Concepts: A New Modularity for Software

Daniel Jackson · MIT CSAIL · SPLASH 2018

with

Santiago Perez De Rosso
& Maryam Archie, Czarina Lao, Barry McNamara

funded by

MIT-SUTD International Design Center

ten years ago...

a simple task: sign and return

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Field Trip Permission Form

Dear Parents:

Ms. Frizzle will again be taking her second grade class on an exciting field trip. Please sign and return the permission slip below.

Thank you!

Yes, I give permission for my child to go on the second grade "Touch and Feel" trip on Friday February 13th to the NastyCo Nuclear Dump. I understood that my child may encounter the normal risks of childhood play, including grazed knees, hurt feelings and exposure to toxic waste.

_____

Parents signature Date

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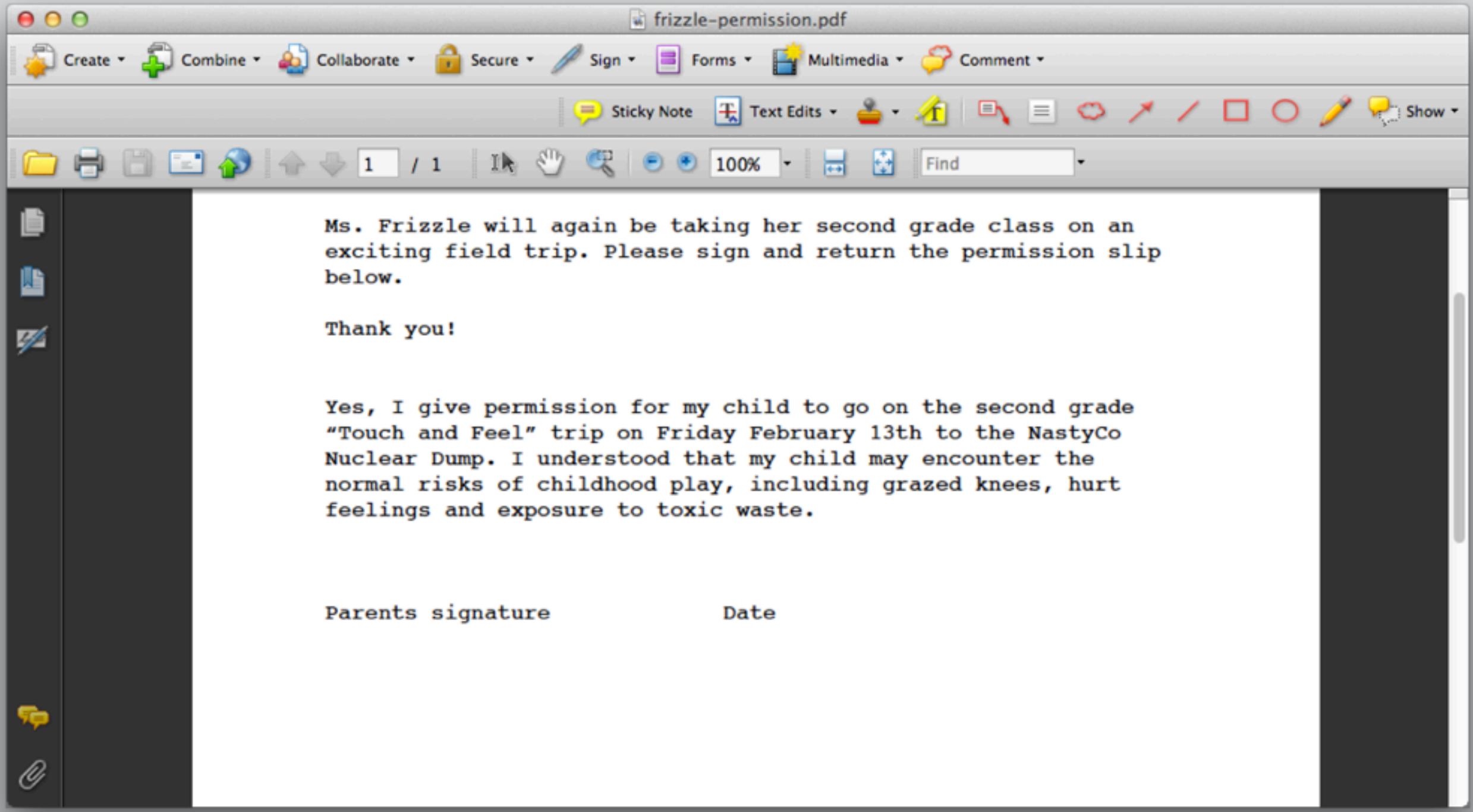
Count Olaf **February 11, 2013**

Parents signature Date

acrobat to the rescue?

acrobat to the rescue?



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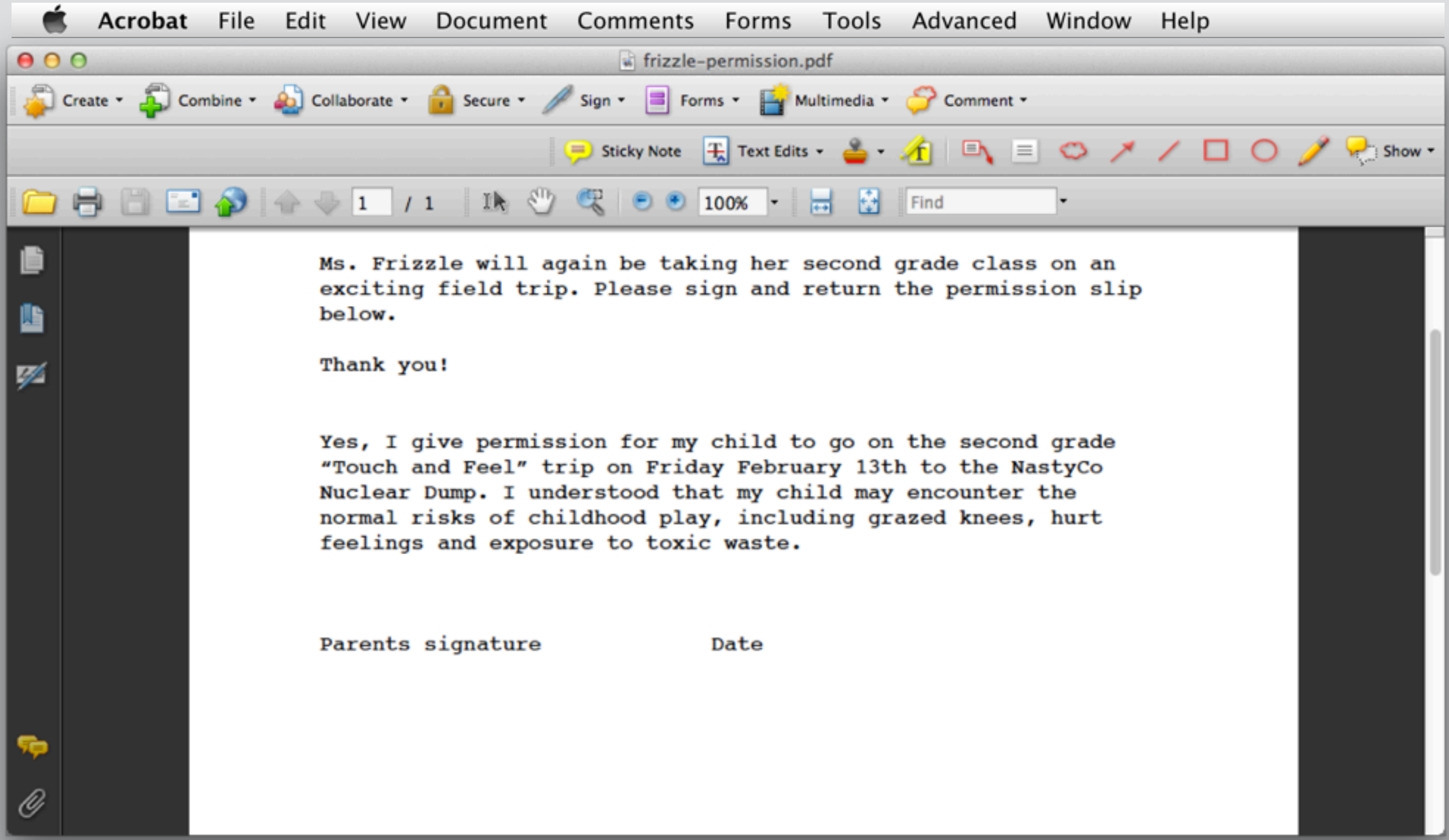

acrobat to the rescue?

Acrobat File Edit View Document Comments Forms Tools Advanced Window Help

frizzle-permission.pdf

Create Combine Collaborate Secure Sign Forms Multimedia Comment

Sticky Note Text Edits Show

1 / 1 100% Find

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Thank you!

acrobat-sig-paste.txt

Last Saved: 8/27/09 5:20:28 PM
File Path ▾ : ~/Filestore/Advice/computers/acrobat-sig-paste.txt

