

6.1040 · software studio · fall 2022

# intro to concept design

Daniel Jackson & Arvind Satyanarayan

# today's plan

**moving into software-specific design**

what makes software special?

**two perspectives on concepts**

the classic UX view: it's about modeling

our view: it's about designing

**concepts: the elements of software design**

what's a concept?

how do you define a concept?

how do concepts help design?

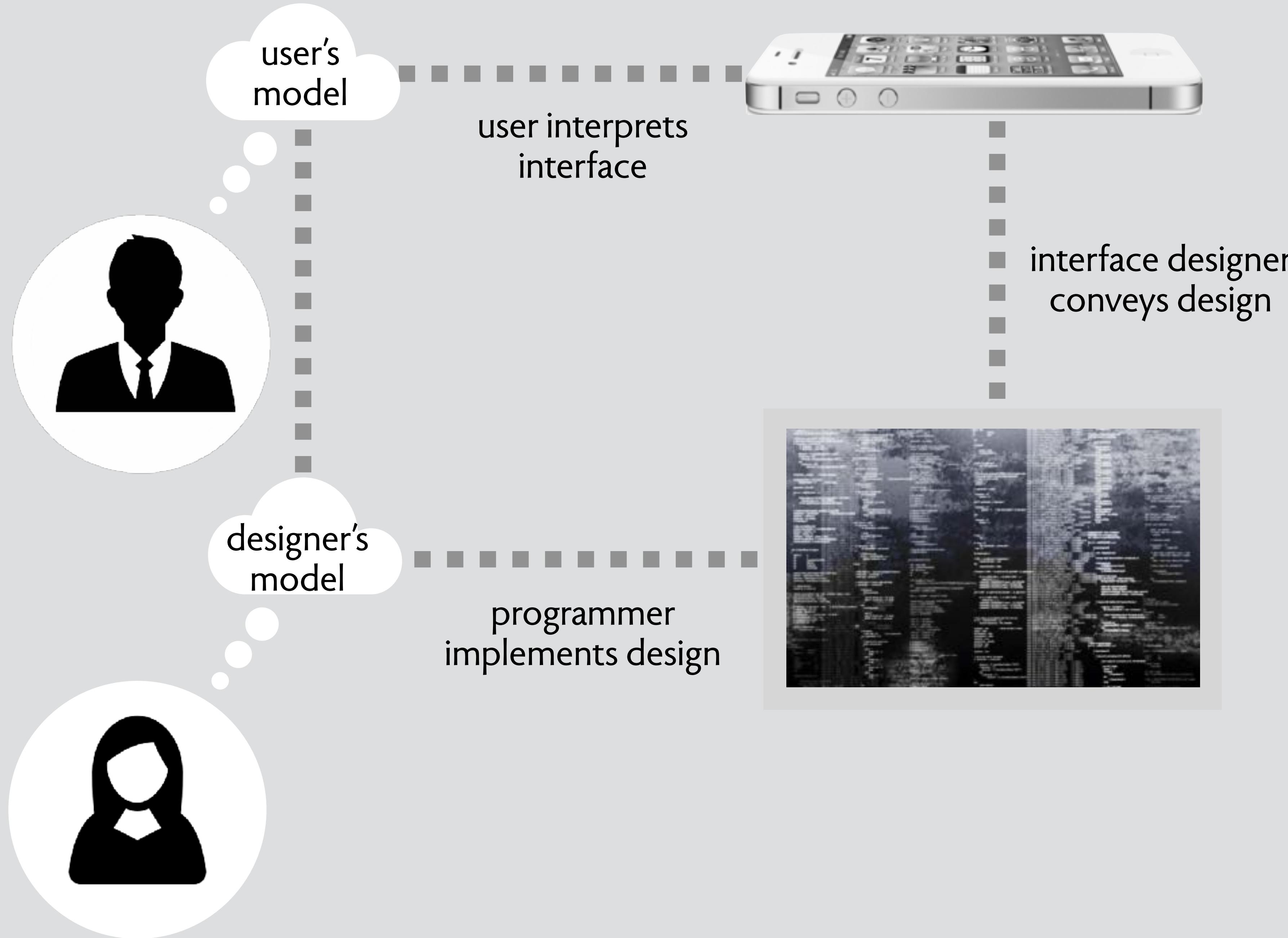
what makes  
software design  
special?

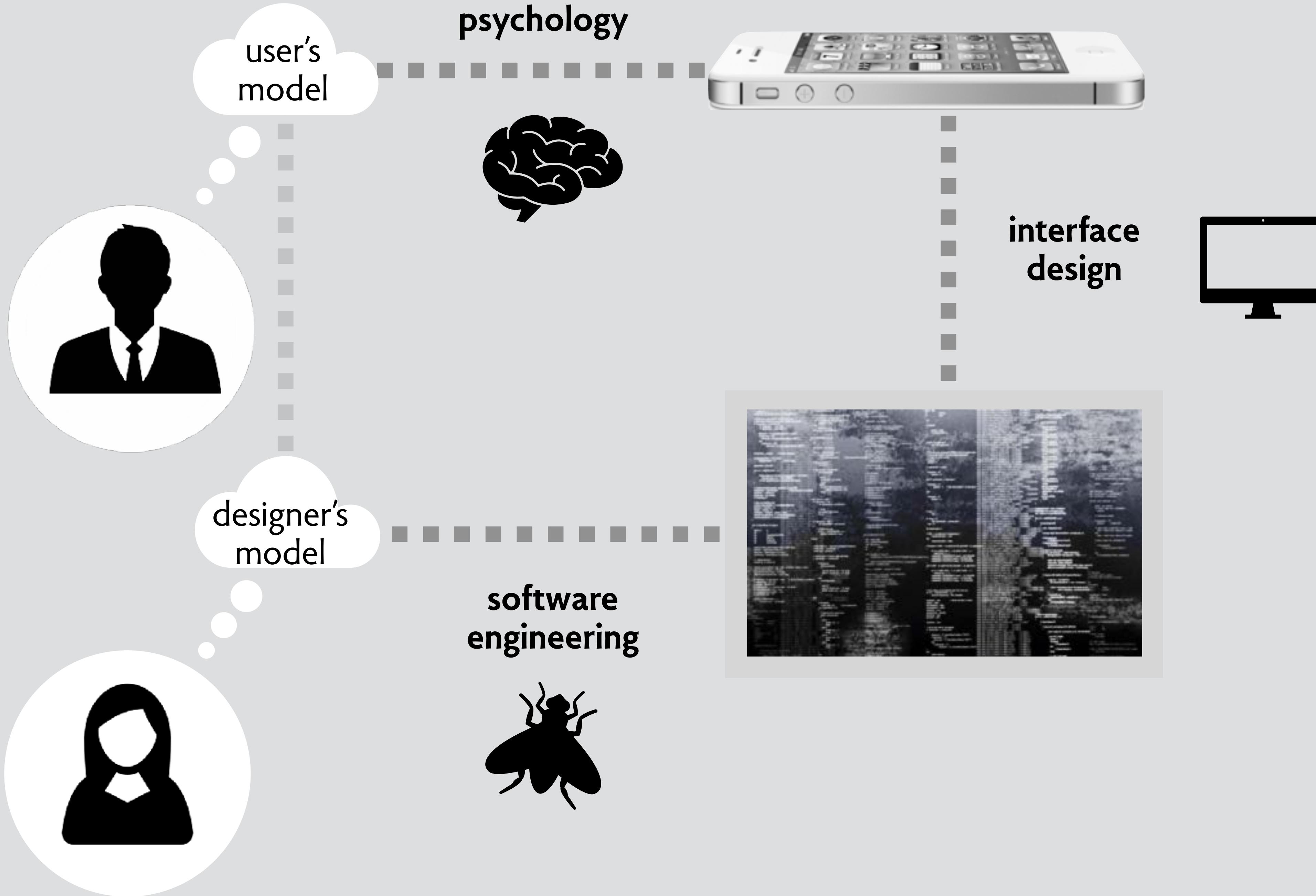
# is software unusable just because we didn't call general designers in?

Now turn to the computer, an area where all the major difficulties of design can be found in profusion. In this realm the user is seldom considered. There is nothing particularly special about the computer; it is a machine, a human artifact, just like the other sorts of things we have looked at, and it poses few problems that we haven't encountered already. But designers of computer systems seem particularly oblivious to the needs of users, particularly susceptible to all the pitfalls of design. The professional design community is seldom called in to help with computer products. Instead, design is left in the hands of engineers and programmers, people who usually have no experience, and no expertise in designing for people.

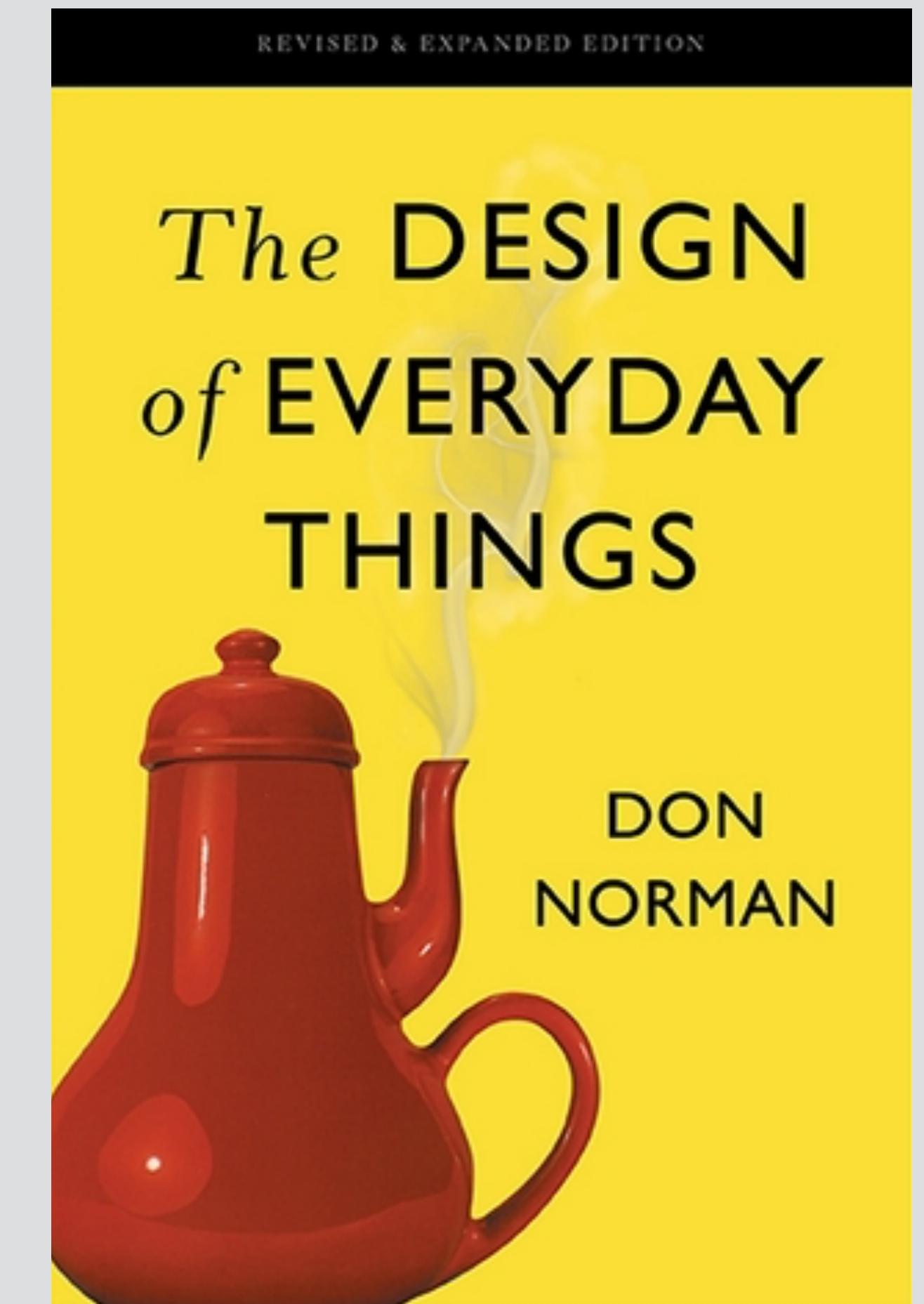
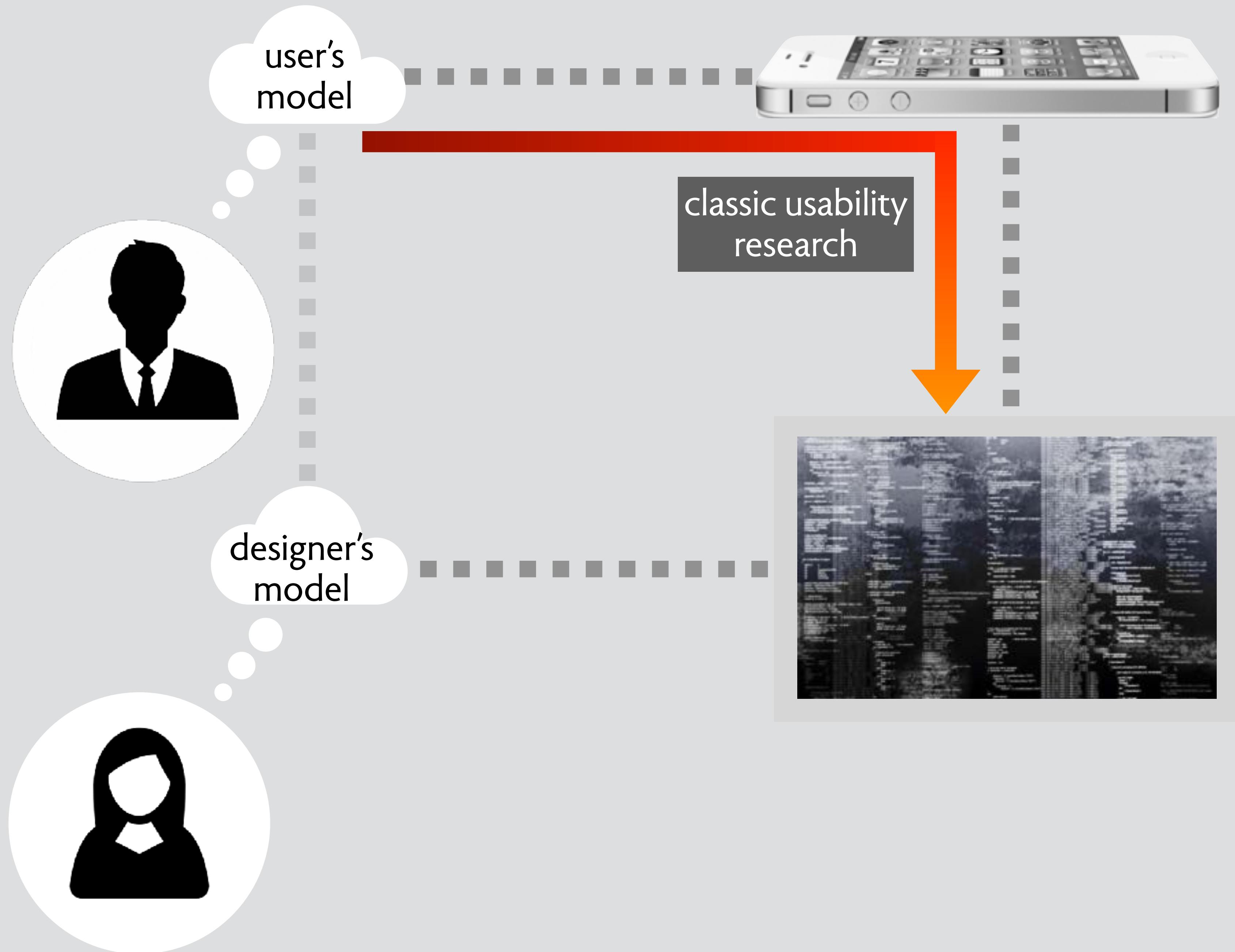
Don Norman, *The Design of Everyday Things*

mental models





REVISED & EXPANDED EDITION



original (revealing) title:  
**The Psychology**  
of Everyday Things  
(POET)

