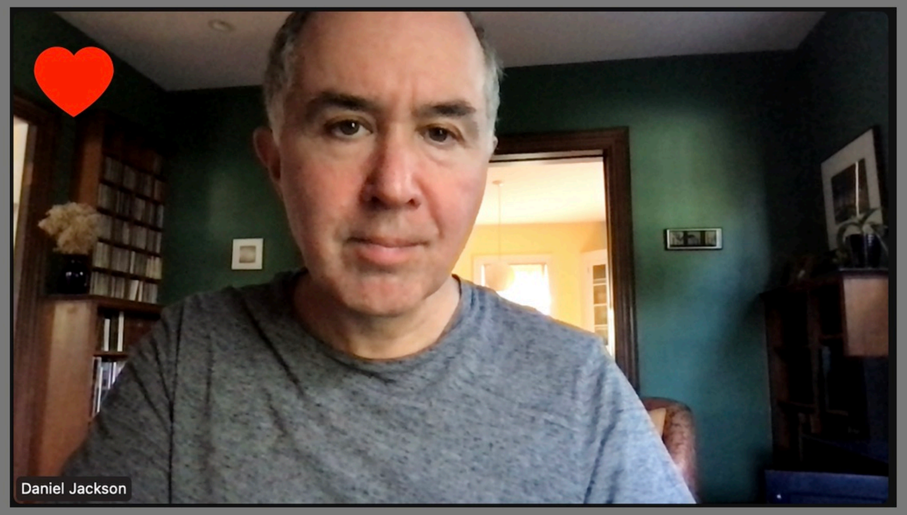


what concepts are involved?
can you identify the concepts behind this widget?
separate them more cleanly?
classify into familiar and novel concepts?

can you do better?
how might you change Zoom's design?
could change UI and behavior for muting, eg