acrobat-sig-paste.txt

```
1  how to add a signature in acrobat
2  -- open document in acrobat
3  -- Tools—>Advanced Editing—>Touchup Object Tool
4  -- right click at desired point | Place Image...
5  then select jpg
6
7  how to add date
8  -- Tools—>Typewriter
9
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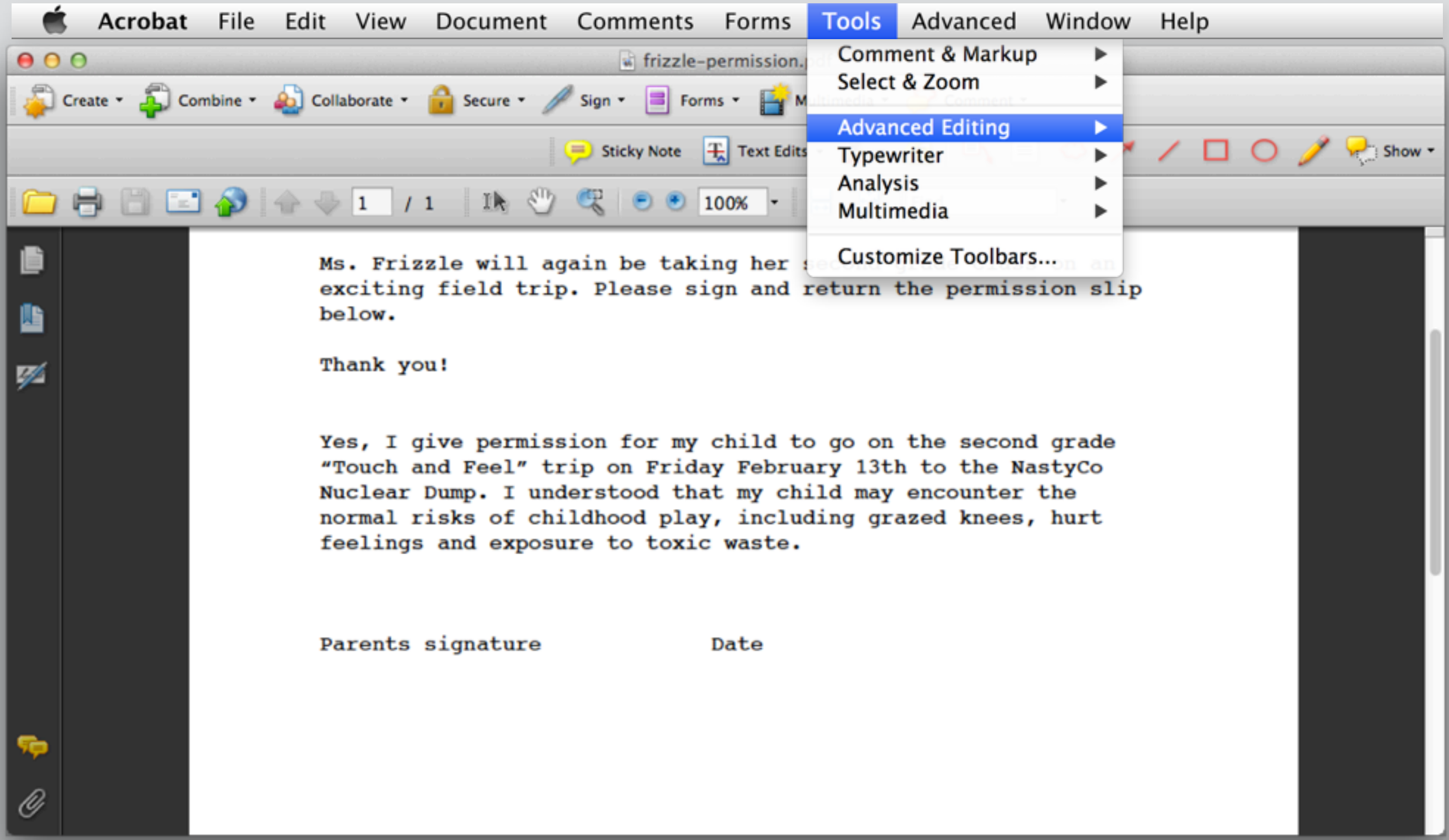

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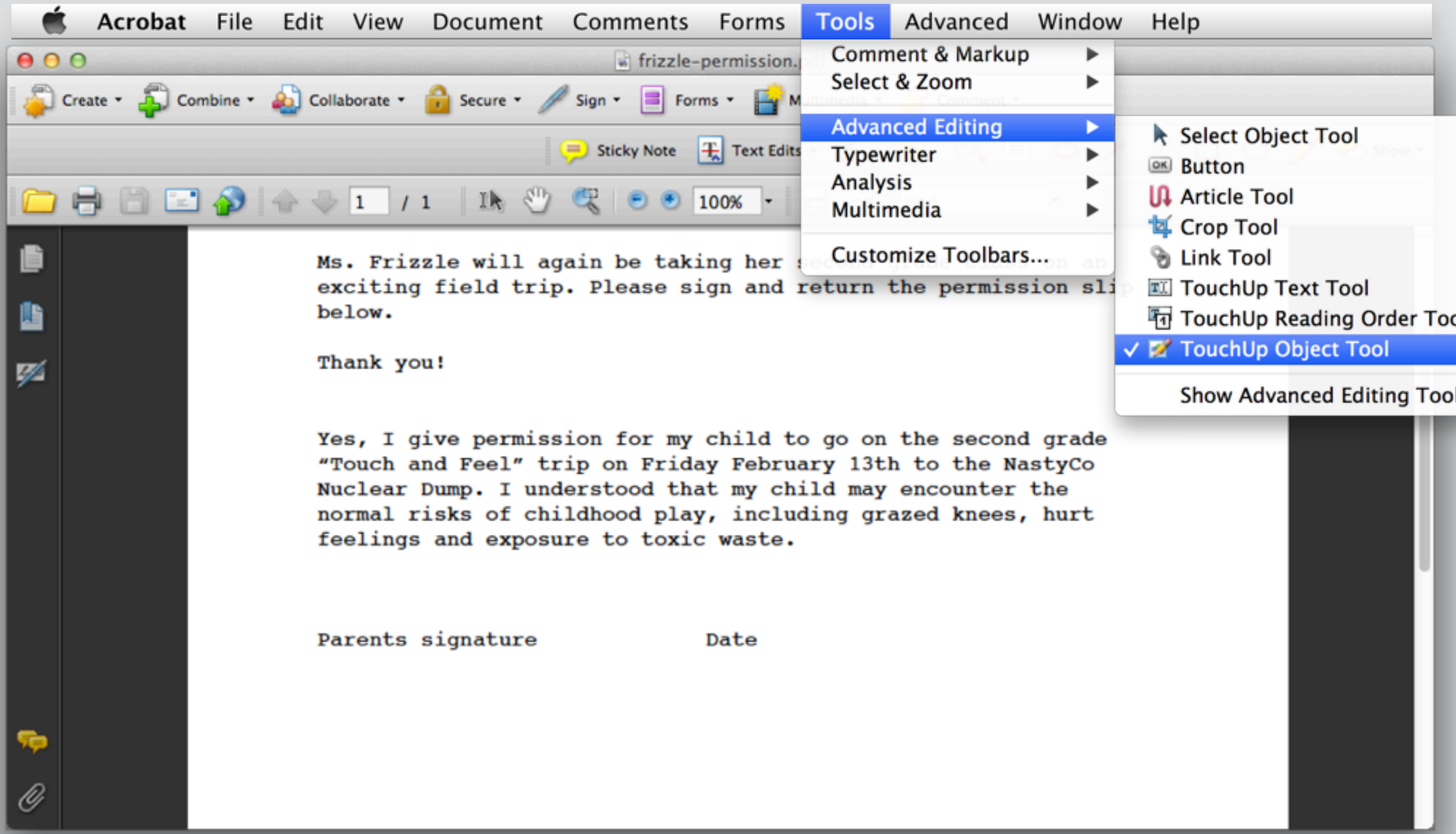

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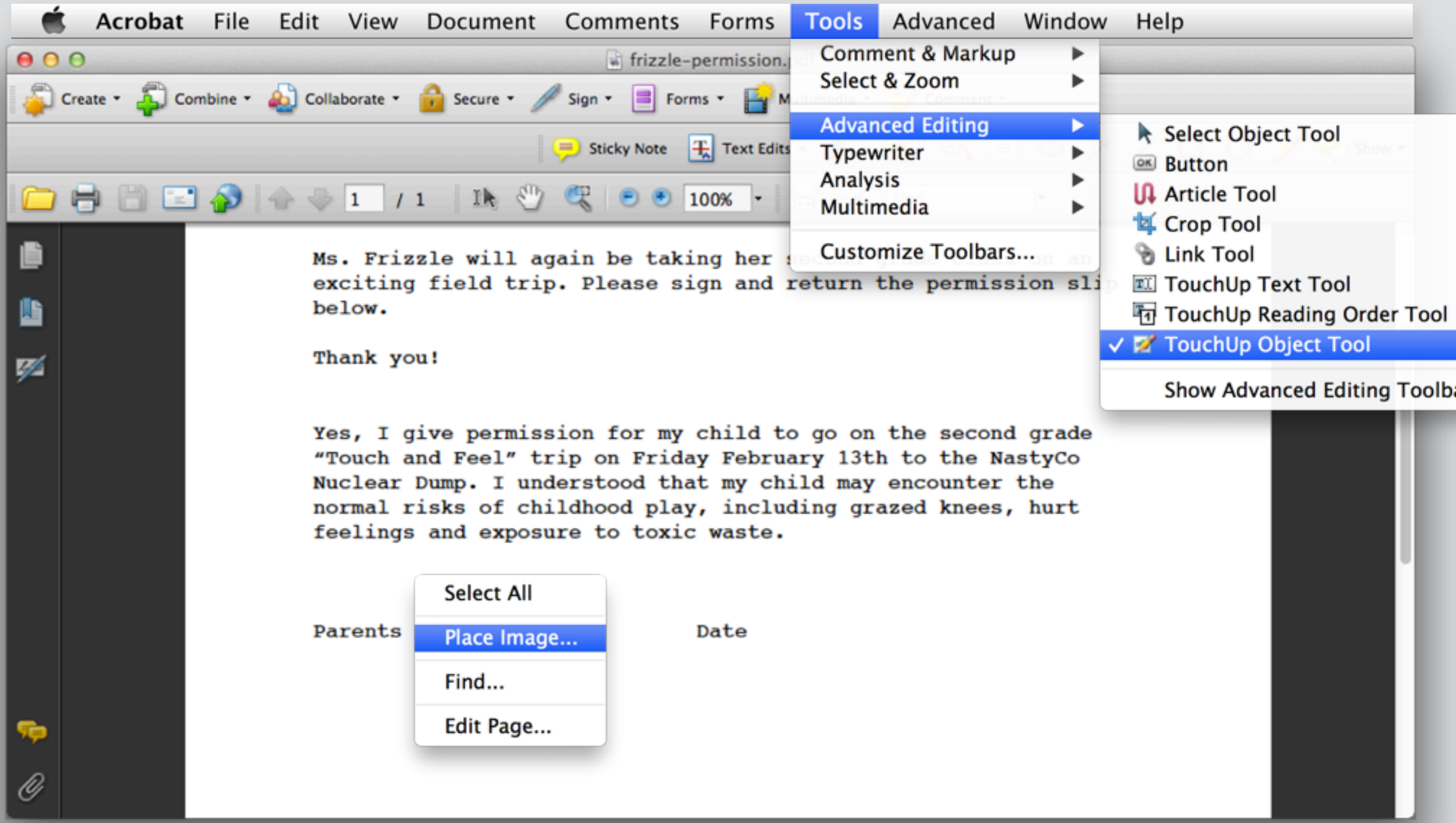
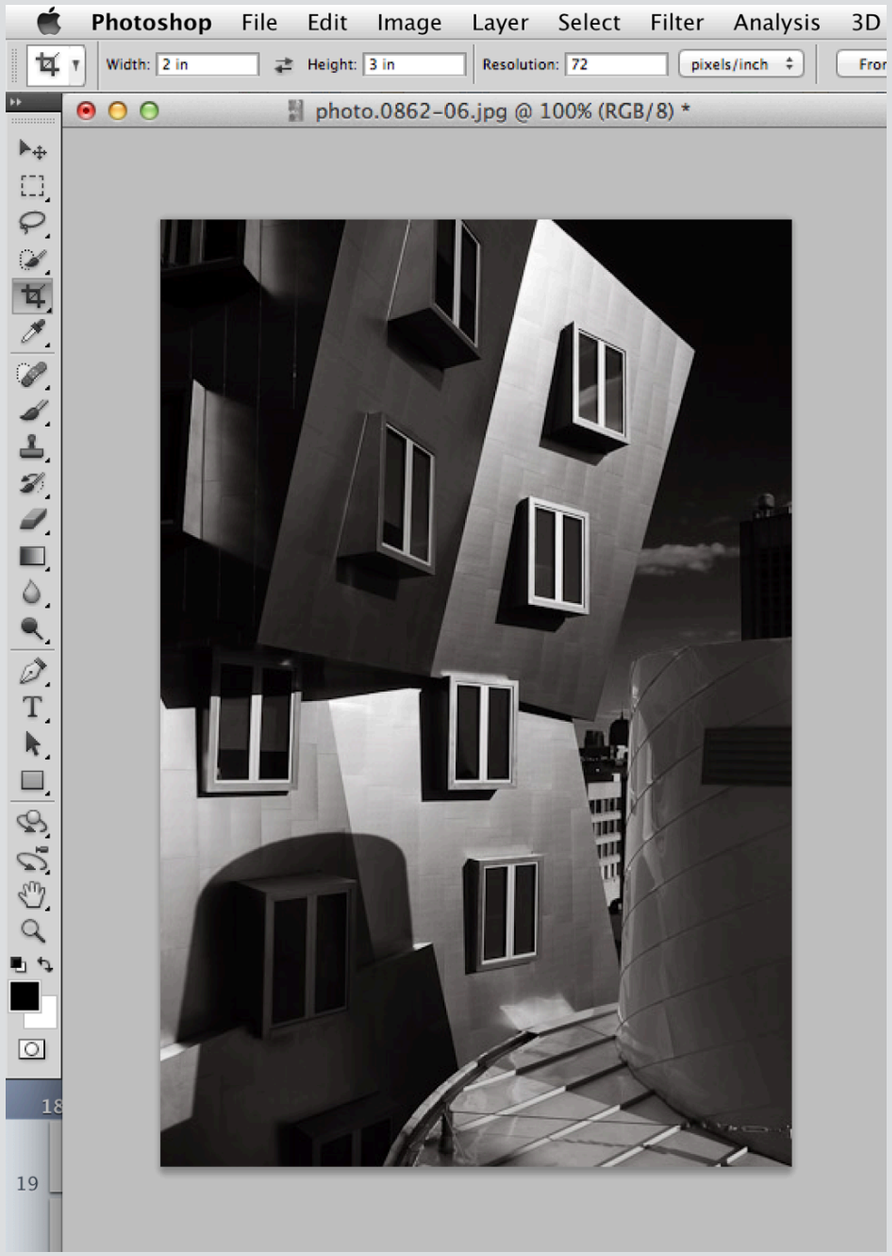


adobe photoshop: cropping surprises



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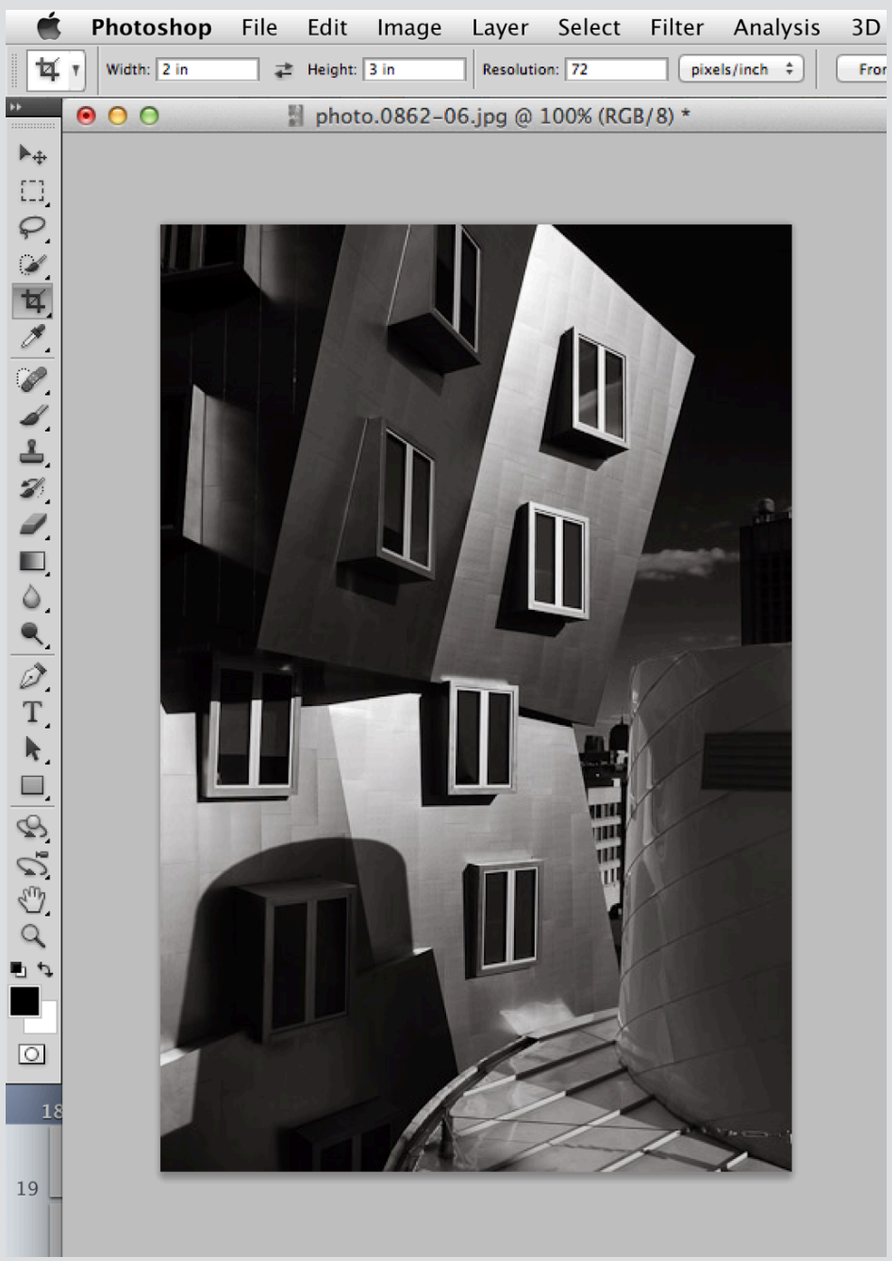

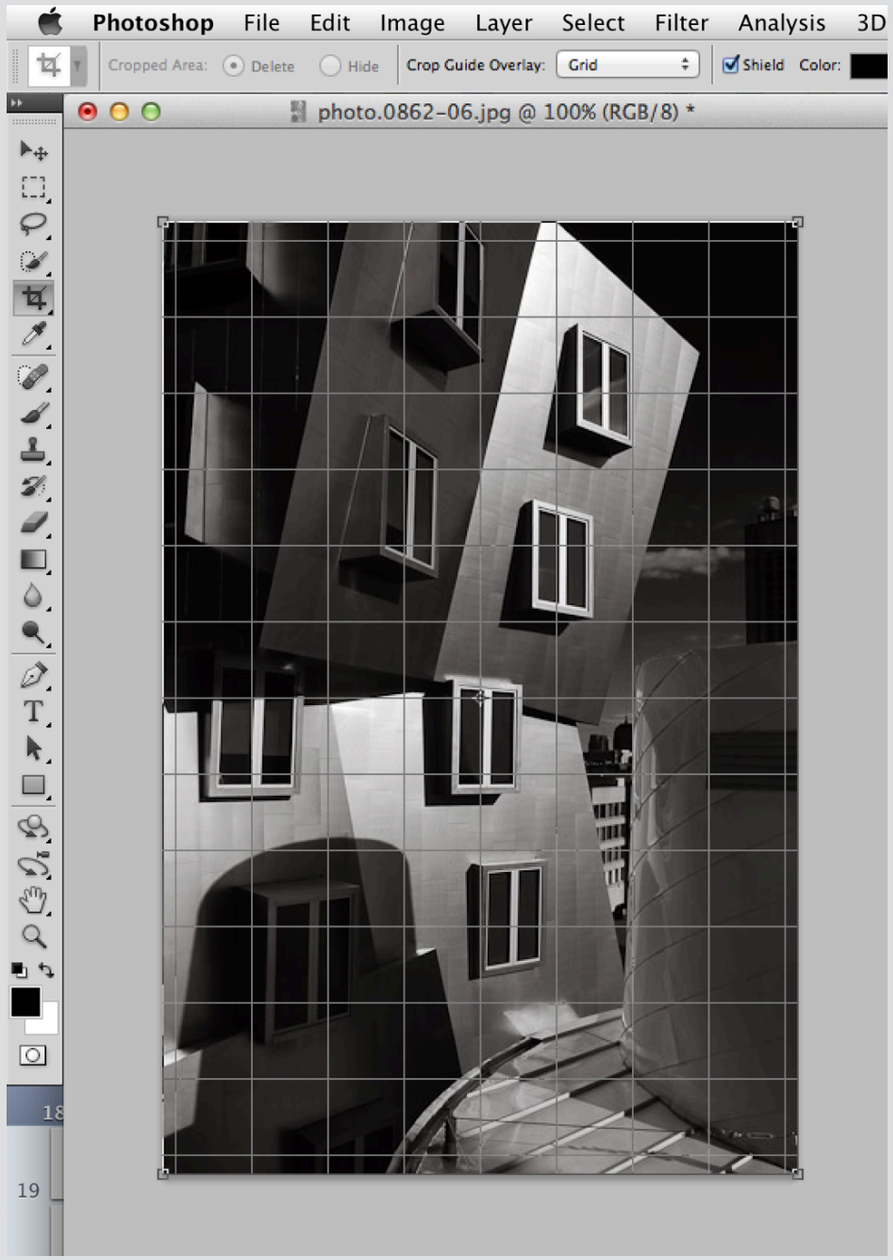

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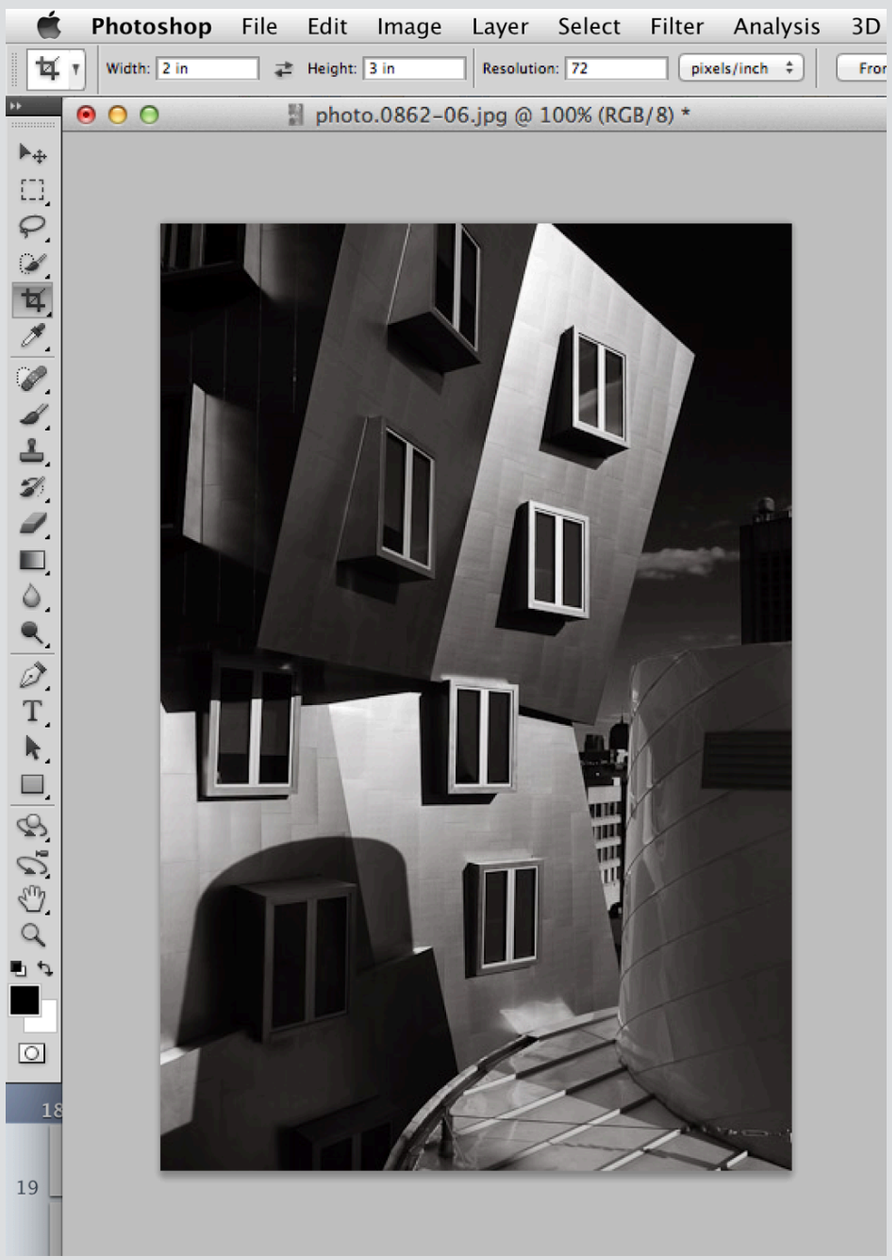

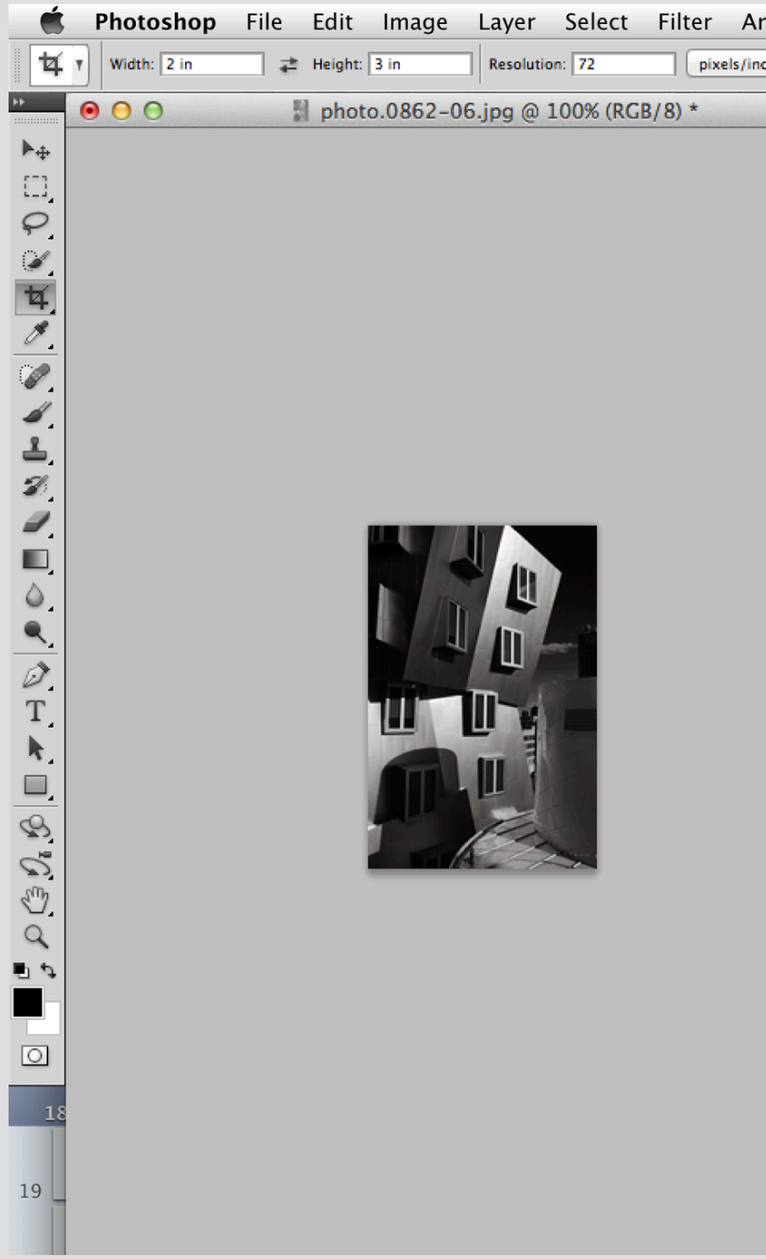

adobe lightroom: easy cropping

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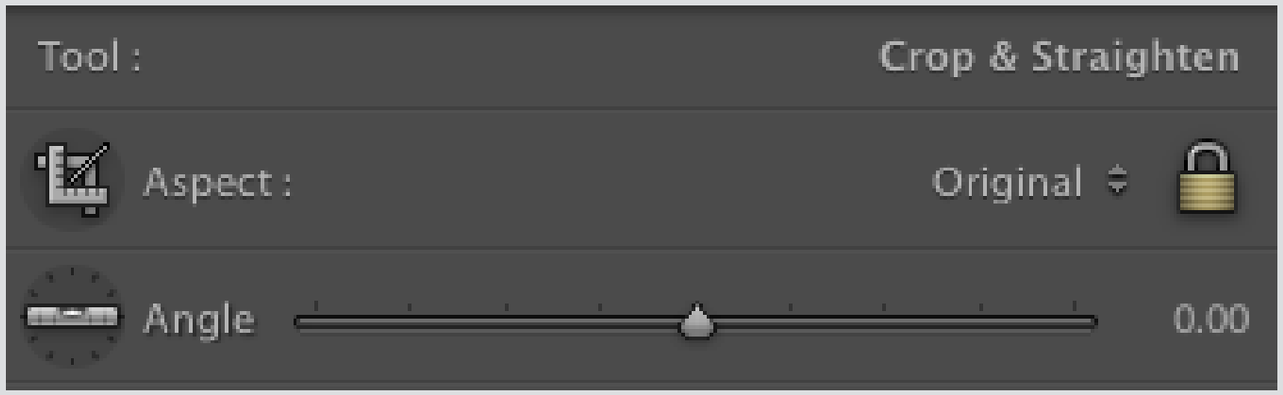

i’m not alone

from http://amplicate.com

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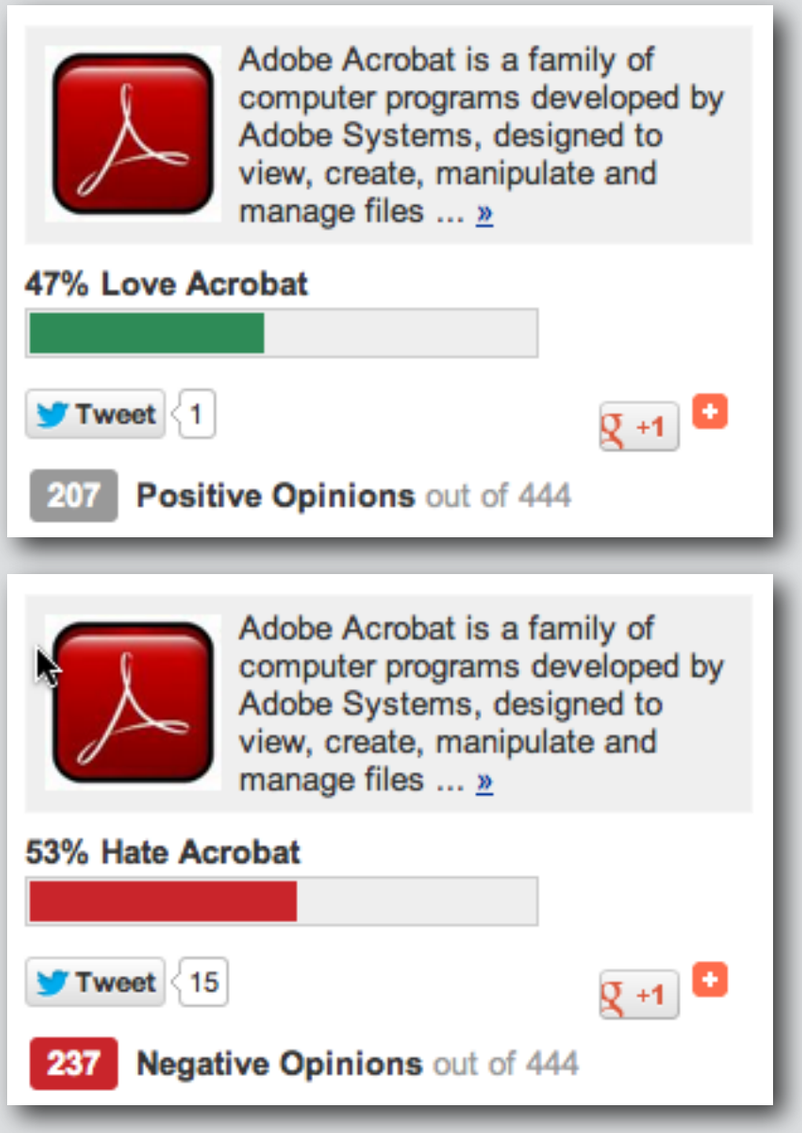

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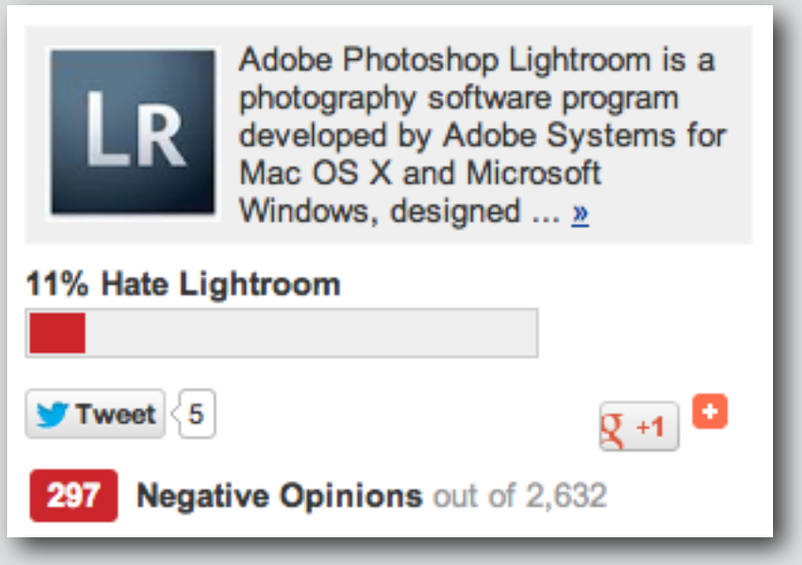

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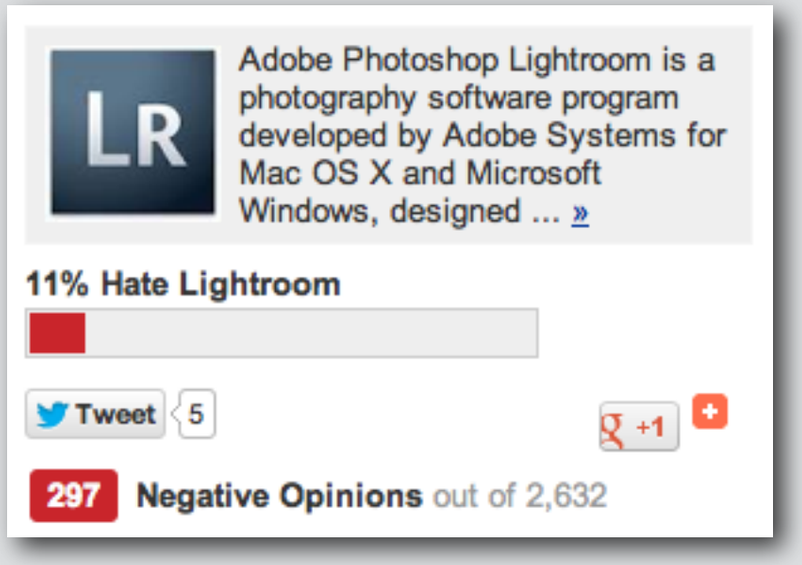

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what's the essence of the problem?

not the user interface!

polished and organized

what's the essence of the problem?

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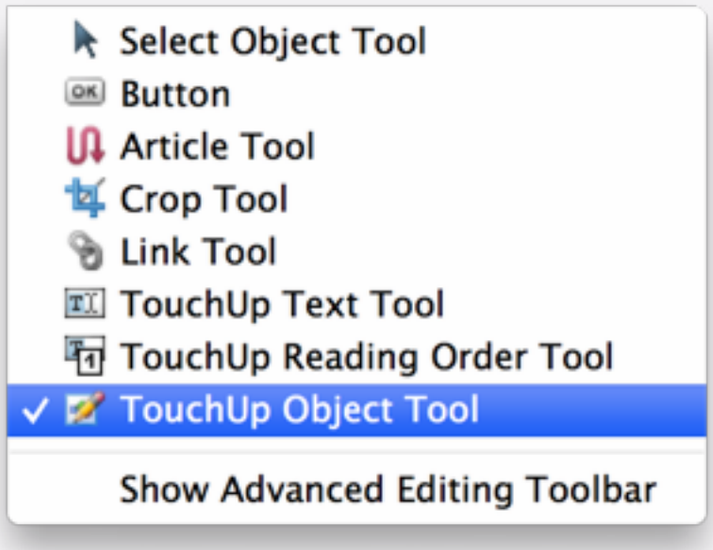

task-oriented design
no unifying concepts

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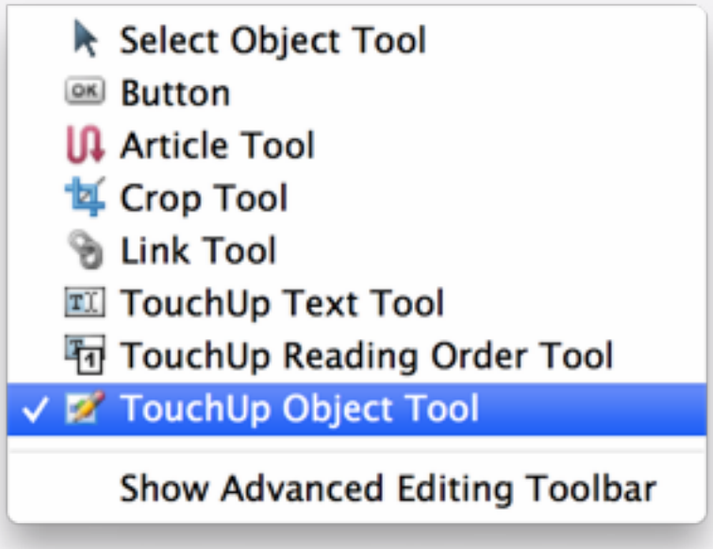

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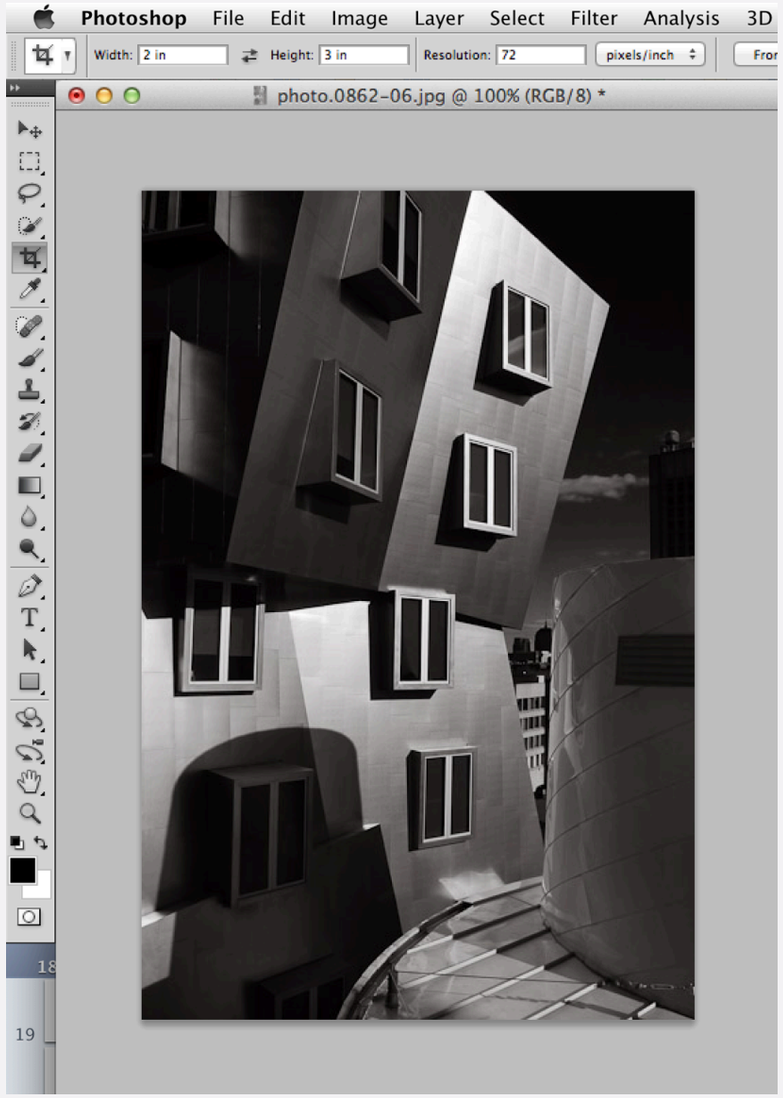

complex concepts
cropping vs. resizing

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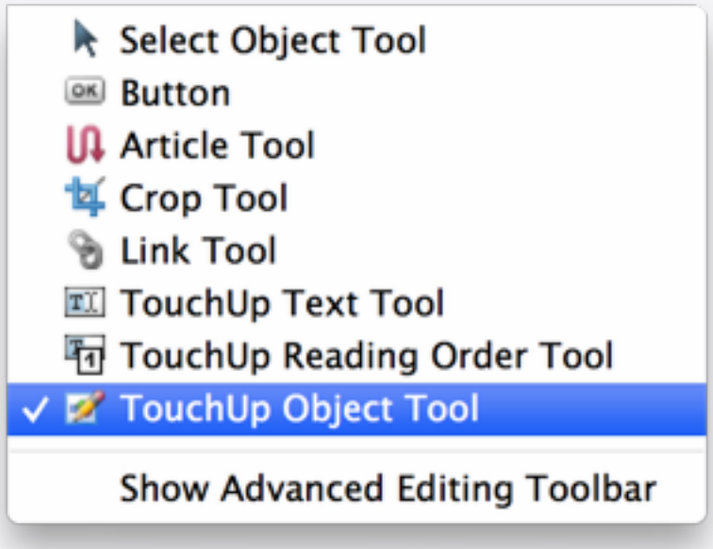

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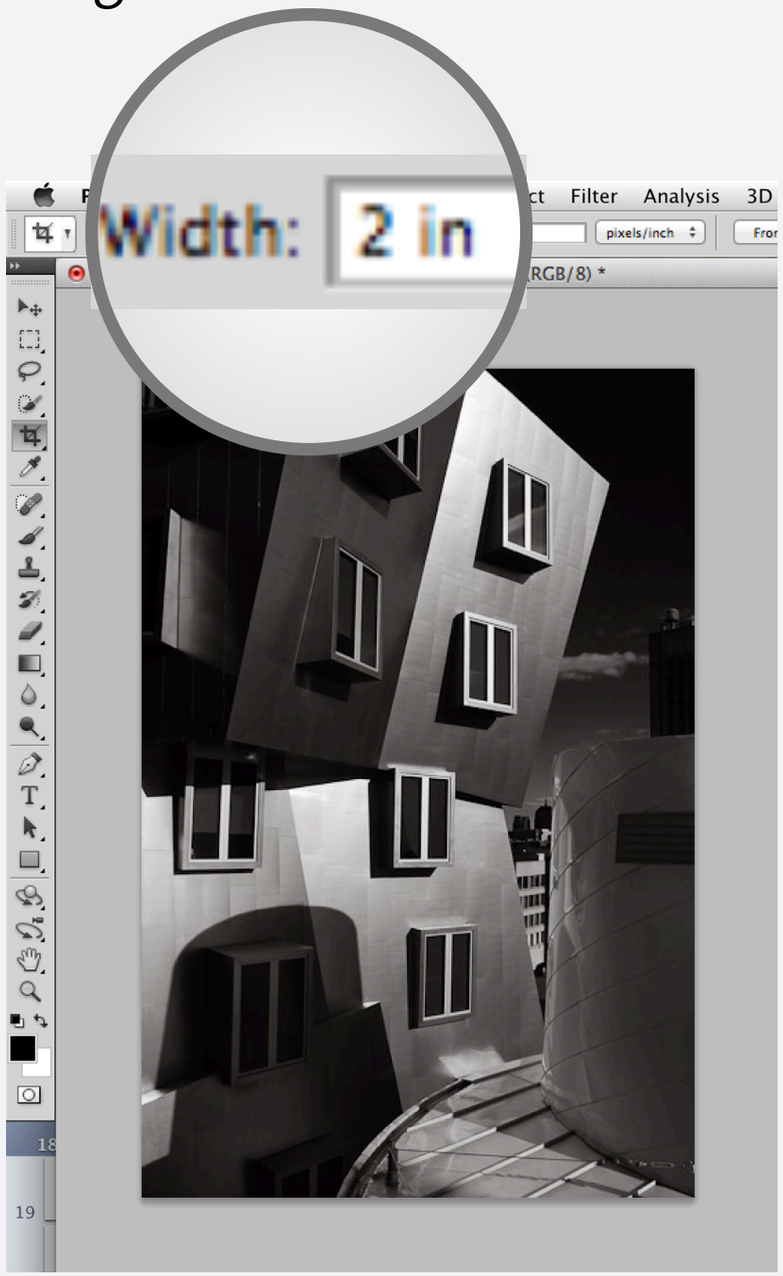
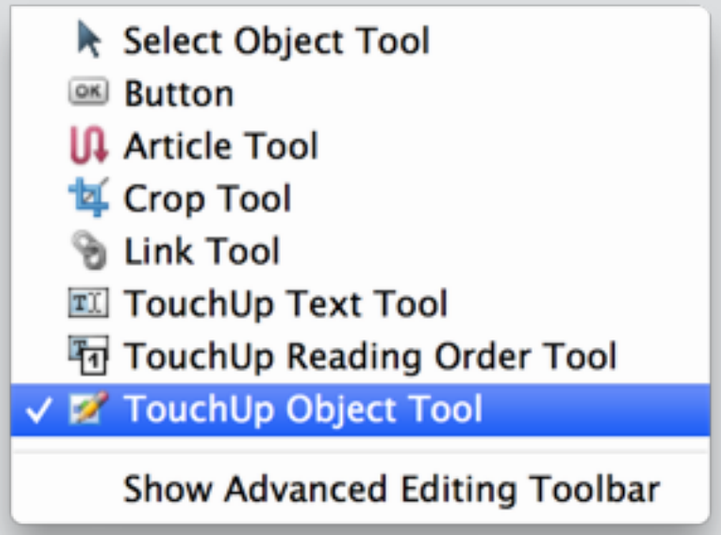


complex concepts
cropping vs. resizing

adobe fixes acrobat

Version 9 (2008)



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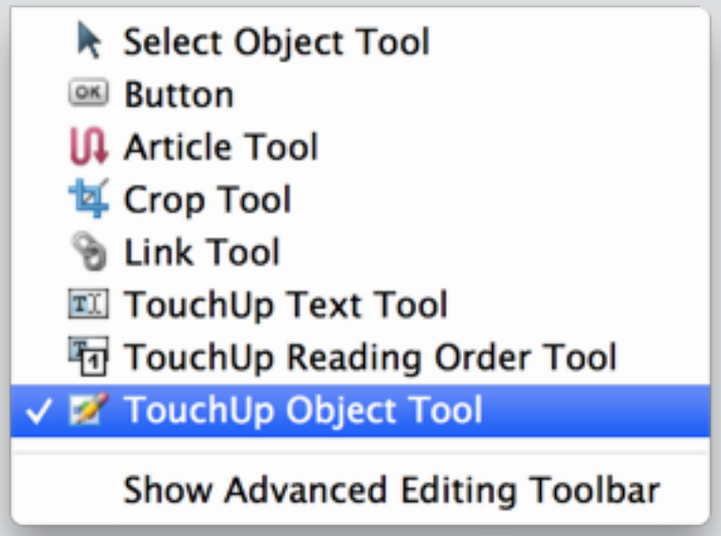

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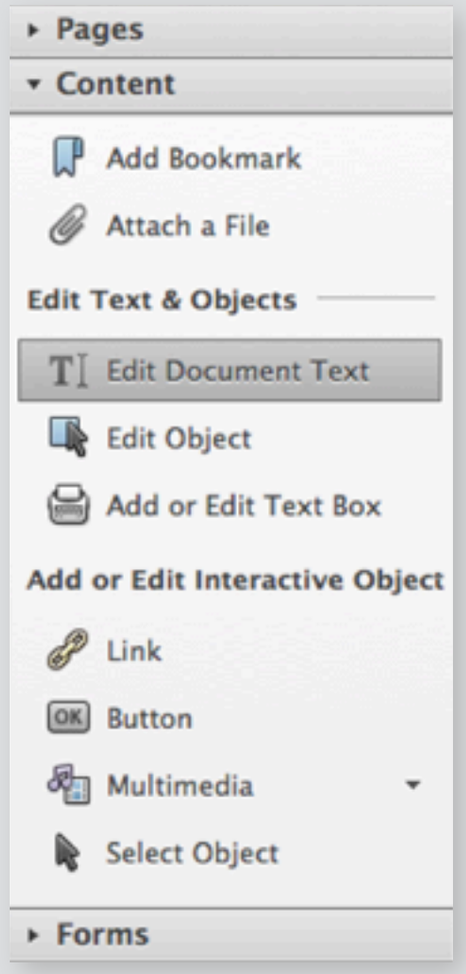

improved interface
but still no concepts

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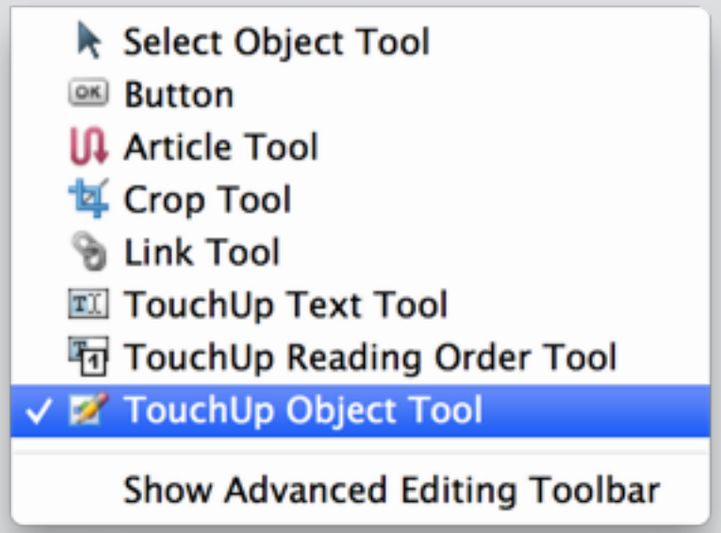

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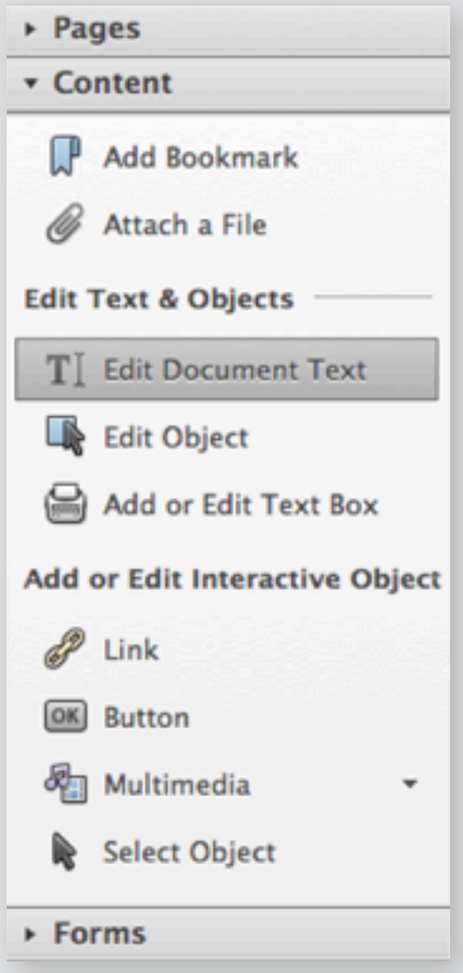

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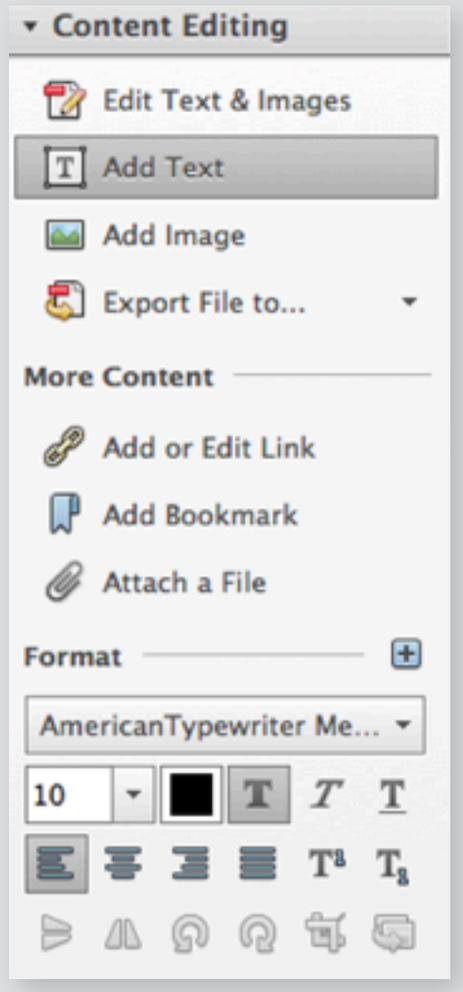
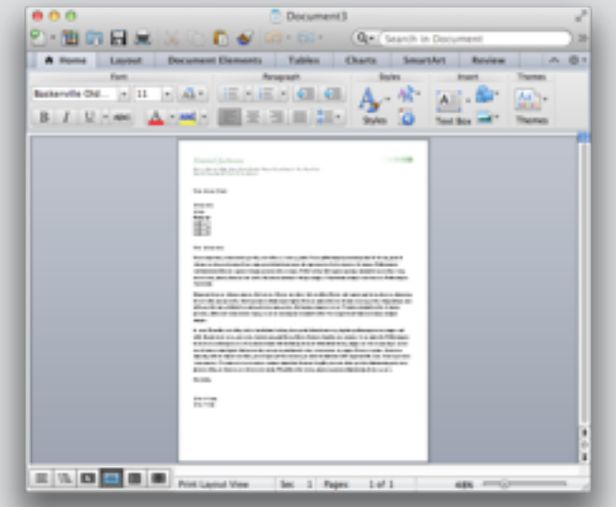


unifying concepts
text/image object

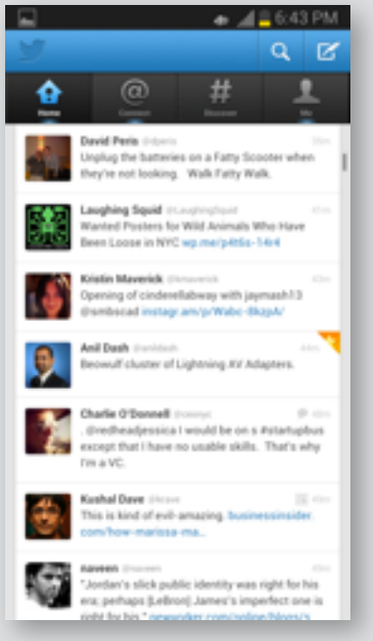
thinking about concepts

apps characterized by their concepts

Microsoft Word



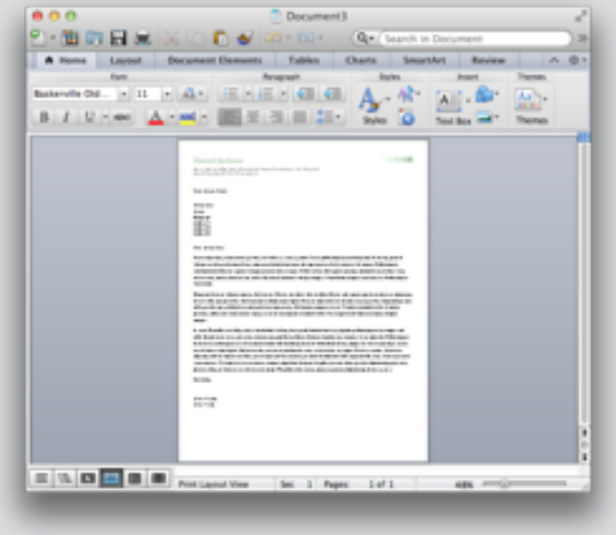
Twitter



Photoshop

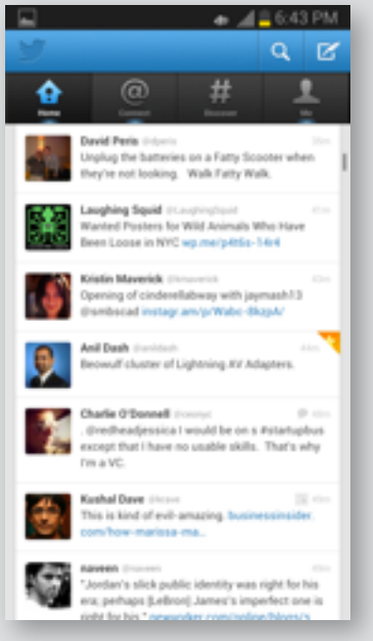
apps characterized by their concepts

Microsoft Word



Paragraph
Format
Style

Twitter



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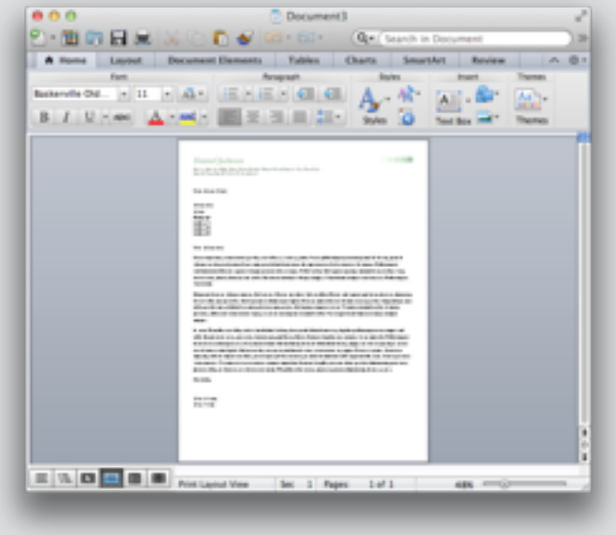
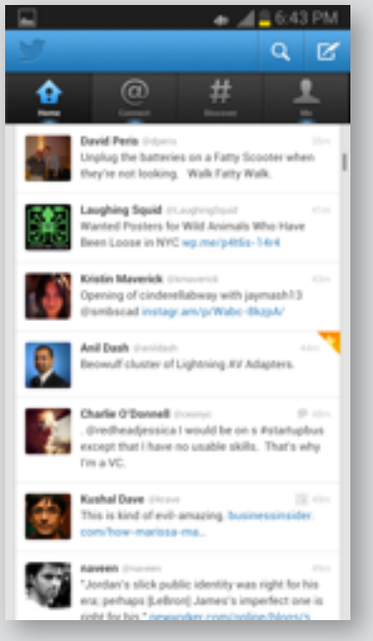


Paragraph
Format
Style

Twitter

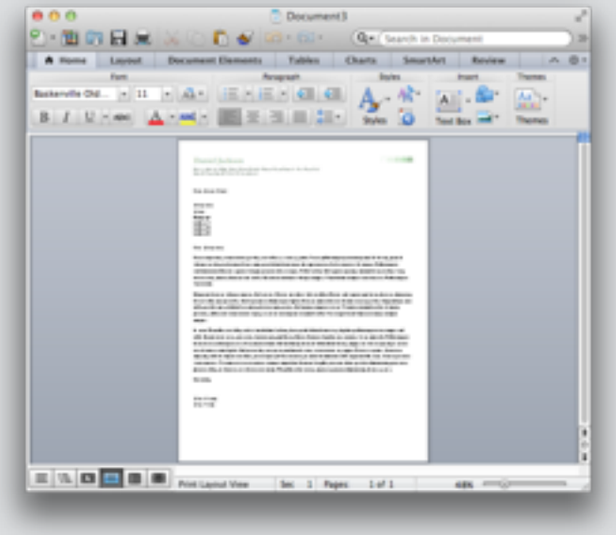


Tweet
Hashtag
Following

Photoshop

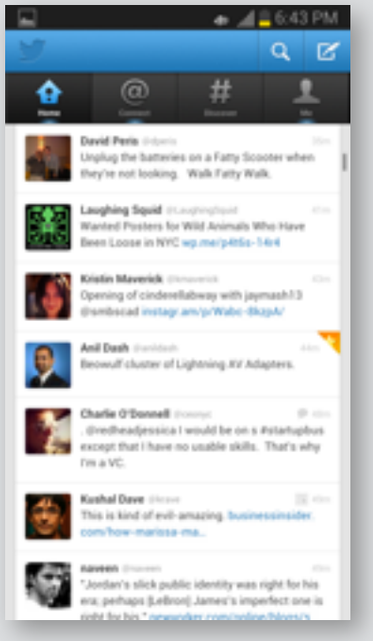
apps characterized by their concepts

Microsoft Word



Paragraph
Format
Style

Twitter



Tweet
Hashtag
Following

Photoshop

PixelMap
Layer/Mask
Adjustment

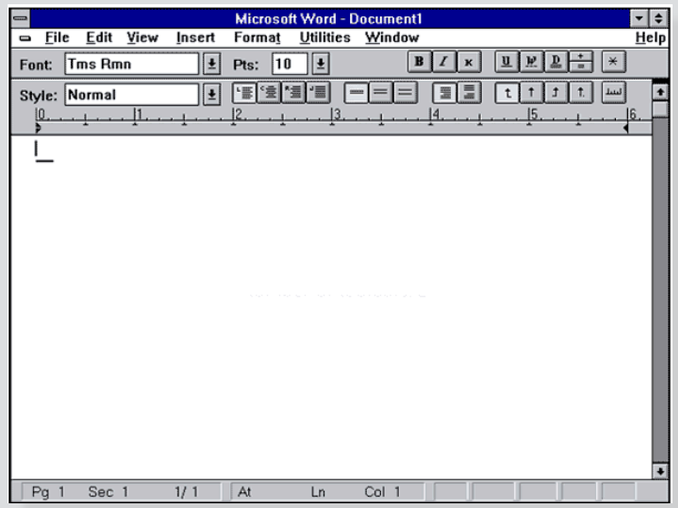
app classes characterized by concepts too

app classes characterized by concepts too

text editor

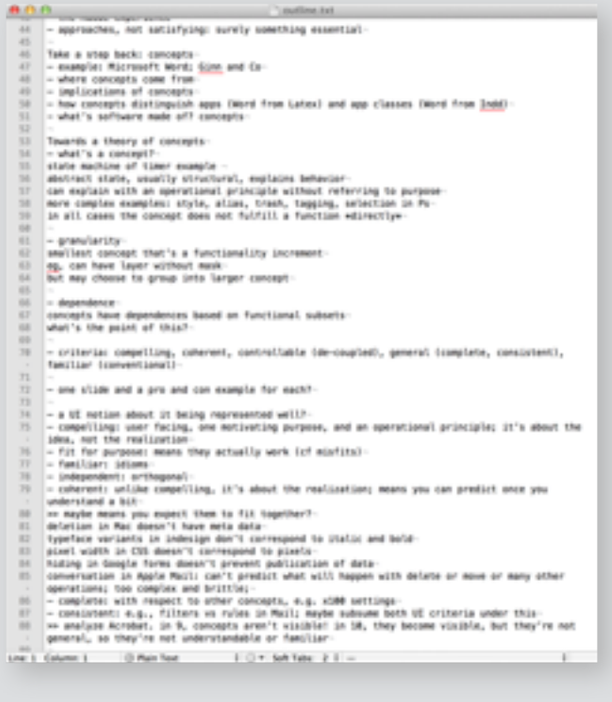
app classes characterized by concepts too

text editor

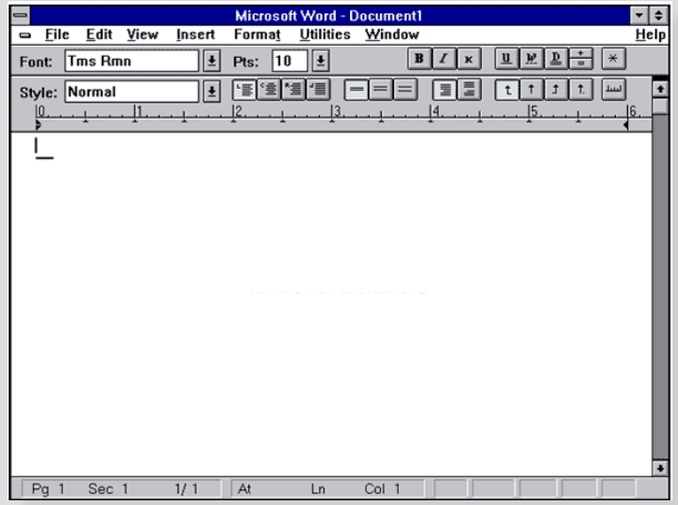


word processor

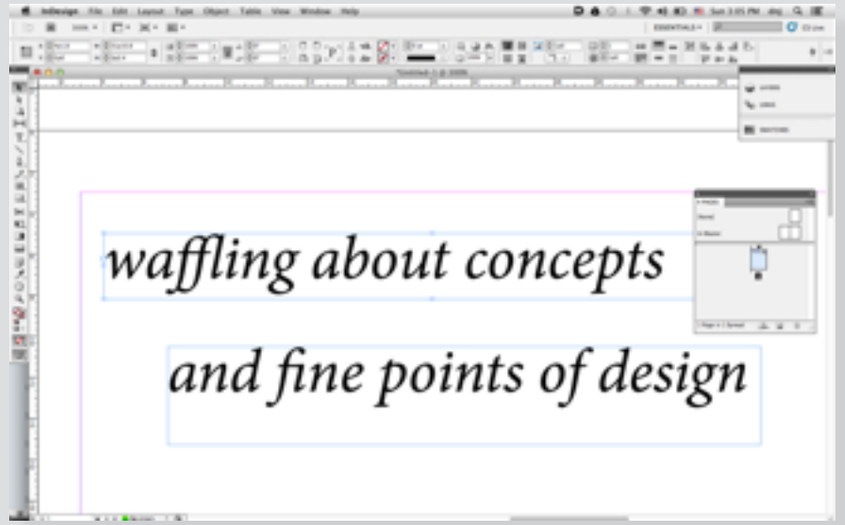
app classes characterized by concepts too



text editor



word processor



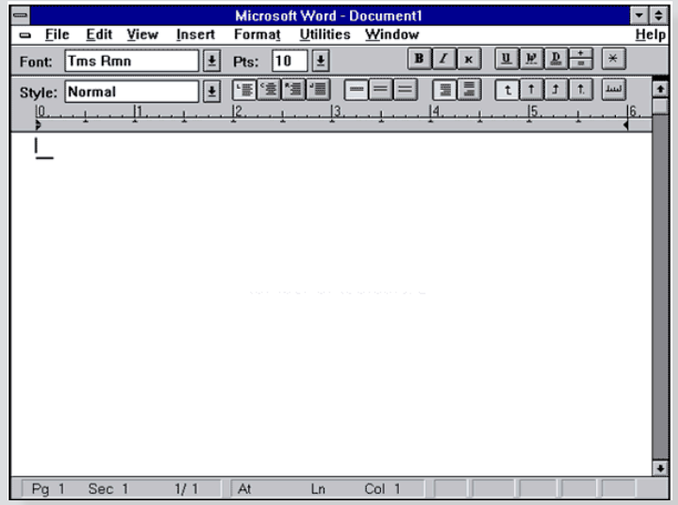
desktop publishing app

app classes characterized by concepts too

text editor

line

buffer



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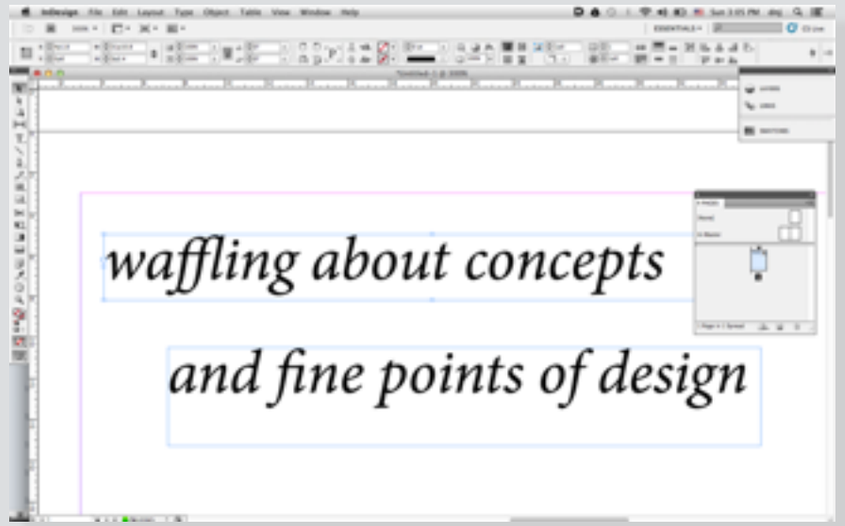

desktop publishing app

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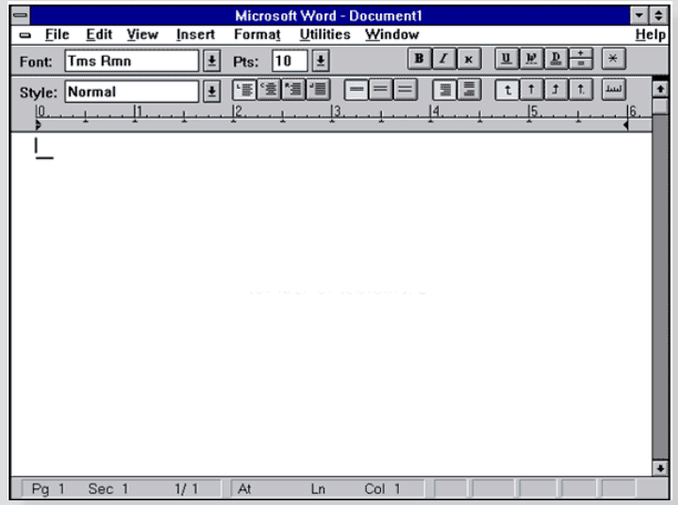
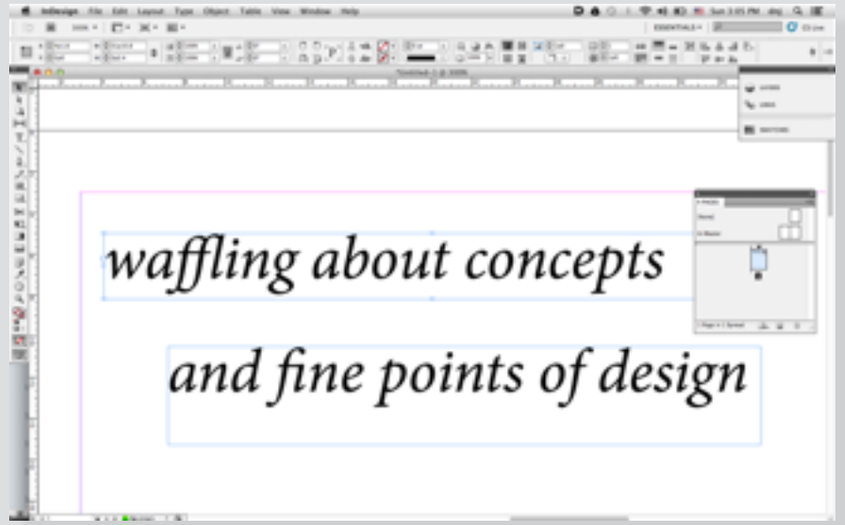


word processor

paragraph
format
style



desktop publishing app

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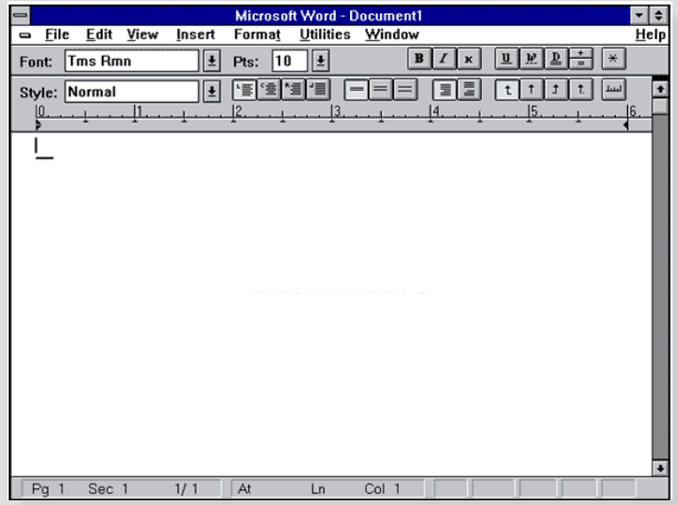

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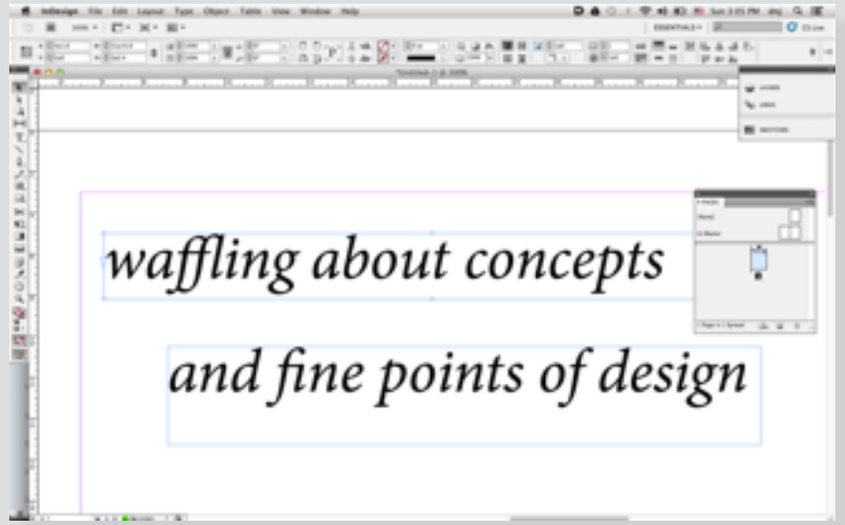

desktop publishing app
stylesheet
text flow
page template

app classes characterized by concepts too

text editor
line
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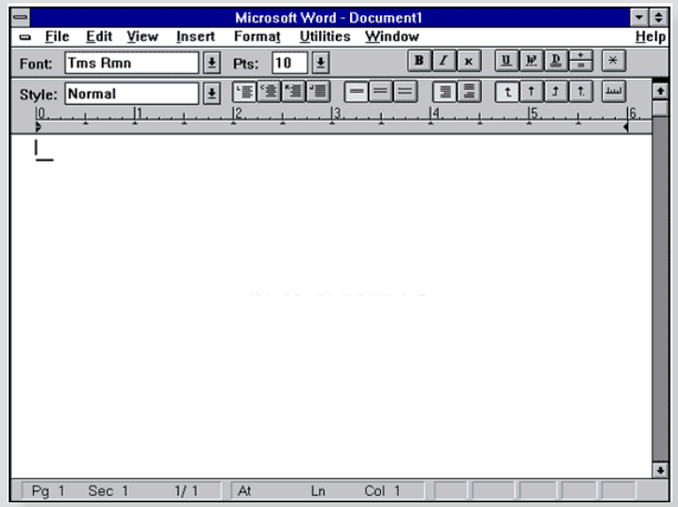

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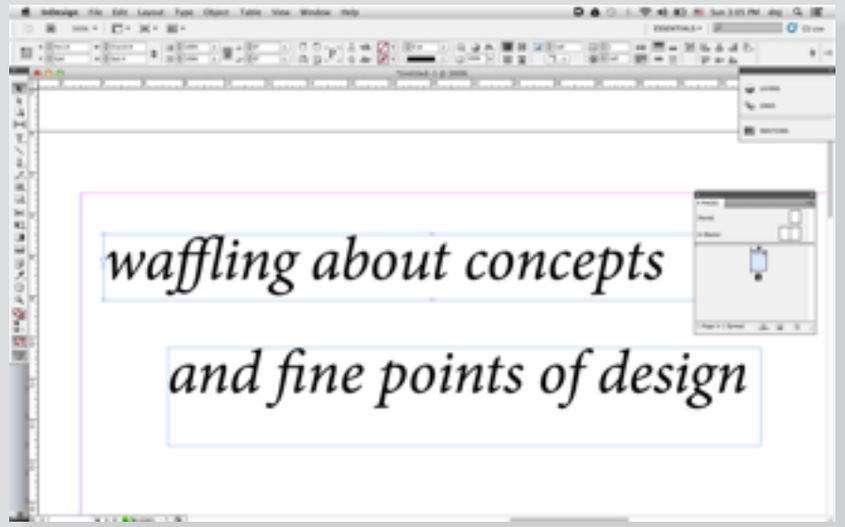


desktop publishing app
stylesheet
text flow
page template

jamonh
Oct 22, 2013 7:19 PM

Just upgraded to the new Pages and can't find a way to link text boxes anymore like

http://www.macobserver.com/tmo/article/pages-linking-text-boxes

Am I missing something, or is it really not possible anymore?

the conventional view

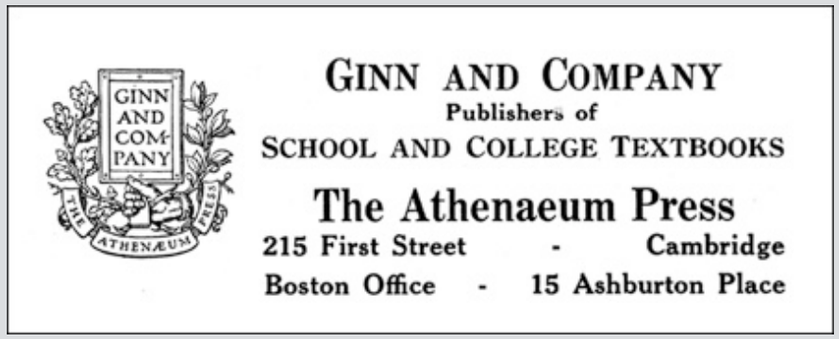
Conceptual model (computer science)

From Wikipedia, the free encyclopedia

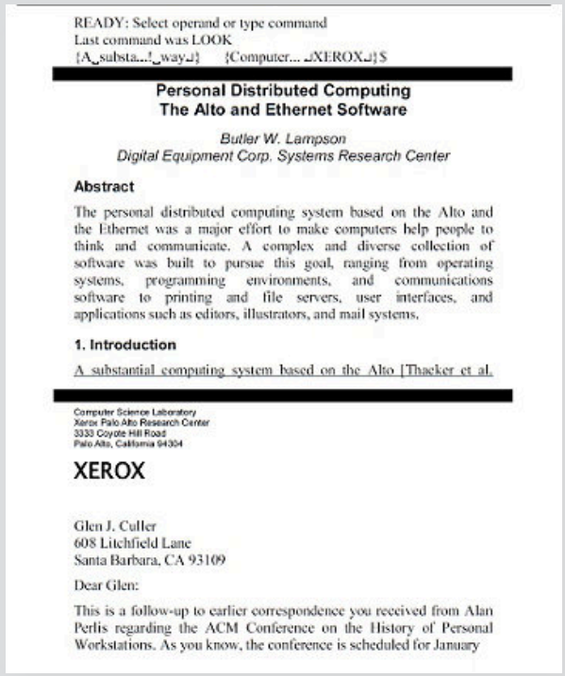
A mental model captures ideas in a problem domain, while a **conceptual model** represents 'concepts' (entities) and relationships between them.

A conceptual model in the field of computer science is a special case of a general conceptual model. To distinguish from other types of models, it is also known as a domain model. Conceptual modeling should not be confused with other modeling disciplines such as data modelling, logical modelling and

concepts are invented, not just out there



Tim Mott visits Ginn in 1974
brings idea of styles to PARC


READY: Select operand or type command
Last command was LOOK
{A␣substa...!␣way↵} {Computer... ↵XEROX↵}$

Personal Distributed Computing
The Alto and Ethernet Software

Butler W. Lampson
Digital Equipment Corp. Systems Research Center

Abstract