# example: backblaze backup

Backblaze Backup

dnj@mit.edu

You are backed up as of: 6/6/22, 10:10 PM

Currently backing up newer files

Pause Backup

Restore Options...

Selected for Backup: 509,021 files / 2,379,995 MB

Backup Schedule: Continuously

Remaining Files: 0 files / 0 KB

Transferring: photo.0259-22.RAF

Settings...

What is being backed up?

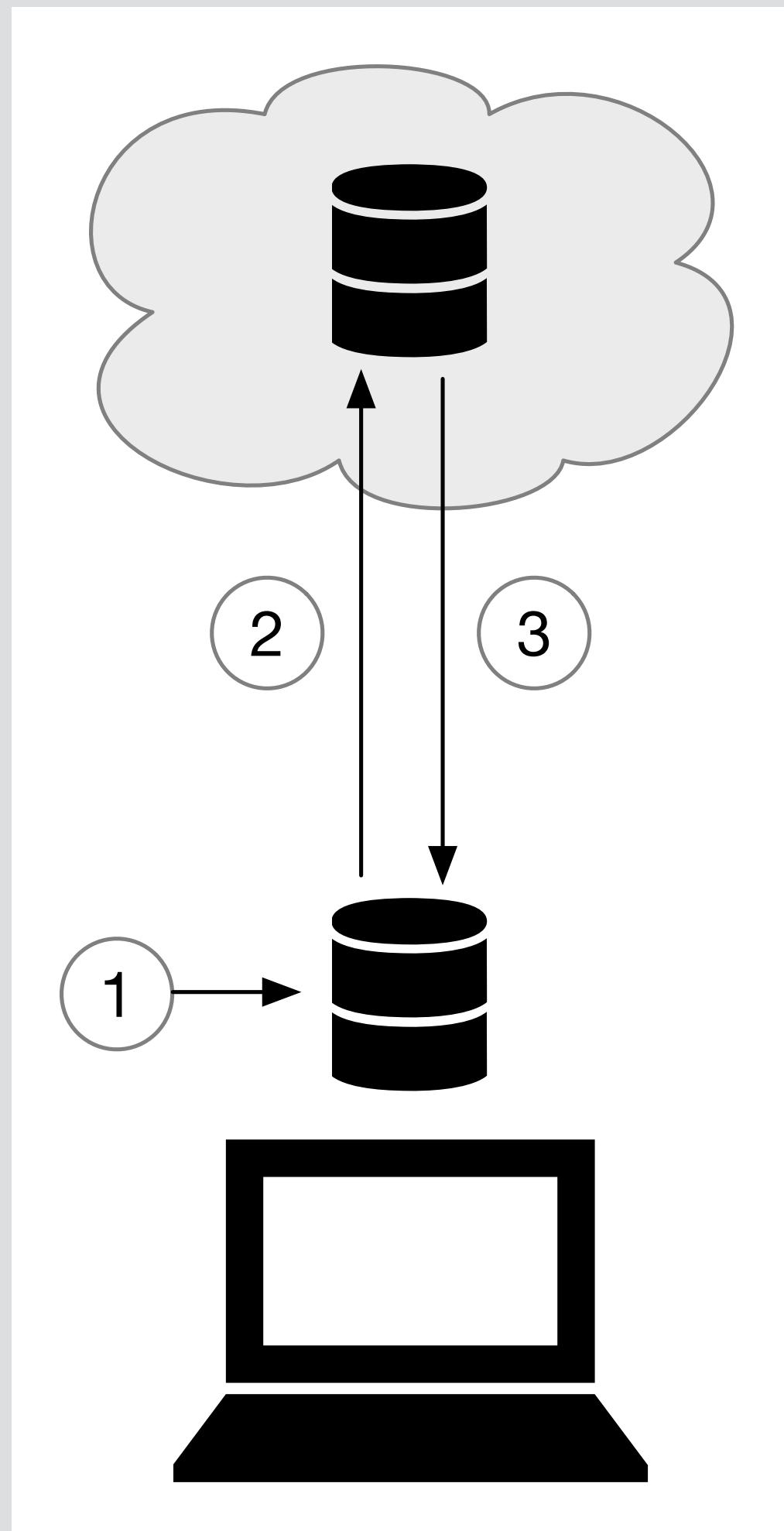
How long will my first backup take?

View files and manage account at: [Backblaze.com](#)

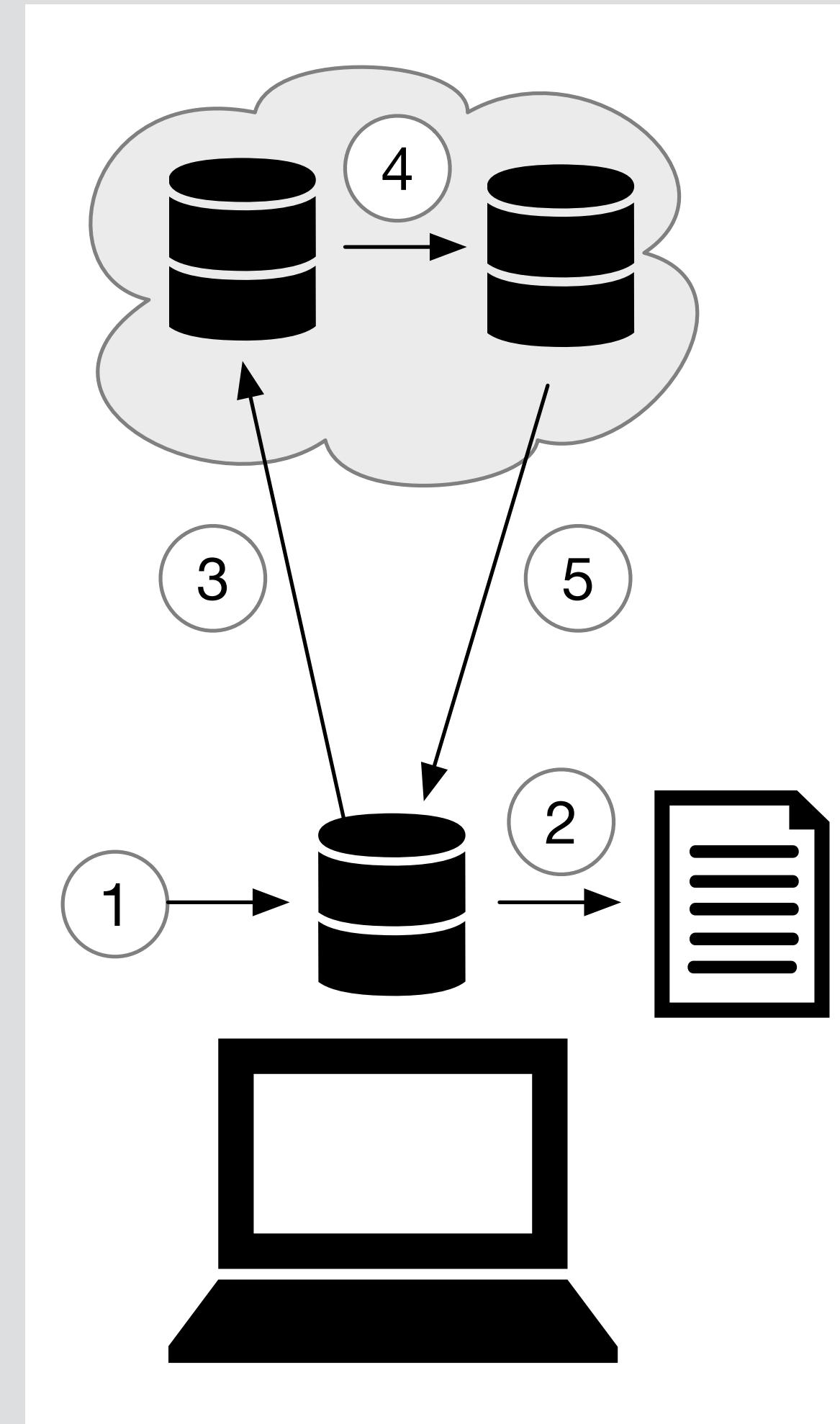
1Y

?

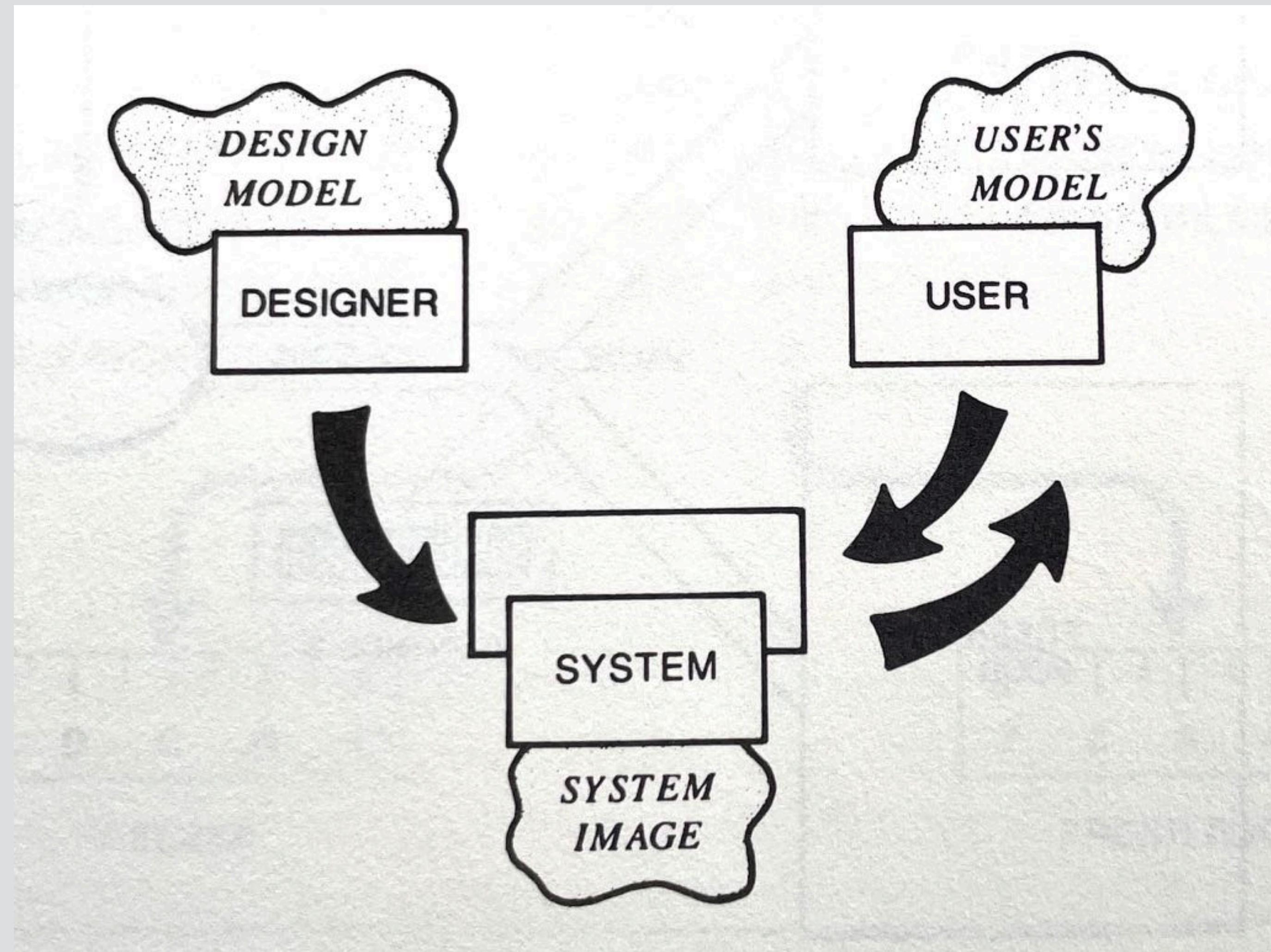
# assumed vs. actual conceptual models



1. file modified
2. list created
3. files backed up
4. files available
5. file restored



# projecting an accurate system image



from *The Design of Everyday Things*

# revisiting backblaze: how would you fix the system image?

Backblaze Backup

dnj@mit.edu

You are backed up as of: 6/6/22, 10:10 PM  
Currently backing up newer files

Pause Backup

Restore Options...