my take: splitting into coherent & independent concepts





Presence

Chat

Reaction

Feedback

Request to speak

Speaking

Watching/listening

I'm away

Audience

Other emoji

Recent emoji

Slow down

Just right

Speed up

16

24

9

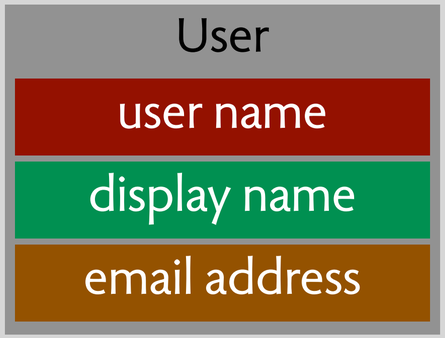
Everyone ▾

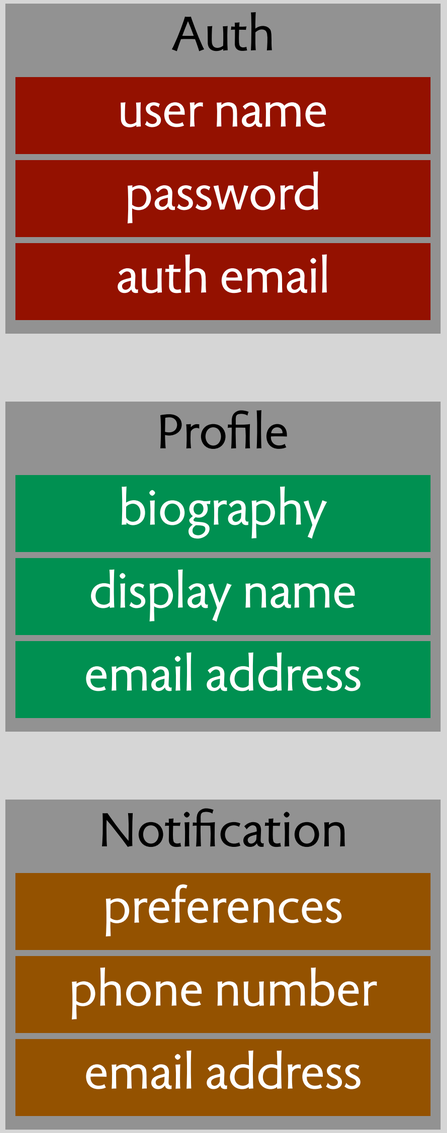
Type here…

takeaways

key idea #1: coherence

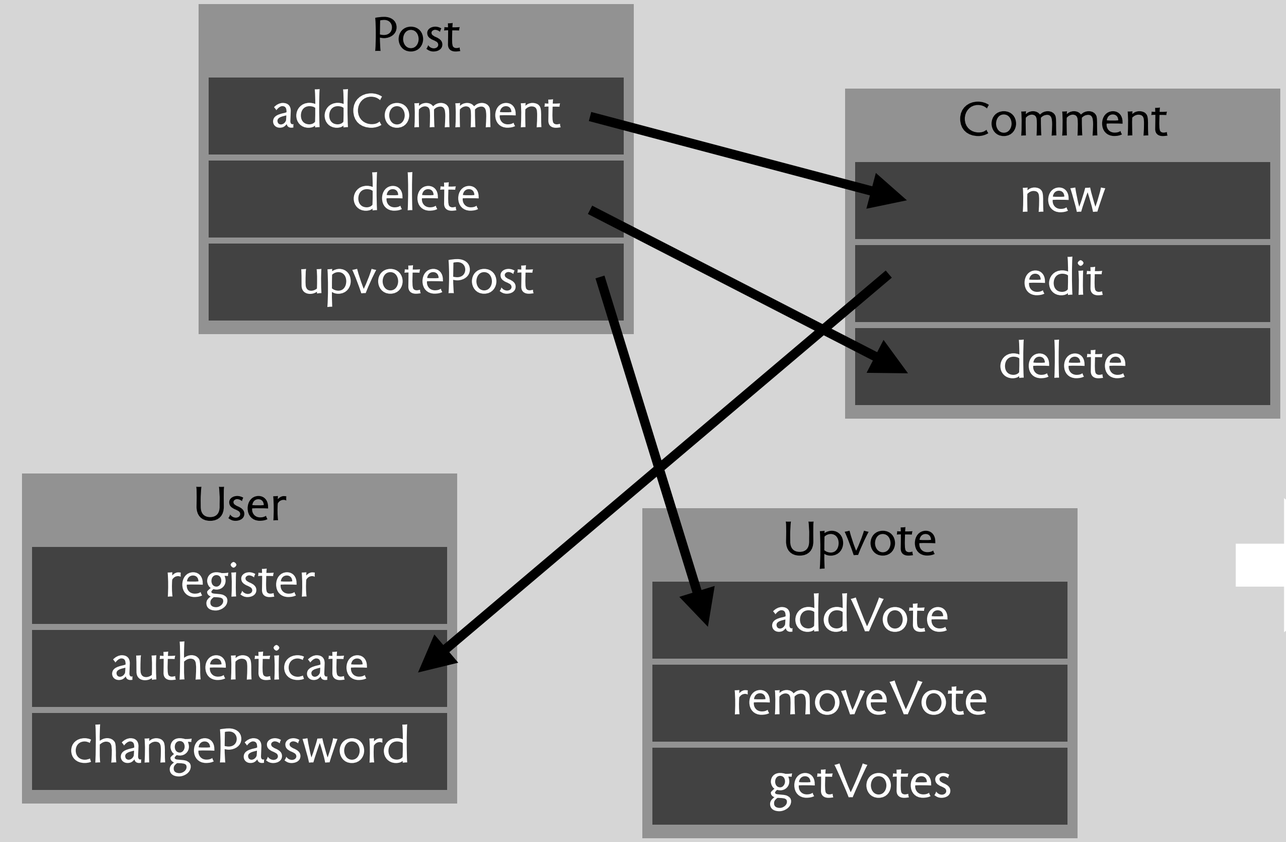
objects tend to conflate functions



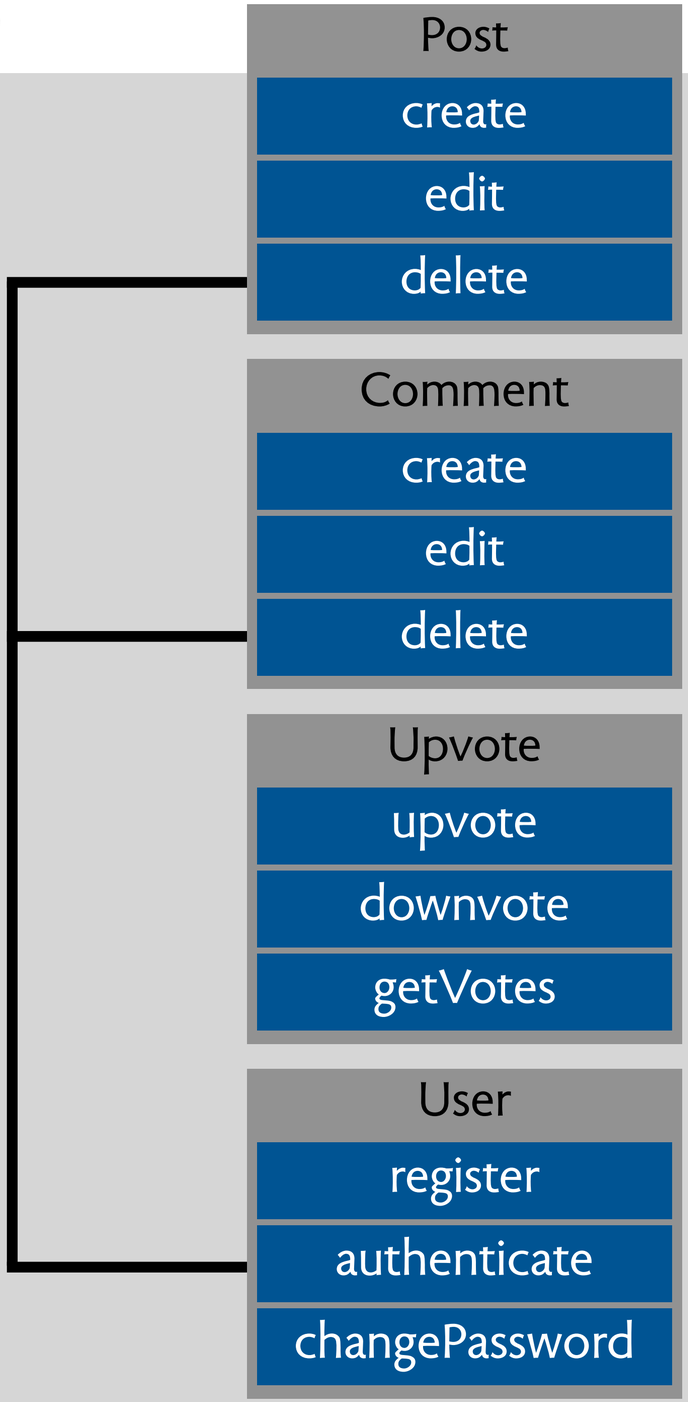


concepts separate functions

key idea #2: independence



in OOP, method calls
couple classes together
so they can't stand alone



in concept design,
syncs are defined externally
so concepts can stand alone

what's next?

what next?

designing concepts
getting to the details
defining behavior: states & actions
purposes & principles