The personal distributed computing system based on the Alto and the Ethernet was a major effort to make computers help people to think and communicate. A complex and diverse collection of software was built to pursue this goal, ranging from operating systems, programming environments, and communications software to printing and file servers, user interfaces, and applications such as editors, illustrators, and mail systems.

1. Introduction

A substantial computing system based on the Alto [Thacker et al.

Computer Science Laboratory
Xerox Palo Alto Research Center
3333 Coyote Hill Road
Palo Alto, California 94304

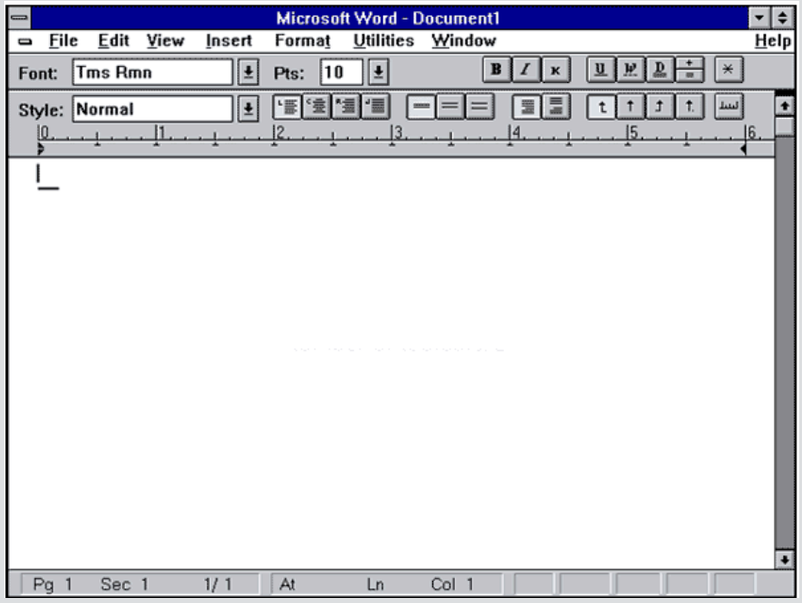
XEROX

Glen J. Culler
608 Litchfield Lane
Santa Barbara, CA 93109

Dear Glen:

This is a follow-up to earlier correspondence you received from Alan Perlis regarding the ACM Conference on the History of Personal Workstations. As you know, the conference is scheduled for January

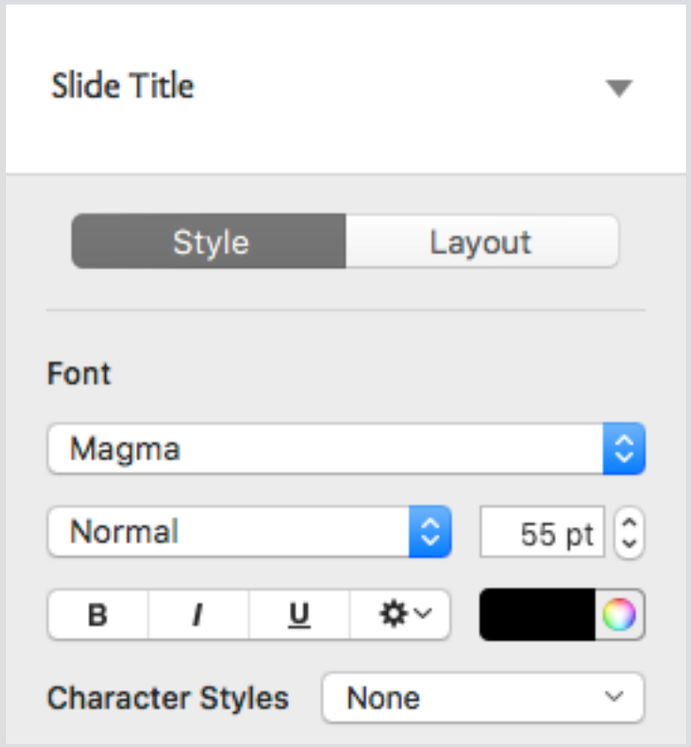
Charles Simonyi's team
implements style in
Bravo text editor



Simonyi brings style
to Microsoft in 1983

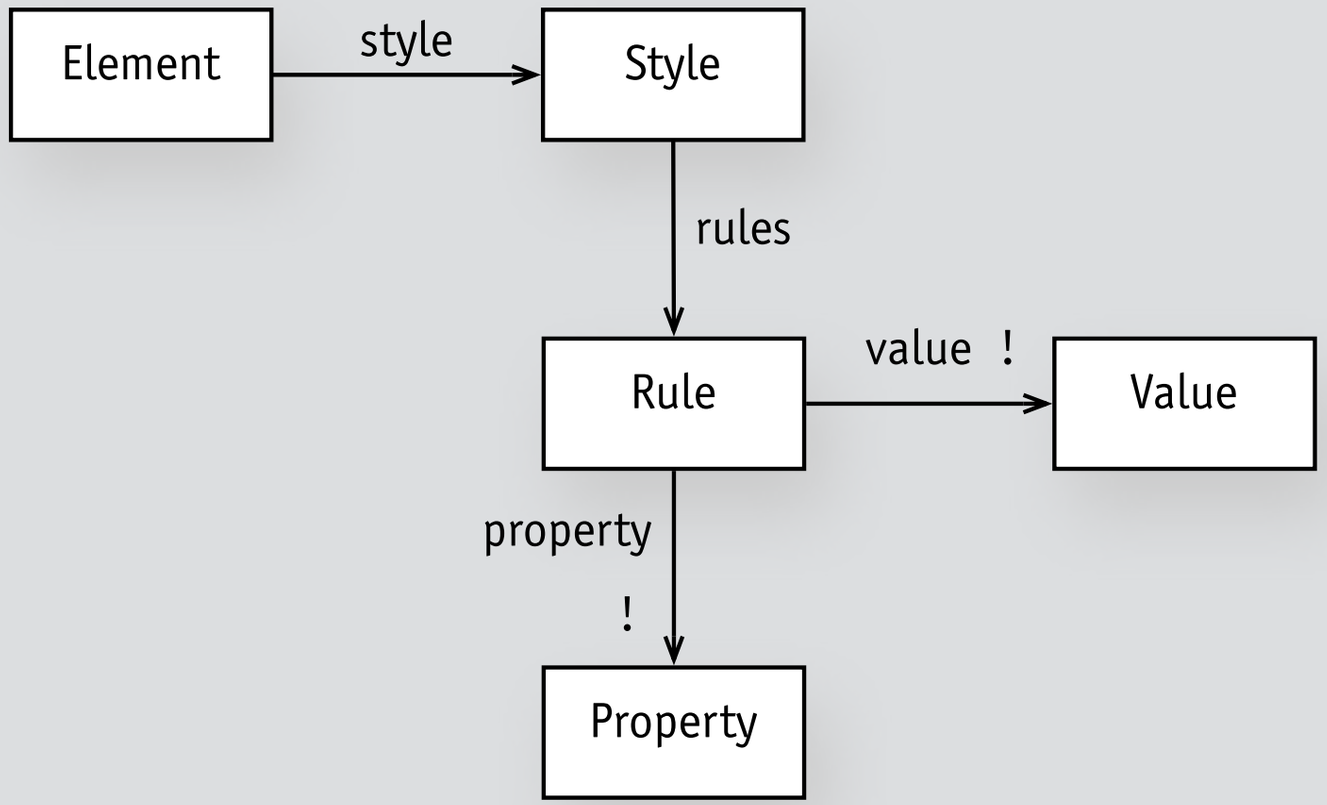
concepts have purpose

purpose of **style**: enable consistent formatting

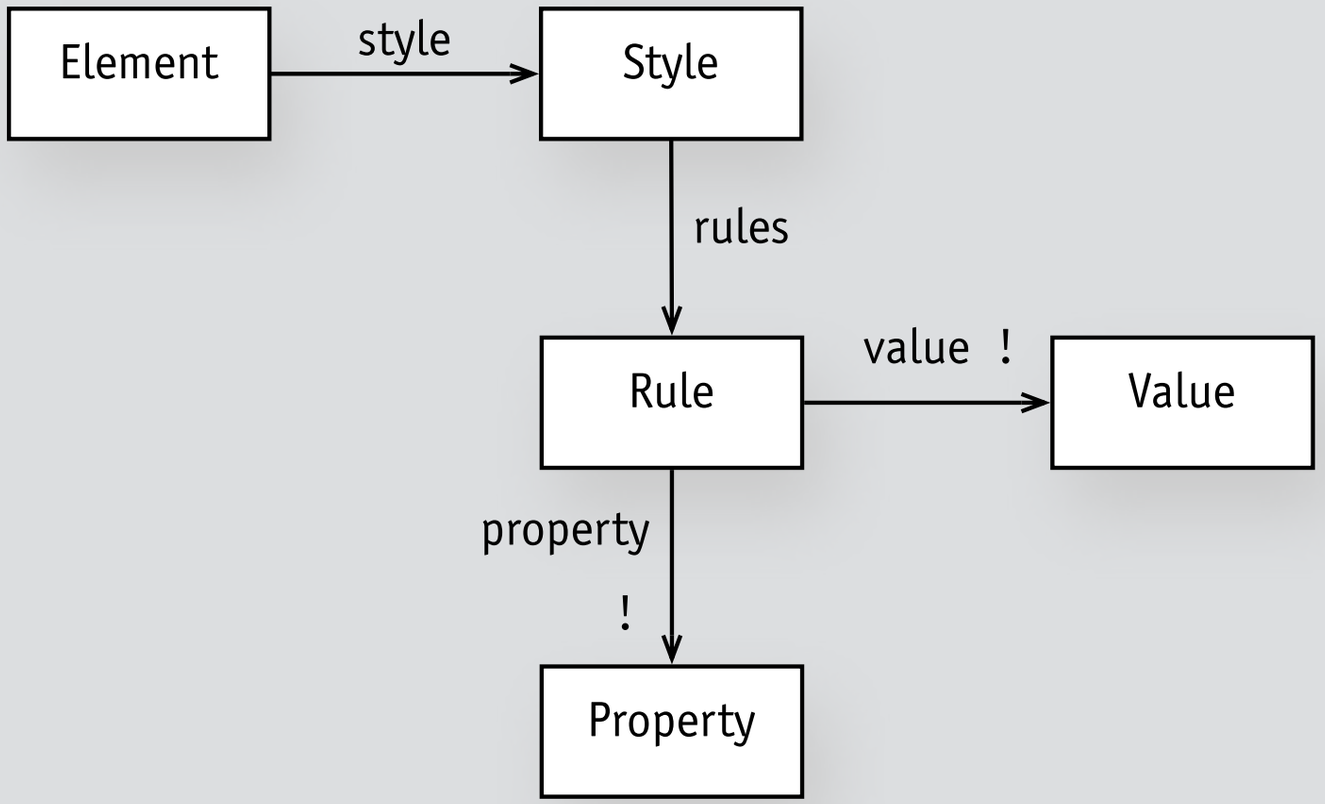


Apple Keynote
adds style concept
(2017?)

concept structure is designed not discovered

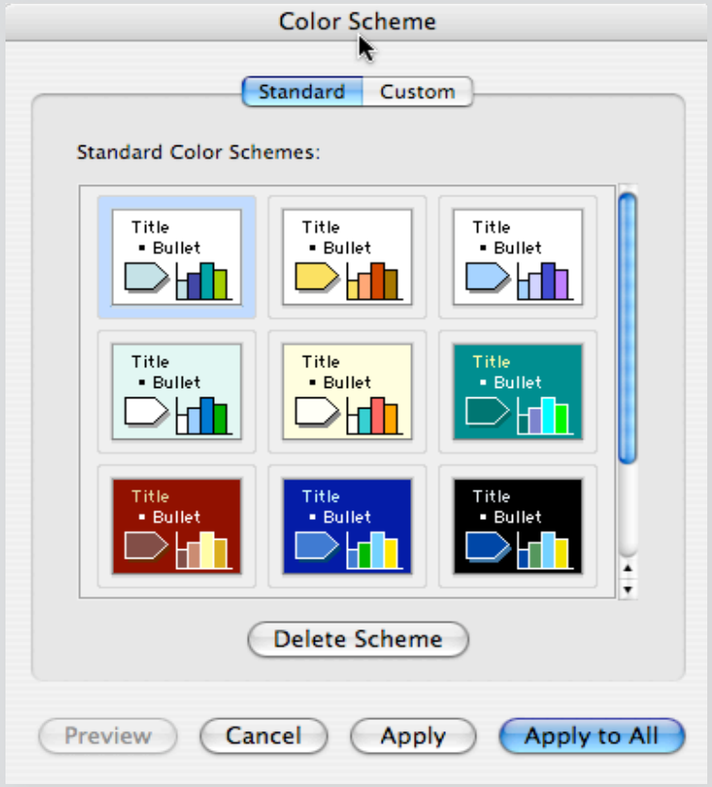


concept structure is designed not discovered

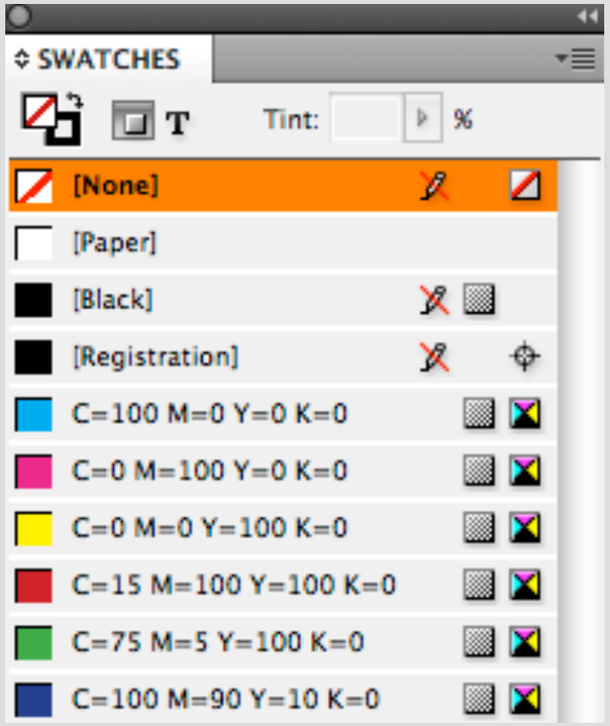


There is no problem
in computer science
that cannot be solved
by introducing another
level of indirection.
David Wheeler

concepts are reusable



Powerpoint color schemes



Indesign swatches

Keynote image styles

explaining concepts

how to explain the style concept?

If you assign Heading to two paragraphs
and then you change the style from bold to italic,
both paragraphs will be changed in concert

explaining concepts

how to explain the style concept?

If you assign Heading to two paragraphs
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both paragraphs will be changed in concert

If you create a style and assign to two elements, then when you modify the style, both elements will change...

explaining concepts

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not ontological: “a style is a mapping...”

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Johnson-Laird:
constructive semantics

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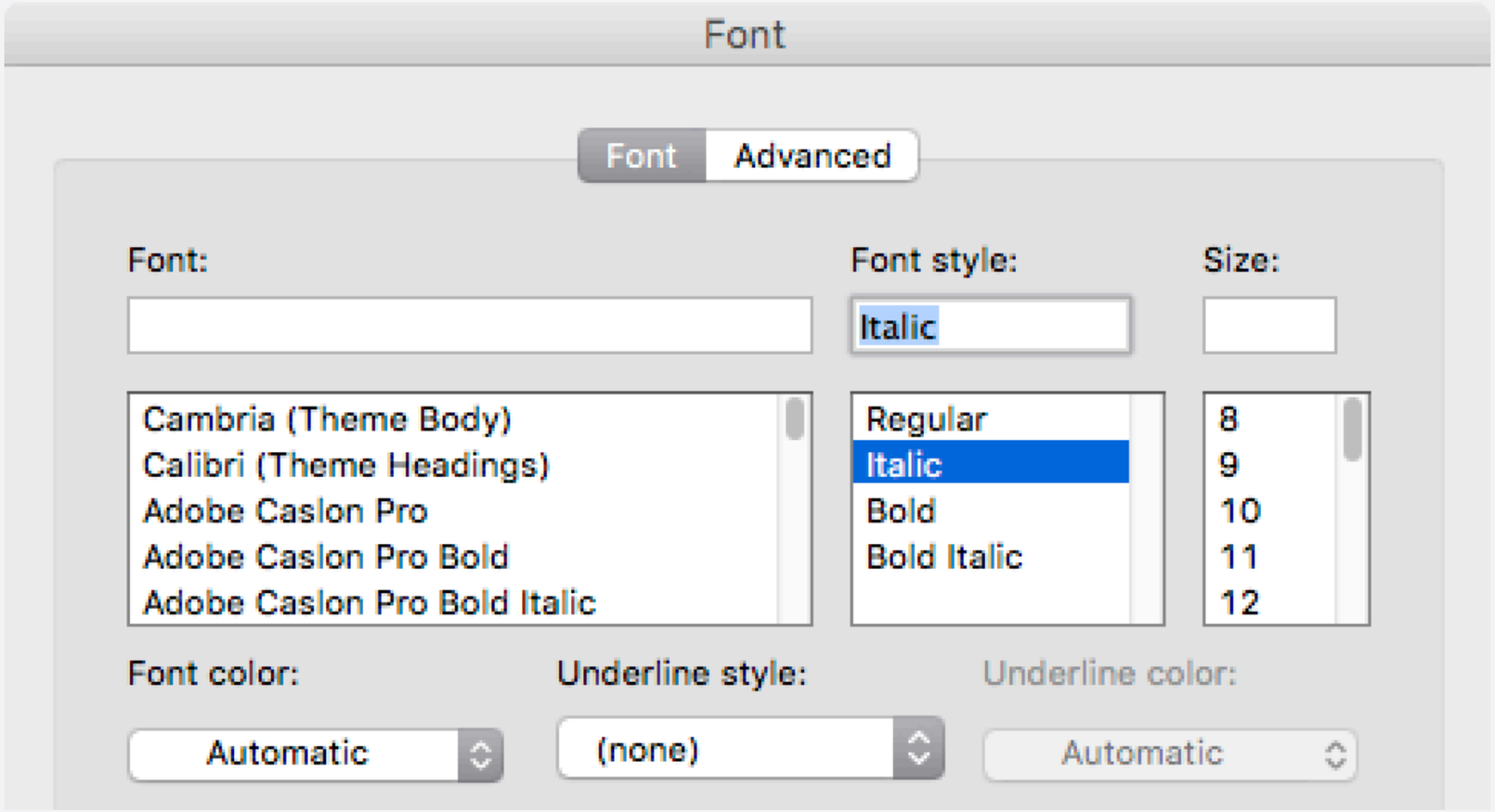
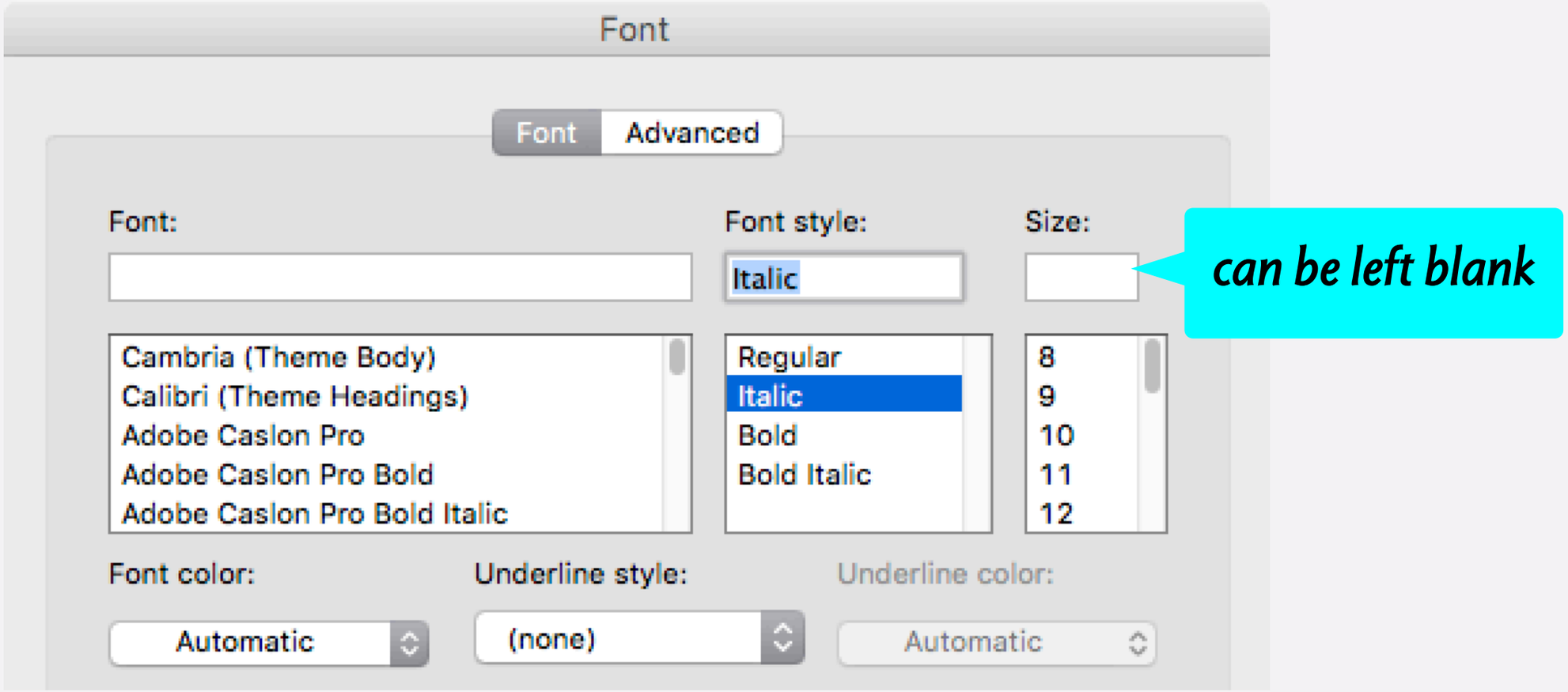
Johnson-Laird:
constructive semantics

Michael Polanyi
operational principle

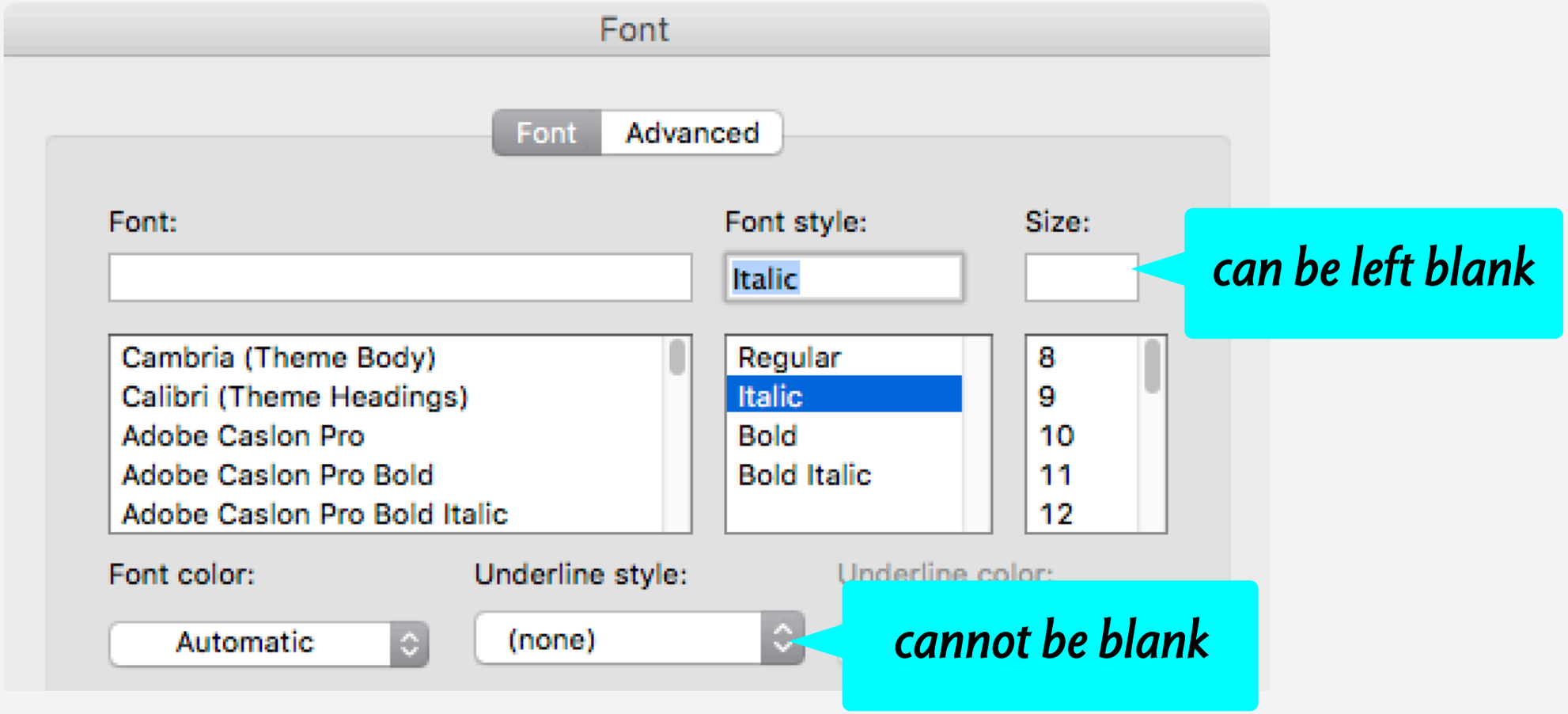
when concepts don't fulfill purpose



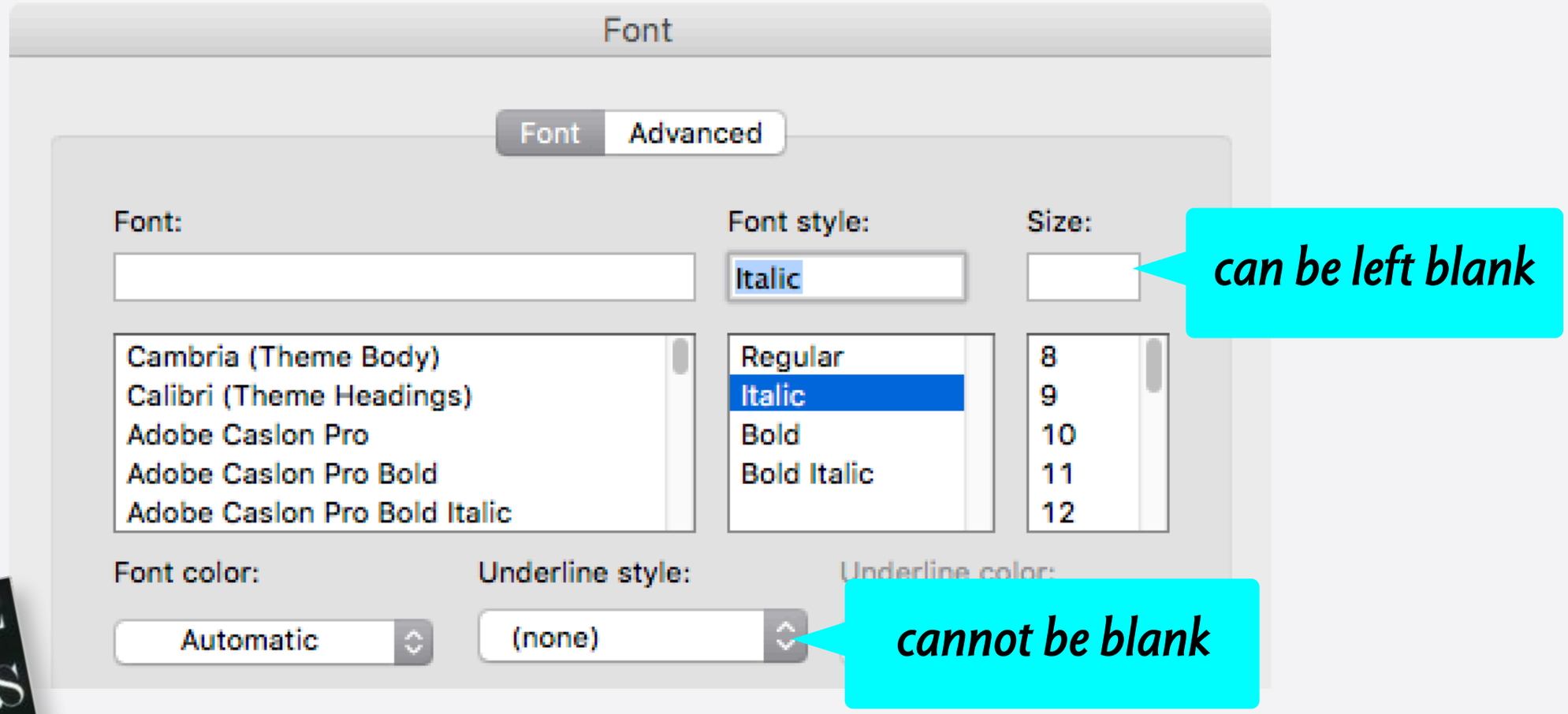
when concepts don't fulfill purpose

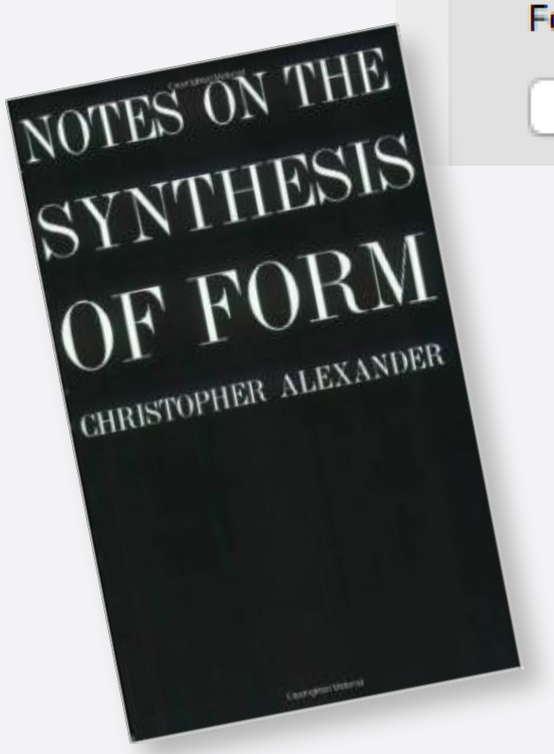


when concepts don't fulfill purpose



when concepts don't fulfill purpose





Alexander's **misfits**:
not bugs but bad specs

concepts: modules of behavior

concepts: modules of behavior

concepts: modules of behavior

inventive

concepts: modules of behavior

inventive

purposeful

concepts: modules of behavior

inventive

purposeful

behavioral

concepts: modules of behavior

inventive

purposeful

behavioral

self-contained

concepts: modules of behavior

inventive

purposeful

behavioral

self-contained

reusable

the style concept

the style concept

name

the style concept

name

purpose

the style concept

name

purpose

structure

the style concept

name

purpose

structure

actions

the style concept

name

purpose

structure

actions

operational principle

the style concept

name

style

purpose

structure

actions

operational principle

the style concept

name **style**

purpose enable consistent formatting

structure

actions

operational principle

the style concept

name	**style**
purpose	enable consistent formatting
structure	style: Element ⟶ Style value: Style ⟶ Property ⟶ Value
actions	
operational principle	

the style concept

name	**style**
purpose	enable consistent formatting
structure	style: Element ⟶ Style value: Style ⟶ Property ⟶ Value
actions	new (pv: Property ⟶ Value) ≙ new s | value := value + s ⟶ pv delete (s: Style) ≙ style := style - Element ⟶ s assign (e: Element, s: Style) ≙ style := style ++ e ⟶ s modify (s: Style, p: Property, v: Value) ≙ value(s) := value(s) ++ p ⟶v
operational principle	

the style concept

name

style

purpose

enable consistent formatting

structure

style: Element ⟶ Style
value: Style ⟶ Property ⟶ Value

actions

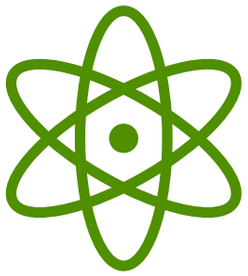
new (pv: Property ⟶ Value) ≜ new s | value := value + s ⟶ pv
delete (s: Style) ≜ style := style - Element ⟶ s
assign (e: Element, s: Style) ≜ style := style ++ e ⟶ s
modify (s: Style, p: Property, v: Value) ≜ value(s) := value(s) ++ p ⟶v

operational principle

if you create a new style, and assign it to two elements, and then modify the style, both elements will have the same property/value mapping

a research & teaching program

designing software with concepts



a design theory

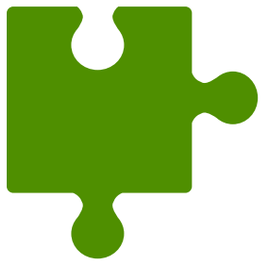
concept structure & design rules [Onward 15]

design case studies

Gitless [Perez De Rosso, Onward 13, OOPSLA 16]

design patterns

about 30 so far



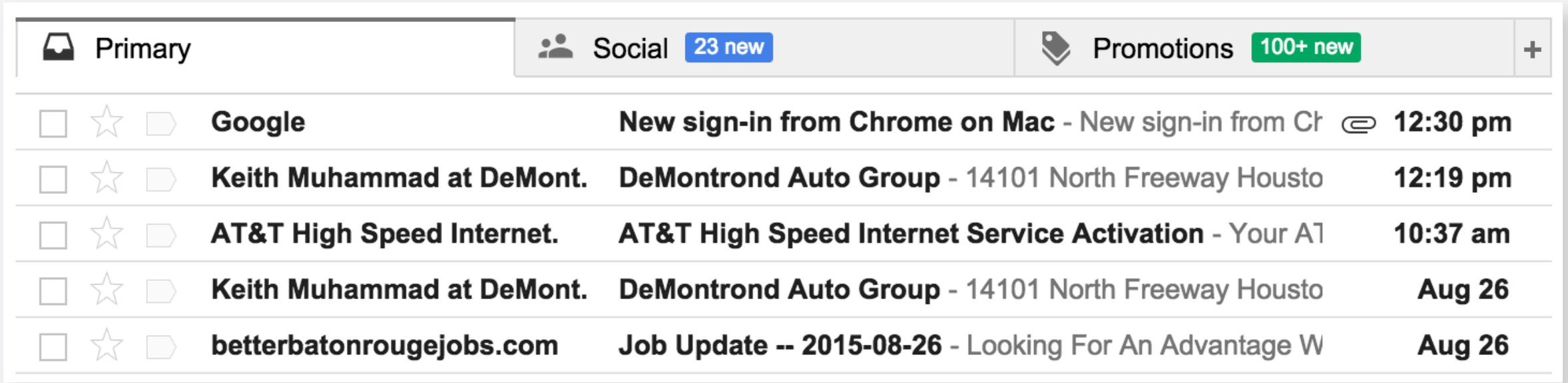
code platform

Deja Vu [Perez De Rosso]

three design problems

gmail categories

gmail's categories



category tab settings

Categories:
Learn more

- [x] **Primary**
- [x] **Social**
- [x] **Promotions**
- [ ] **Updates**
- [ ] **Forums**

Starred messages

- [x] **Include starred in Primary**

Choose which message categories to show as inbox tabs. Other messages will appear in the Primary tab.

some reactions

some reactions

Everything You Need to Know About Gmail's New, Super-Confusing Layout

Melanie Pinola

Filed to: GMAIL 6/07/13 9:00am

301,482 12

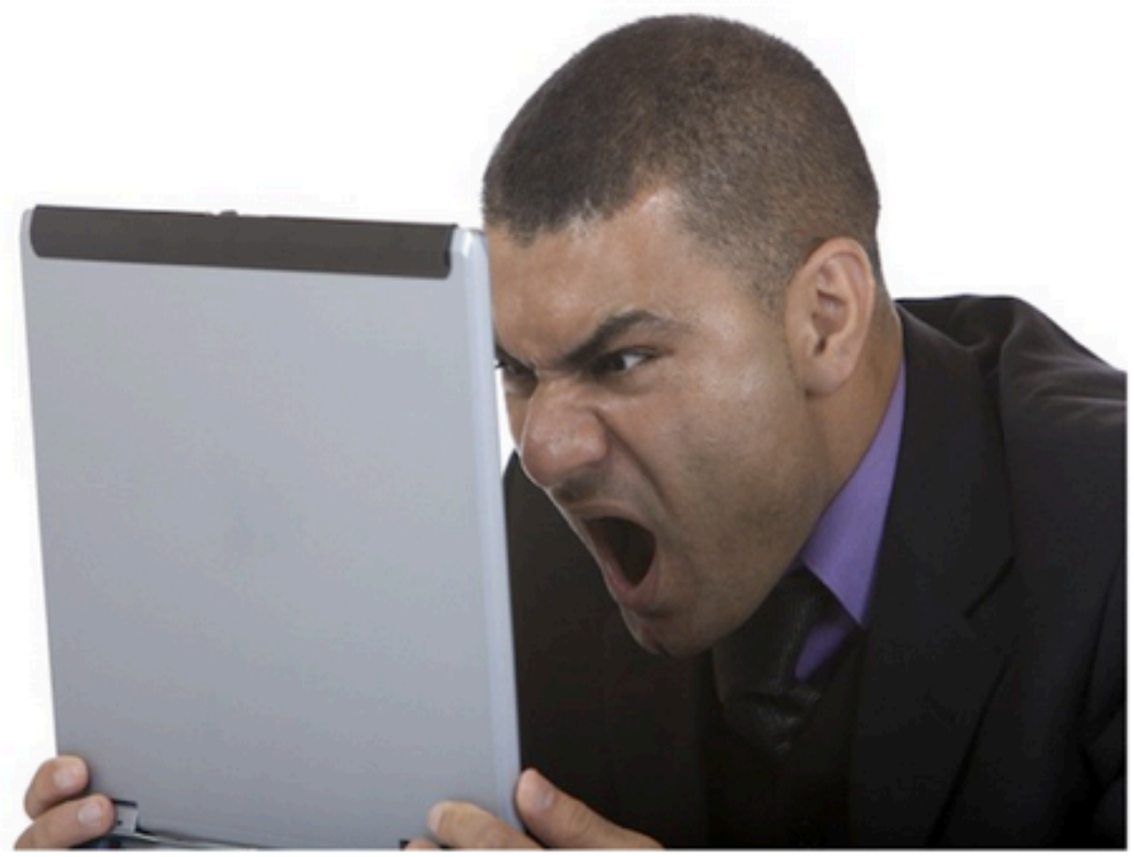
some reactions

Google gets it terribly, terribly wrong with Gmail tabs and makes me angry

By Mark Wilson | Published 2 years ago | Follow

71 Comments | Like 55 | Share 11 | +1 37 | Tweet 30

Like many Gmail users, I greeted the news of the introduction of tabs to the interface with a degree of anticipation -- now it was just a matter of waiting for the feature to roll out so I could try it for myself. Earlier today I was randomly signed out of my Gmail account, and after signing back in and checking the settings menus, I could see that tabs were now available to me. Excitement was short-lived, however; it quickly became apparent that this new feature is a disaster.