Selected for Backup: 509,021 files / 2,379,995 MB

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Settings...

What is being backed up?

How long will my first backup take?

View files and manage account at: [Backblaze.com](#)

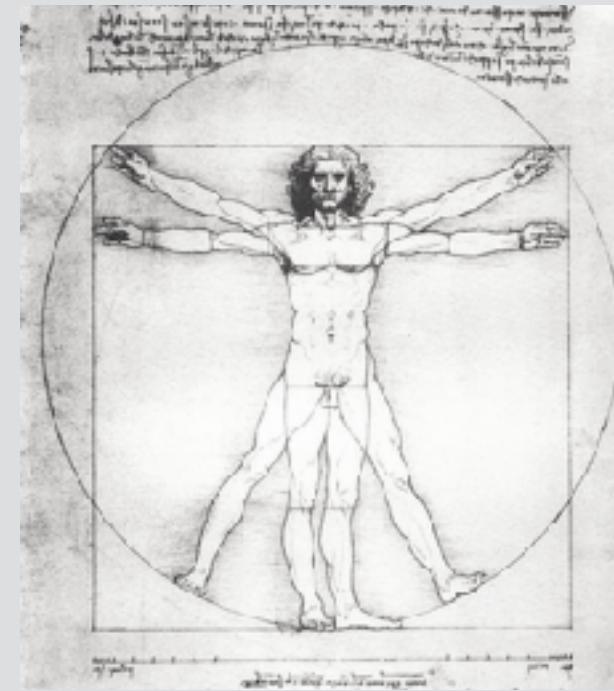
1Y

?

beyond the  
user interface

# levels of UX design (again)

UI



physical

color, size, layout,  
type, touch, sound

concrete



linguistic

icons, labels, tooltips,  
site structure

abstract



conceptual

semantics, actions,  
data model, purpose



**Dropbox:** Edit

## **Someone accidentally deleted thousands of files in my company Dropbox: how can I quickly undelete them?** Edit

[Add Question Details](#)

[Comment](#) • [Share](#) • [Report](#) • [Options](#)



Ava is a party planner

Search AA

## Dropbox

Overview Show ...

Name ↑	Members ↓	...
<input type="checkbox"/> Bella Party <span>☆</span>	2 members	...

does the name change for Ava too?

answer: it depends

if Ava just shares **Bella Party** with Bella (this case)  
and Bella renamed the folder, Ava sees no change

if Ava shared a folder containing **Bella Party**  
then Ava does see the change



Bella is having a party

Search BB

## Dropbox

Overview Show ...

Name ↑	Members ↓	...
<input type="checkbox"/> My Party <span>☆</span>	2 members	<input type="checkbox"/> ...

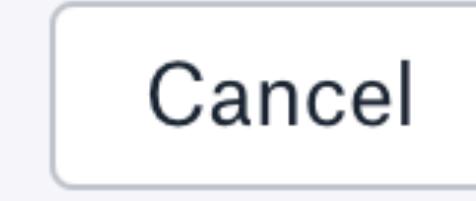
- Share
- Download
- Send with Transfer
- Request files
- Star
- Rewind
- Rename



Remove shared folder?

Bella deletes  
shared folder  
Bella Party

Are you sure you want to remove the shared folder **Bella Party** from your Dropbox? This folder will stay shared with any existing members. You can re-add it later.



Cancel



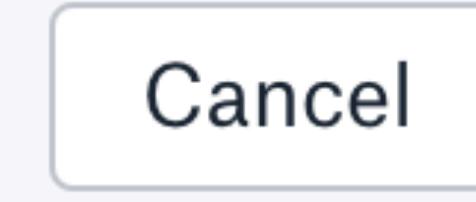
Remove



Delete folder?

Bella deletes  
Bella Plan from  
shared folder  
Bella Party

Are you sure you want to delete **Bella Plan** from the shared folder 'Bella Party'?



Cancel

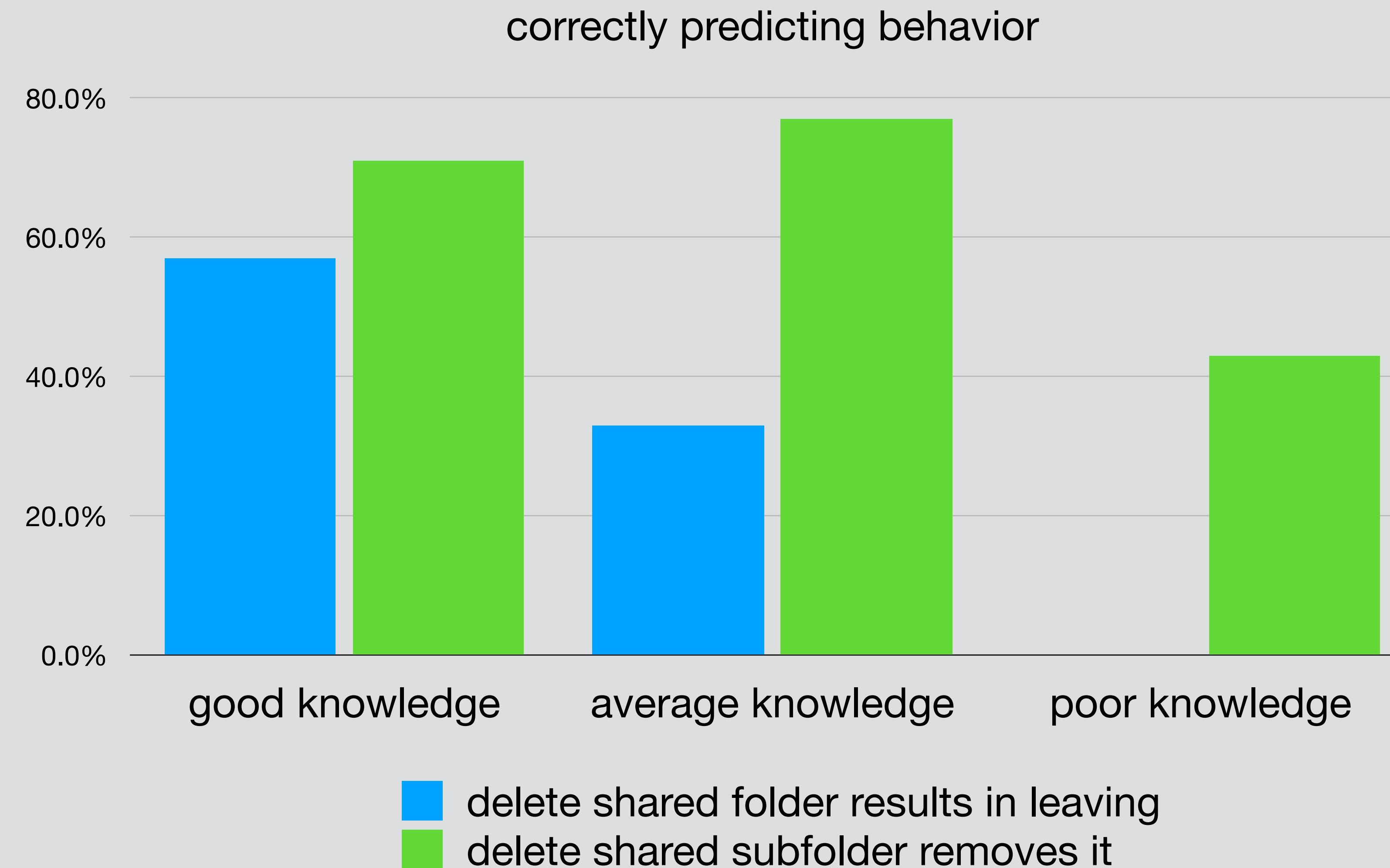


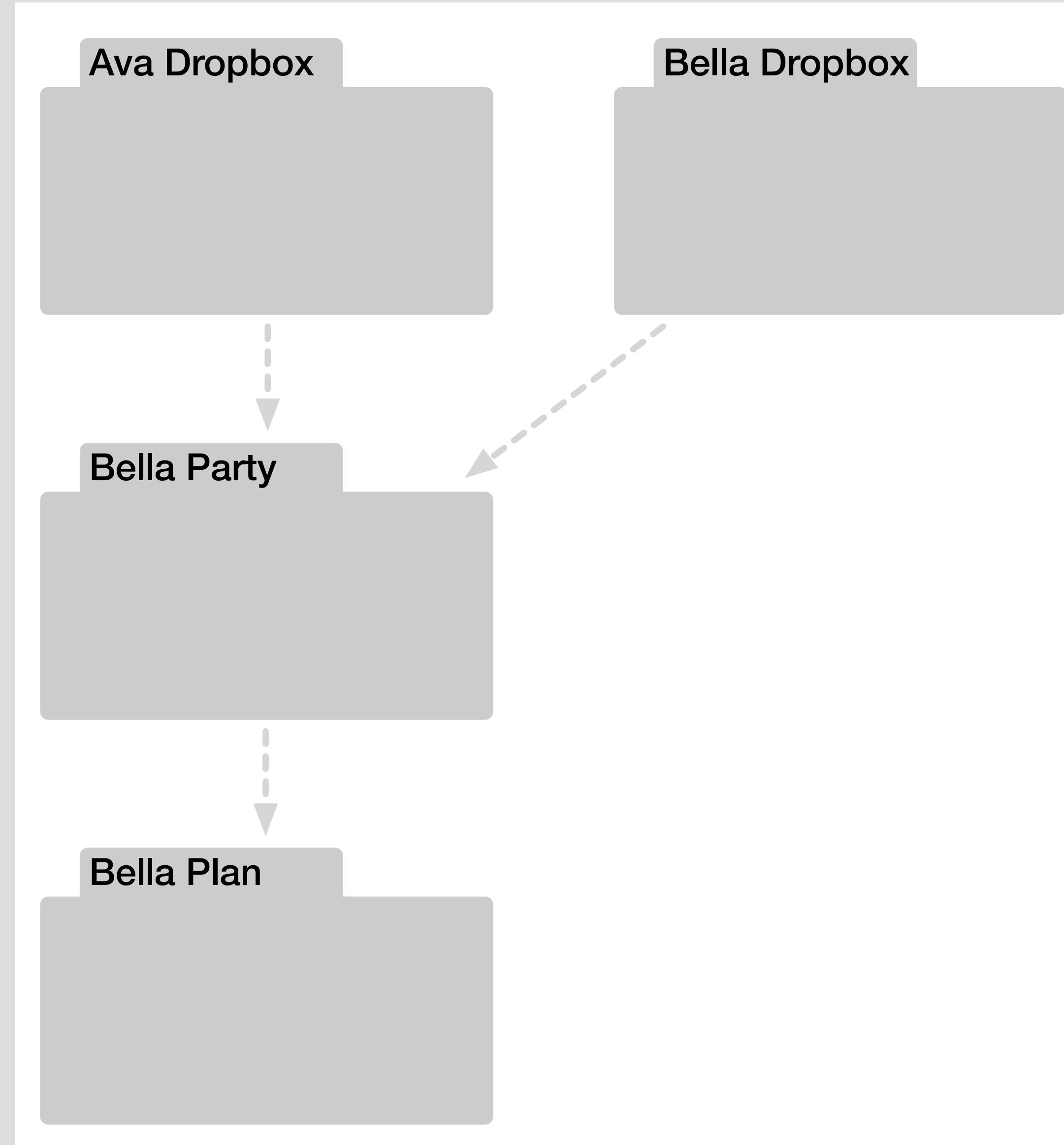
Delete

# survey of dropbox users (MIT CS undergrads)

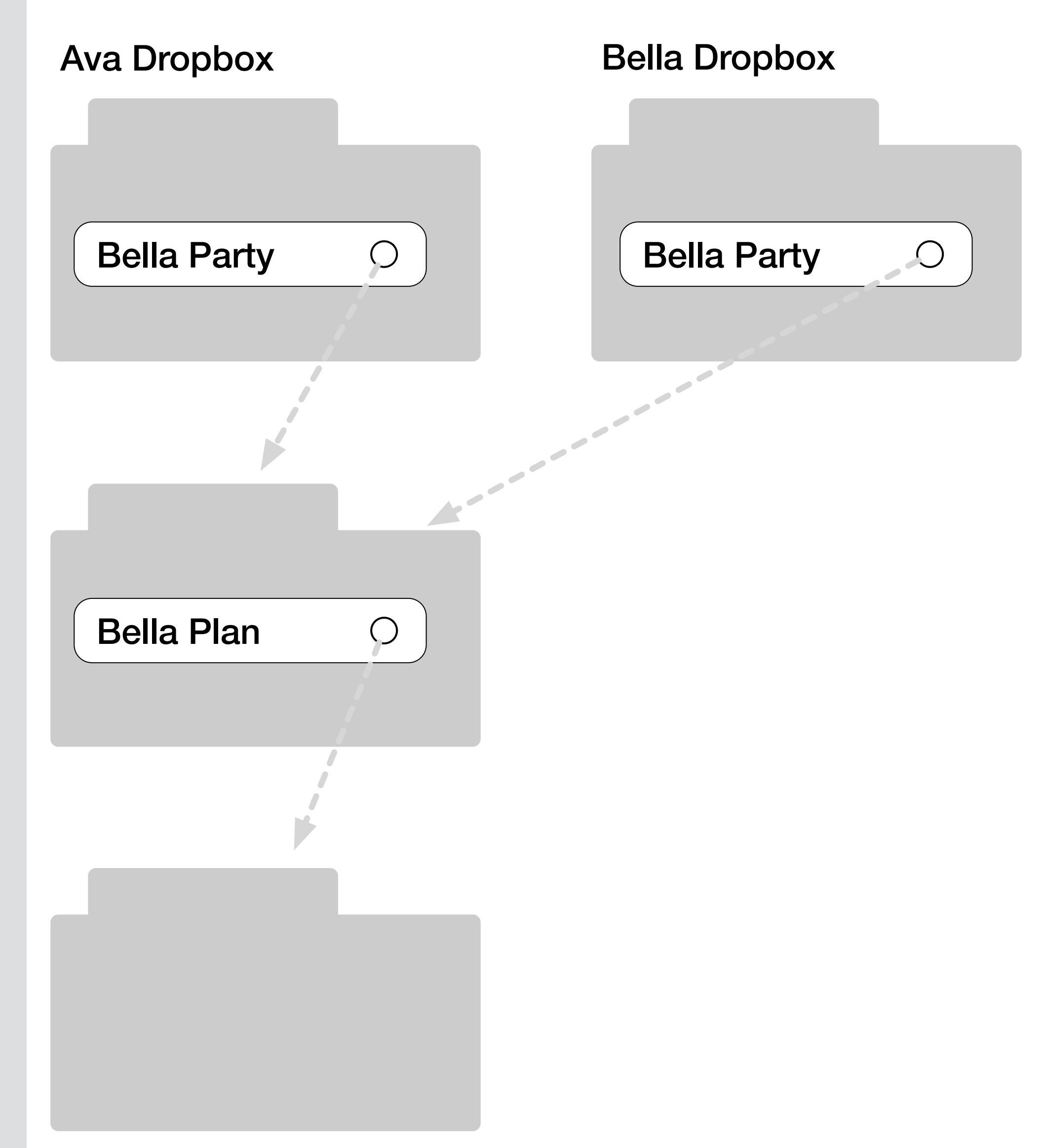


Kelly Zhang

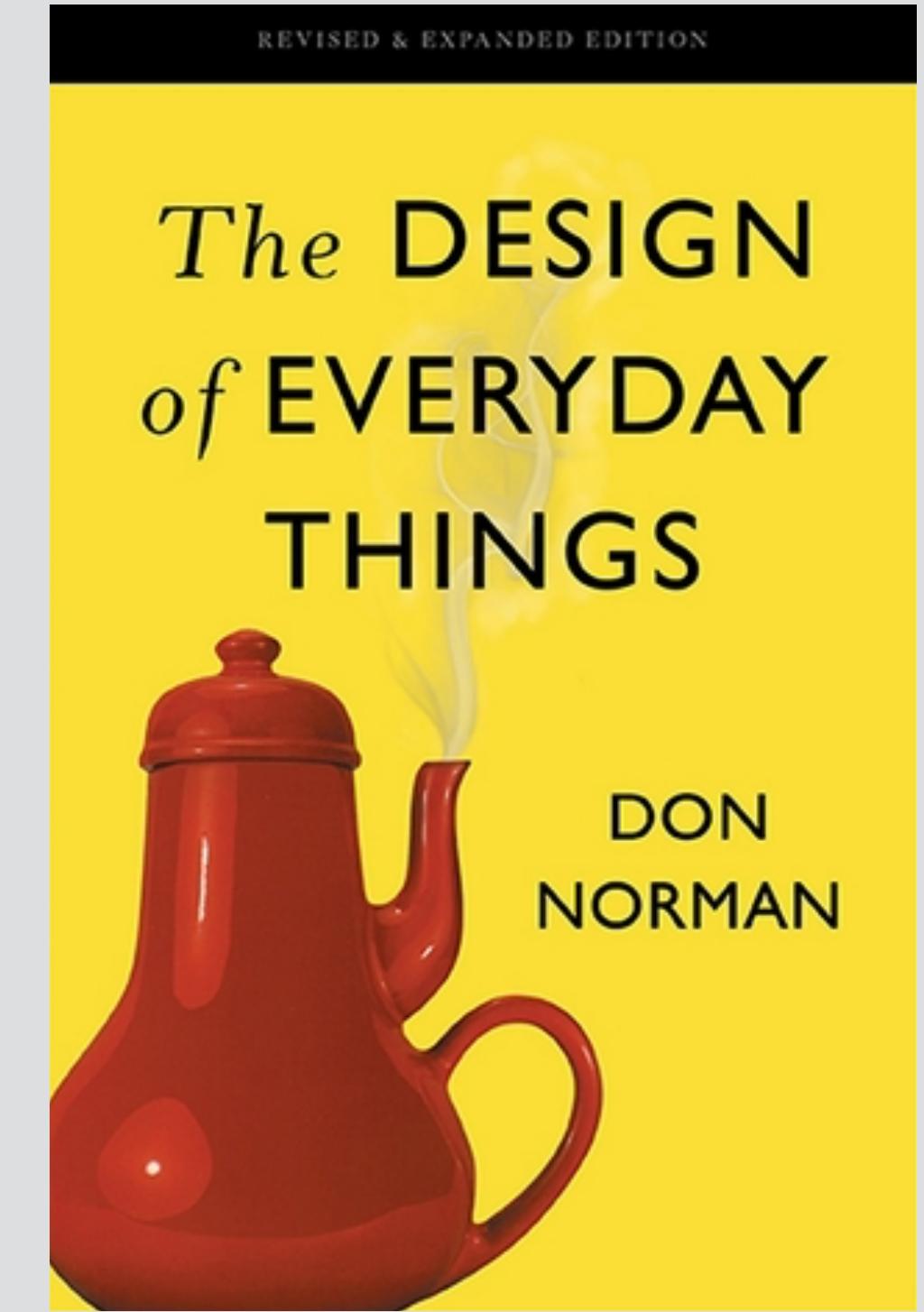
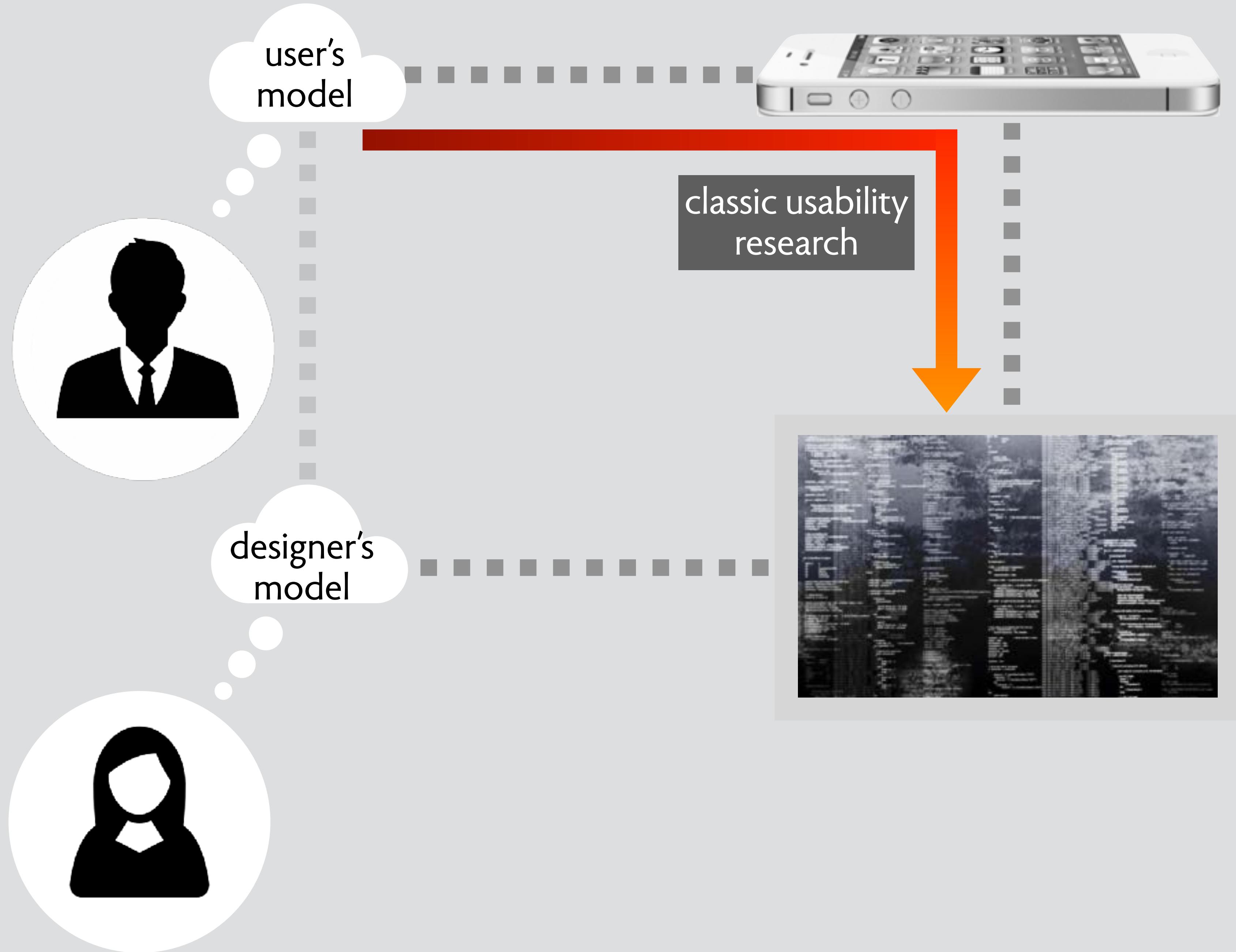


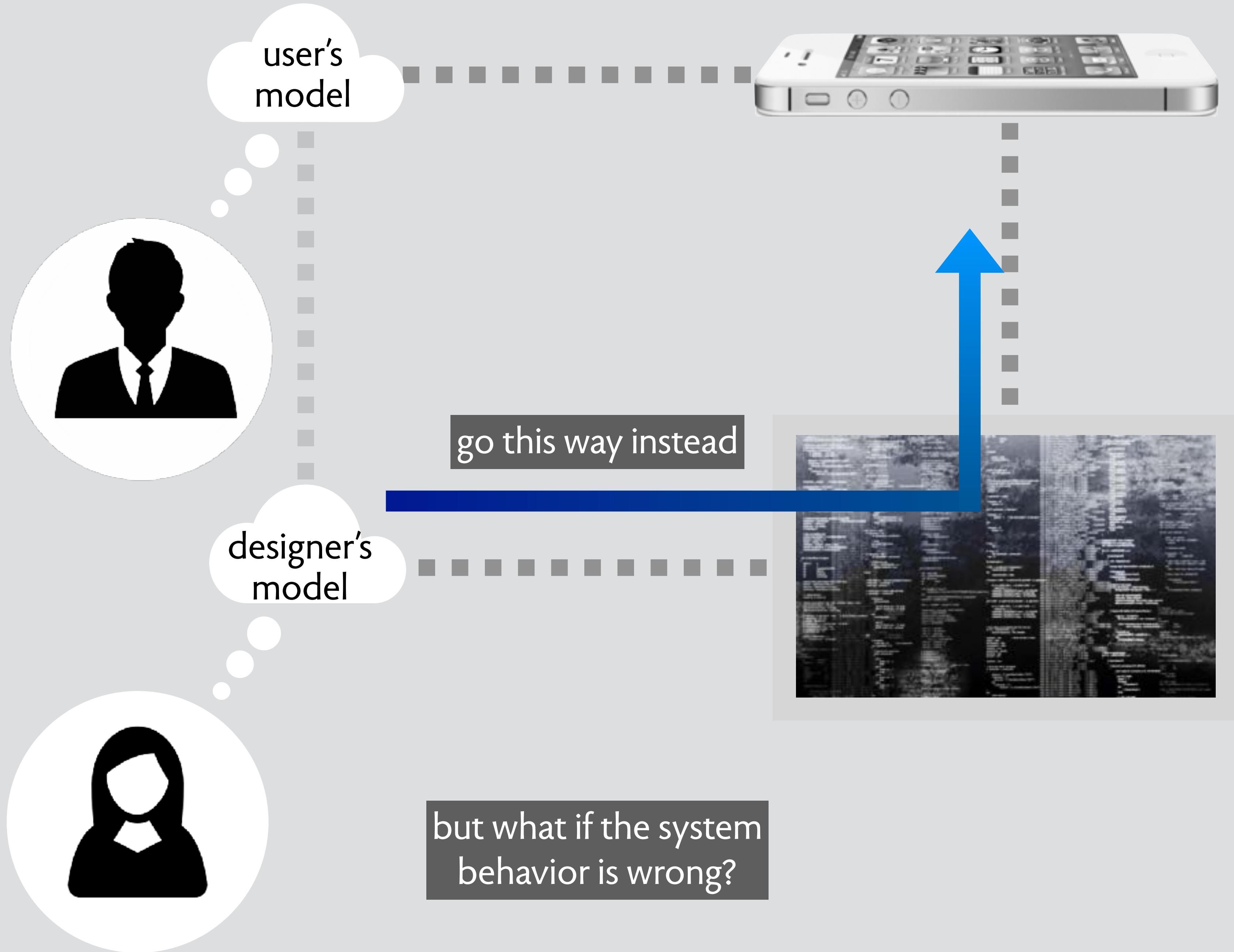


how many users believe the folder concept works



how folders actually work (in Dropbox, Unix, Multics)





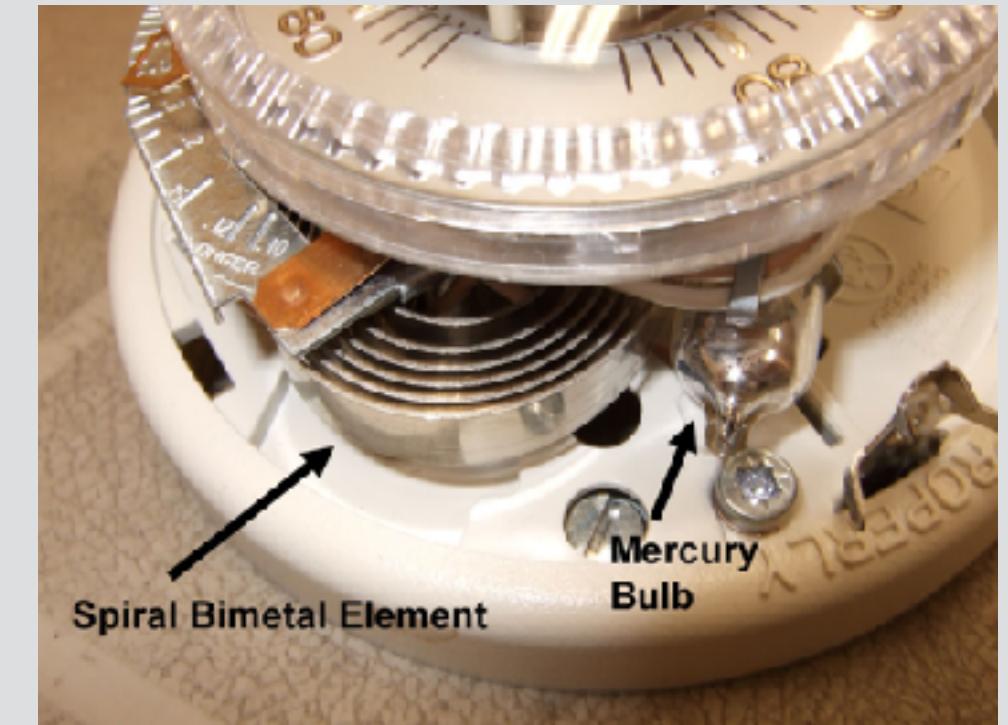
# lessons



## classic UX approach

underlying mechanism is fixed by engineers

UX designer's job is to project an accurate system image



[electrical-forensics.com](http://electrical-forensics.com)



## software UX approach

the conceptual model *is* the mechanism!