some reactions

Quick Tech Tip: Disabling Gmail's Category Tabs

Mon, 07/29/2013 - 12:17 | Chuck Gray
in LibraryPoint Blog Tech Tutorials Teen Blog Tech Answers Science and Technology Self-Help and Instructional

Are you a Gmail user? Did you wake up a week or two ago to find that your new messages were now being automatically organized by Gmail into tabs of different, pre-determined categories? And, did you think, like me, that they were really ugly, stupid, and unnecessary? Here's a quick tip on how to rid yourself of them!

how google explains labels (!)

Gmail Help

GMAIL FORUM

Using labels

Labels help you organize your messages into categories -- work, family, to do, read later, jokes, recipes, any category you want. Labels do all the work that folders do, but with an added bonus: you can add more than one to a message.

what you can’t do

what you can’t do

associate tabs with labels

feature available only for categories

what you can't do

associate tabs with labels
feature available only for categories

create new categories
only new labels

what you can't do

associate tabs with labels
feature available only for categories

create new categories
only new labels

use tabs outside inbox
tabs disappear when you filter on a label

fuji aspect ratio

my camera fuji x100s

image quality setting

image quality setting

image quality setting

aspect ratio

aspect ratio

image size setting

image size setting

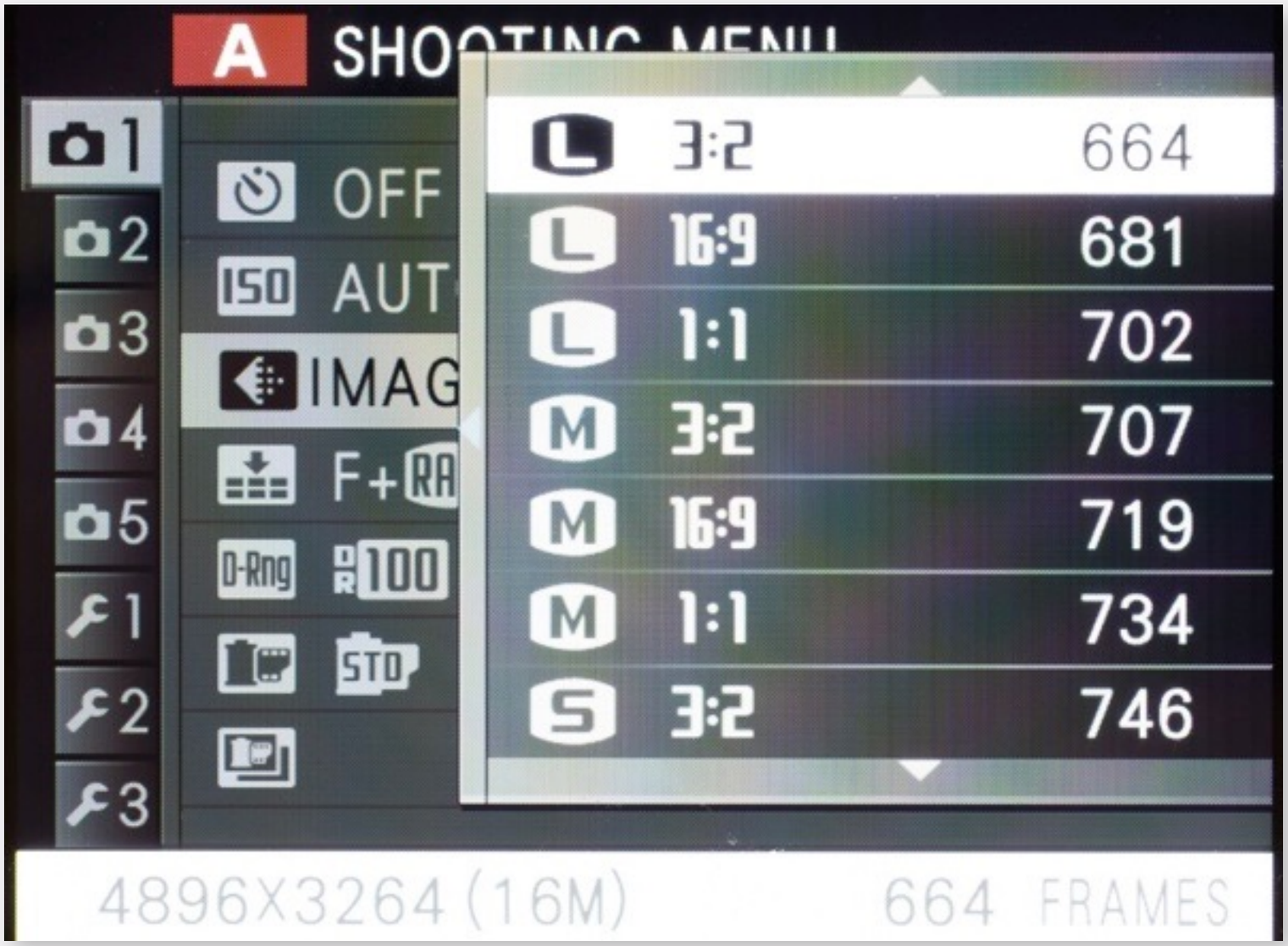


image size setting

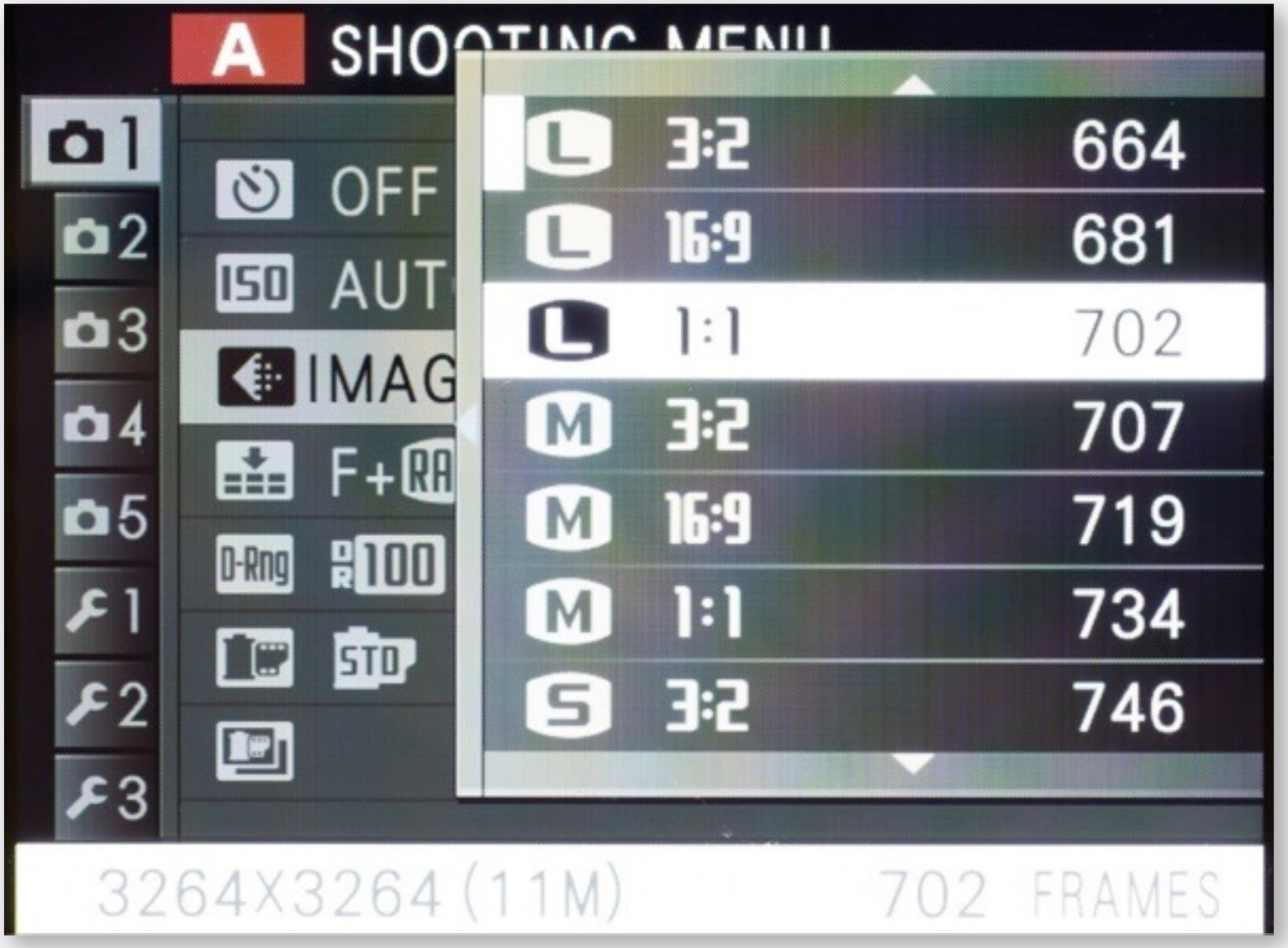


image size setting

non-standard ratio + raw?

what you can't do

non-standard aspect ratio + raw

even though raw images get nice nondestructive crop!

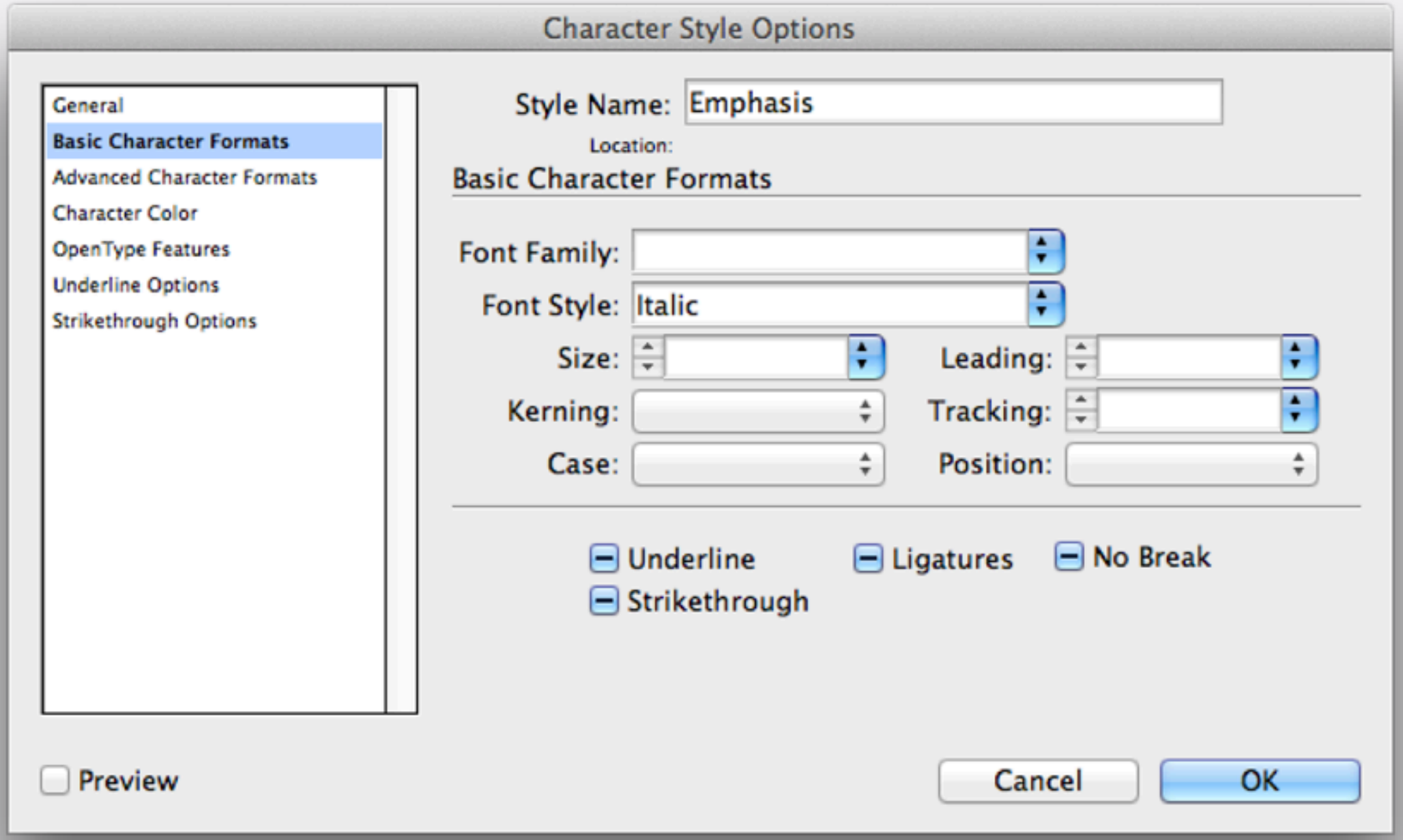
what you can't do

non-standard aspect ratio + raw

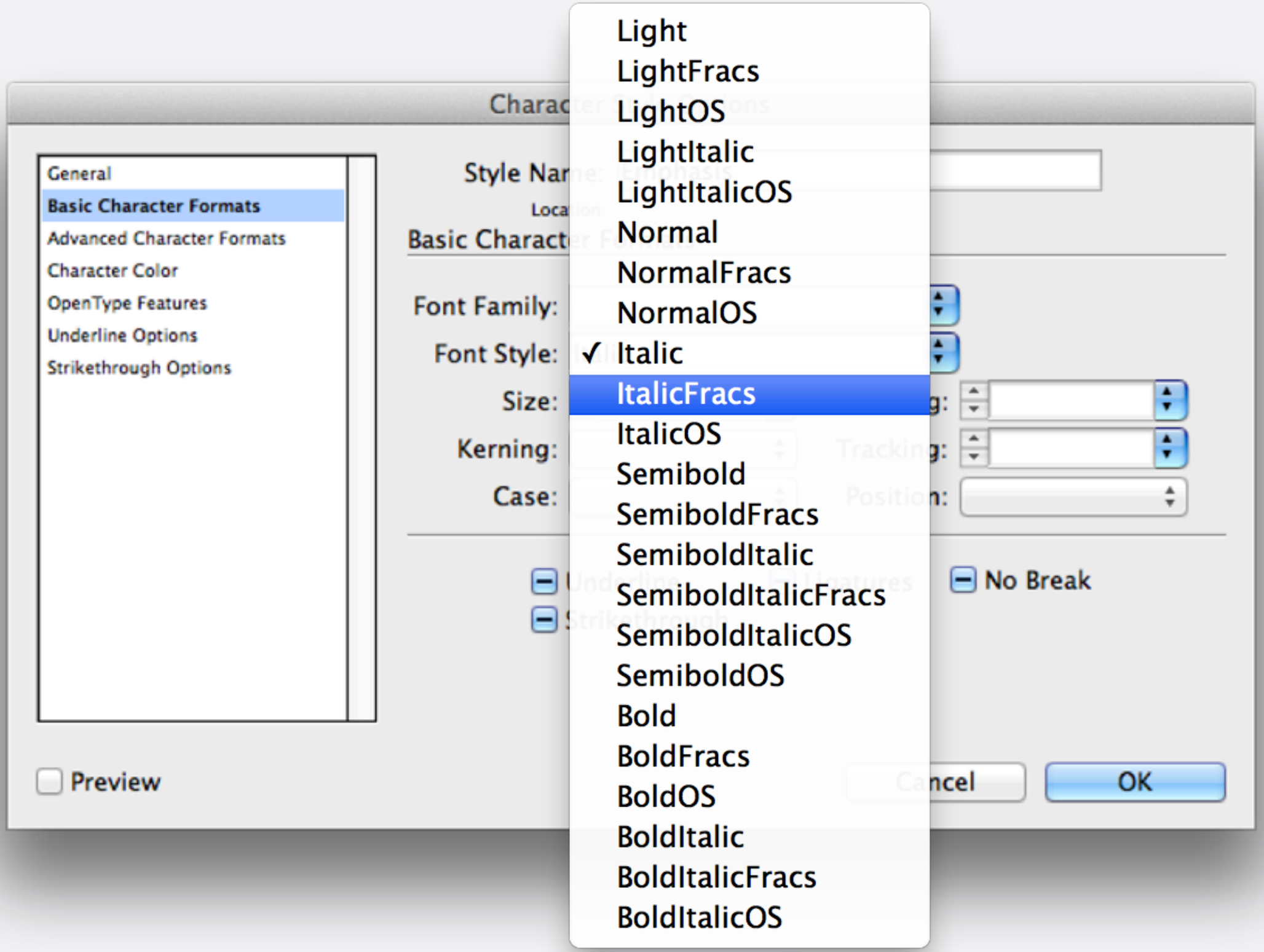
even though raw images get nice nondestructive crop!

indesign styles

what's a font?


Character Style Options
General
Basic Character Formats
Advanced Character Formats
Character Color
OpenType Features
Underline Options
Strikethrough Options
Style Name: Emphasis
Location:
Basic Character Formats
Font Family:
Font Style: Italic
Size:
Leading:
Kerning:
Tracking:
Case:
Position:
Underline
Ligatures
No Break
Strikethrough
Preview
Cancel
OK

what's a font?


General
Basic Character Formats
Advanced Character Formats
Character Color
OpenType Features
Underline Options
Strikethrough Options
Font Family:
Font Style:
Size:
Kerning:
Case:
No Break
Preview
OK
Light
LightFracs
LightOS
LightItalic
LightItalicOS
Normal
NormalFracs
NormalOS
✓ Italic
ItalicFracs
ItalicOS
Semibold
SemiboldFracs
SemiboldItalic
SemiboldItalicFracs
SemiboldItalicOS
SemiboldOS
Bold
BoldFracs
BoldOS
BoldItalic
BoldItalicFracs
BoldItalicOS

what you can’t do

define a style that italicizes

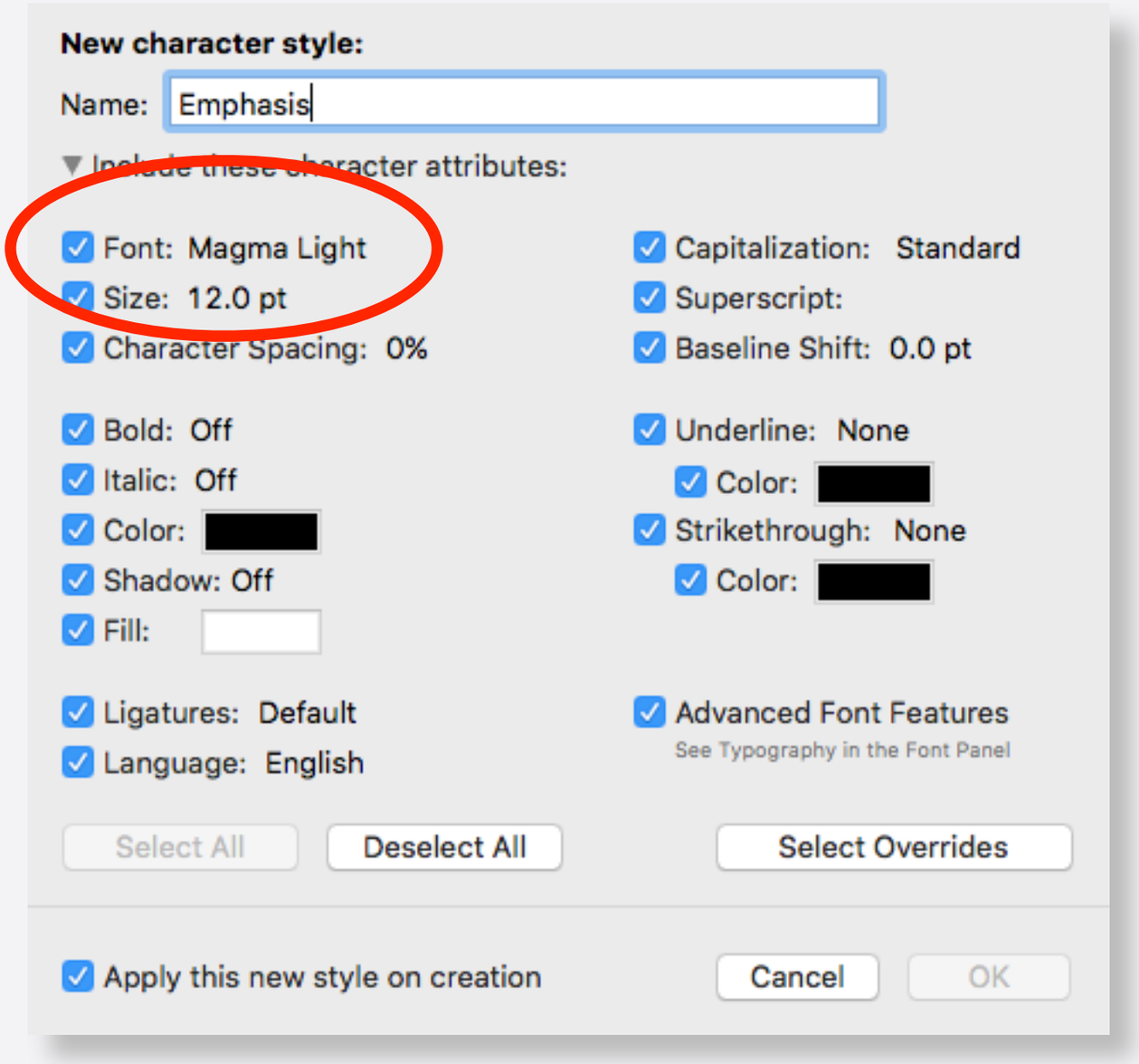
Arno Regular to Arno Italic

Futura Book to Futura Book Oblique

Magma Light to Magma Light Italic

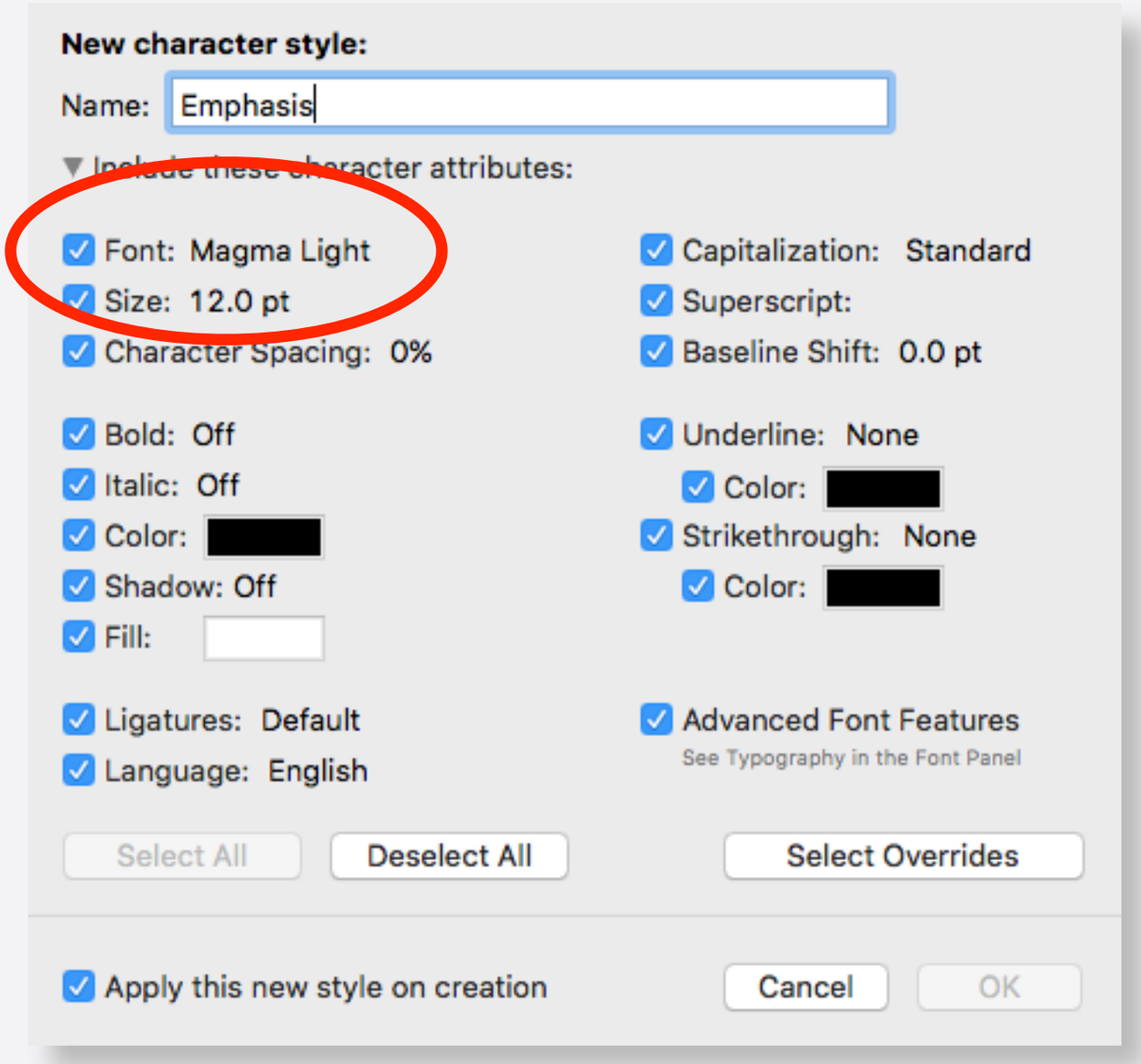
introducing a concept

introducing a concept

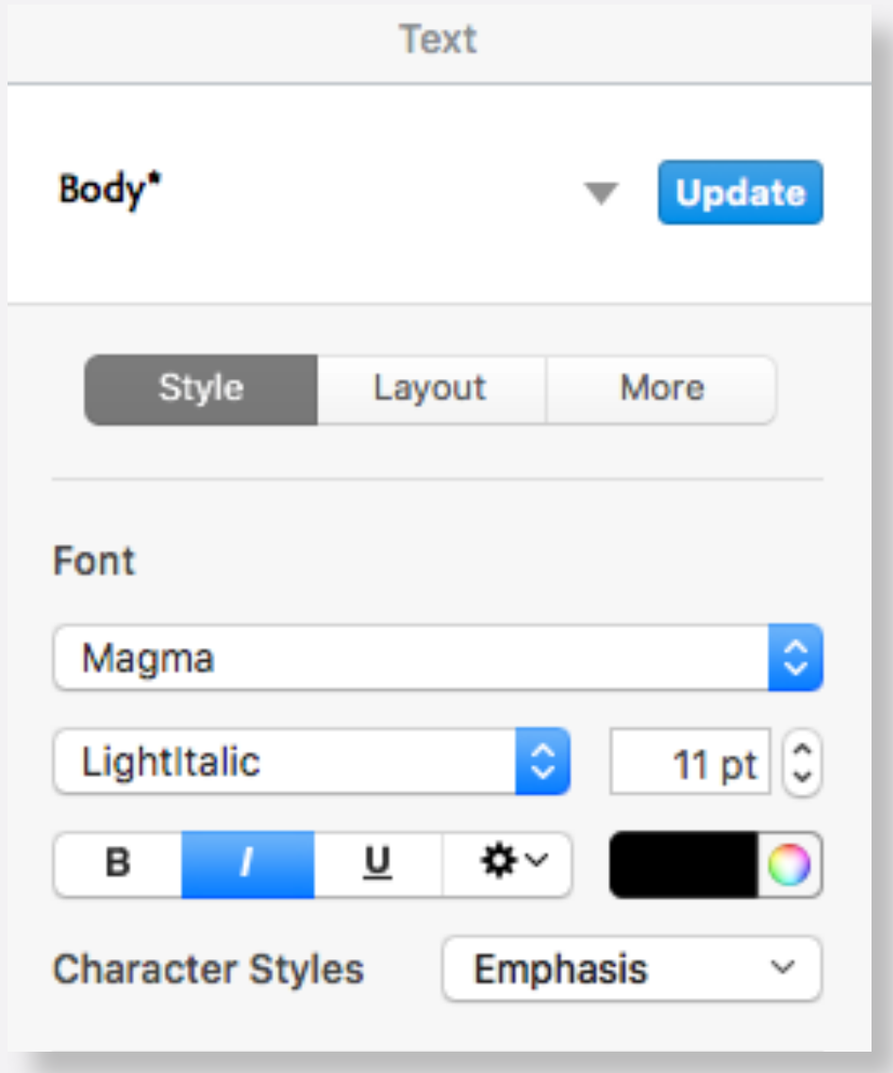


Keynote ’09: has subfamilies

introducing a concept



Keynote ’09: has subfamilies



Keynote 6: gone again!

what's going on?

what's going on?

gmail

one purpose :: two concepts

organizing messages :: label + category

what's going on?

gmail

one purpose :: two concepts

organizing messages :: label + category

camera

two purposes :: one concept

aspect ratio + image resolution :: image size

what's going on?

gmail

one purpose :: two concepts
organizing messages :: label + category

camera

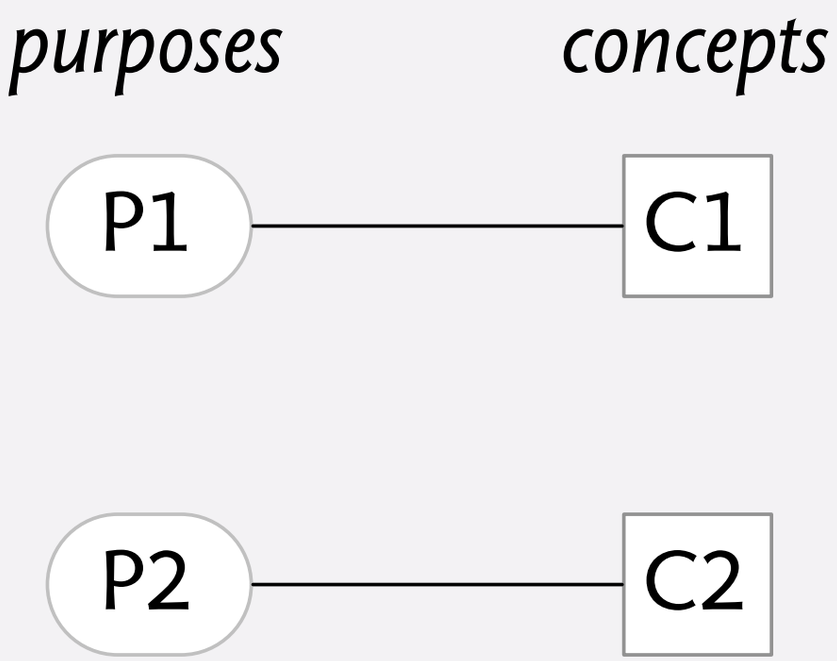
two purposes :: one concept
aspect ratio + image resolution :: image size

style

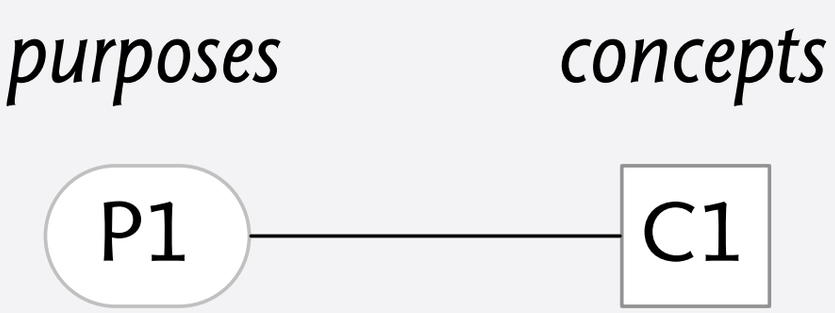
one purpose :: no concept
specify a font-independent styling :: ?

the singularity rule

one-to-one mapping



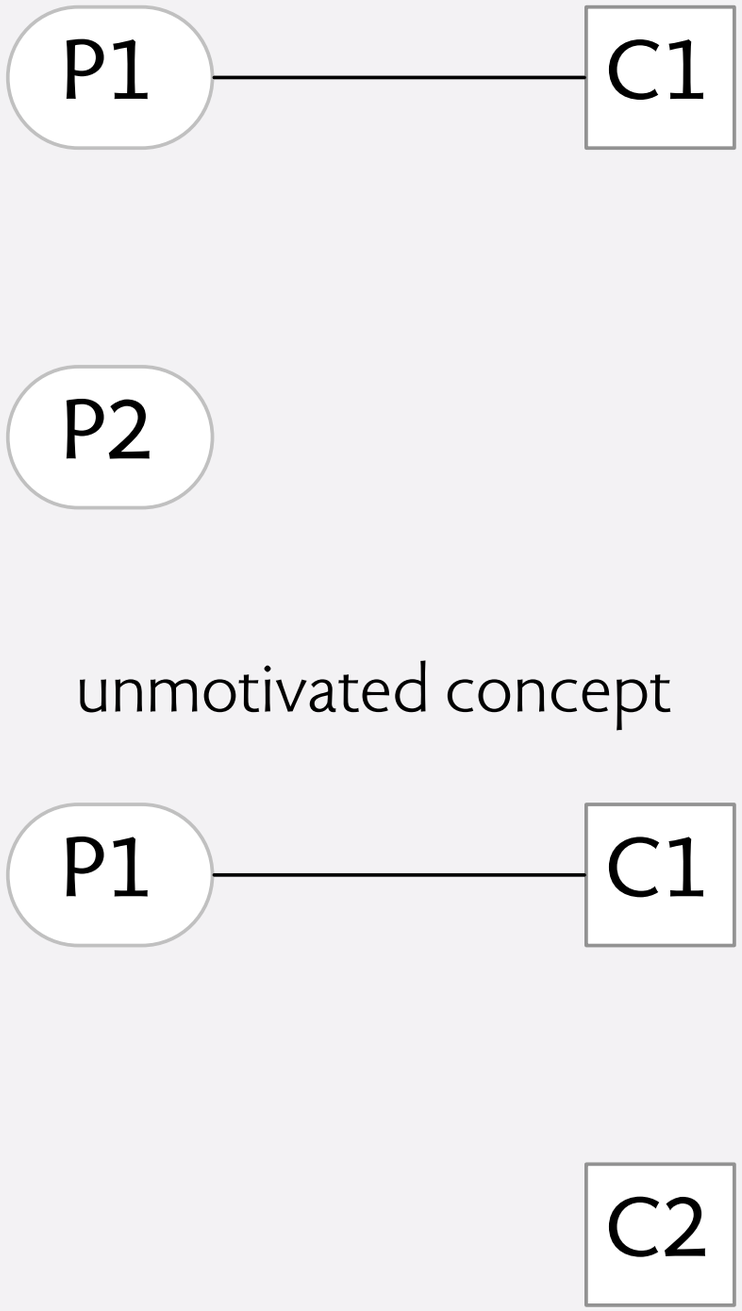
one-to-one mapping



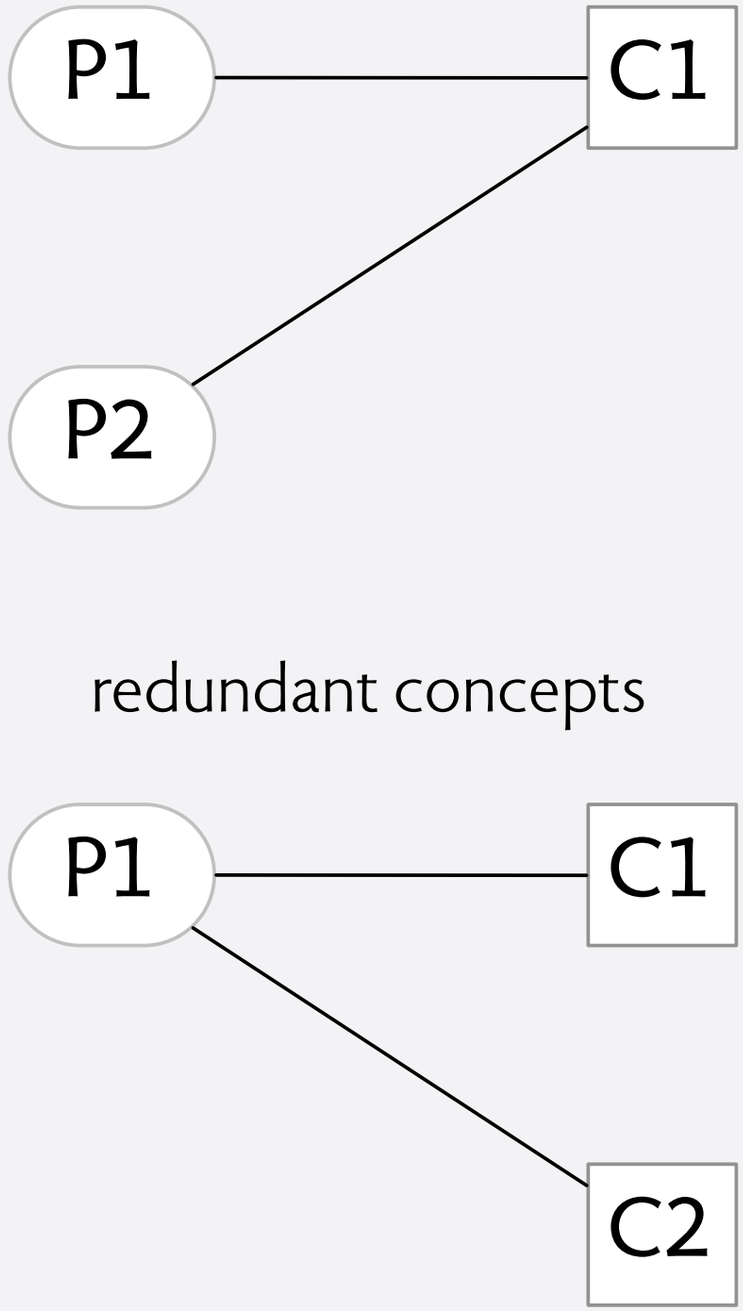
Nam Suh:
Axiomatic Design

four ways to fail

unfulfilled purpose



overloaded concept



unmotivated concept

redundant concepts

overloading fuji camera

new purpose piggybacked on old concept

overloading fuji camera

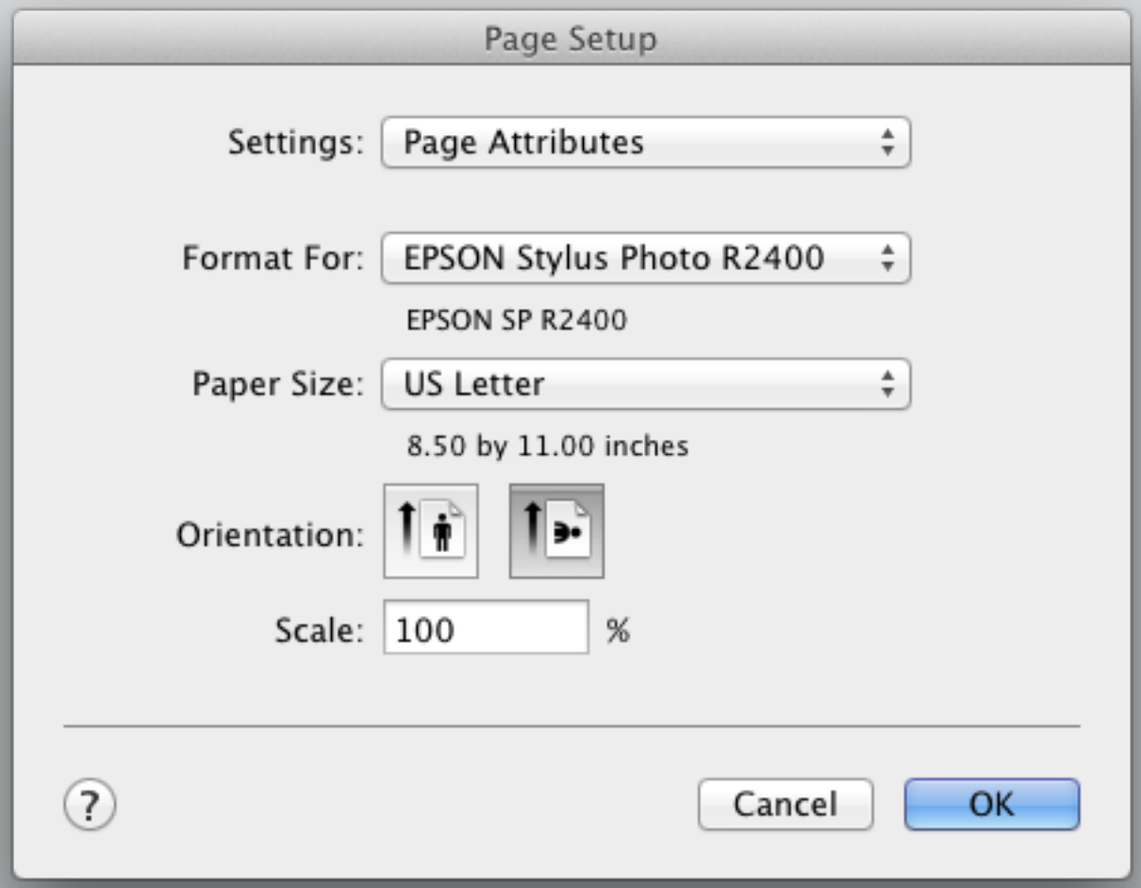
new purpose piggybacked on old concept

image size

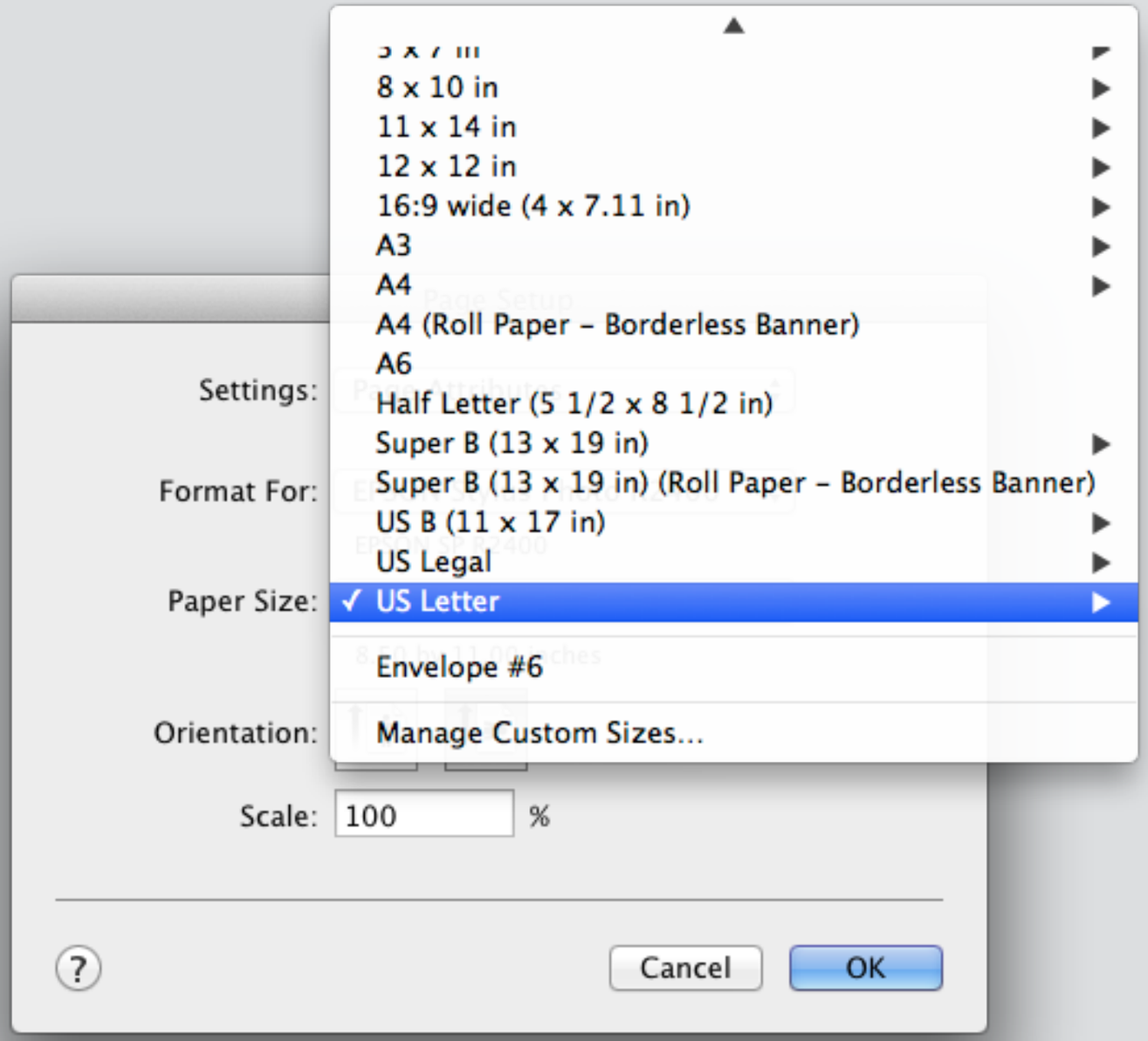
aspect ratio piggybacked on JPEG dimensions

overloading epson driver

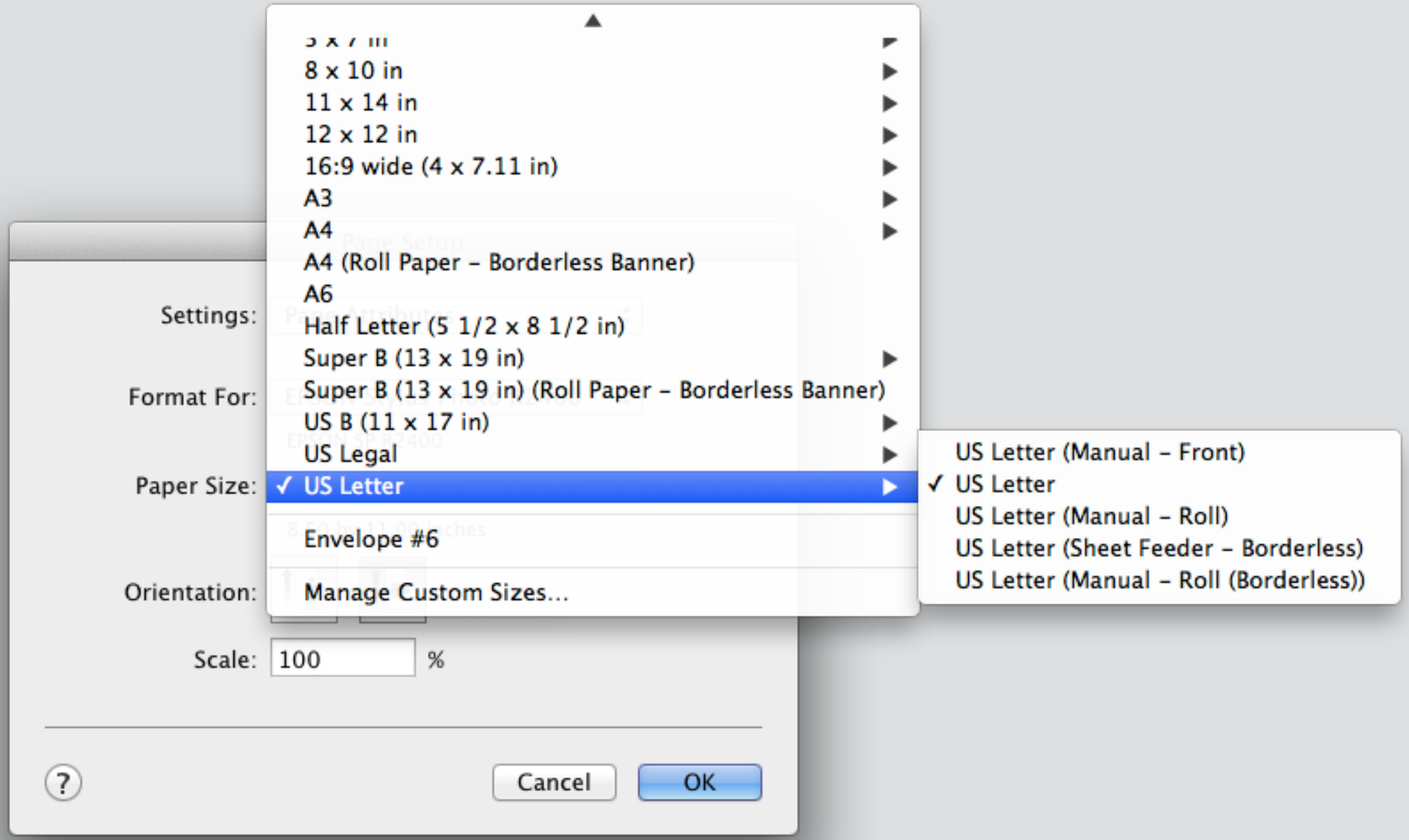
overloading epson driver



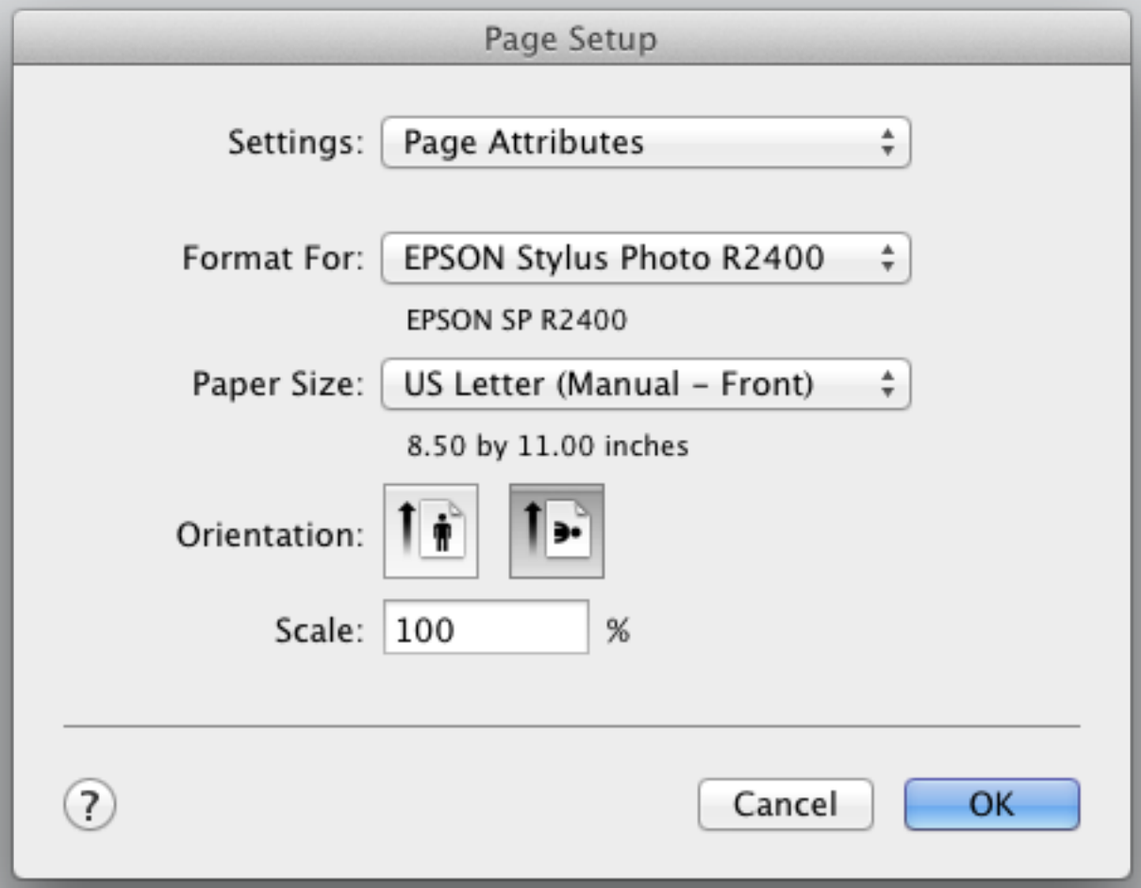
overloading epson driver



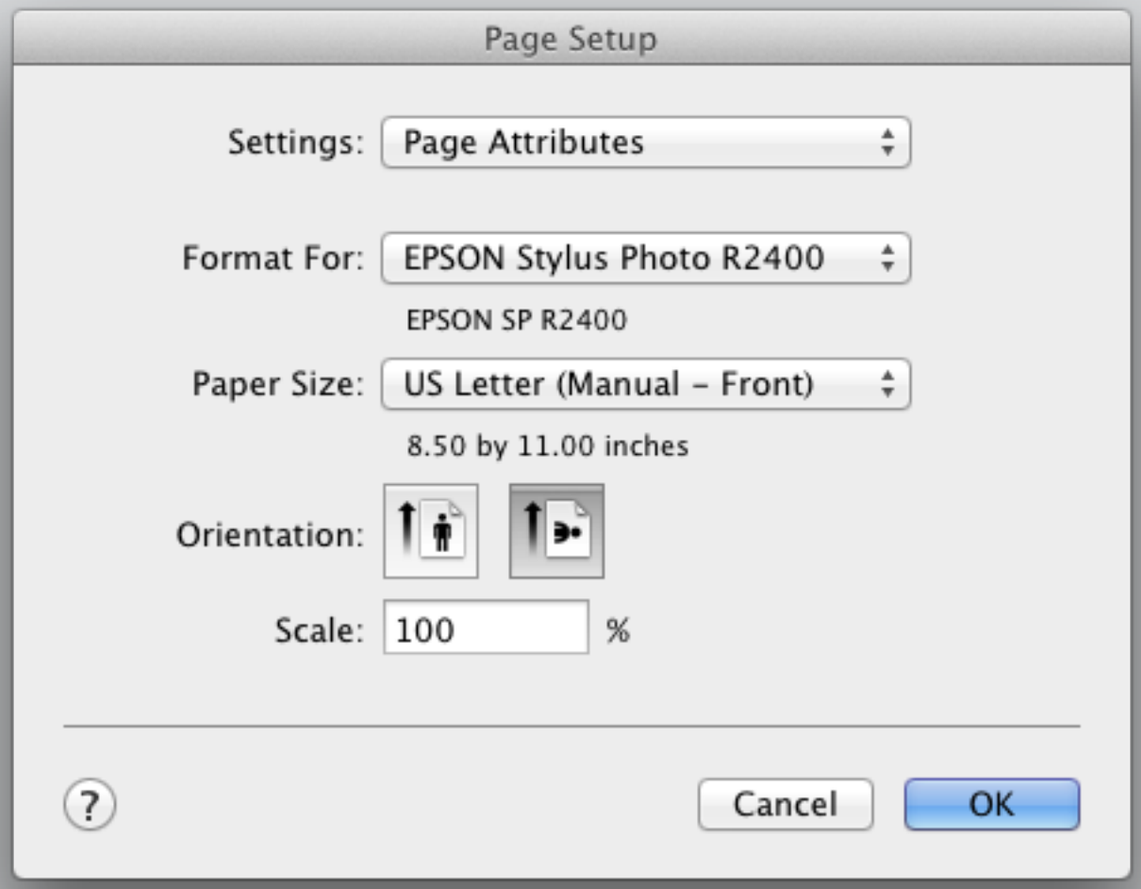
overloading epson driver



overloading epson driver



overloading epson driver



result: can't create custom size for front loading
also, page size presets in Lightroom hold feed setting

overloading email subject

new purposes emerge for old concept

overloading email subject

new purposes emerge for old concept

To: Daniel Jackson <dnj@mit.edu>
Re: Catch me if you can in real life!

initial purpose: summarize content

overloading email subject

new purposes emerge for old concept

To: Daniel Jackson <dnj@mit.edu>
Re: Catch me if you can in real life!

initial purpose: summarize content

To: csail-related@lists.csail.mit.edu
Re: [csail-related] turn off the lights?

emergent purpose: show sender

if you bcc a list, subject reveals to-address

thanks to Shriram Krishnamurthi

overloading email subject

new purposes emerge for old concept

To: Daniel Jackson <dnj@mit.edu>
Re: Catch me if you can in real life!

initial purpose: summarize content

To: csail-related@lists.csail.mit.edu
Re: [csail-related] turn off the lights?

emergent purpose: show sender
if you bcc a list, subject reveals to-address

thanks to Shriram Krishnamurthi

To: Daniel Jackson <dnj@mit.edu>
your trip reservation

emergent purpose: group by conversation
can't label reservations from Expedia by trip

thanks to Eunsuk Kang

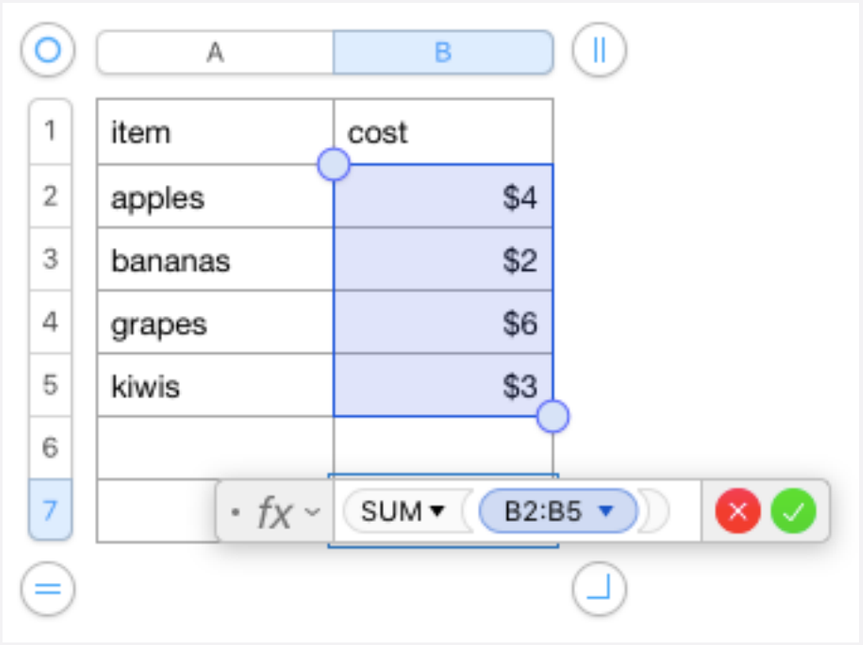
the uniformity rule

the uniformity rule

the operational principle should apply uniformly over states, types, arguments

the uniformity rule

the operational principle should apply uniformly over states, types, arguments



Numbers range: ... unless new cell is at end

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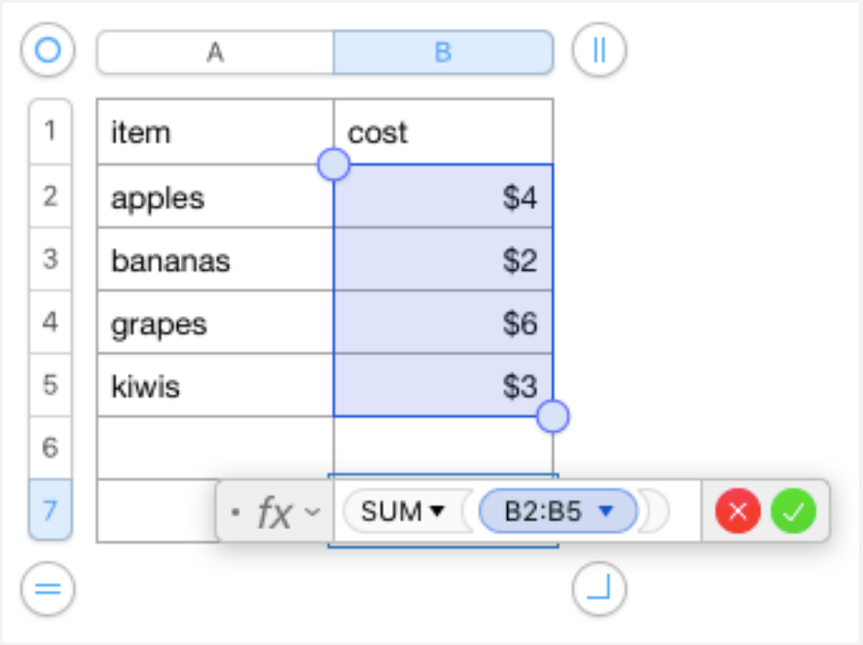