UX designer's job is to *create* a good model (and then project it)

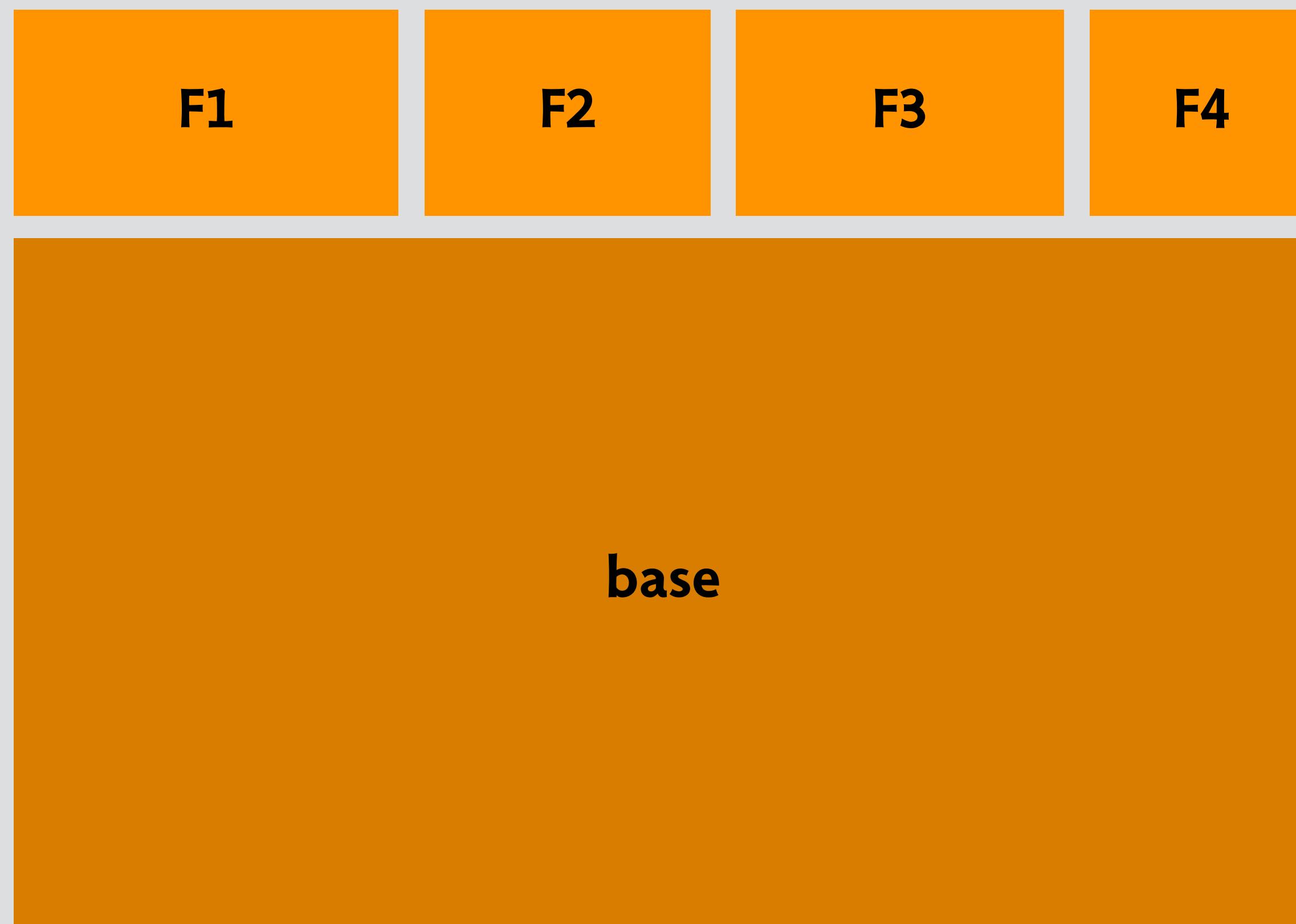
## the big questions

so how do we design the conceptual model?

what are the modules? design criteria?

**from features  
to concepts**

# features: a starting point



## ▲ Jackson structured programming (wikipedia.org)

106 points by haakonhr 63 days ago | hide | past | favorite | 69 comments

**upvote****favorite**

▲ danielnicholas 63 days ago [-]

user: danielnicholas

created: 63 days ago

karma: 11

You might find helpful an annotated version [0] of Hoare's explanation of JSP that I edited for a Michael Jackson festschrift

; I'd point to these ideas as worth knowing:

ing problem that involves traversing context-free structures can be solved very systematically. HTDP addresses this class, but bases one structure only on input structure; JSP synthesized input and output.

- The **karma** one archetypal problems that, however you code, can't be pushed under the rug—most notably structure clashes—and just recognizing them

- Coroutines (or code transformation) let you structure code more cleanly when you need to read or write more than one structure. It's why real iterators (with yield), which offer a limited form of this, are (in my view) better than Java-style iterators with a next method.

- The idea of viewing a system as a collection of asynchronous processes (Ch. 11 in the JSP book, which later became JSD) with a long-running process for each real-world entity. This was a notable contrast to OOP, and led to a strategy (seeing a resurgence with event storming for DDD) that began with events rather than objects.

[0] <https://groups.csail.mit.edu/sdg/pubs/2009/hoare-jsp-3-29-09...>

▲ ob-nix 63 days ago [-]

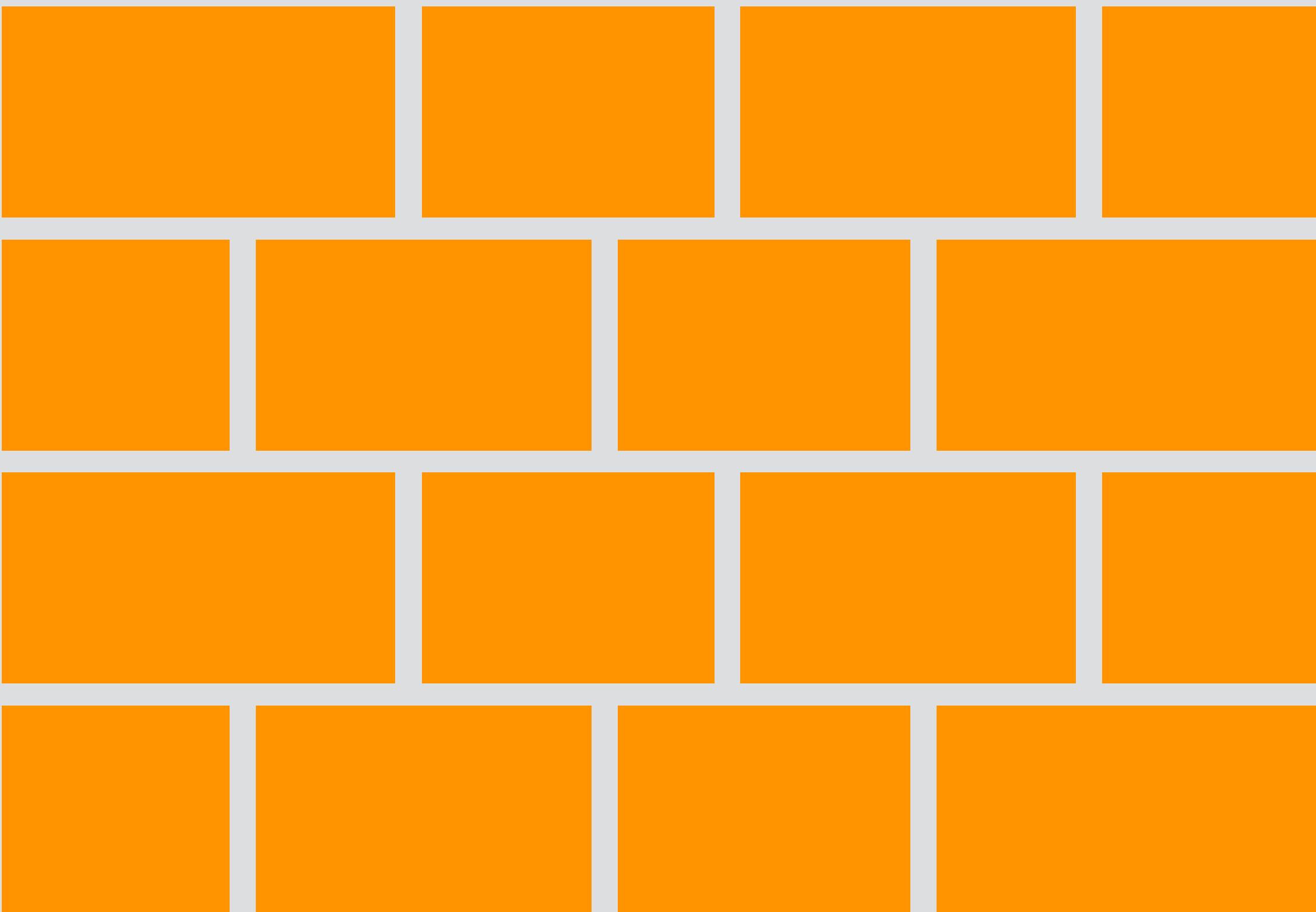
... this brings back memories! In the late eighties I, as a teenager, found a Jackson Struct. Pr. book at the town library. I remember I was amazed at the text and wondered why I hadn't heard about the method before.

If I remember correctly did the book clearly point out backtracking as a standard method, while mentioning that most languages lacked that, so it had to be implemented manually.

▲ CraigJPerry 63 days ago [-]

This is referenced(1) as a core inspiration in the preface to "How to Design Programs" but i never researched it further because i've found the "design recipes" approach in htdp to be pretty solid in real life problems

features all the way down?



## ▲ Jackson structured programming (wikipedia.org)

post

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session

upvote

favorite

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comment

- The karma are archetypal problems that, however you code, can't be pushed under the rug—most notably structure clashes—and just recognizing them

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defining a concept

# seeking a UI-independent definition

This is homework and I'm having a  
are the definitions of the objects:

8

```
sig Library {  
    patrons : set Person,  
    on_shelves : set Book,  
}
```

1

StackOverflow

Reader Picks

All



J

John  
Boston | Oct. 27

To protect children? Seems far more likely it's yet one more way to extract personal information to feed the insatiable advertising machines.

1 Reply 143 Recommend Share

Flag

NYTimes



Oliver Jumperz @oliverjumpertz · Aug 30

...

Don't only learn programming languages and frameworks.

Also, learn:

- Problem-solving
- Critical thinking
- People skills
- **Software design** and architecture
- Computer science fundamentals

Languages and frameworks are a good start, but the above will make you even better.



49



392



1,935



Twitter

# #1: give it a name

**concept Upvote**

what other names might you choose?

why do names matter?

## #2: say what it's for (purpose)

**concept** Upvote

**purpose** rank items by popularity

**purpose** encourage authors

**purpose** engage evaluators

why is it important to know your purpose?

why's it good to identify a primary purpose?

what is the design impact of one purpose over another?

# similar UIs, very different purposes

**concept** Upvote

**purpose** rank items by popularity

▲ This is homework and I'm having a  
are the definitions of the objects:  
8  
▼  
1

```
sig Library {  
    patrons : set Person,  
    on_shelves : set Book,  
}
```

**concept** Reaction

**purpose** send reactions to author

Today ▾  
**Daniel** I think we should organize a  
software concepts forum.  
 1 

**concept** Recommendation

**purpose** use prior likes to recommend



# #3: explain how it works (operational principle)

**concept** Upvote

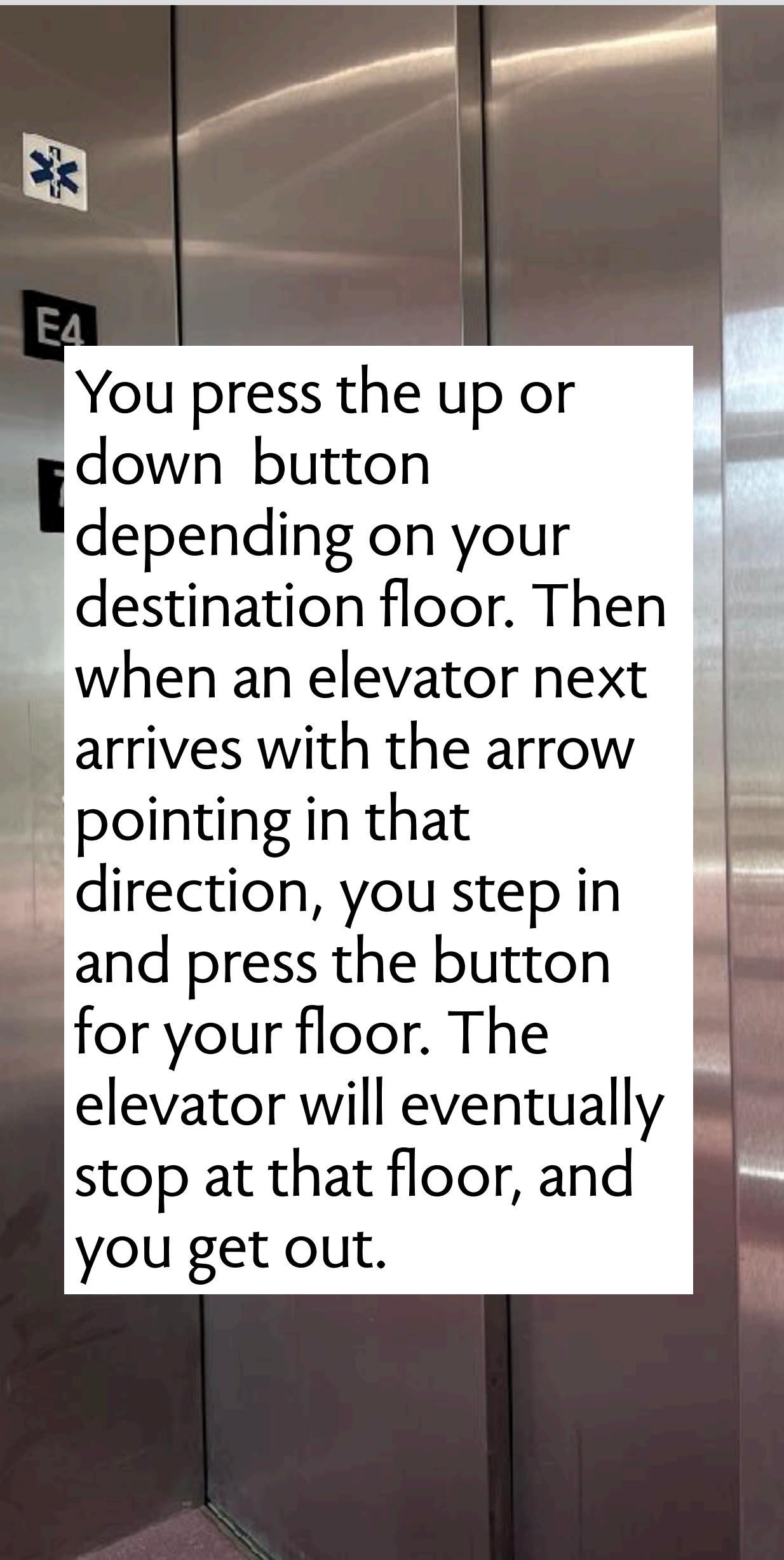
**purpose** rank items by popularity

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



Michael Polanyi

# can you explain elevators to a martian?



You press the up or down button depending on your destination floor. Then when an elevator next arrives with the arrow pointing in that direction, you step in and press the button for your floor. The elevator will eventually stop at that floor, and you get out.