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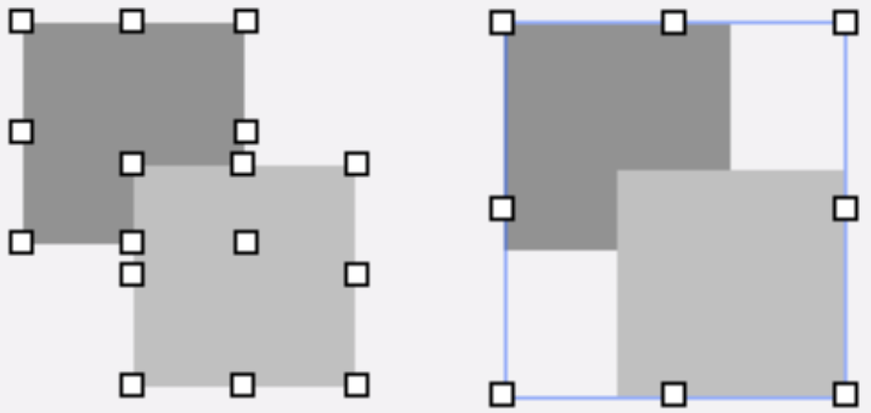

Keynote group: ... unless object is placeholder

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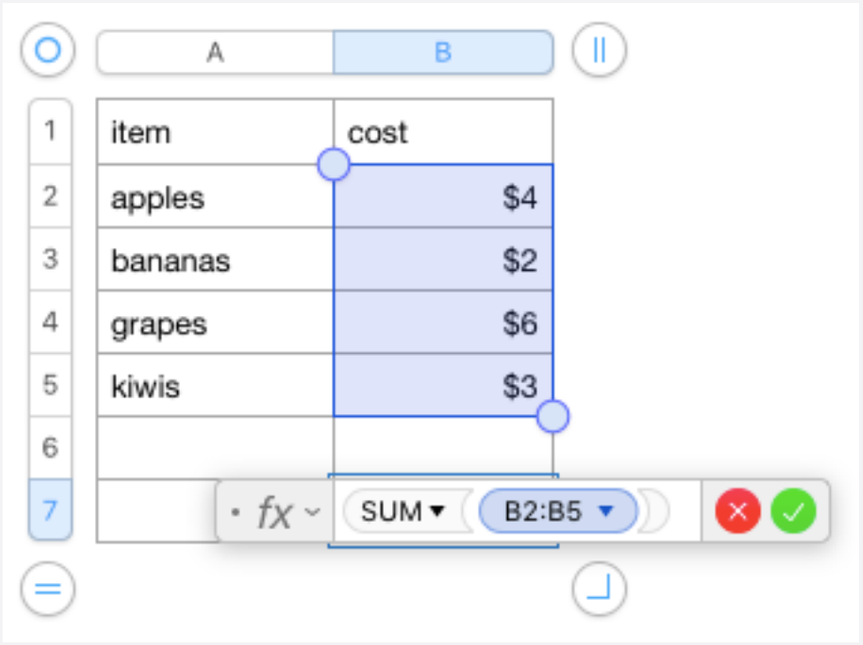

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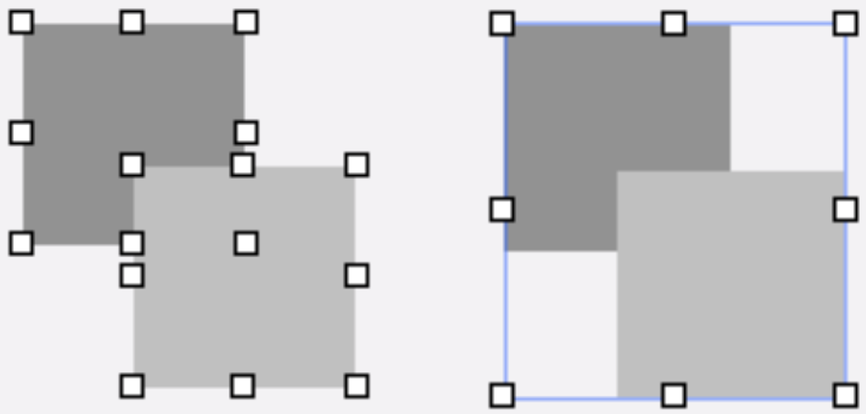

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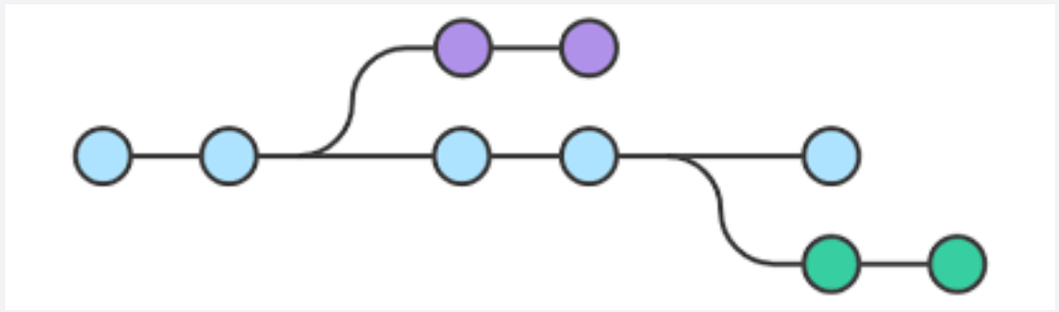

Git branch: ... unless conflicts

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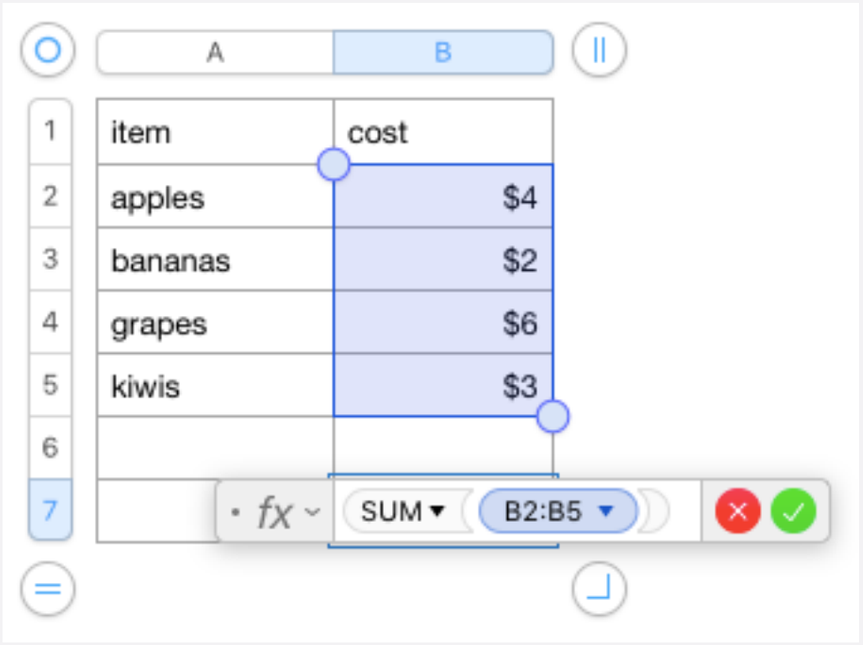

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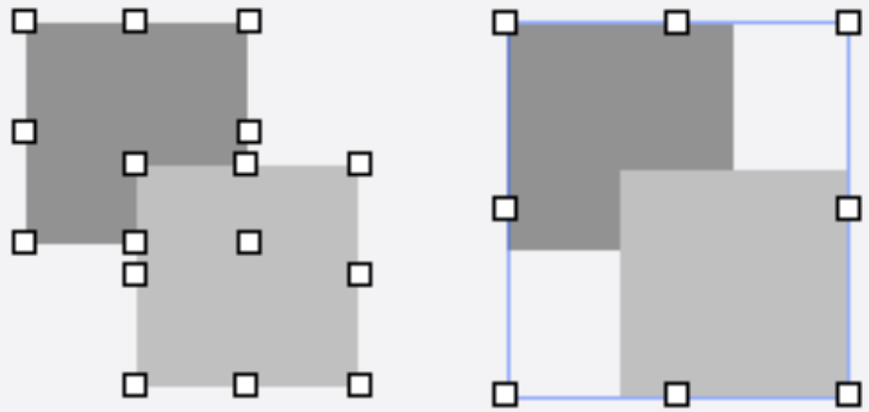

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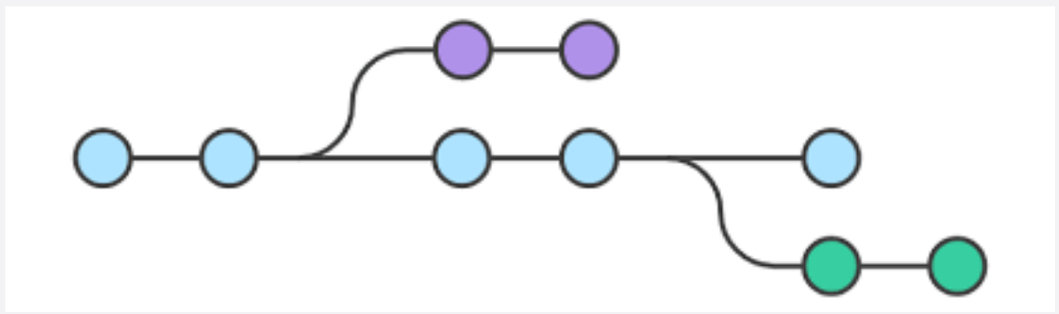

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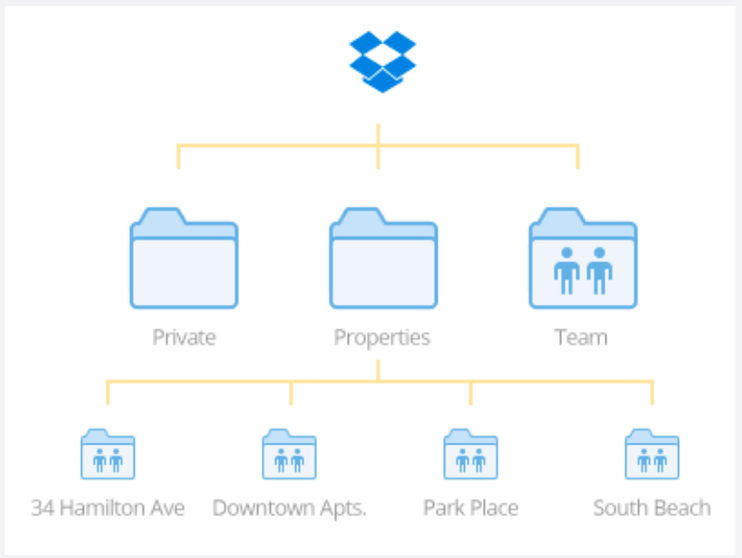

Dropbox share: ... unless ancestor

the genericity rule

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reusing a well-known generic concept is usually preferable to inventing one

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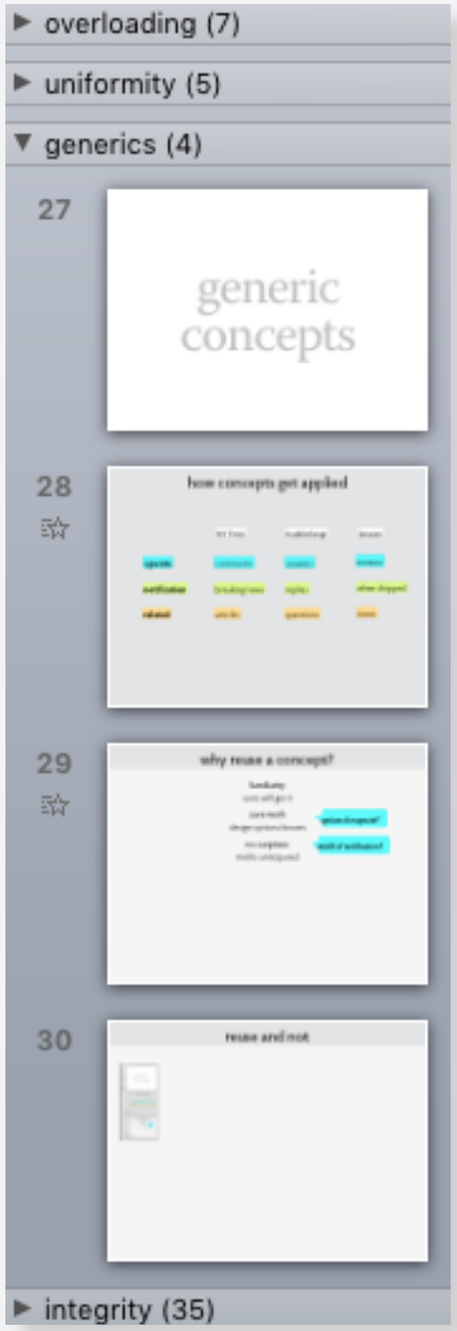
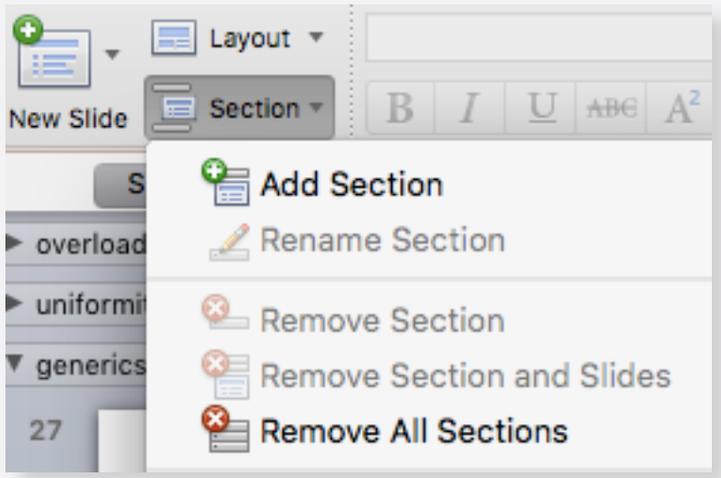
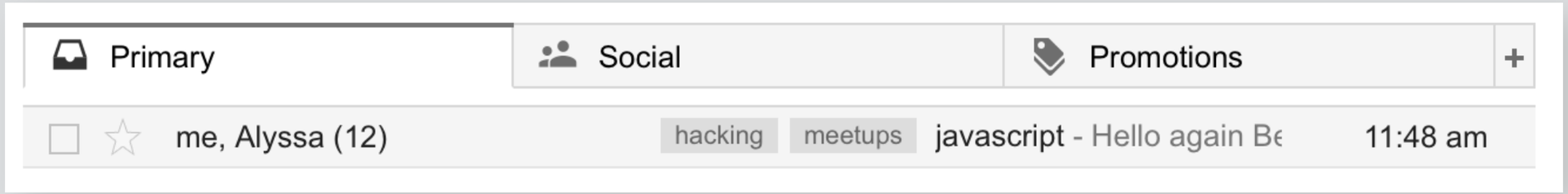


Powerpoint commands



the integrity rule

slightly surprising gmail behavior



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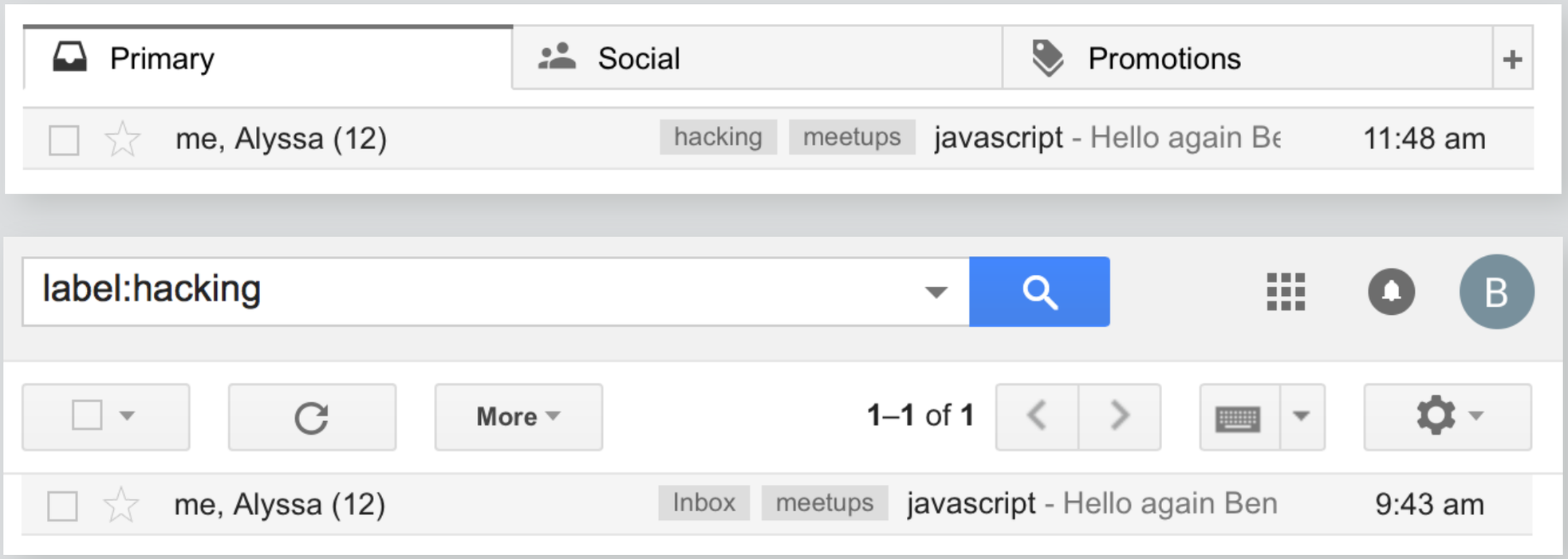

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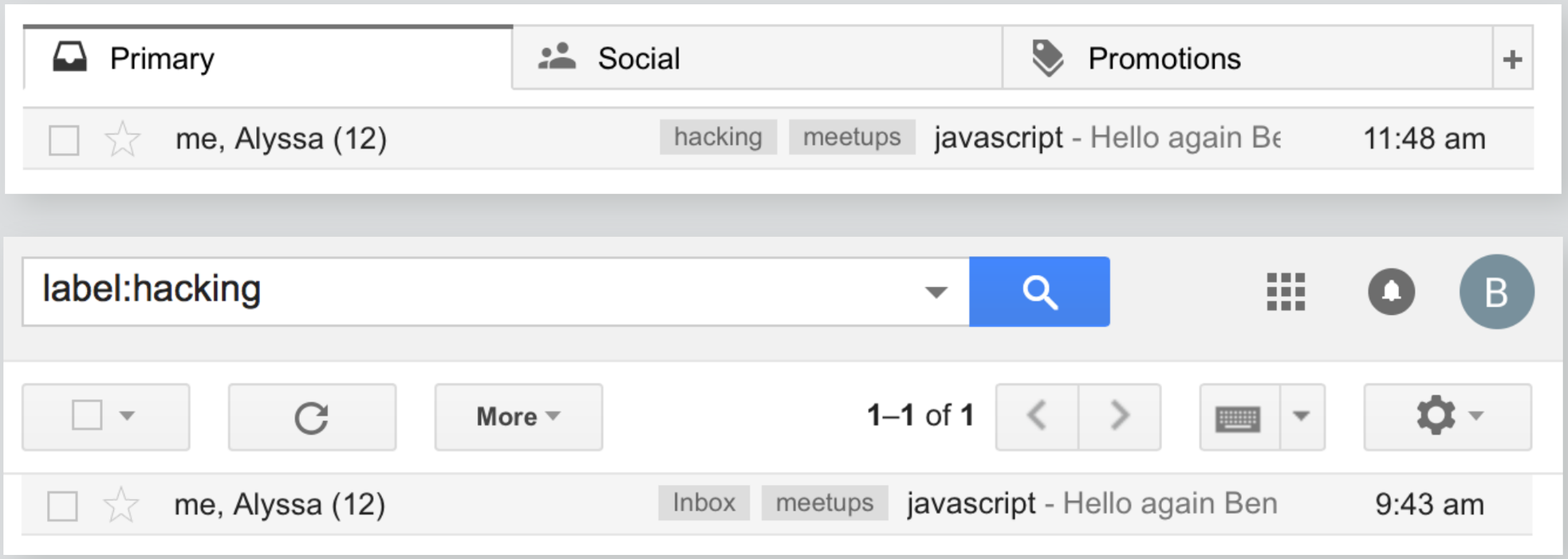

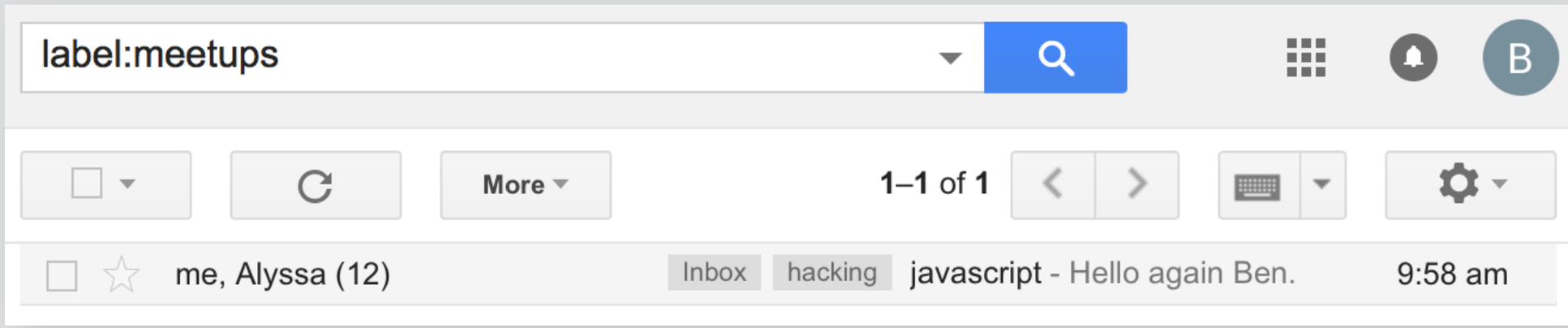

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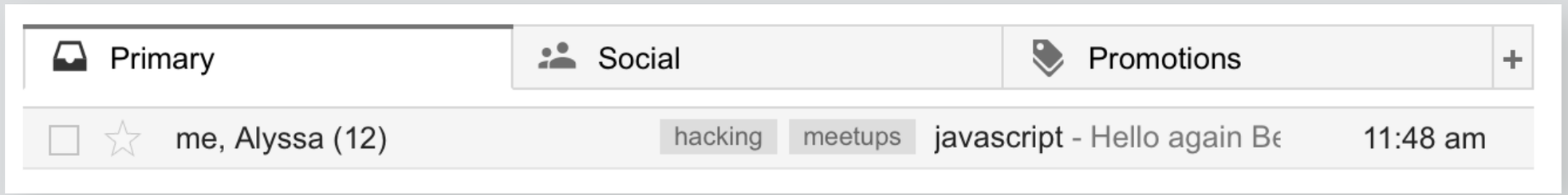
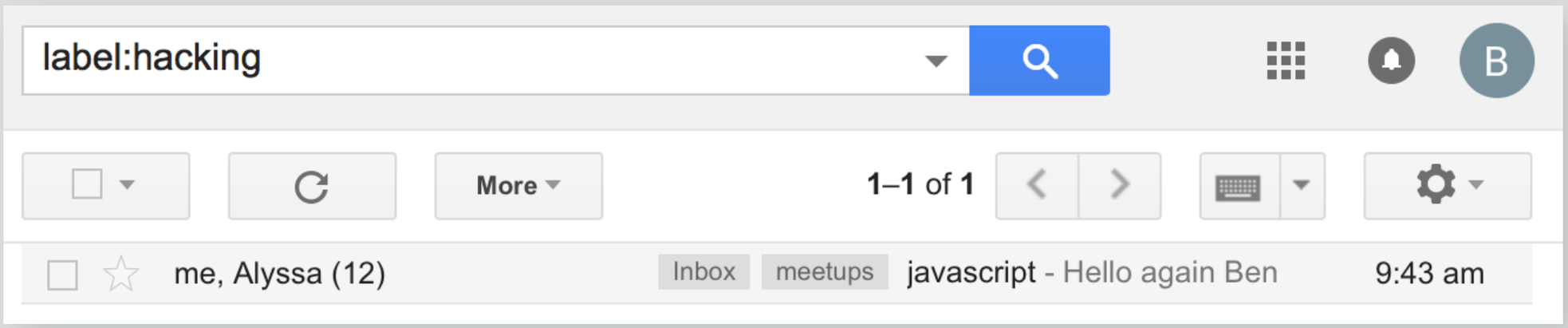
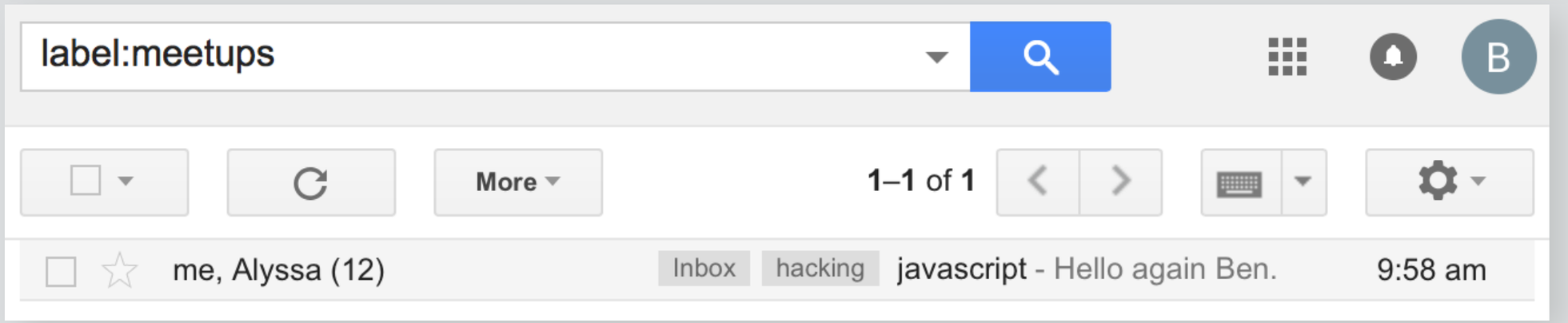
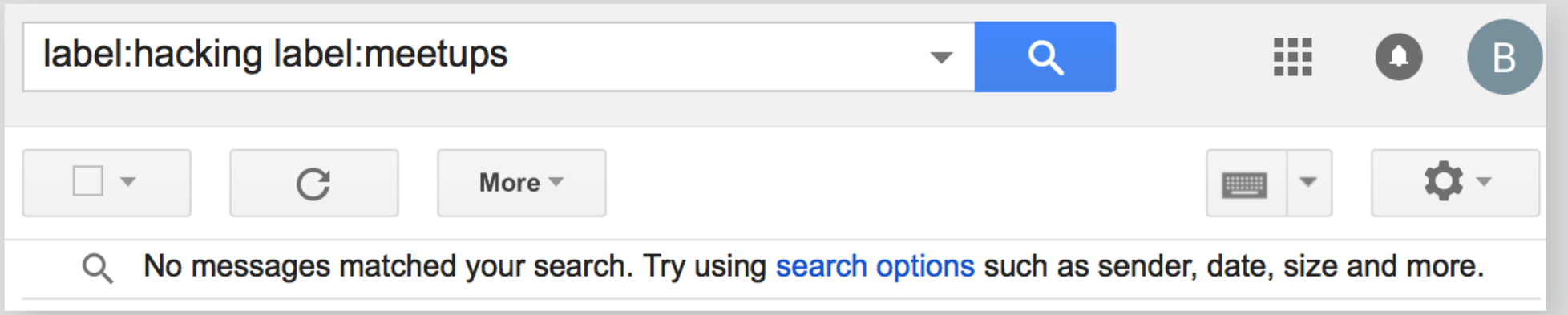
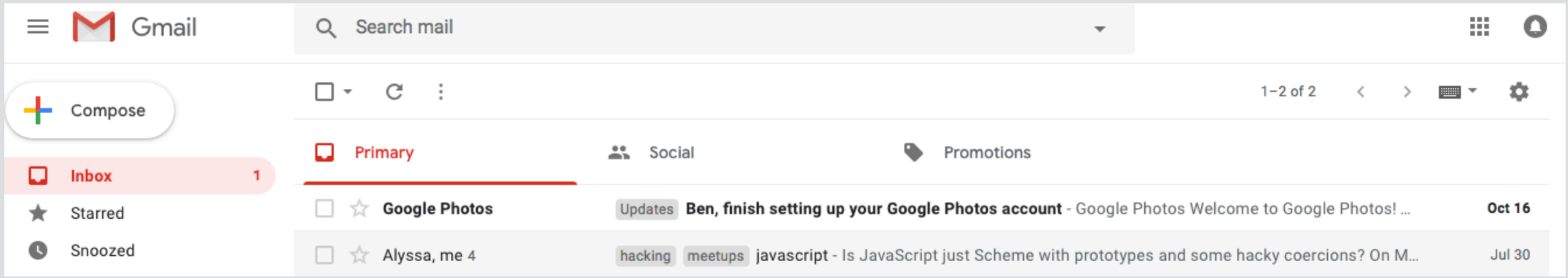








less surprising but more problematic?



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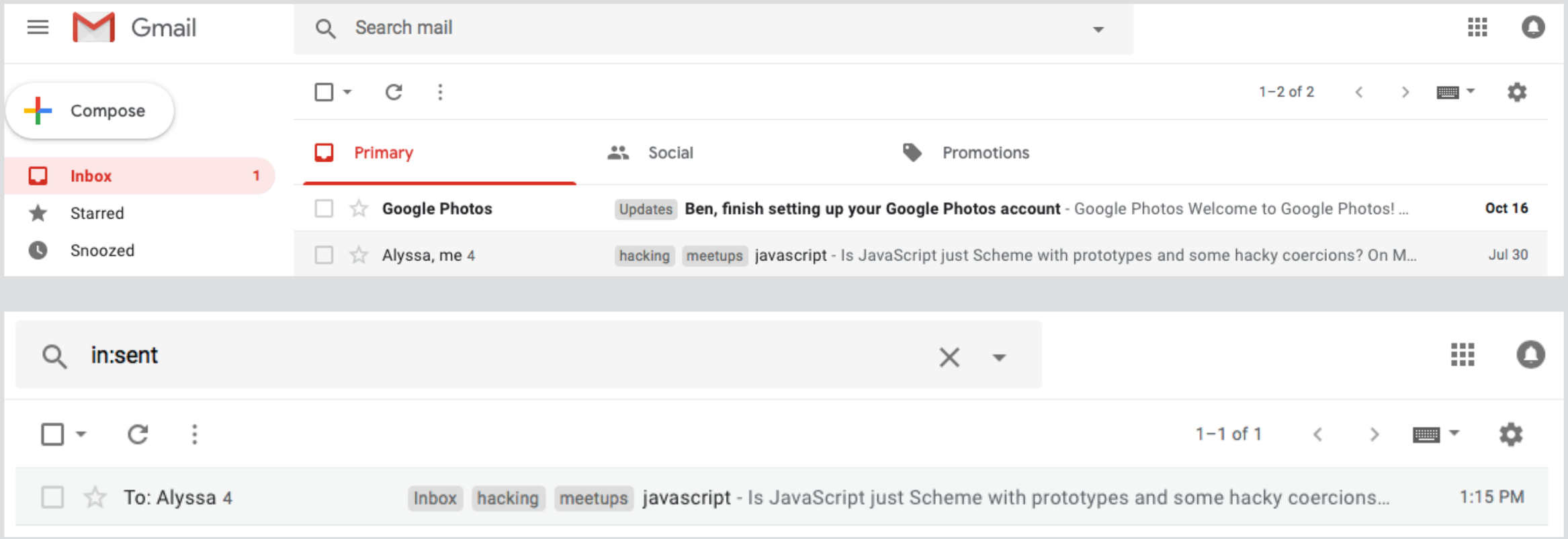

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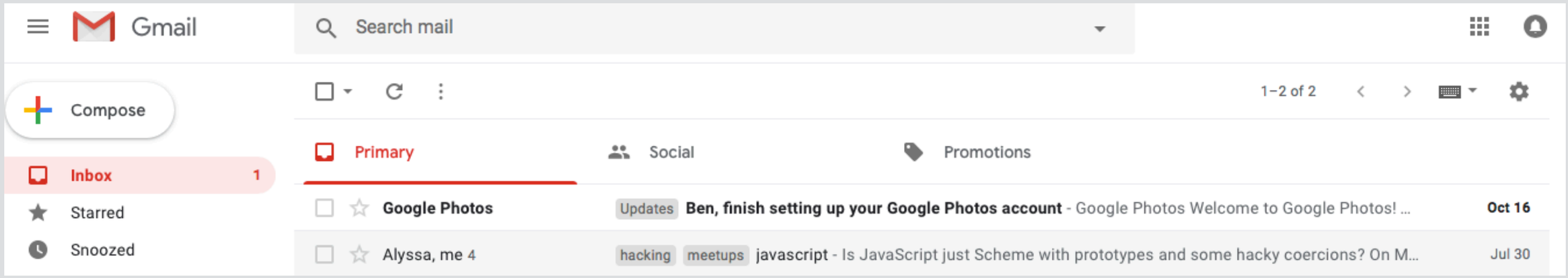

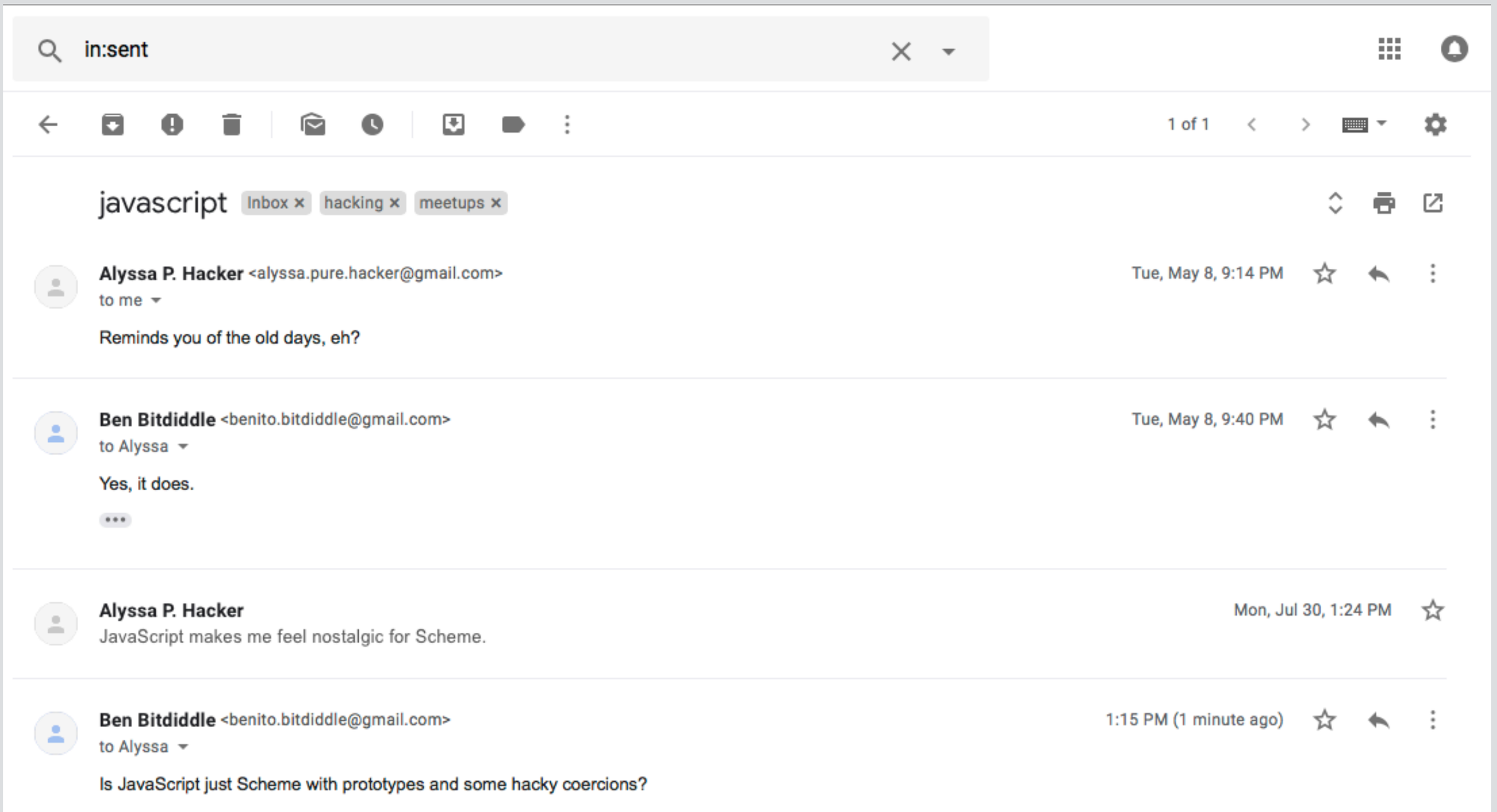

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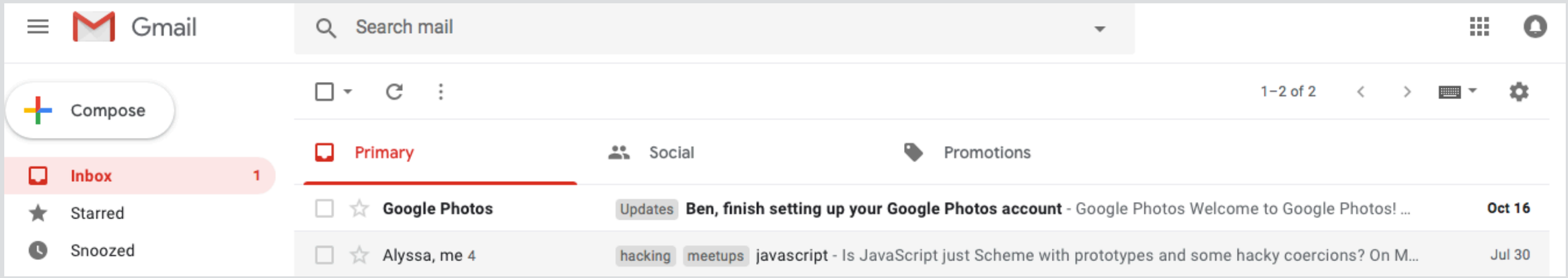
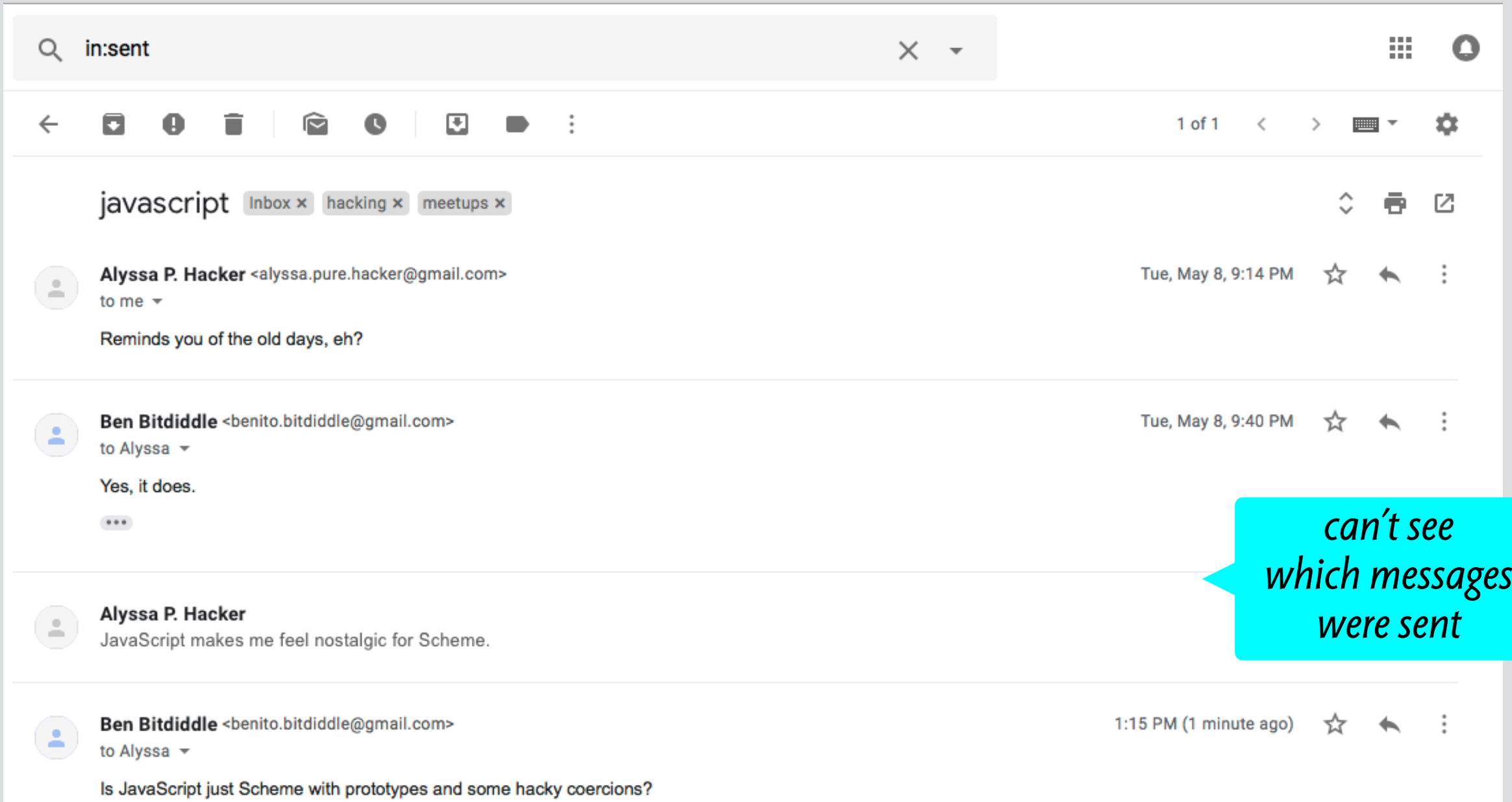
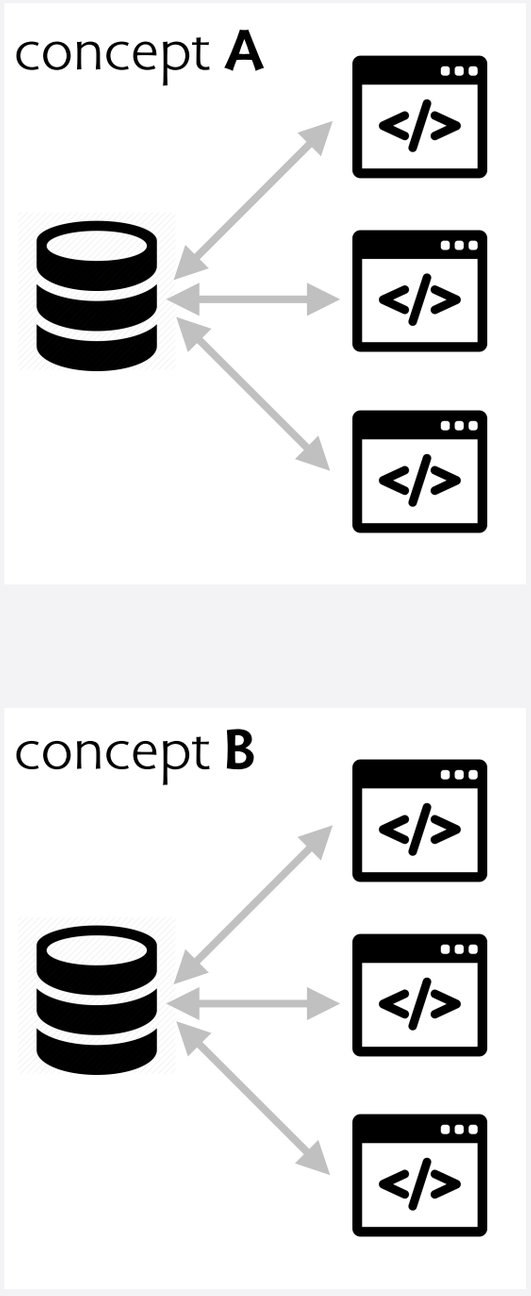




can't see which messages were sent

interpreting composite behavior

each action in composite system
interpreted as zero or more actions in each concept



code icon by Freepik from www.flaticon.com

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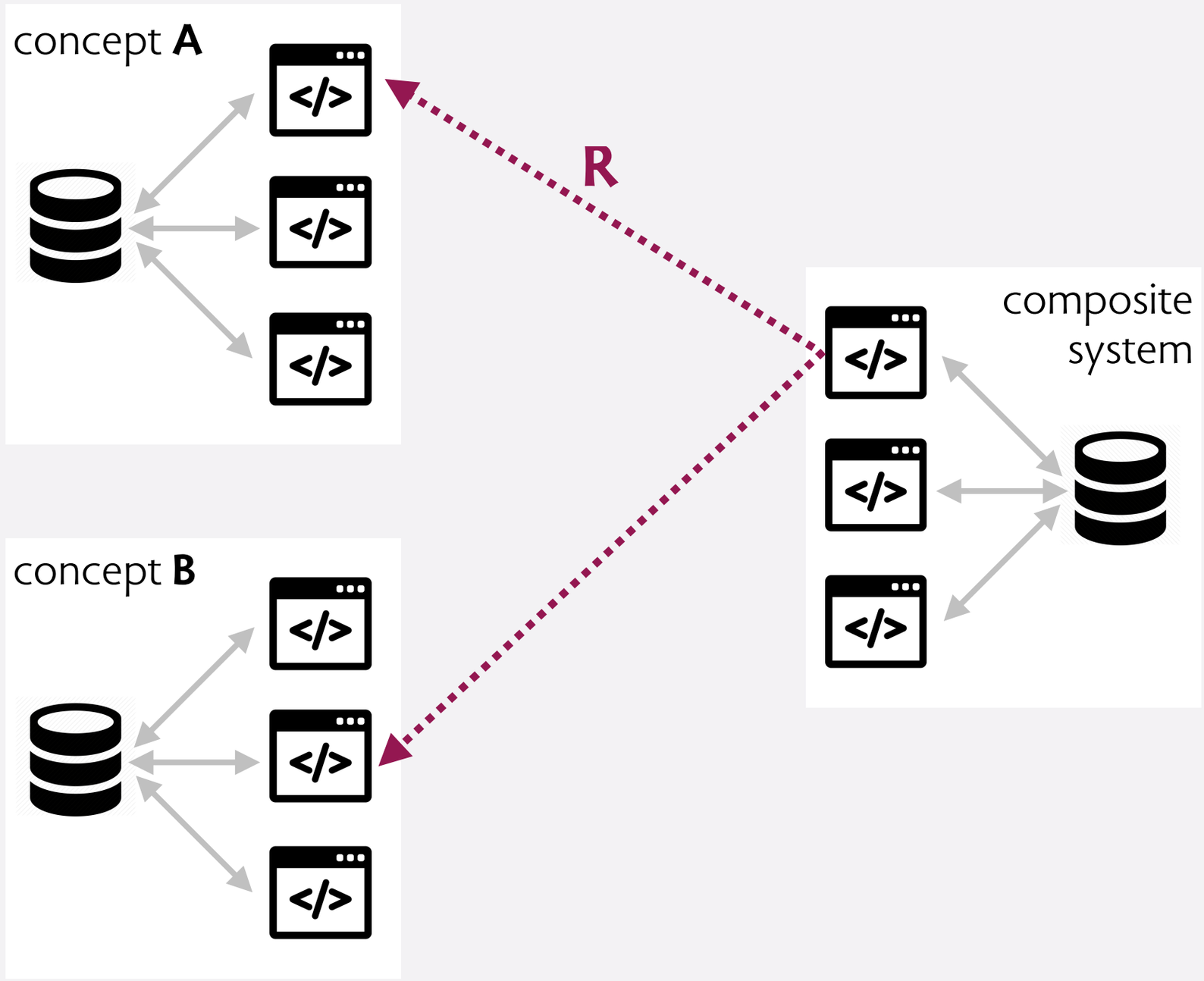

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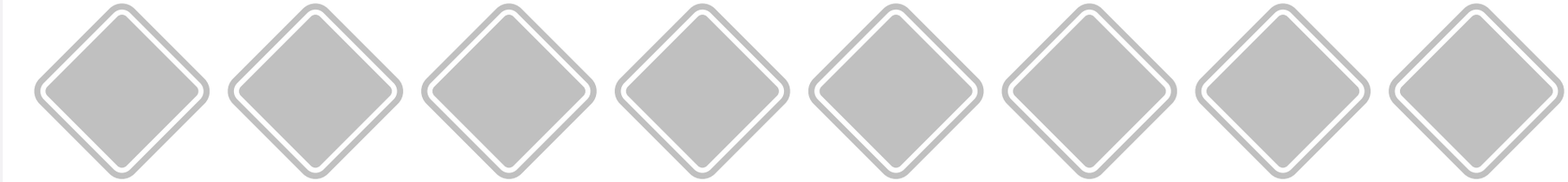
the integrity rule

when concepts are combined, each concept's behavior and OP should still apply

a simple criterion

projected behavior must satisfy concept spec:

$\forall$ c: concept | $\forall$ t: traces(sys) | $R_c(t) \in$ traces(c)



system

concept **A**

concept **B**

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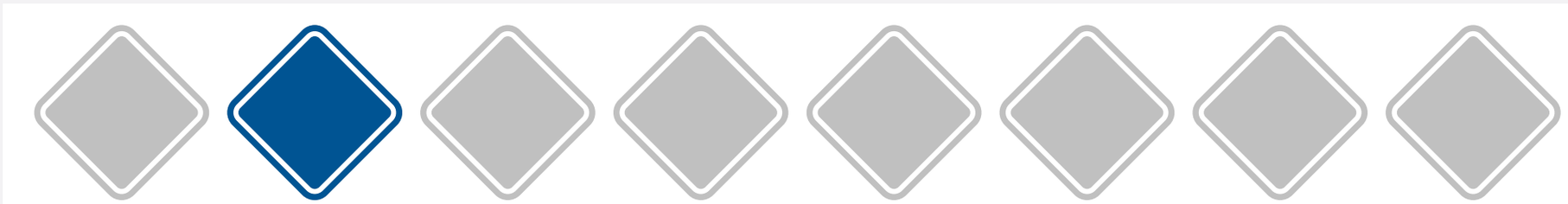

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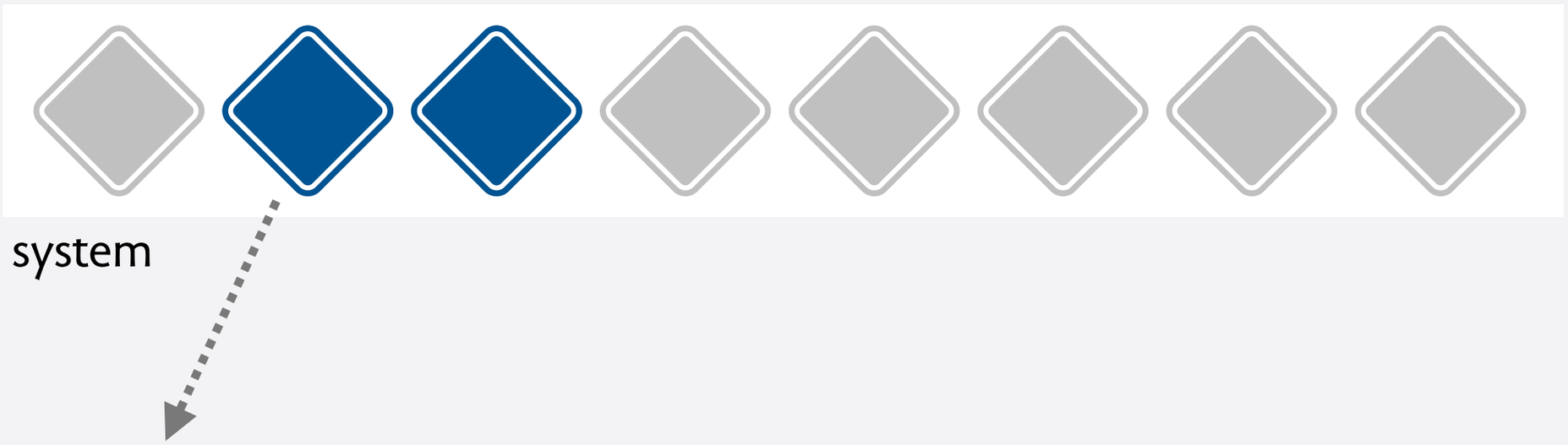

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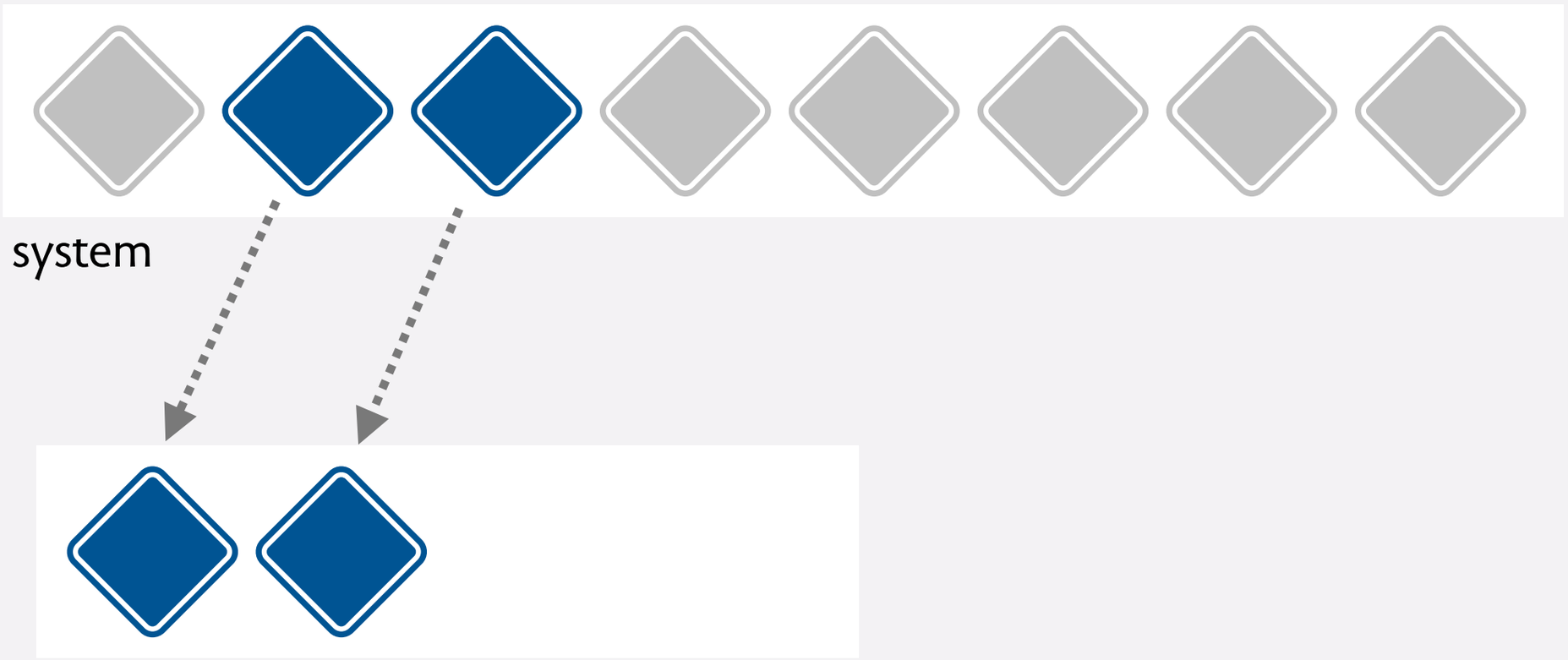

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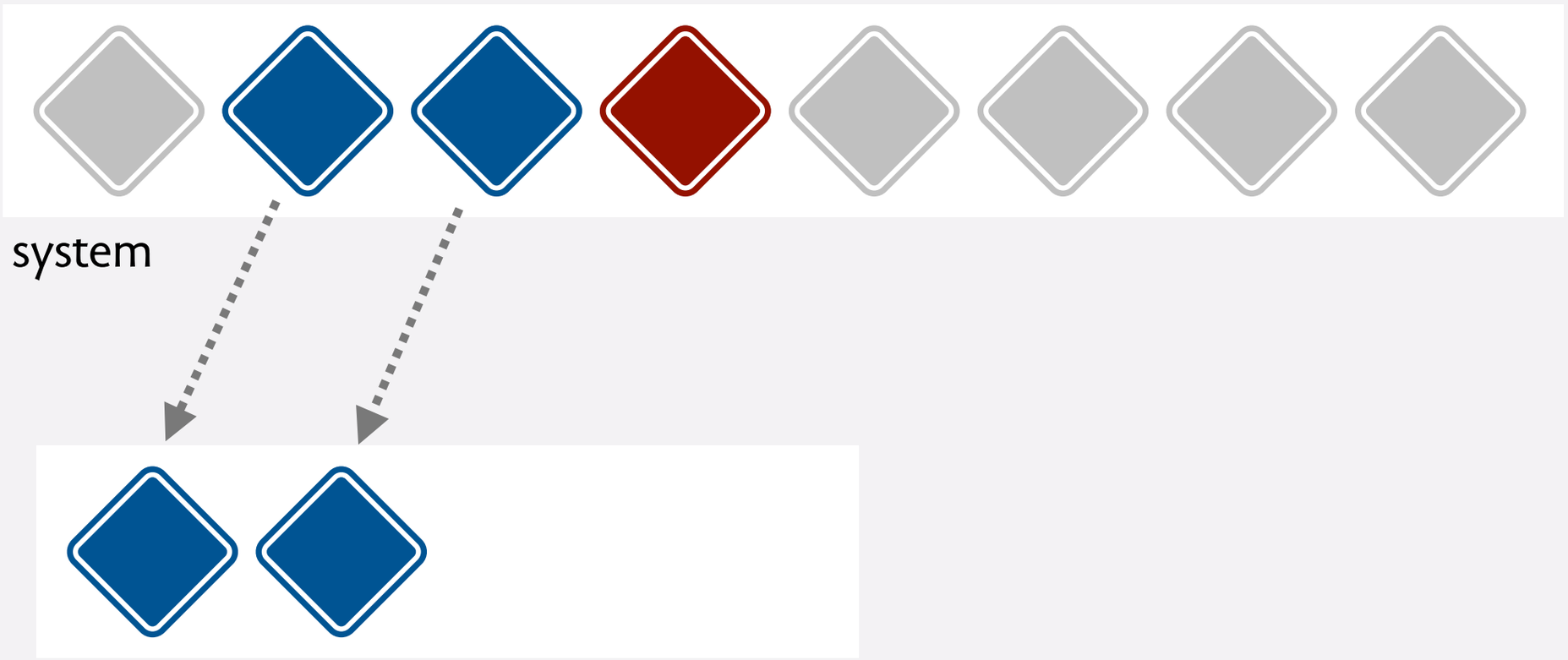

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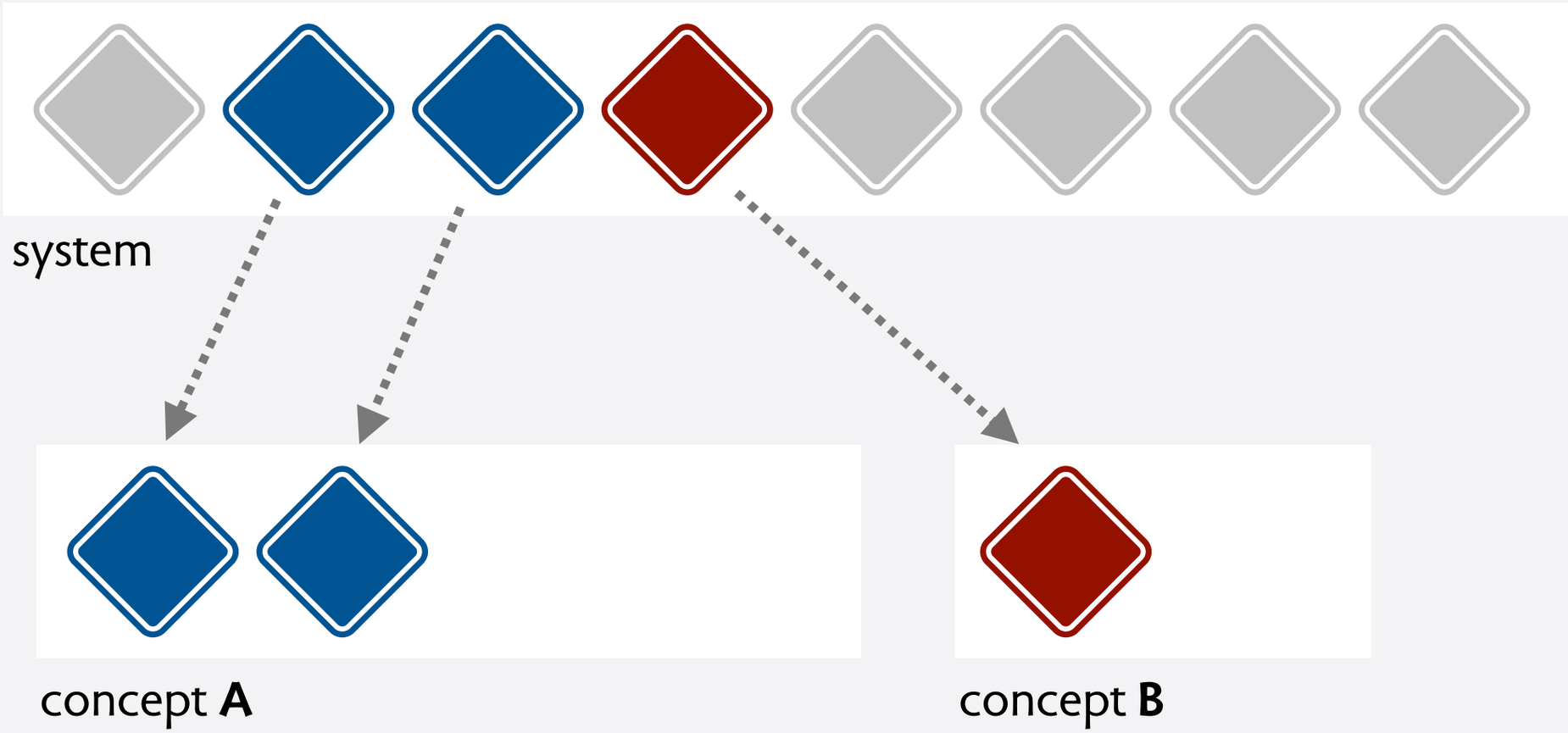

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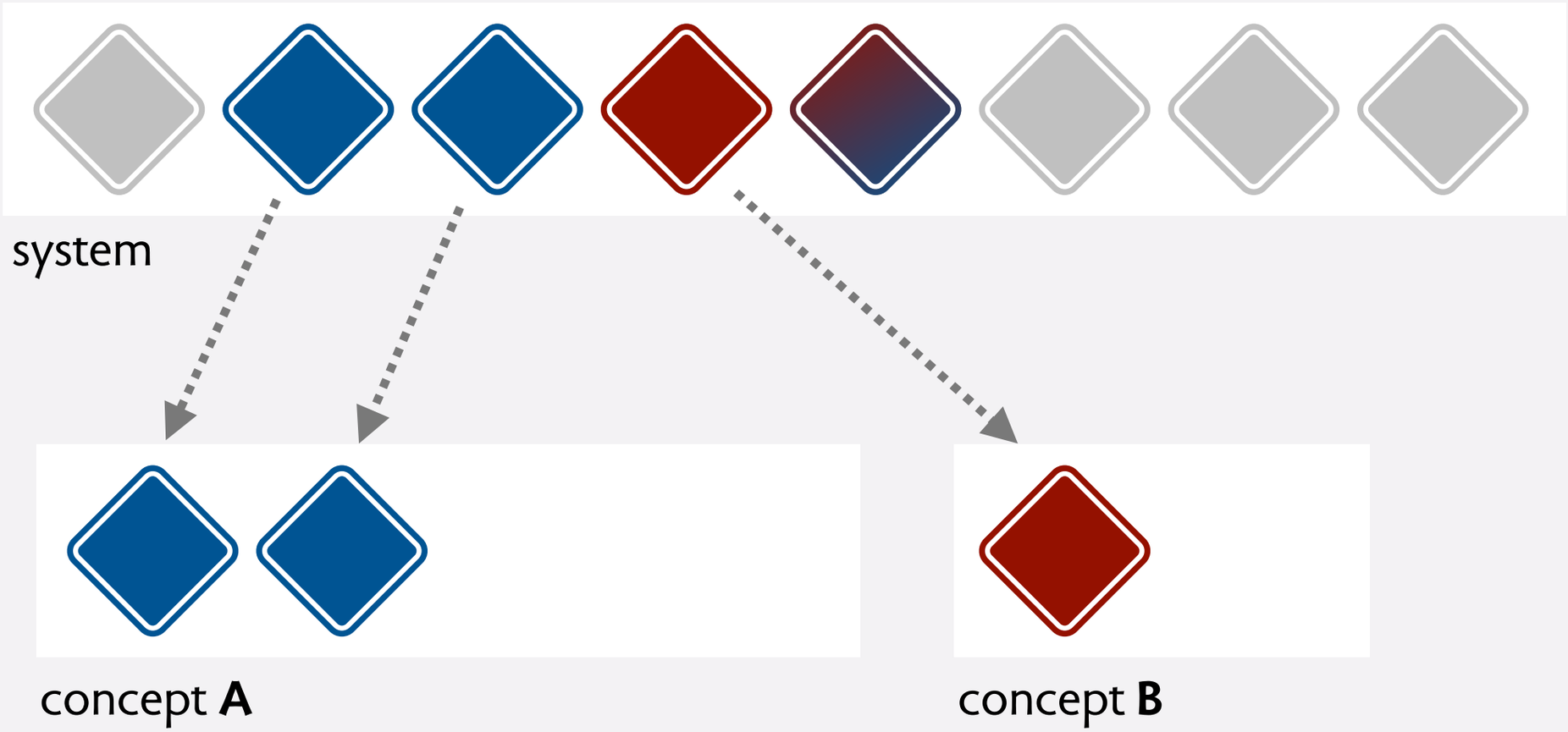

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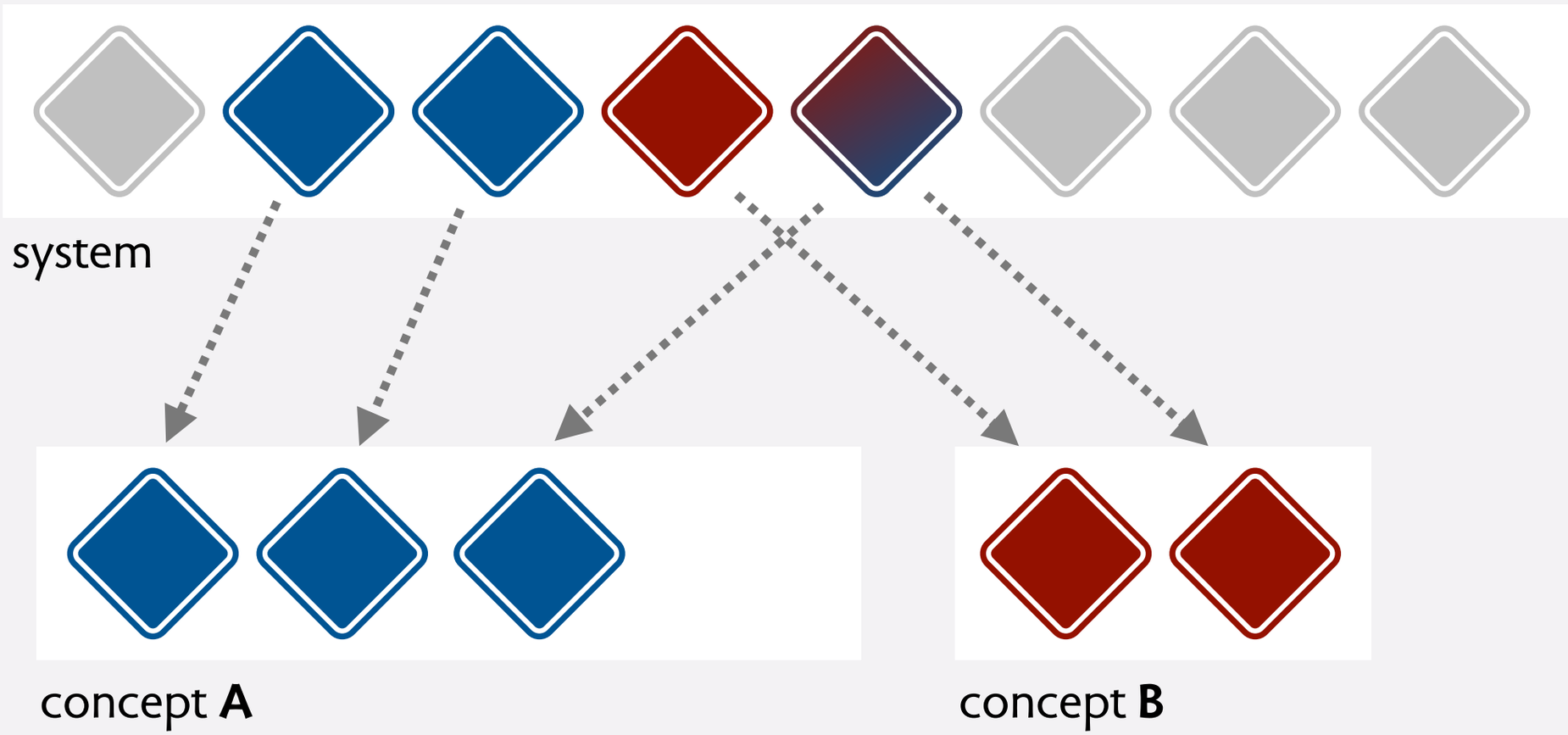
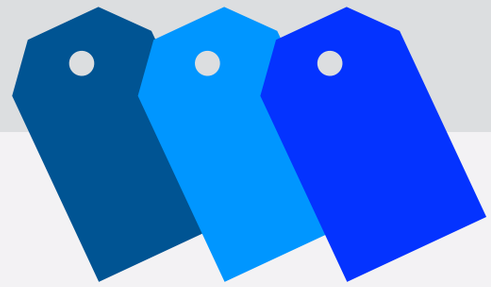


the label concept



purpose	organize items for easy retrieval

state labels: X → Label
actions
mark (x: X,p: Label) ≜ labels' = labels + x → p
unmark (x: X, p: Label) ≜ labels' = labels - x → p
find (ps: **set** Label): **set** X ≜ **result** = {x | ps **in** x.labels}

spec

operational principle	mark(x,p) then find(p):xs ⇒ x in xs if no mark(x,P) and then find(p):xs ⇒ x !in xs

conversation breaks label

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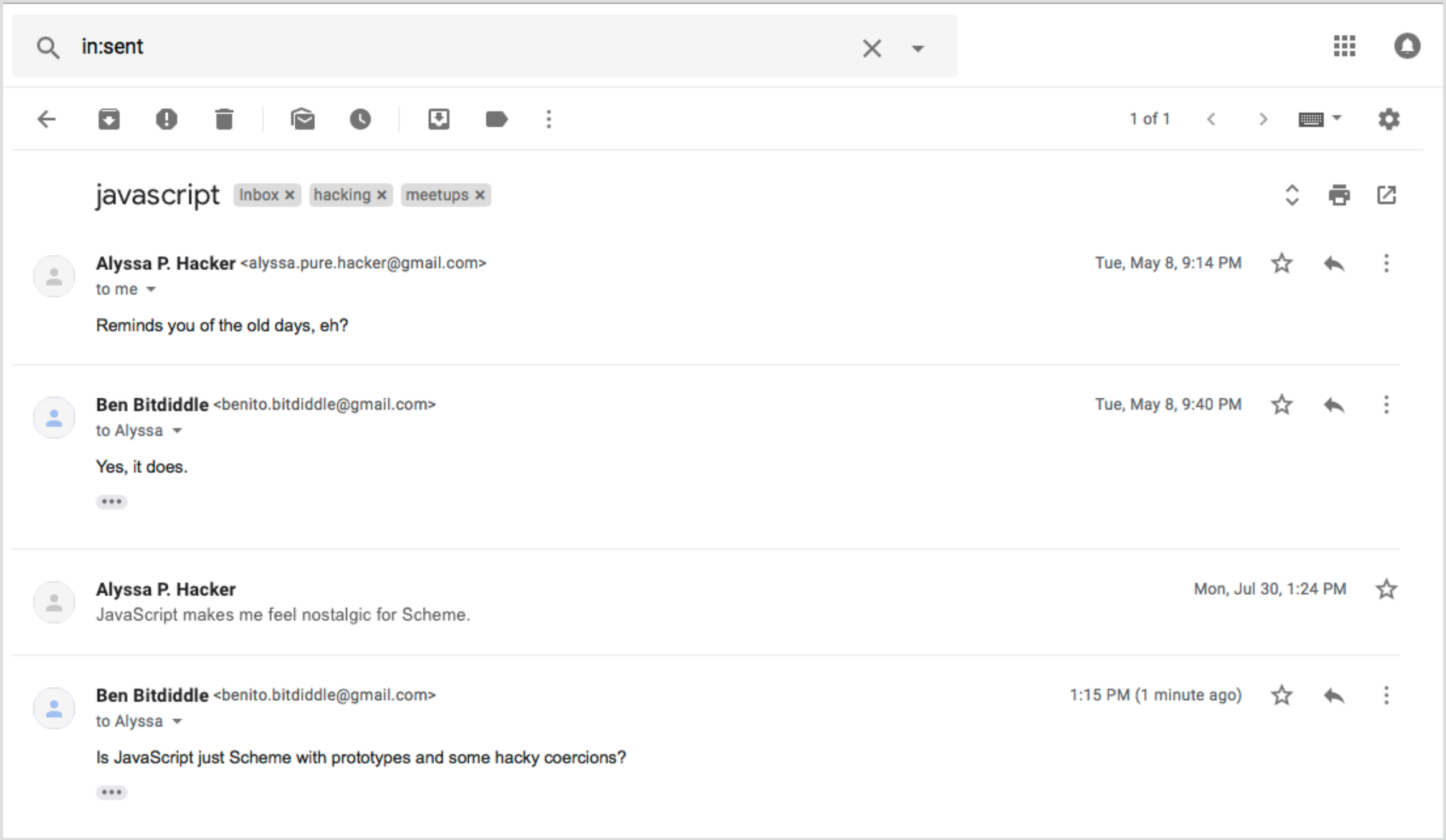

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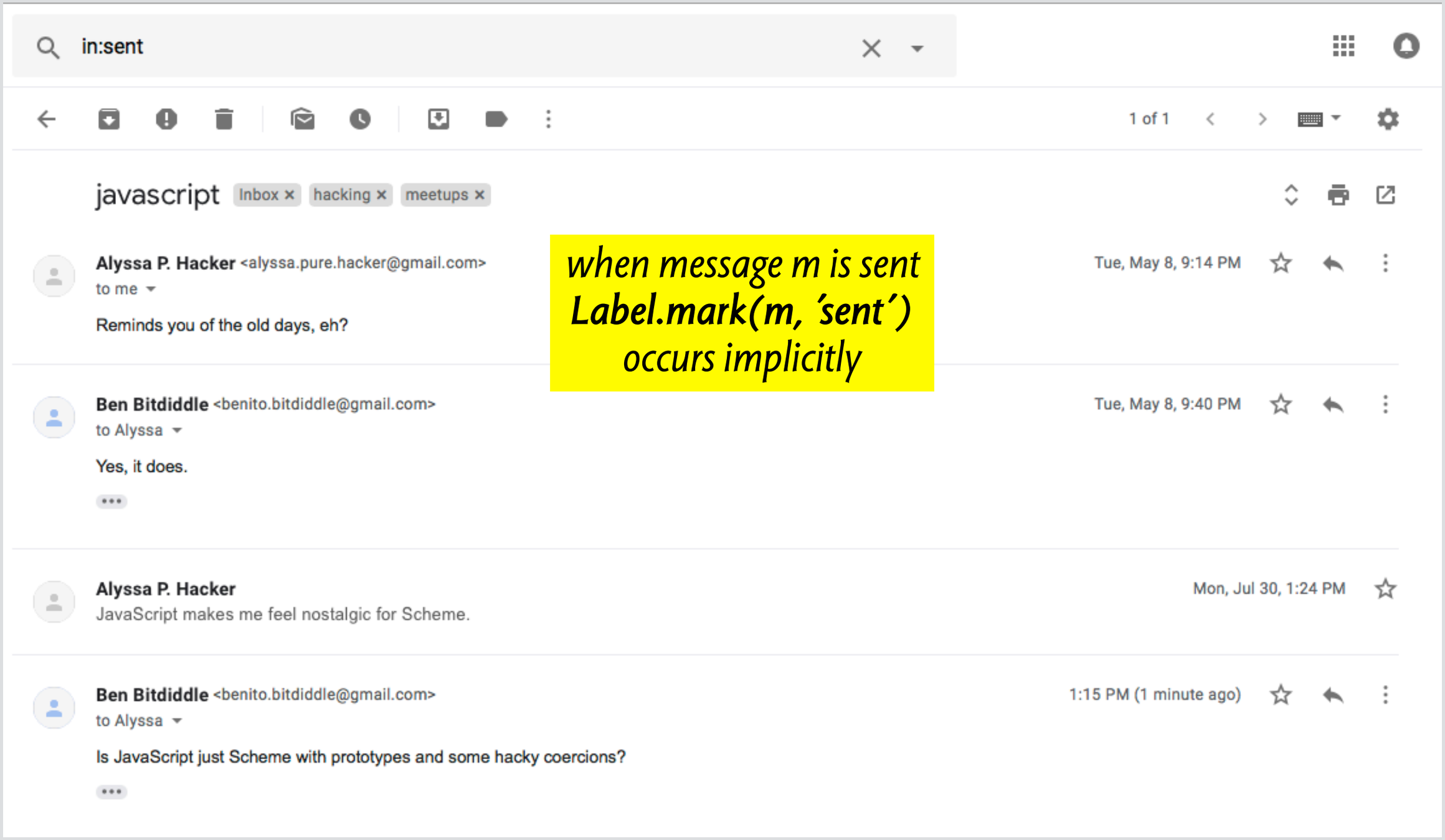

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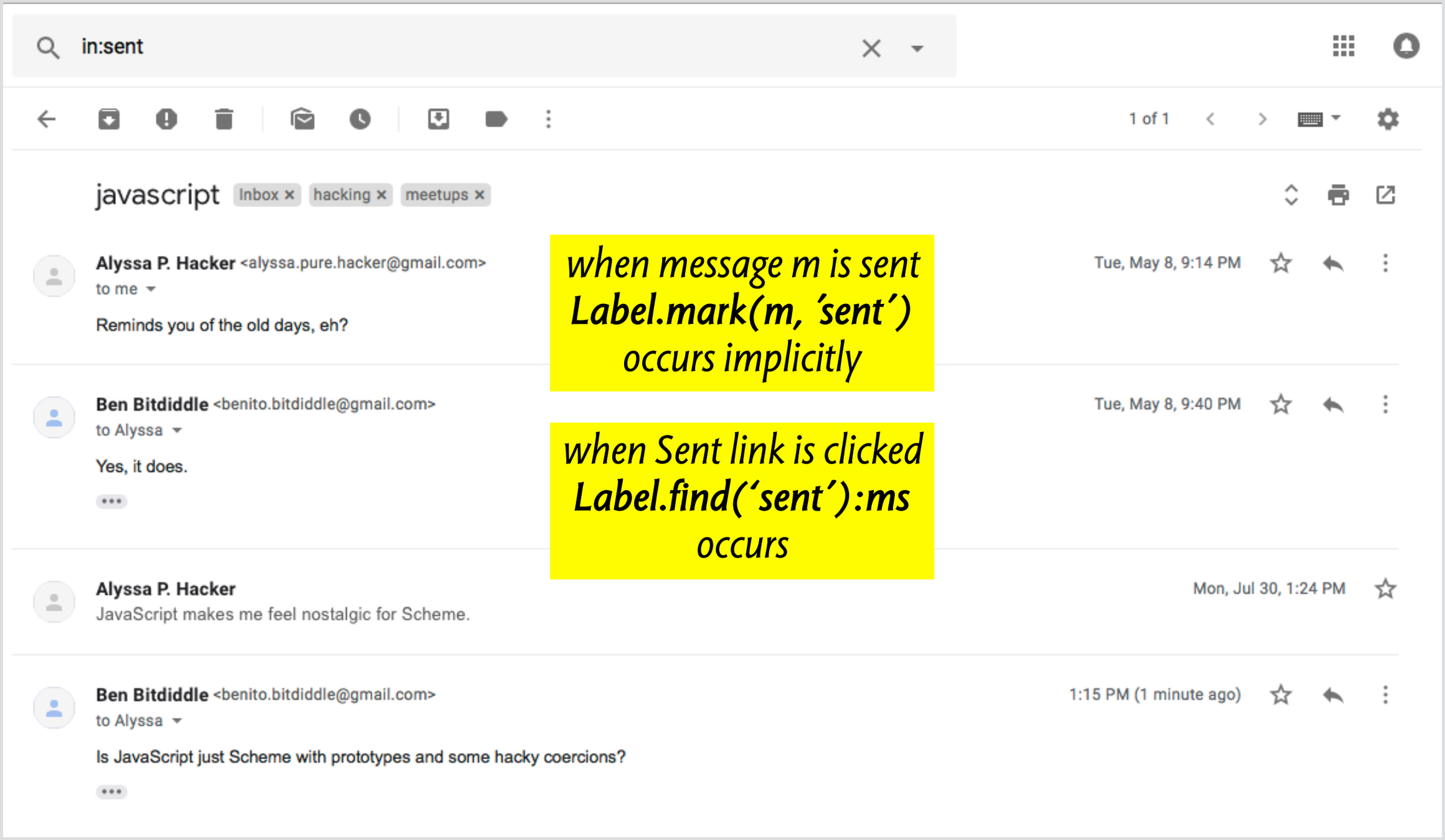

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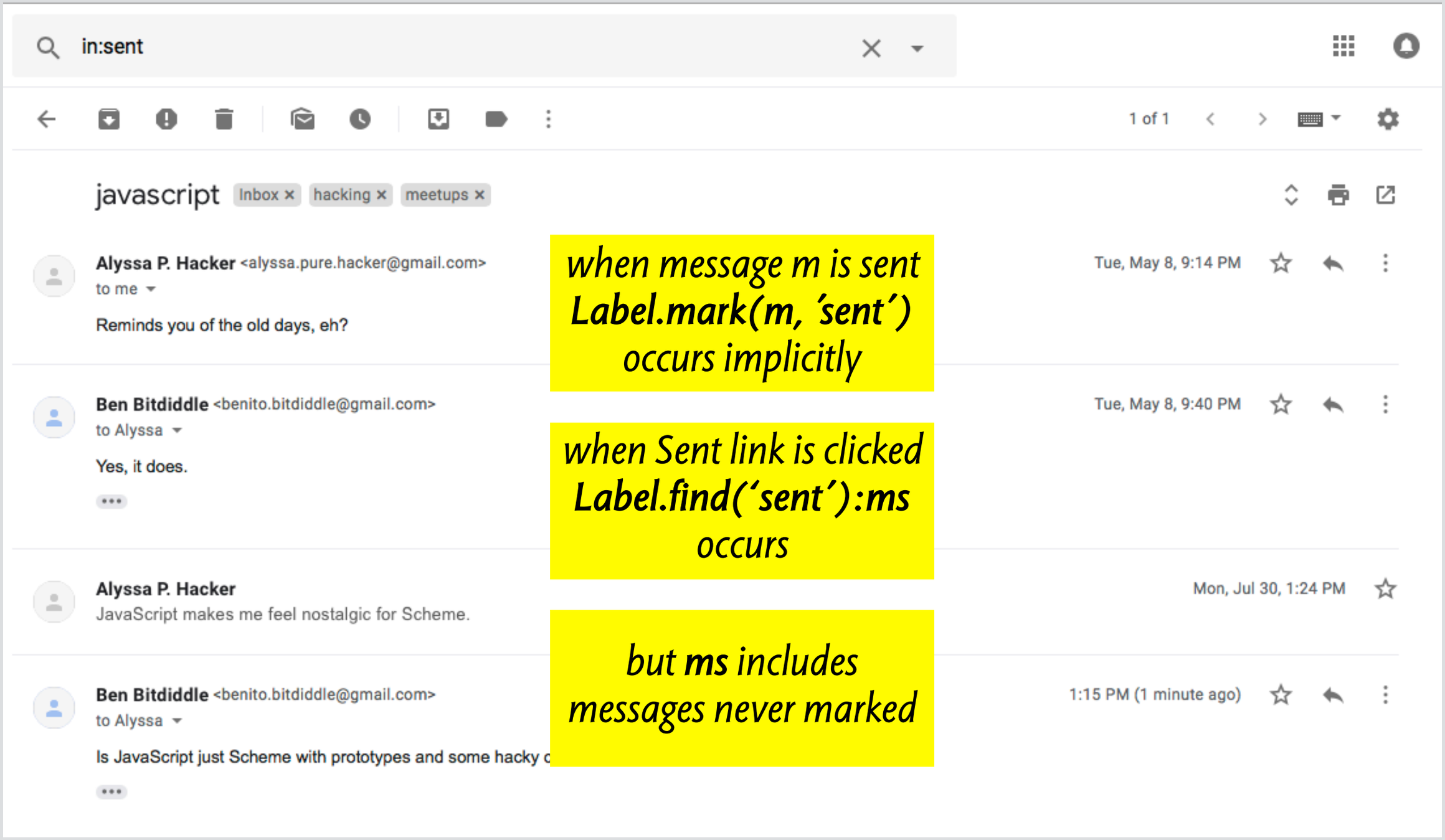


deja vu

reversing the process

reversing the process

the same concepts, again & again

post, comment, upvote, notification, ...

hard work to build

libraries often just client- or server-side

easy in a CMS, but structure hard-wired

reversing the process

the same concepts, again & again
post, comment, upvote, notification, ...

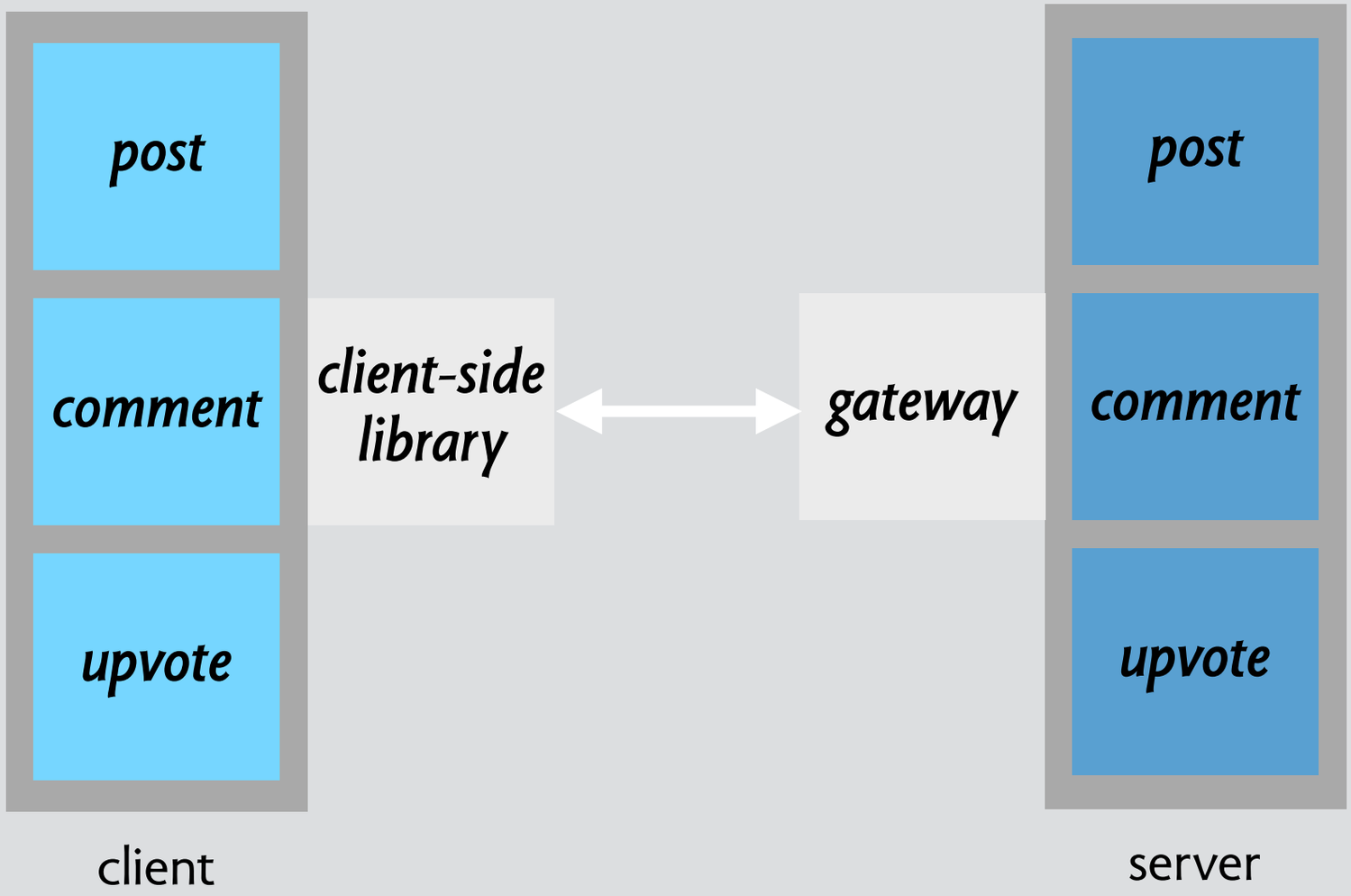
hard work to build
libraries often just client- or server-side
easy in a CMS, but structure hard-wired

idea: concept cliches
full stack implementation

app-specific assembly
in HTML, no JS or backend code

action synchronization
build app action by joining cliche actions

architecture of deja vu



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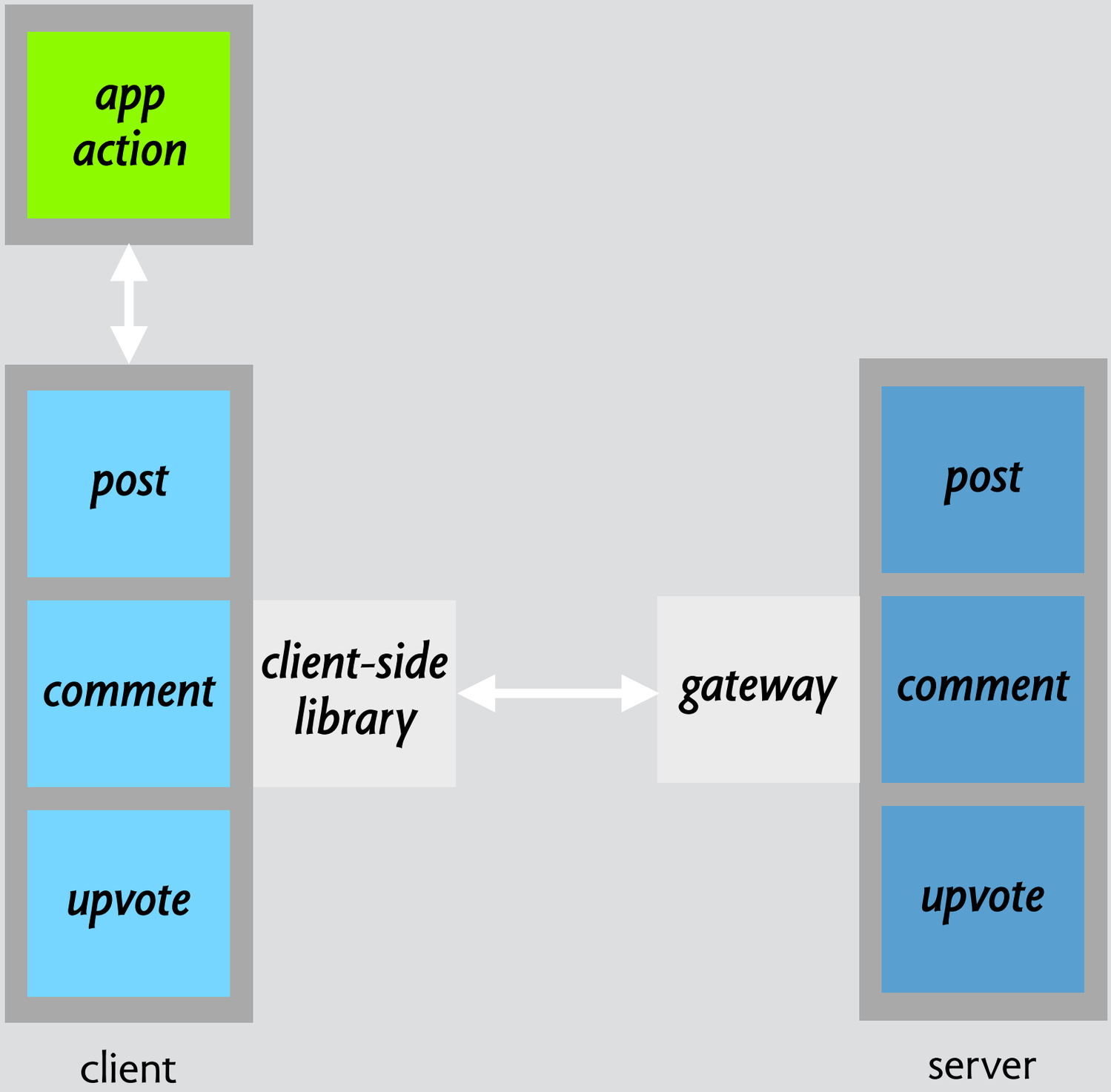
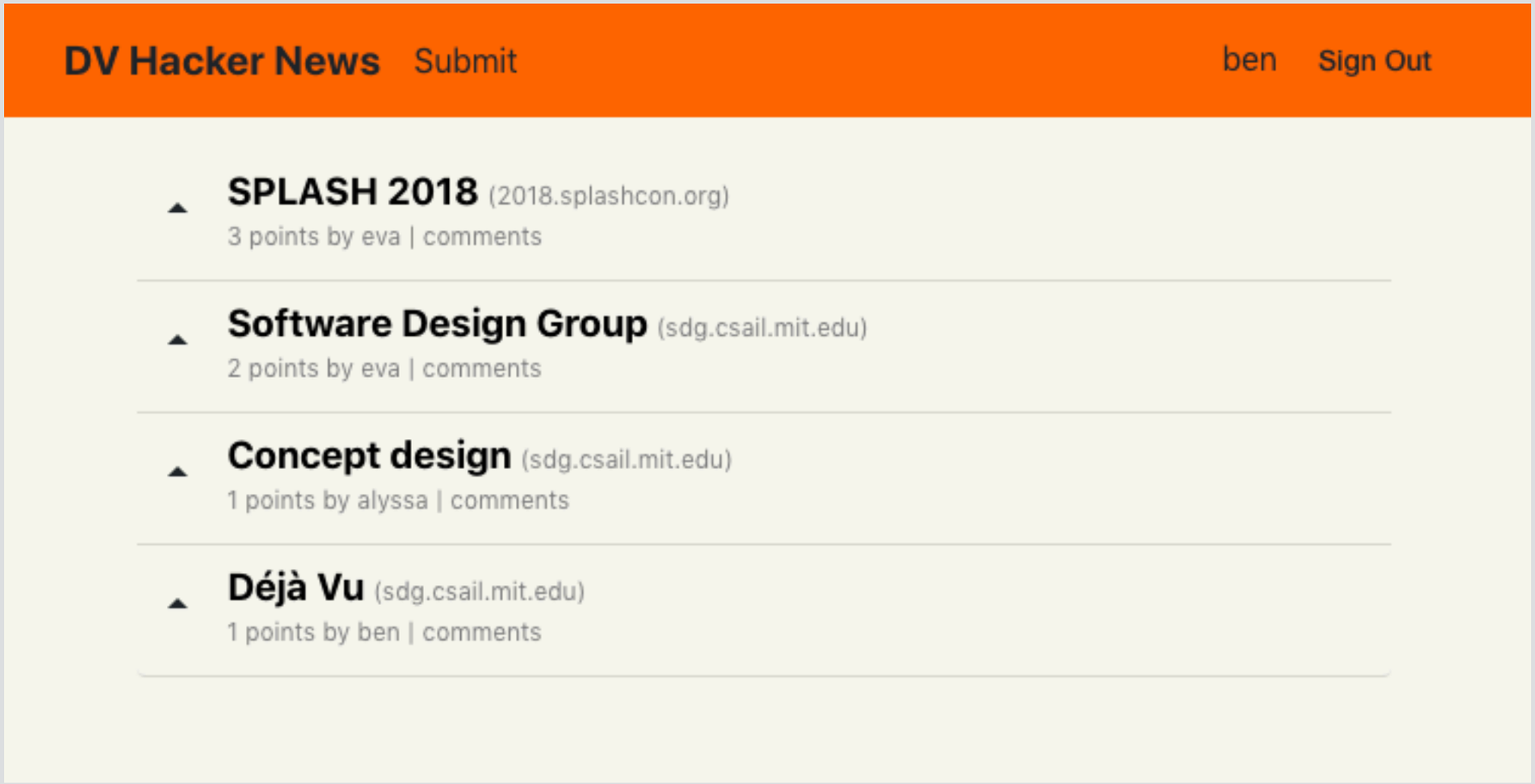


a sample app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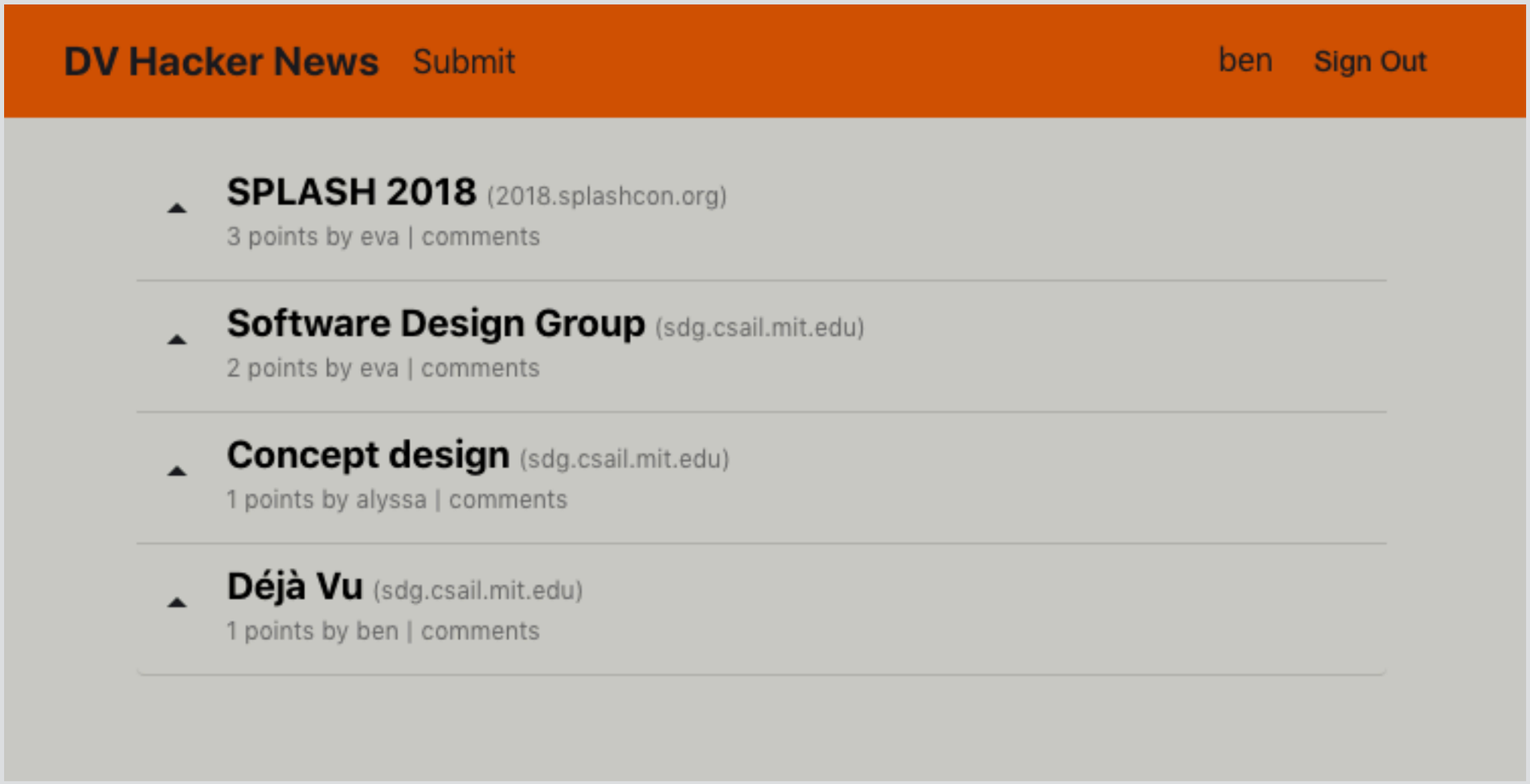
1 points by alyssa | comments
Déjà Vu (sdg.csail.mit.edu)
1 points by ben | comments

a sample app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1 points by alyssa | comments
Déjà Vu (sdg.csail.mit.edu)
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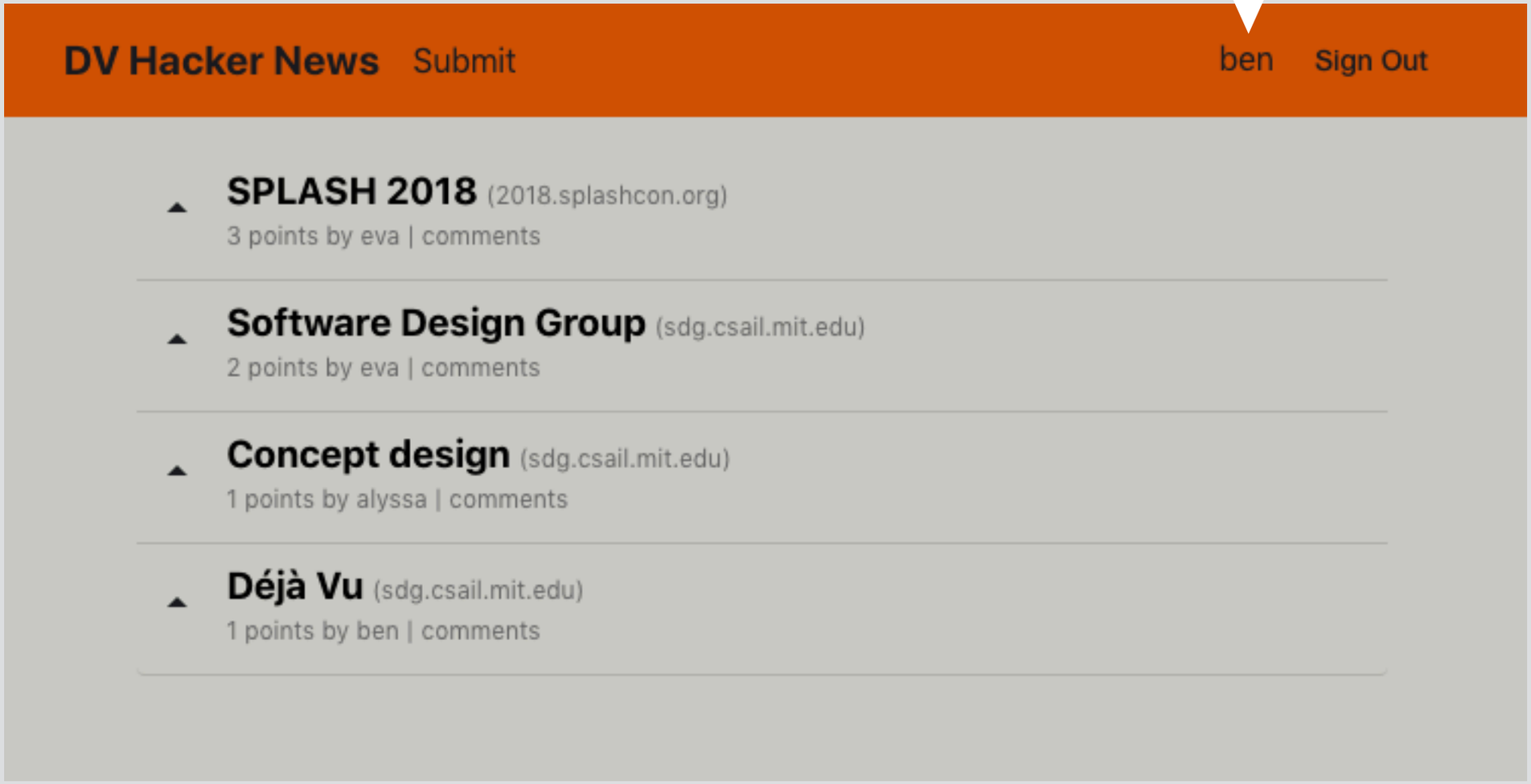
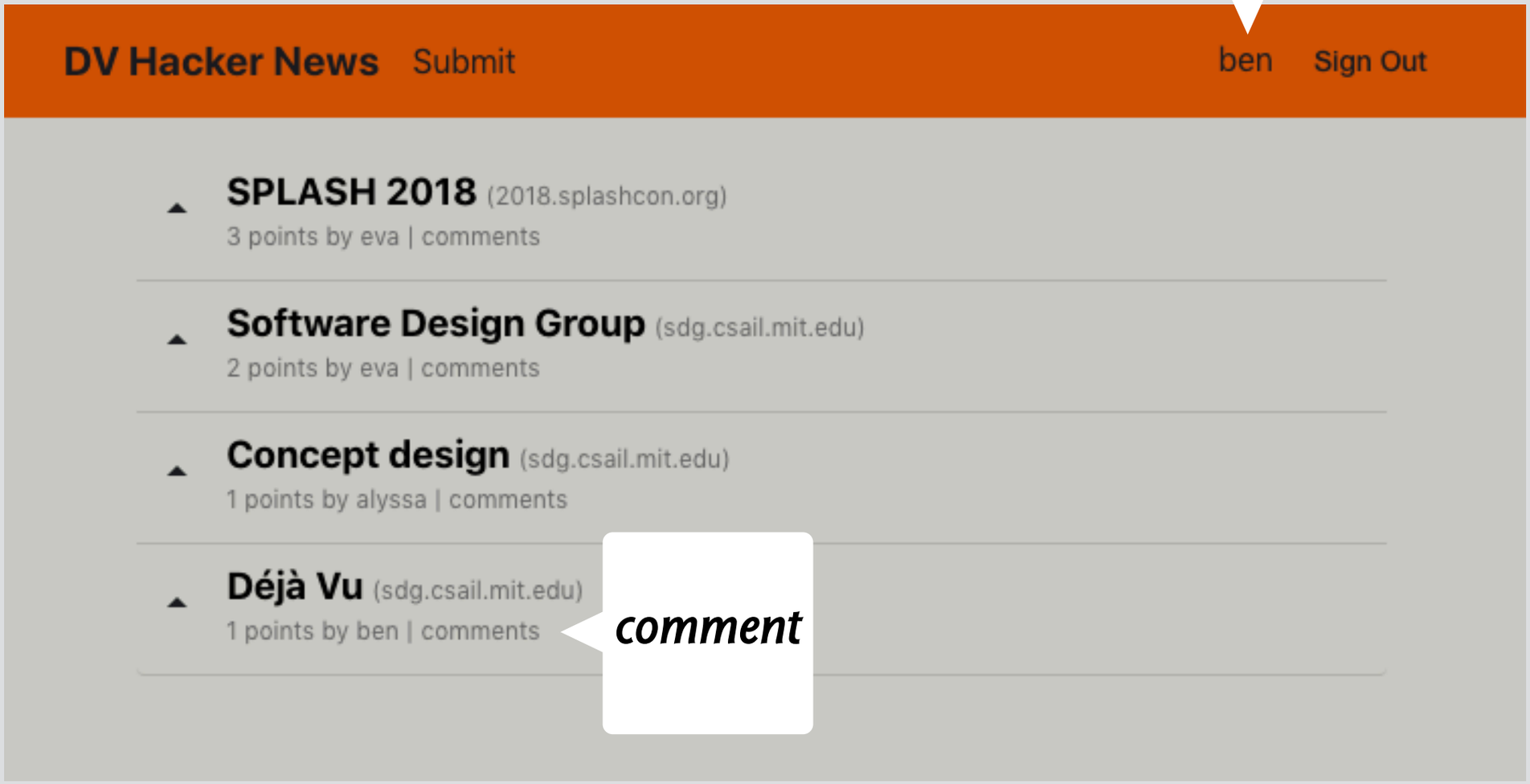
a sample app

auth



a sample app


auth
DV Hacker News
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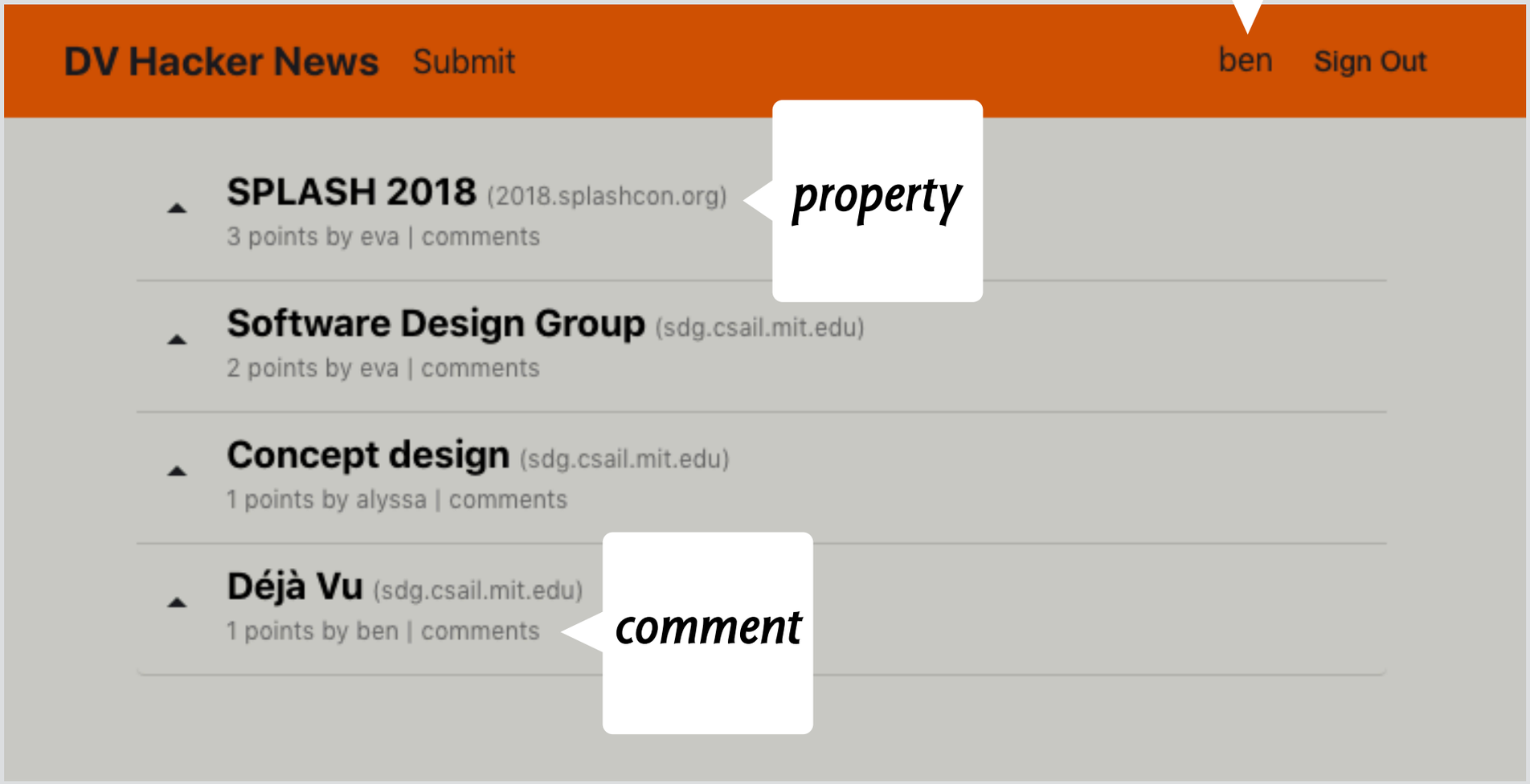
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property
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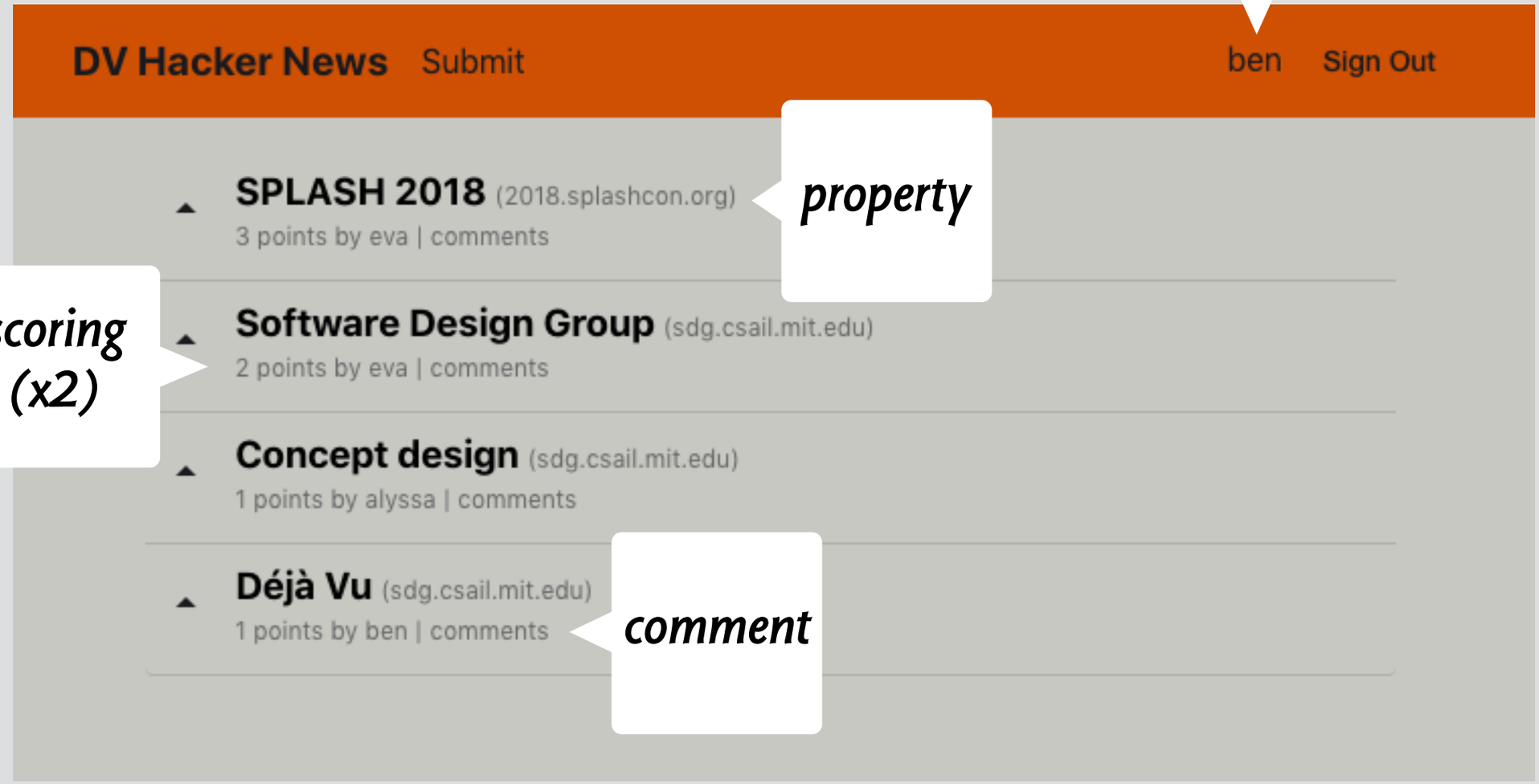
a sample app


auth
DV Hacker News
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Sign Out
property
SPLASH 2018 (2018.splashcon.org)
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scoring (x2)
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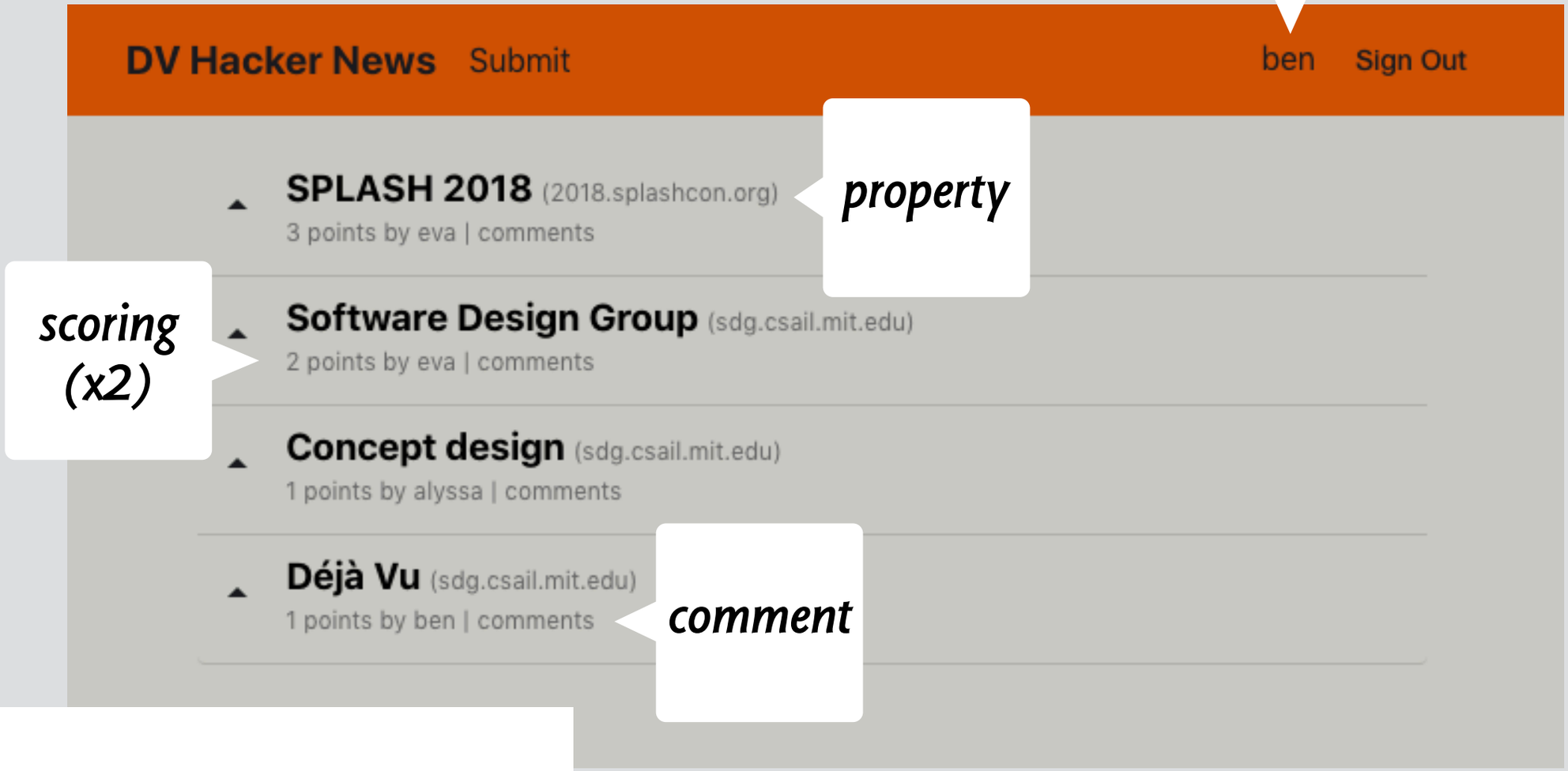
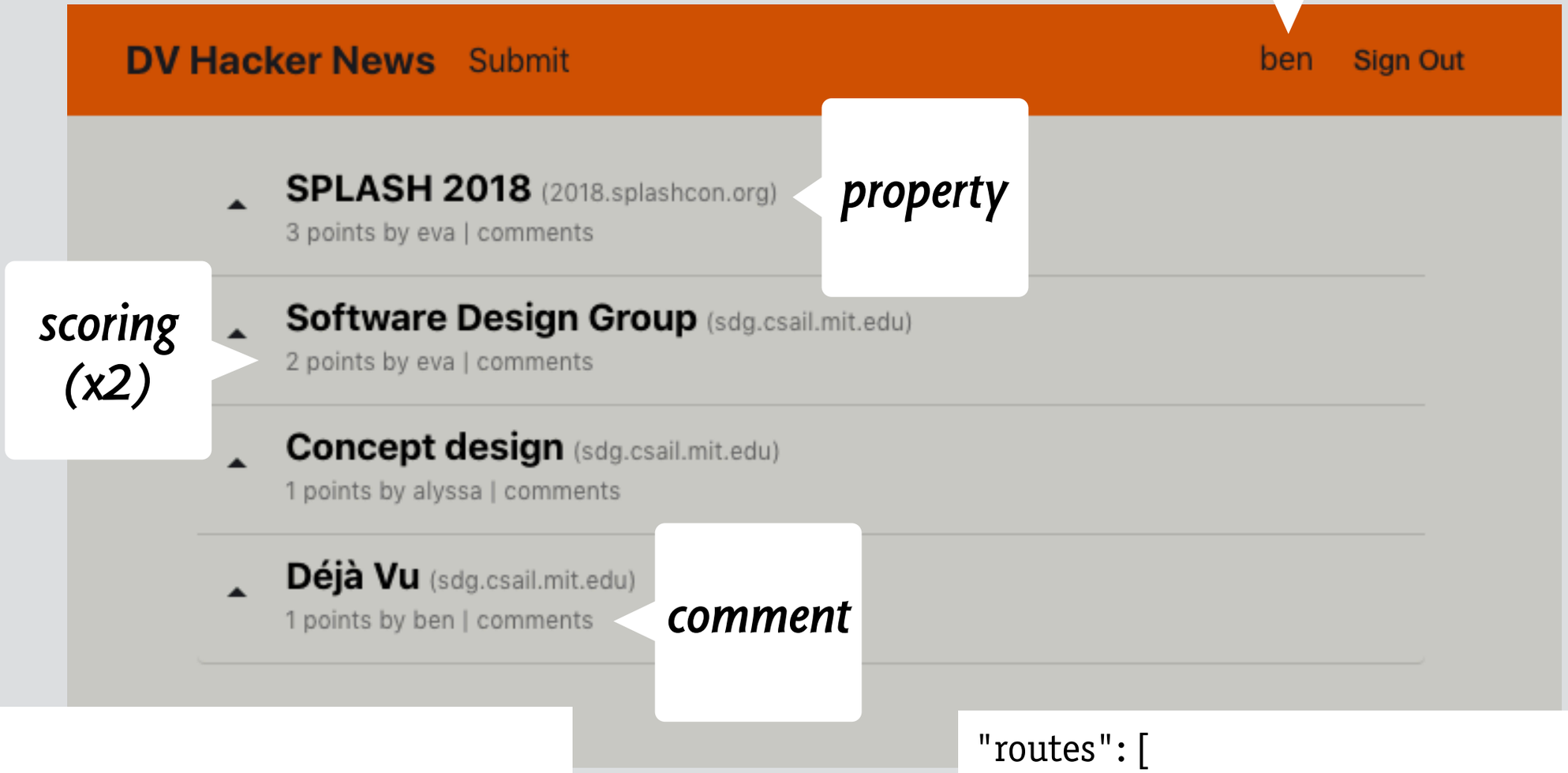
a sample app




```
{
 "name": "hackernews",
 "usedCliches": {
  "authentication": {},
  "comment": {},
  "property": {...},
  "scoringposts": {"name": "scoring"}
  "scoringcomments": {"name": "scoring"}
  },
```

a sample app

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{
 "name": "hackernews",
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  "authentication": {},
  "comment": {},
  "property": {...},
  "scoringposts": {"name": "scoring"}
  "scoringcomments": {"name": "scoring"}
  },
```
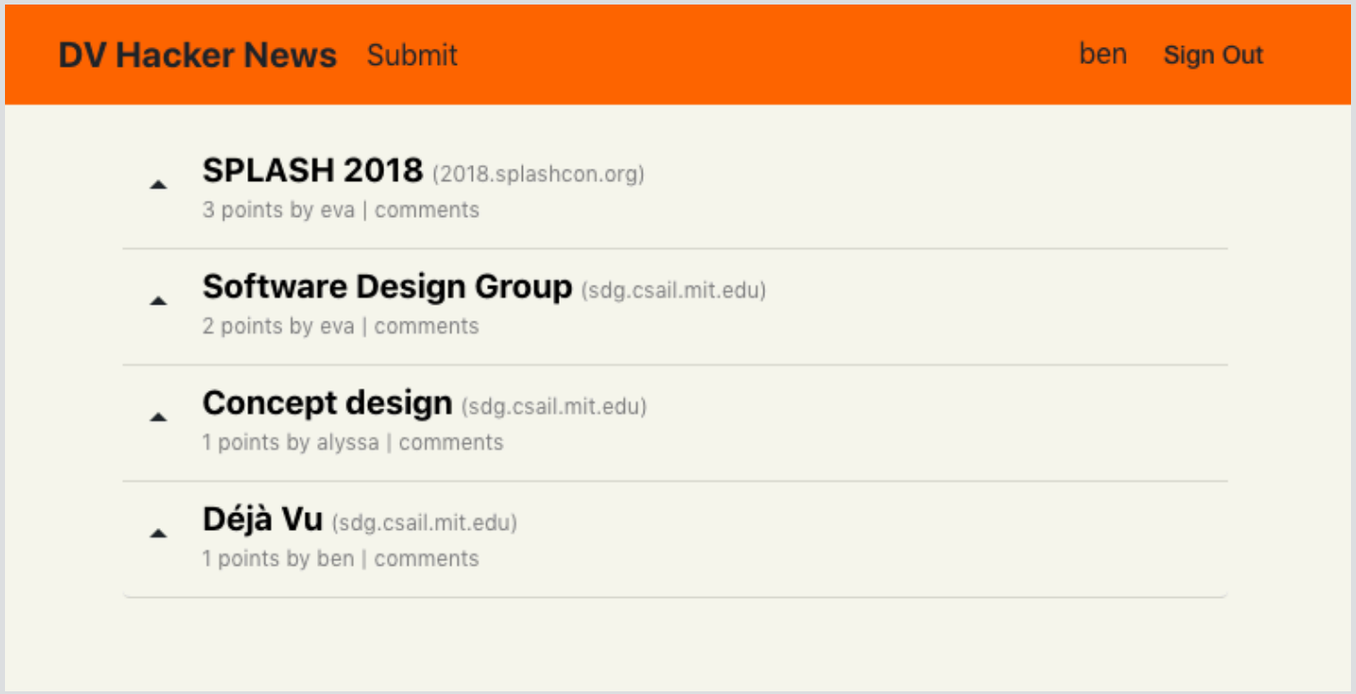

```
 "routes": [
  { "route": "", "action": "home" },
  { "route": "news", "action": "home" },
  { "route": "post", "action": "post-detail" },
  { "route": "login", "action": "login" },
  { "route": "submit", "action": "submit-post" }
 ]
}
```