Schindler's PORT elevator

You enter your destination floor on the keypad. You then go to the indicated elevator bank, and you take the first elevator that arrives there. The elevator will eventually stop at your floor, and you get out.

# operational principles for related concepts

**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** send reactions to author

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

**concept** Recommendation

**purpose** use prior likes to recommend

**principle** user's likes lead to ranking of kinds of items, determining which items are recommended

*note: OPs are always **end-to-end**; the more **generic**, the better*

# even more closely related concepts: how do purposes and OPs differ?

question @157 Actions **80 views**

## Meaning of indirectly being a friend in 4e

When problem 4e says that **everyone is a friend of Zuckerberg, directly or indirectly**, does indirectly just mean that you can be a friend of a friend of a friend... of a friend of Zuckerberg?

p5

~ An instructor (dnj@mit.edu) endorsed this question ~

Edit undo good question | 1 Updated 12 months ago by [redacted]

the instructors' answer, where instructors collectively construct a single answer Actions

Yes, that can be an interpretation of indirectly.

~ An instructor (dnj@mit.edu) endorsed this answer ~

Edit undo good answer | 1 Updated 12 months ago by [redacted]

## concept Endorsement

7. OTTO 450 Pizza \$ • Harvard Square Open until 9:00 PM  
"Bringing Portland to Cambridge, OTTO has tasty foodie pizza. Mashed potatoes on pizza is an unexpectedly good combo." [more](#)

✓ Outdoor dining ✓ Delivery ✓ Takeout Start Order

## concept Rating

# larger design issues for upvote concept

do early votes dominate?

can cheaters exploit the ranking?

is double voting possible?

will old items be over-represented?

do upvotes encourage more upvotes?

does upvoting favor “chips” over “salad”?

any other issues can you think of?

which are specific to Upvote and don't apply to Rating eg?

# 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

## typical uses

social media posts  
comments on articles  
Q&A responses



## known issues

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

**often used with**

Karma, Auth, ...

concept confusion:  
an example

# concepts: some implications

## software apps are mostly composed of conventional parts

concepts that are understood by designs and by users

unlike features, can be defined entirely independently

## implications for design

use familiar concepts unless good reason not to

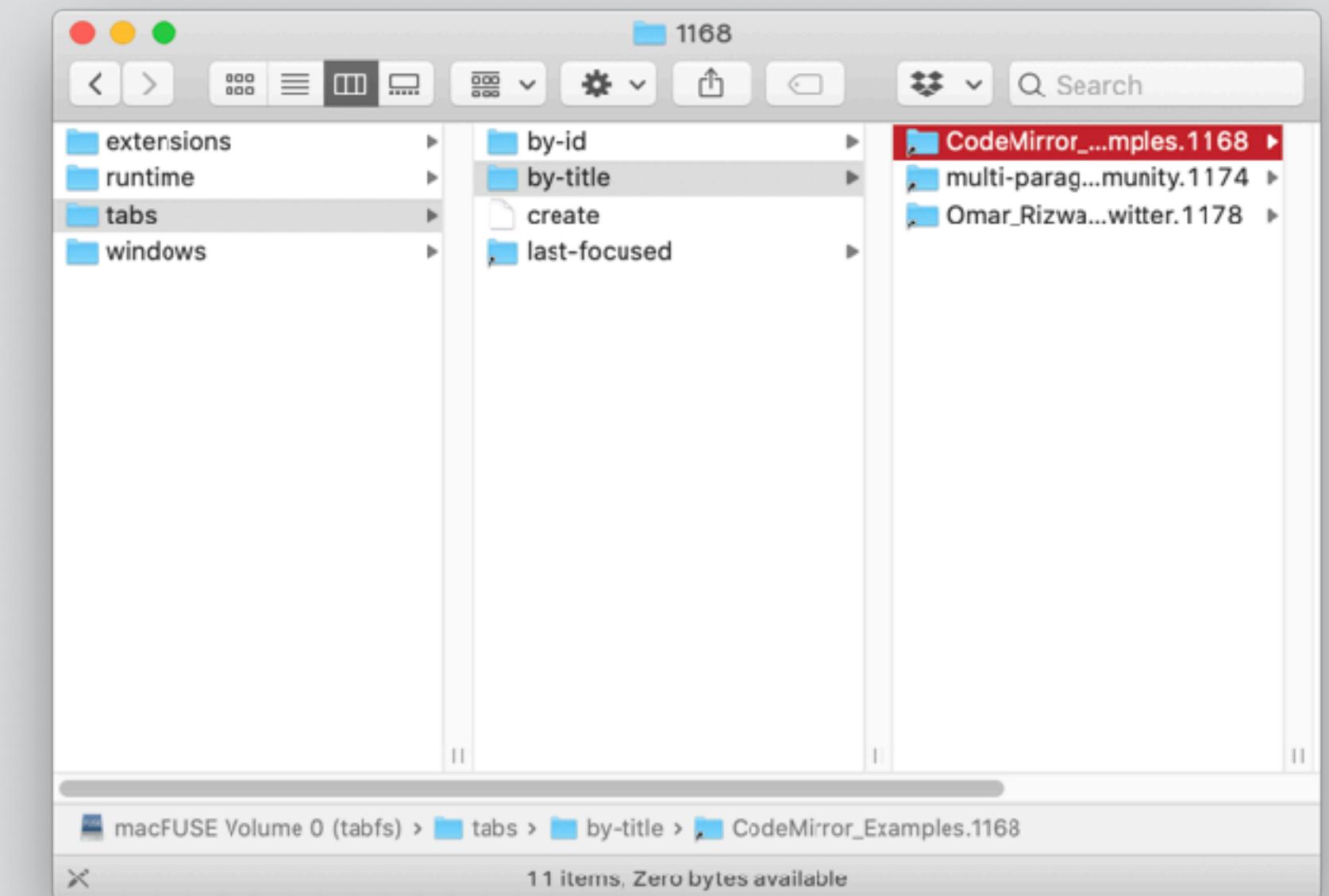
operational principle is known, but UI must convey *which* concepts

## so where is the innovation?

always: selection and composition of existing concepts

often: adaptation of concepts

sometimes: invention of new concepts



Rizwan's TabFS



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

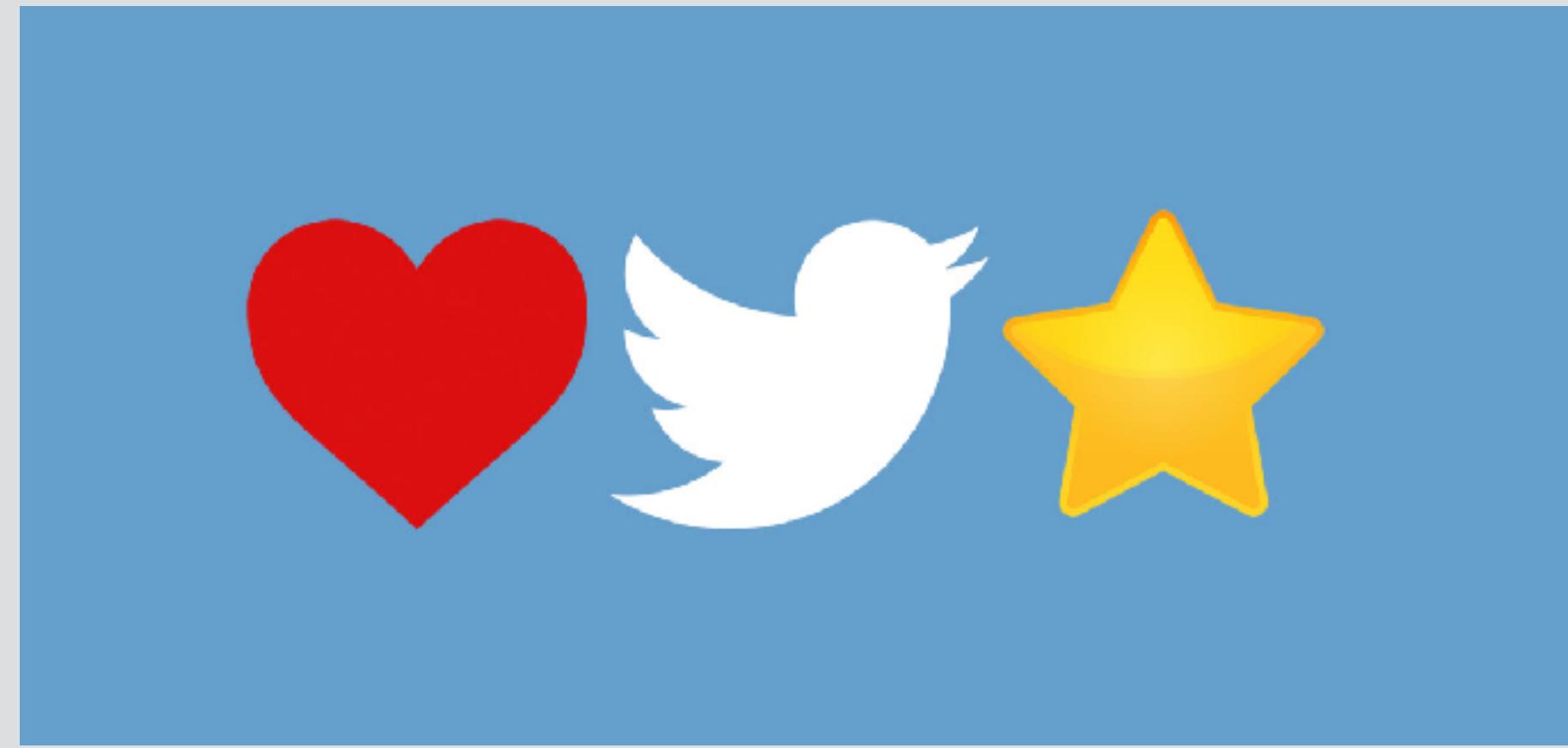


💬 4,022 people are talking about this



**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



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*

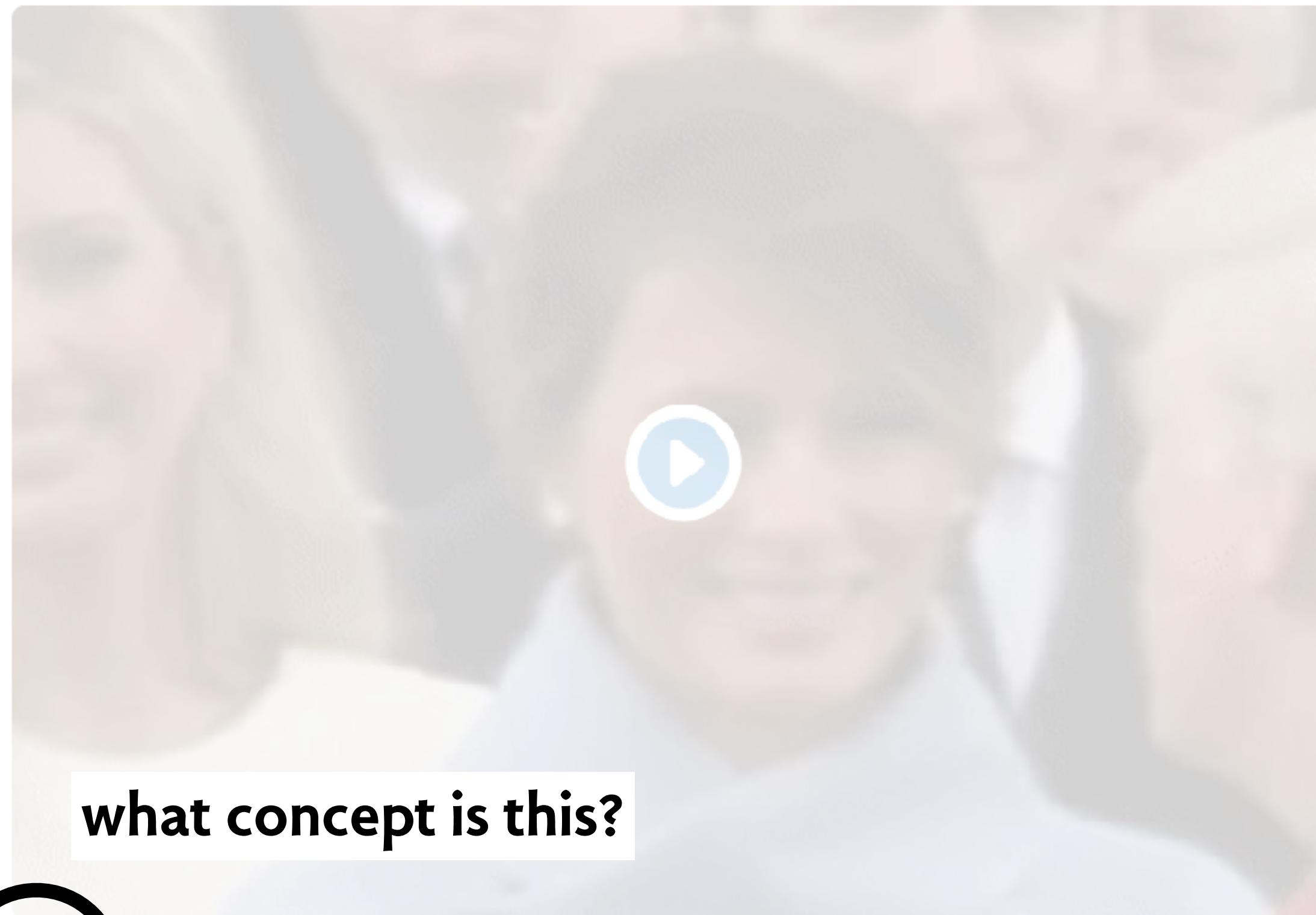


Andy Ostroy

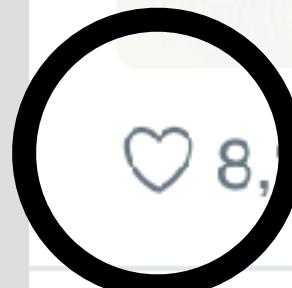
@AndyOstroy



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

?