home action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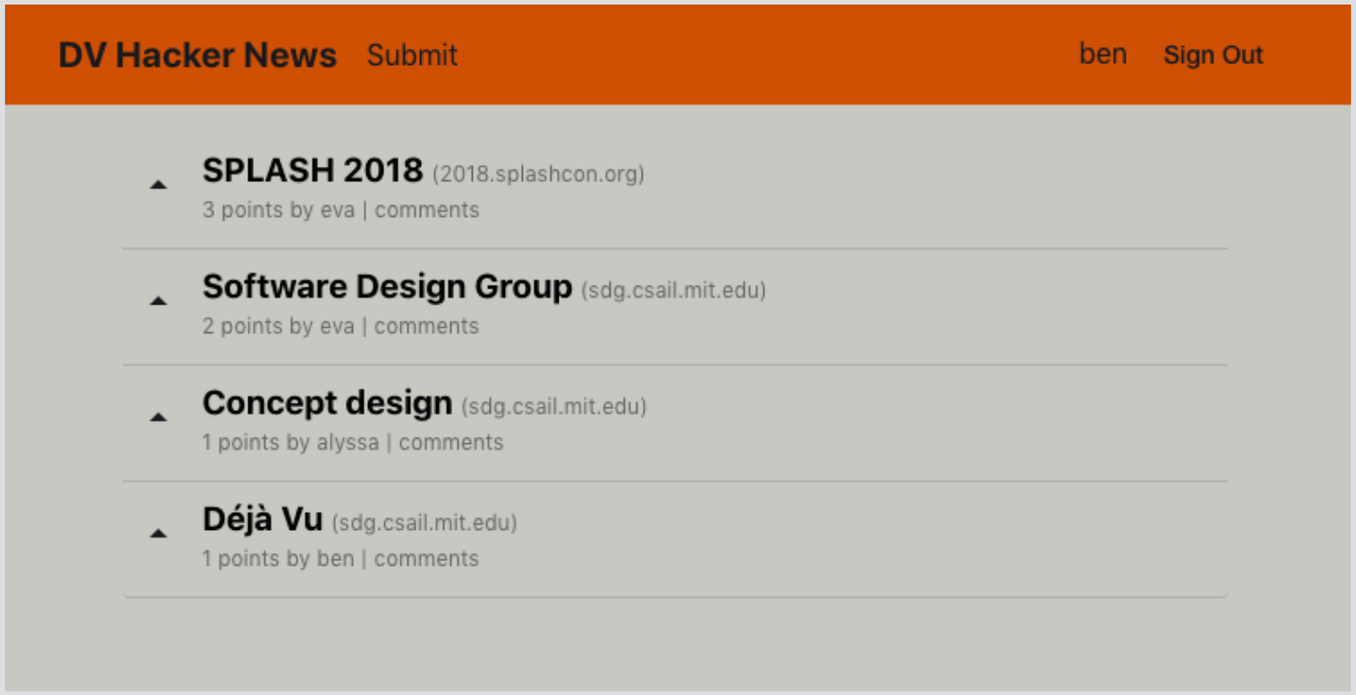
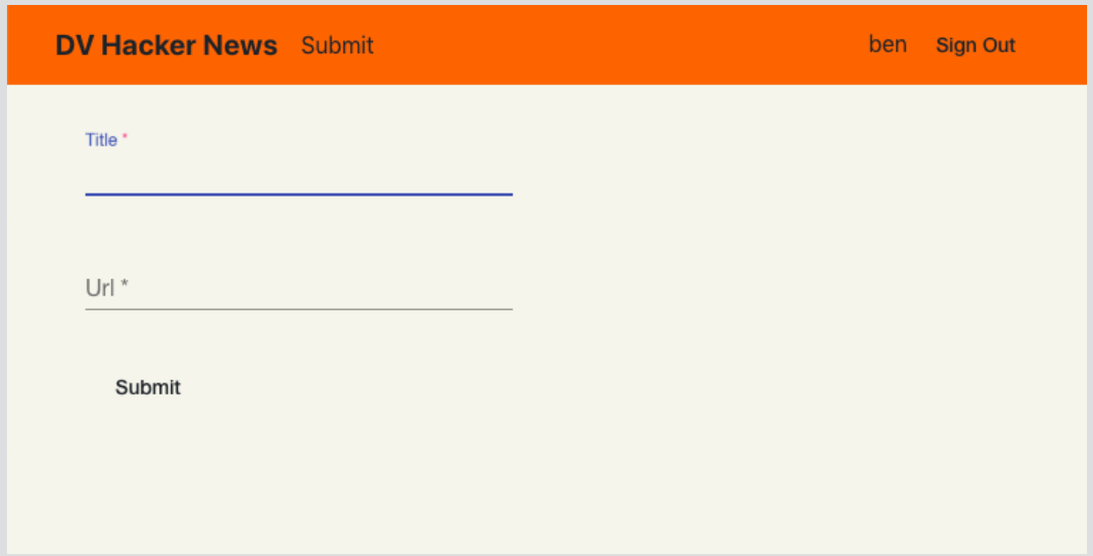
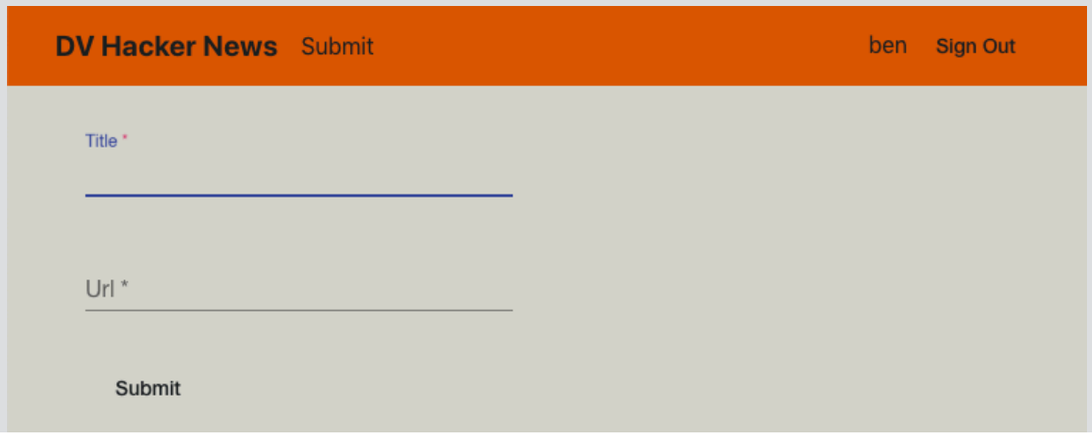



```
<dv.action name="home">
 <hackernews.navbar />
 <div class="main">
   <scoringposts.show-targets-by-score
     noTargetsText="No posts yet"
     showAscending=false
     showScores=false
     showTarget=<hackernews.show-post post=$target id=$id />
   </scoringposts.show-targets-by-score>
 </div>
</dv.action>
```