**concept** Bookmark

**purpose** save items to revisit

missing  
concept!

# twitter adds a new concept (2018)

The Boston Globe  @BostonGlobe · 21h  
Andrew Yang would fine gunmakers for deaths caused by their products.



Yang would fine gunmakers for deaths caused by their products - Th...  
You probably know Andrew Yang wants to give every American \$1,000 a month. Something you might not know: He wants to fine gun ...  
[bostonglobe.com](http://bostonglobe.com)

29 9  94



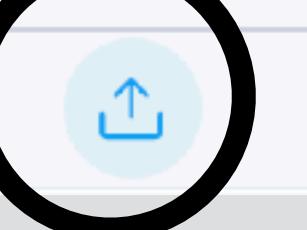
**concept** Upvote

**purpose** rank items by popularity

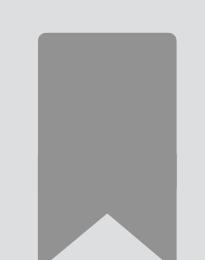
The Boston Globe  @BostonGlobe · 21h  
Andrew Yang would fine gunmakers for deaths caused by their products.



Yang would fine gunmakers for deaths ca...  
You probably know Andrew Yang wants t...  
a month. Something you might not know:  
[bostonglobe.com](http://bostonglobe.com)

29 9  94 

Send via Direct Message  
Add Tweet to Bookmarks  
Copy link to Tweet  
Share Tweet via ...



**concept** Bookmark

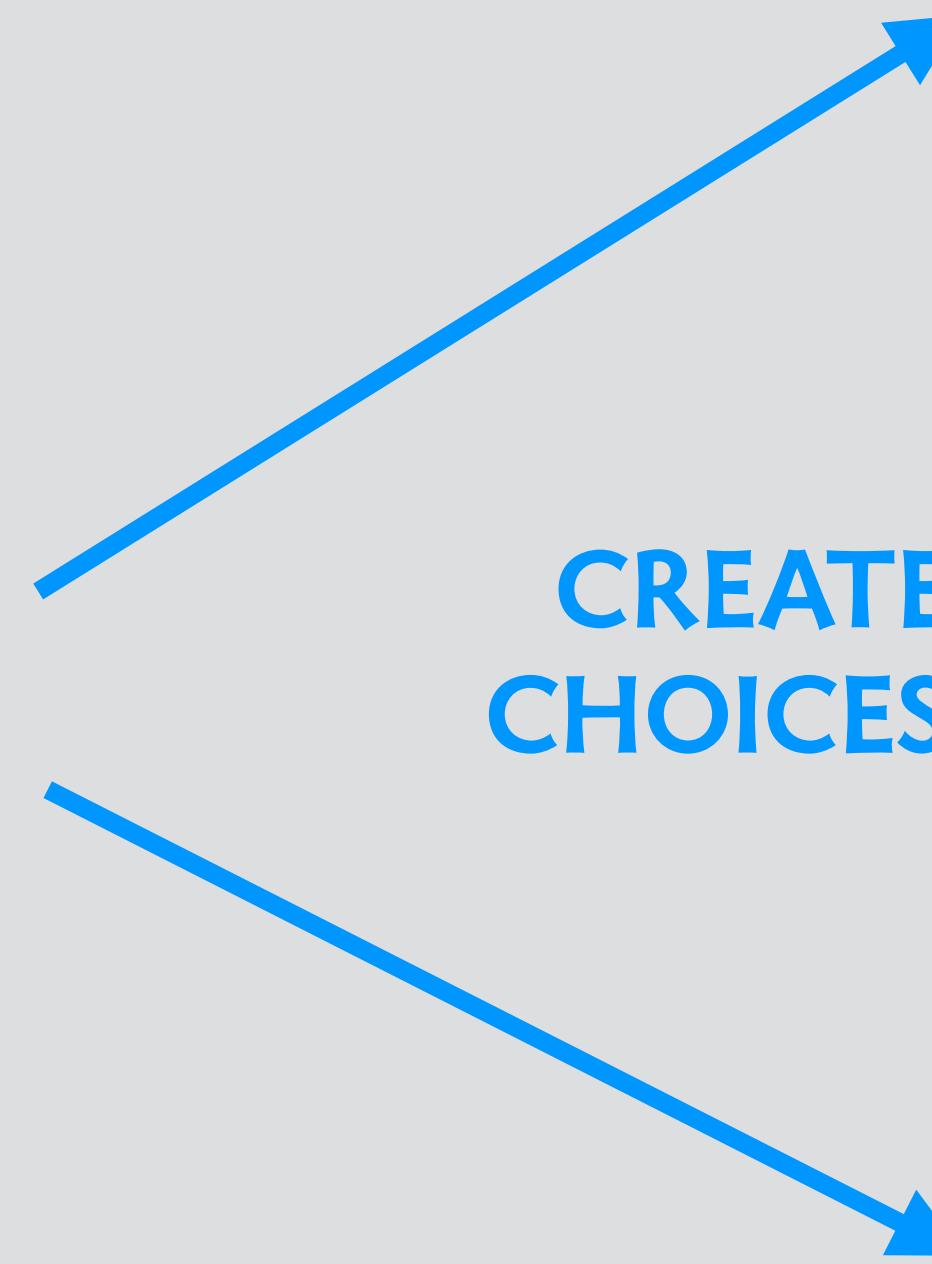
**purpose** save items to revisit

divergent design  
exercise

# diverge-converge

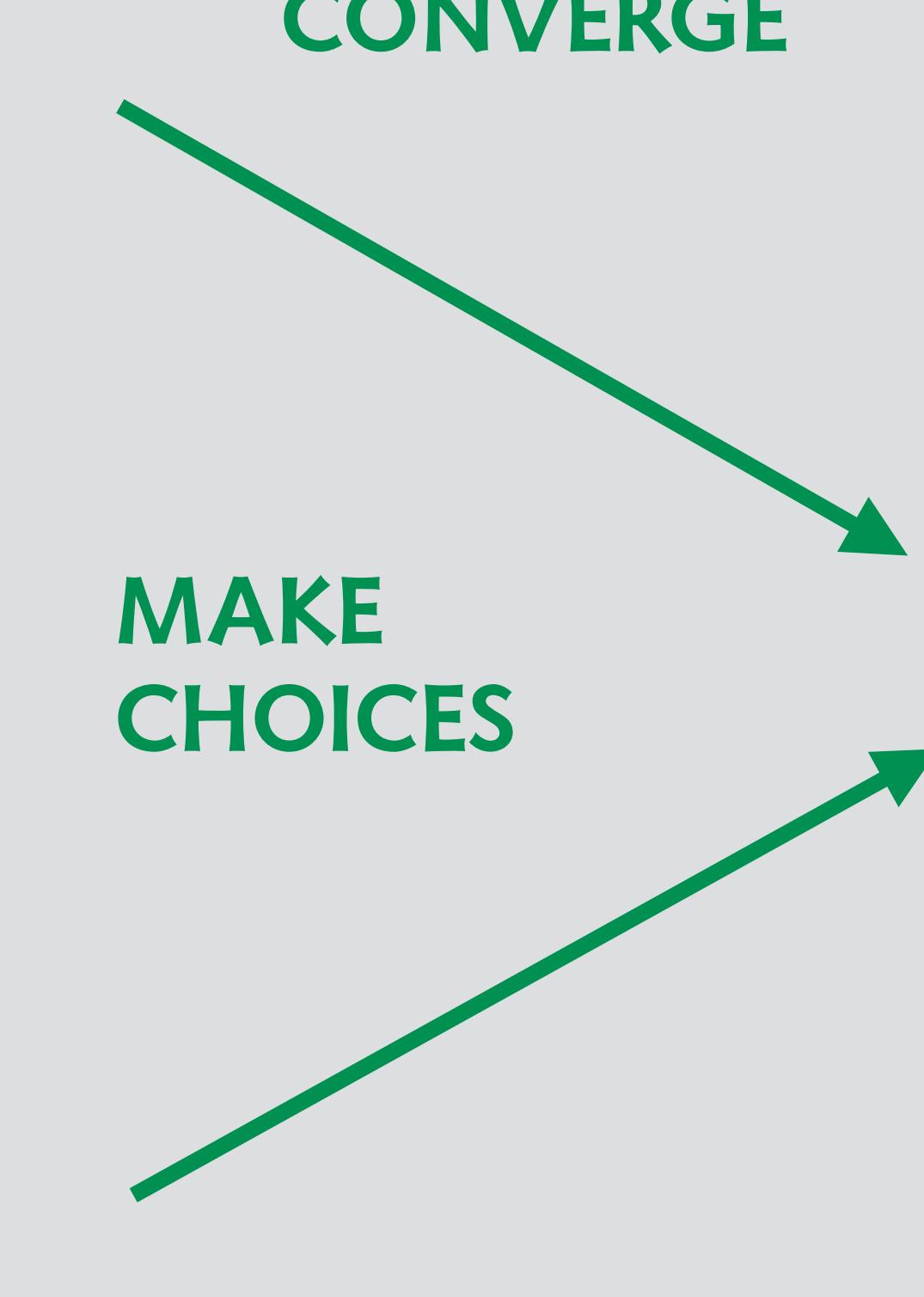
DIVERGE

CREATE  
CHOICES



CONVERGE

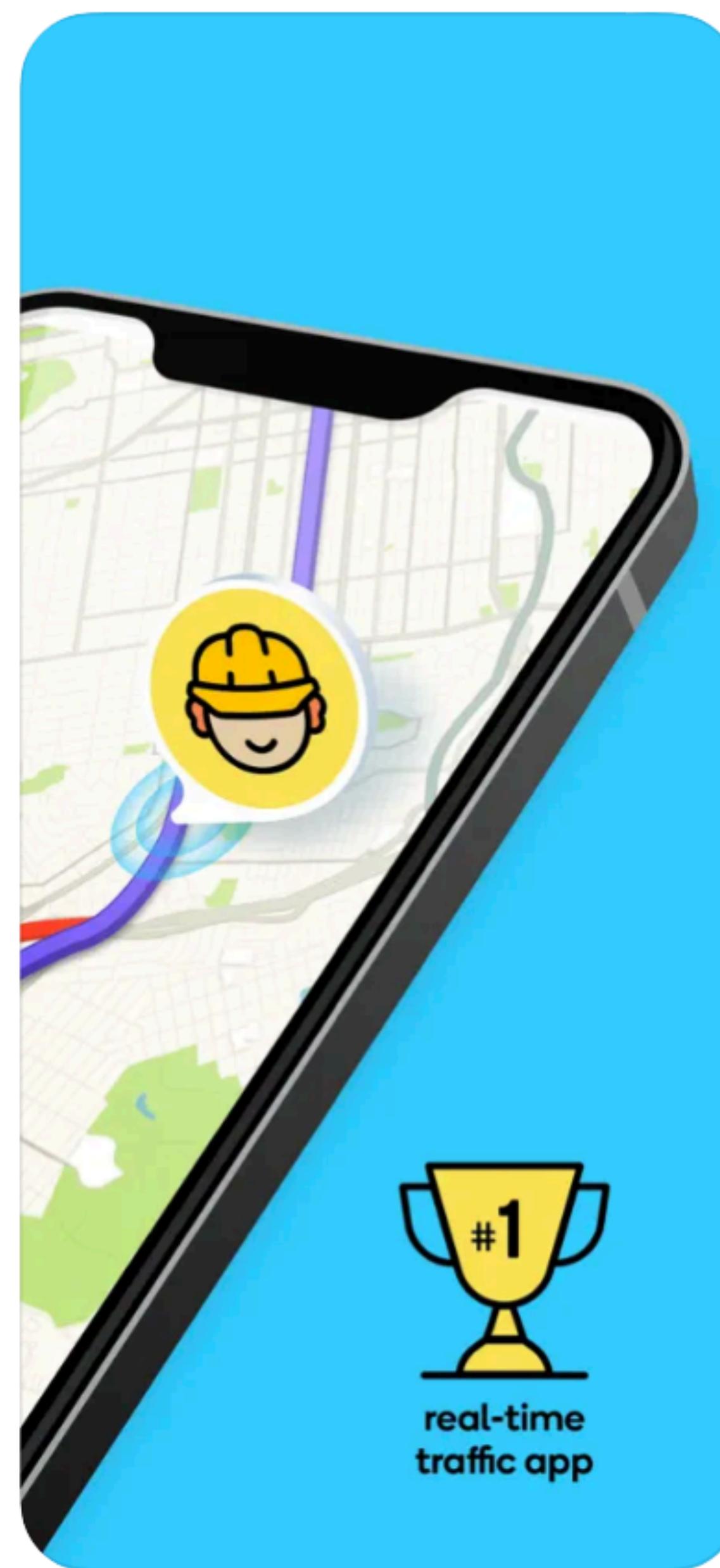
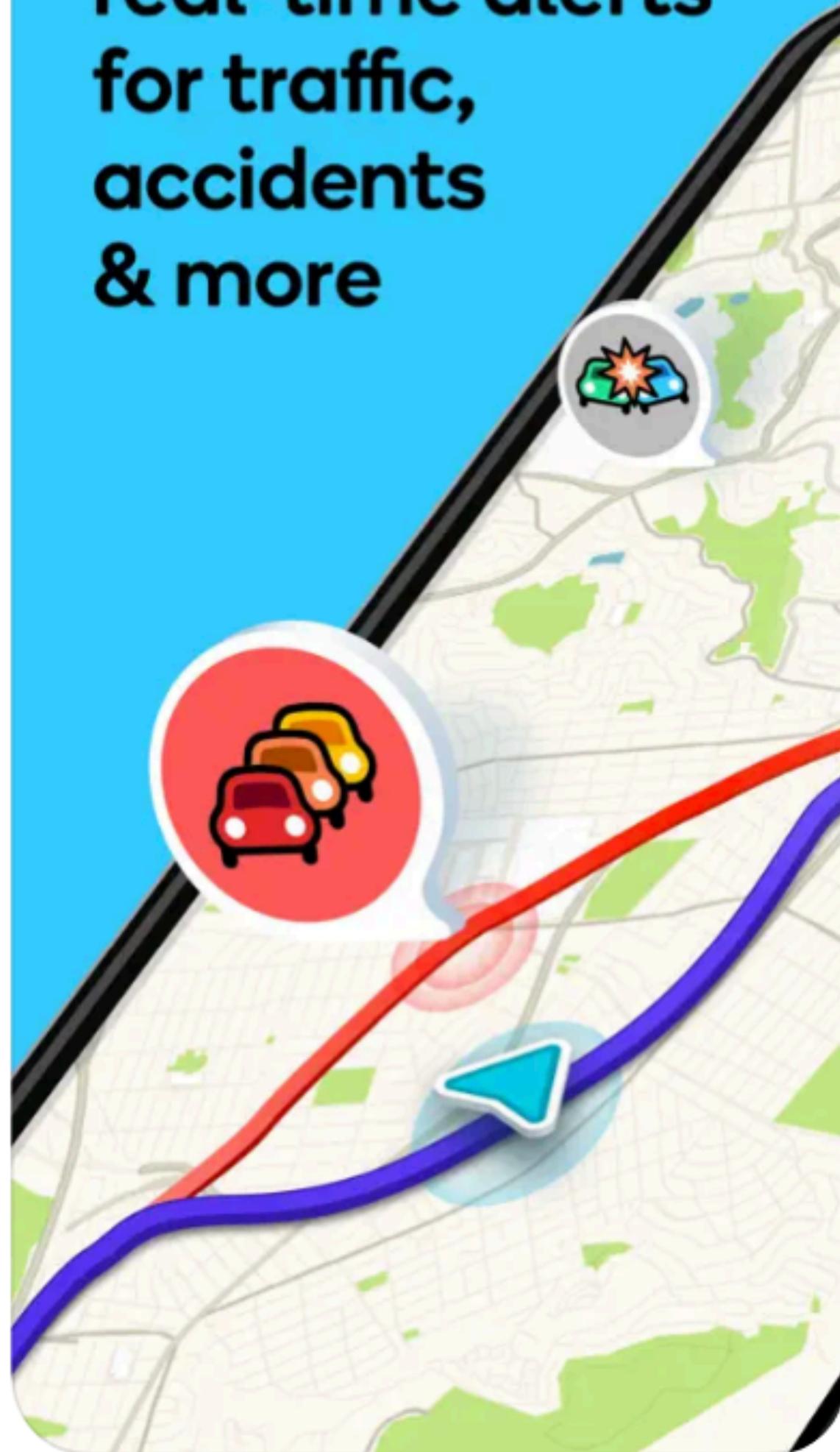
MAKE  
CHOICES



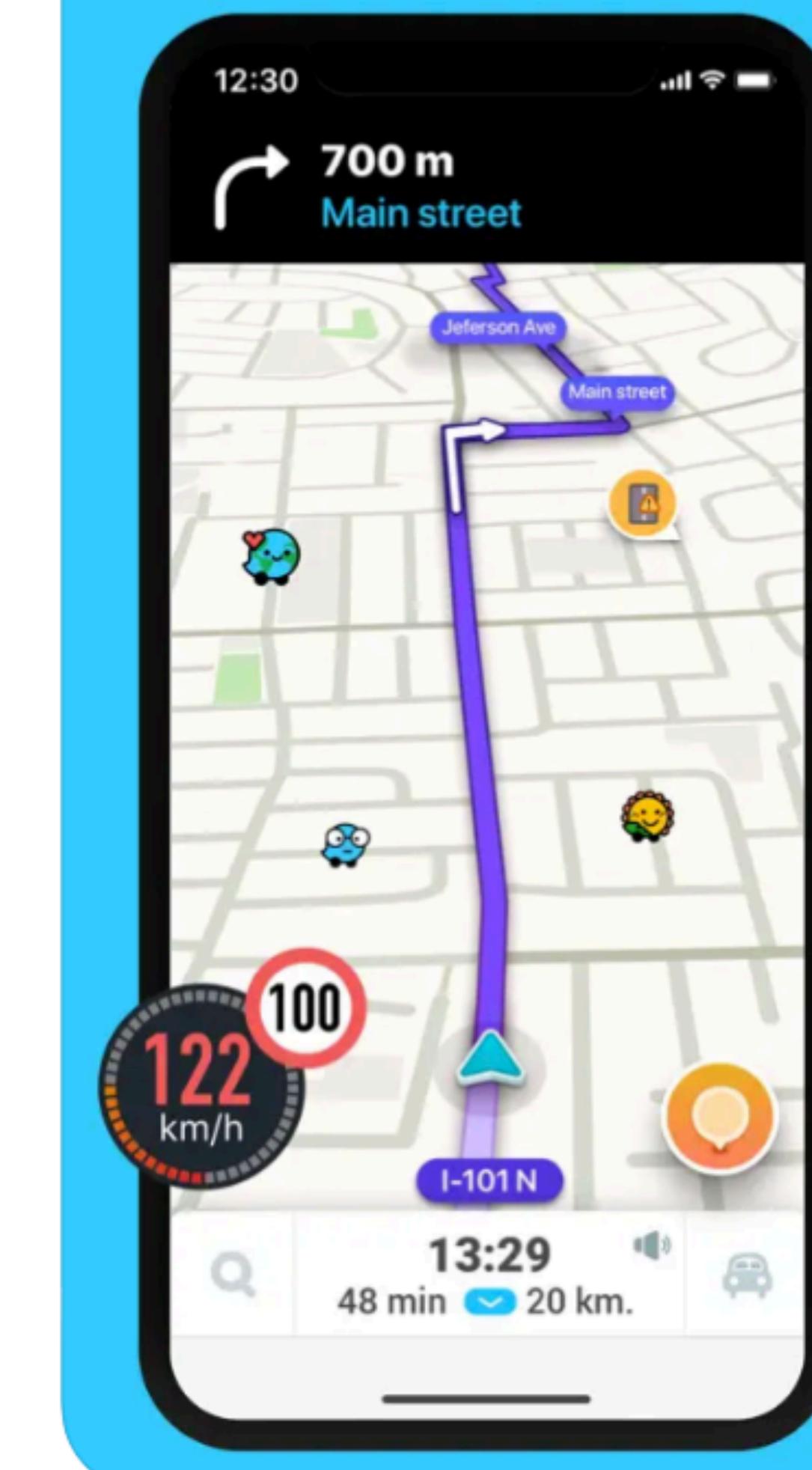
**diverge mode**  
generate ideas freely  
make connections  
ignore problems

**converge mode**  
refine design details  
make coherent whole  
address known misfits

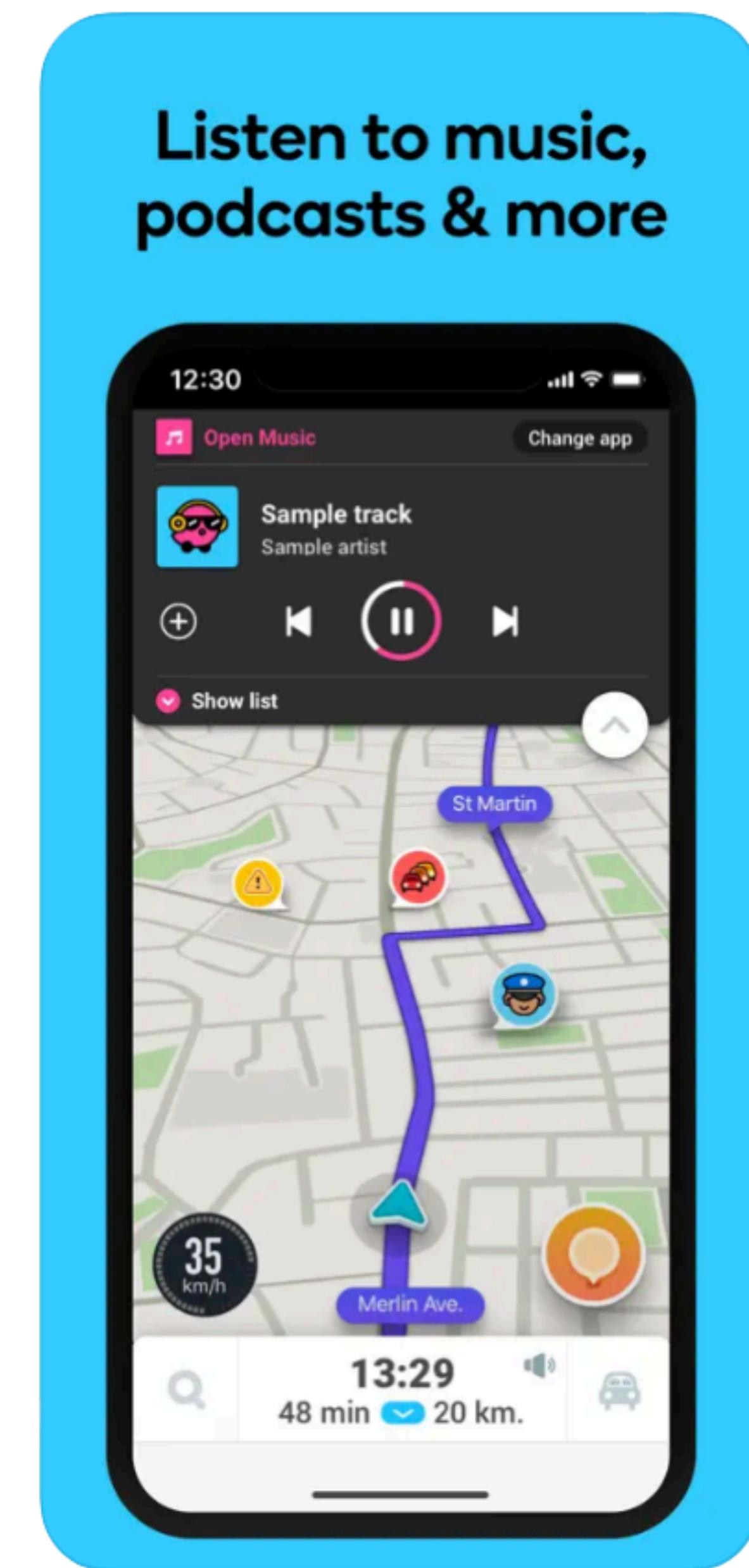
**Get the best routes with real-time alerts for traffic, accidents & more**



**Avoid unnecessary speeding tickets**



**Listen to music, podcasts & more**



## identify concepts

LiveRoute  
IncidentReport  
LocationBasedAd  
PoliceLocator  
AuthUser  
Notification

## identify misfits

Loss of driver privacy  
Driver distraction  
Risk to police from locator  
Routing traffic onto side streets

## brainstorm other concepts

Karma  
Reservation  
Paywall  
ResourceBudget  
RoadPricing  
LoyaltyReward  
CrowdFundedProject  
CarbonOffset

## example of exploring mitigations

**issue:** routing traffic onto side streets upsets residents

**adjust** a current concept

concept: LiveRoute

purpose: find optimal traffic routes using live data

principle: position data collected continuously from drivers; driver enters destination, system suggest optimal route based on inferred traffic speeds and capacity limits

**adopt** a known concept

concept: Paywall

purpose: limit resource usage with paywall

principle: if a driver pays and then searches, the route may include side streets; if a drive does not pay, routes will not include them

**invent** a new concept

concept: DigitalRoadBump

purpose: dissuade users from antisocial behavior

principle: when on side street, plays audio of residents complaining

# other ideas

## **pick an issue**

routing traffic onto side streets upsets residents

## **adjust a current concept**

LiveRoute: spread traffic randomly across similar routes

## **adopt a known concept**

RoadPricing: granulate charges for road segments

ResourceBudget: give each user limited budget of side-street access

CarbonOffset: encourage users to donate to local municipalities

Audit: tax Waze for externality costs

Reservation: have drivers reserve routes in advance

## **invent a new concept**

AntiKarma: punish excessive use of side streets by blocking features

AdaptiveTrafficLight: use app data to speed traffic on main roads

takeaways

# today's takeaways

<http://tiny.cc/61040-fa22-mud>

<http://tiny.cc/61040-fa22-feedback>

## **modularity**

just as essential for design as for code

## **concepts as design modules**

defined by a purpose and an operational principle  
can be understood independently, hence reusable

## **concepts in context**

bring their own problems, including social & ethical  
are carriers of design knowledge

## **implications for social/ethical analysis**

examine the concepts first: trouble when used elsewhere?

eg: IncidentReporting: false alarms, collusion

## **implications for design & innovation**

start by trying to use known concepts

innovation = adjustment + adoption + invention