submit post action

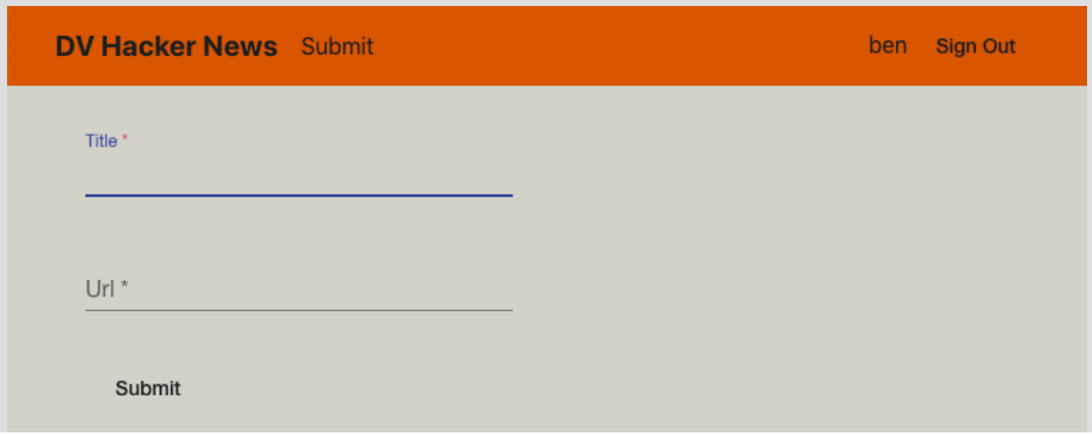


submit post action




```
<dv.action name="submit-post">
<hackernews.navbar />
<div class="main"> <dv.tx>
  <dv.gen-id />
  <property.create-object
   id=dv.gen-id.id
   initialValue={ author: hackernews.navbar.user.username }
   showExclude=["author"]
   buttonLabel="submit"
   newObjectSavedText="Post submitted" />
  <scoringposts.create-score
   targetId=dv.gen-id.id
   value=0
   hidden=true />
  <authentication.authenticate id=hackernews.navbar.user hidden=true />
  <dv.link href="/item" params={ id: dv.gen-id.id } />
</dv.tx> </div> </dv.action>
```

submit post action

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   value=0
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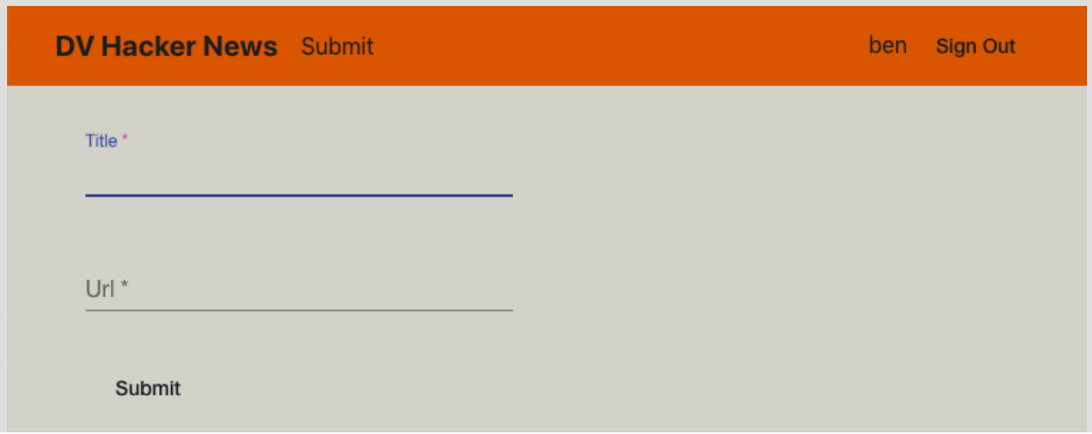
  <authentication.authenticate id=hackernews.navbar.user hidden=true />
  <dv.link href="/item" params={ id: dv.gen-id.id } />
</dv.tx> </div> </dv.action>
```

transaction

submit post action

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   hidden=true />
  <authentication.authenticate id=hackernews.navbar.user hidden=true />
  <dv.link href="/item" params={ id: dv.gen-id.id } />
</dv.tx> </div> </dv.action>
```
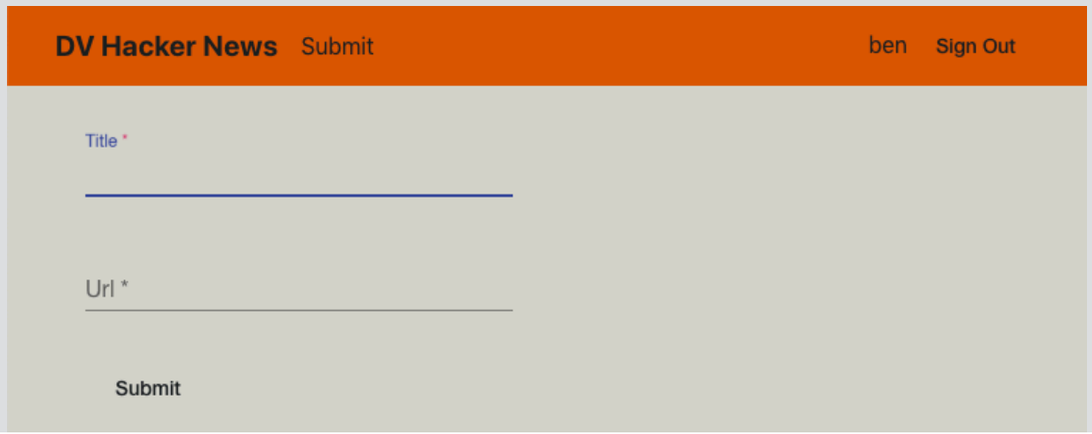

generate id

transaction

submit post action

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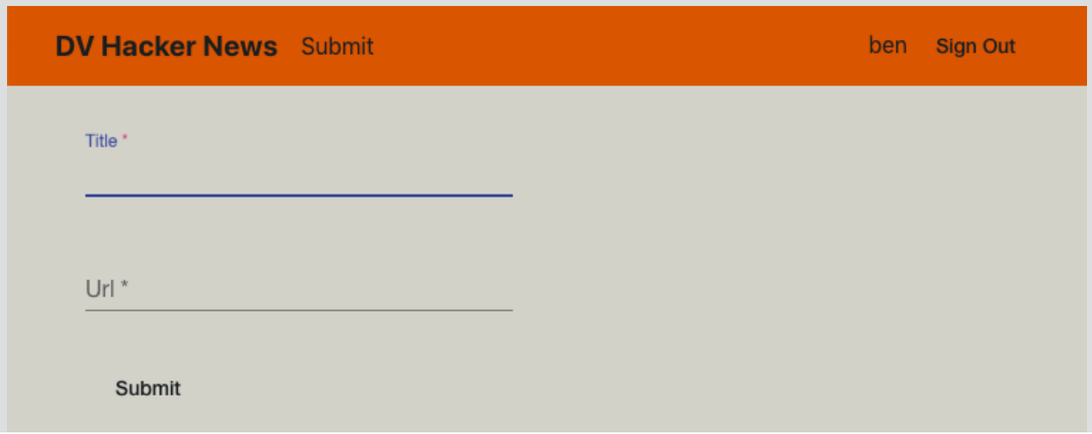
generate id

transaction

id used

id used

submit post action

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   buttonLabel="submit"
   newObjectSavedText="Po
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   value=0
   hidden=true />
  <authentication.authenticate id=hackernews.navbar.user hidden=true />
  <dv.link href="/item" params={ id: dv.gen-id.id } />
</dv.tx> </div> </dv.action>
```

generate id

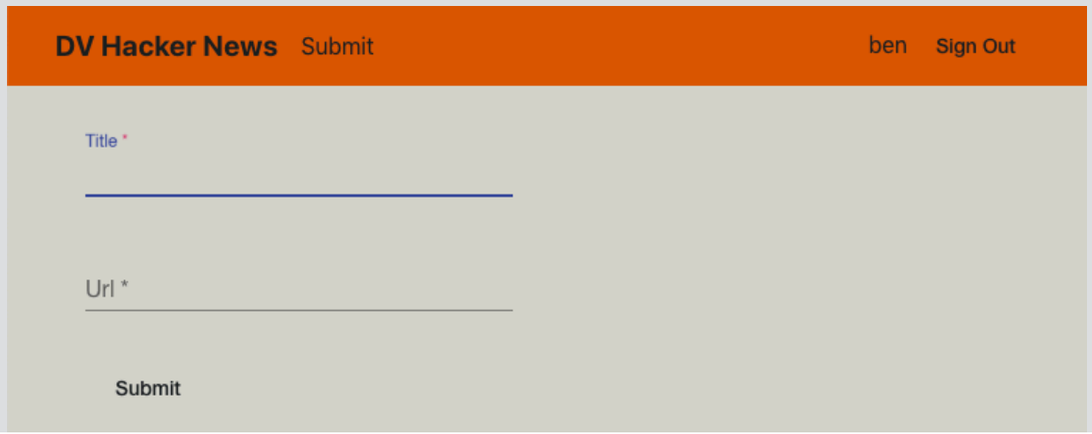
id used

transaction

set param

id used

submit post action

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</dv.tx> </div> </dv.action>
```

generate id

transaction

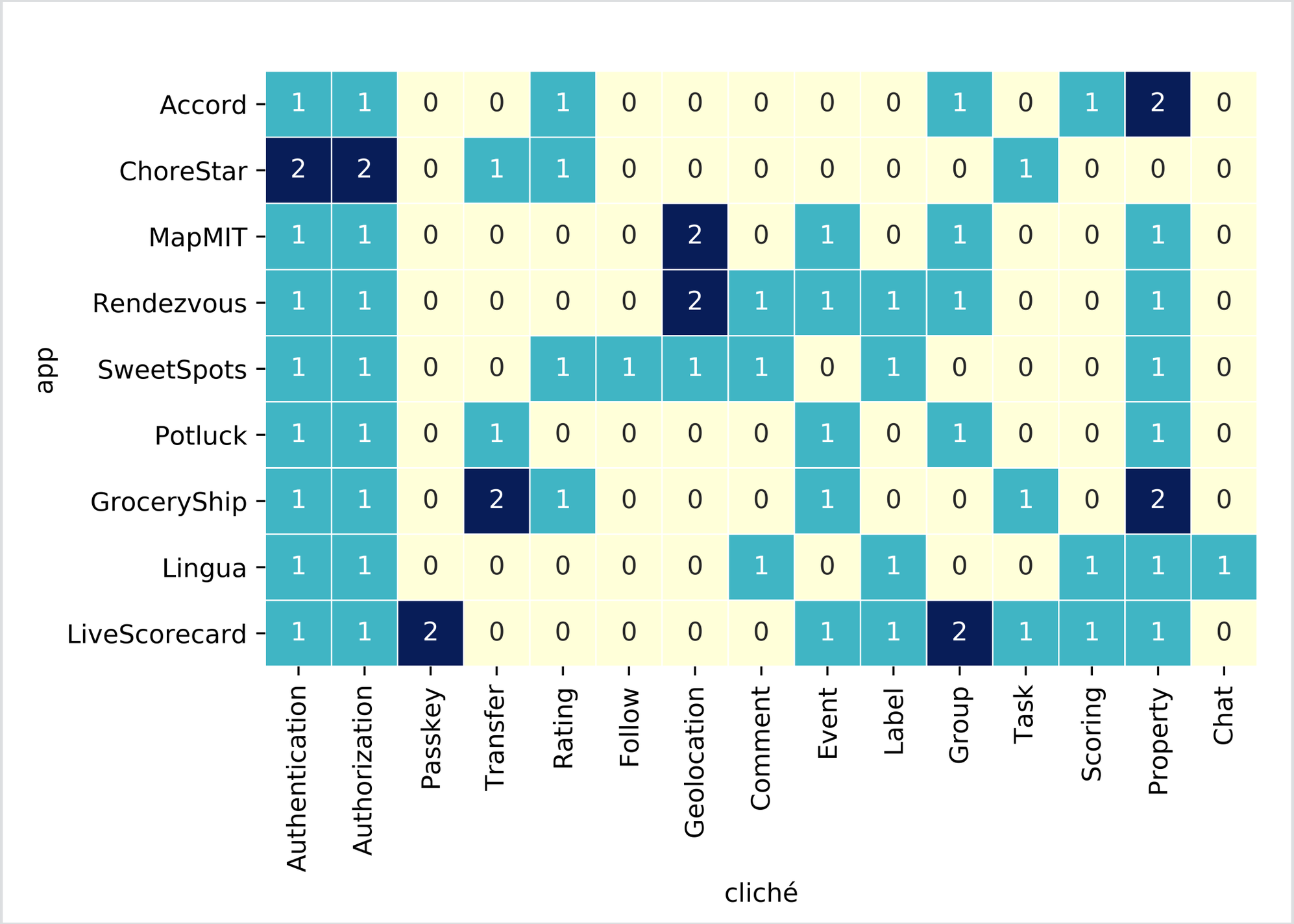
id used

set param

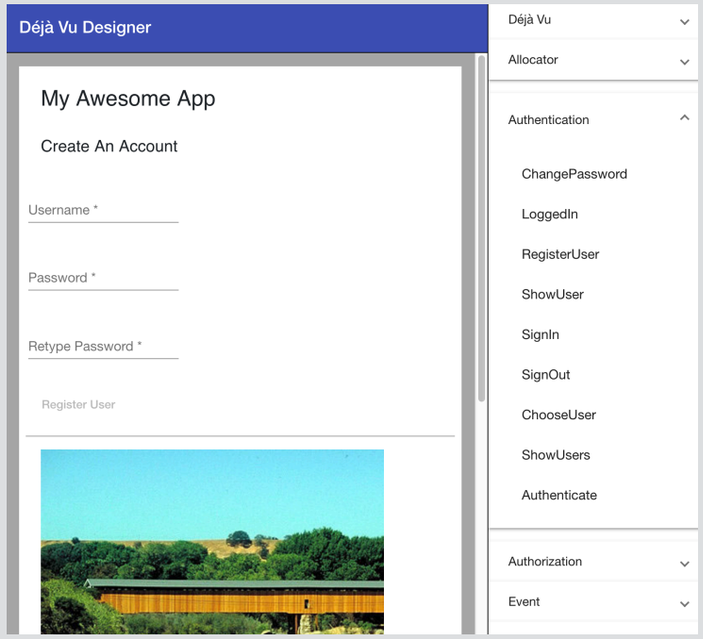
id used

redirect

rebuilding class projects



deja vu plans



WYSIWYG designer
(Barry McNamara)

gateway

security: stop
request forgeries

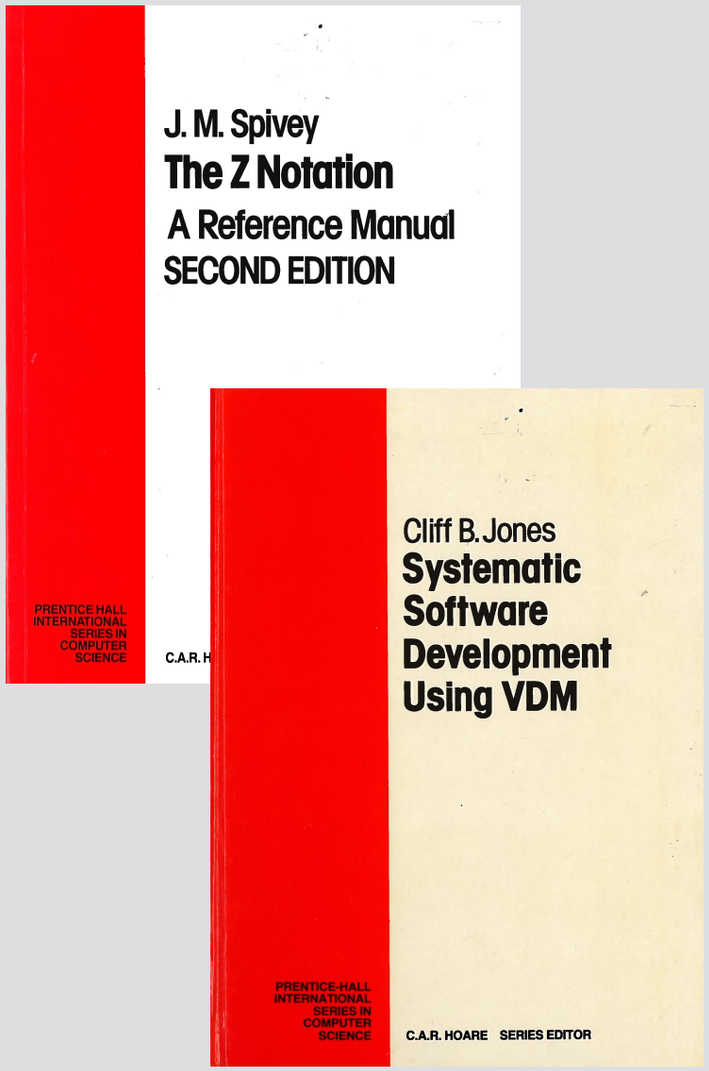
cliche library
for social apps
(Maryam Archie)

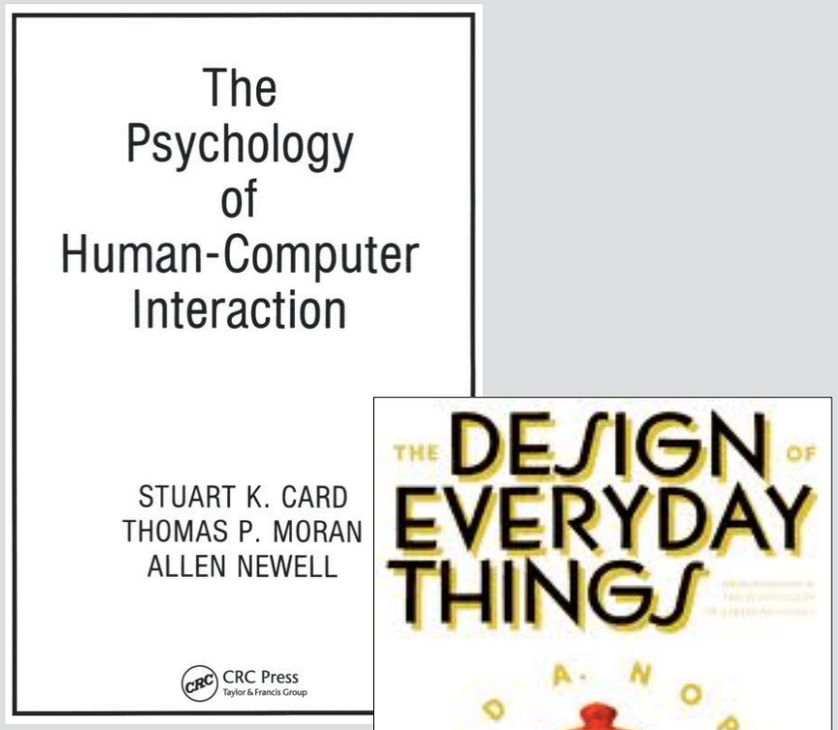
cliche support

make it easier
to author cliches
(Czarina Lao)

closing thoughts

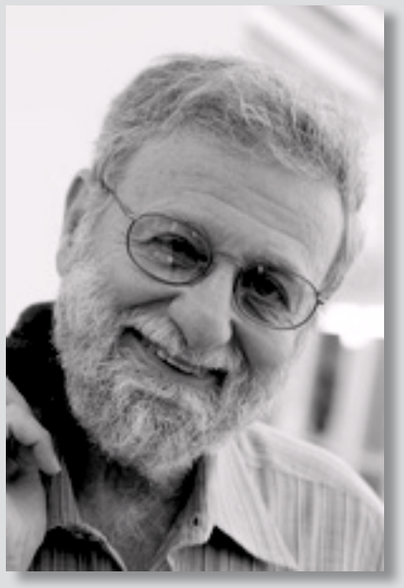
bringing two fields together





user-centered design: conceptual model should be designed
formal methods: software defined by its behavior
both originating around 1974

putting the "thinking" into "design thinking"



theory of usability: collections of heuristics
design thinking: focused on empirical evaluation
see Natasha Jen, *Design Thinking is Bullsh*t*

patterns

128 INDOOR SUNLIGHT*

. . . according to SOUTH FACING OUTDOORS (105), the building is placed in such a way as to allow the sun to shine directly into it, across its gardens. From INTIMACY GRADIENT (127), you have some idea of the overall distribution of public and private rooms within the building. This pattern marks those rooms and areas along the intimacy gradient which need the sunlight most, and helps to place them so that the indoor sunlight can be made to coincide with the rooms in the INTIMACY GRADIENT which are most used.

❖ ❖ ❖

If the right rooms are facing south, a house is bright and sunny and cheerful; if the wrong rooms are facing south, the house is dark and gloomy.

Everyone knows this. But people may forget about it, and get confused by other considerations. The fact is that very few things have so much effect on the feeling inside a room as the sun shining into it. If you want to be sure that your house, or building, and the rooms in it are wonderful, comfortable places, give this pattern its due. Treat it seriously; cling to it tenaciously; insist upon it. Think of the rooms you know which do have sunshine in them, and compare them with the many rooms you know that don't.

From the pattern SOUTH FACING OUTDOORS (105), the building gets an orientation toward the south. Now the issue is the particular arrangement of rooms along this south edge. Here are some examples: (1) a porch that gets the evening sun late in the day; (2) a breakfast nook that looks directly into a garden which is sunny in the morning; (3) a bathing room arranged to get full morning sun; (4) a workshop that gets full southern exposure during the middle of the day; (5) an edge of a living room where the sun falls on an outside wall and warms a flowering plant.

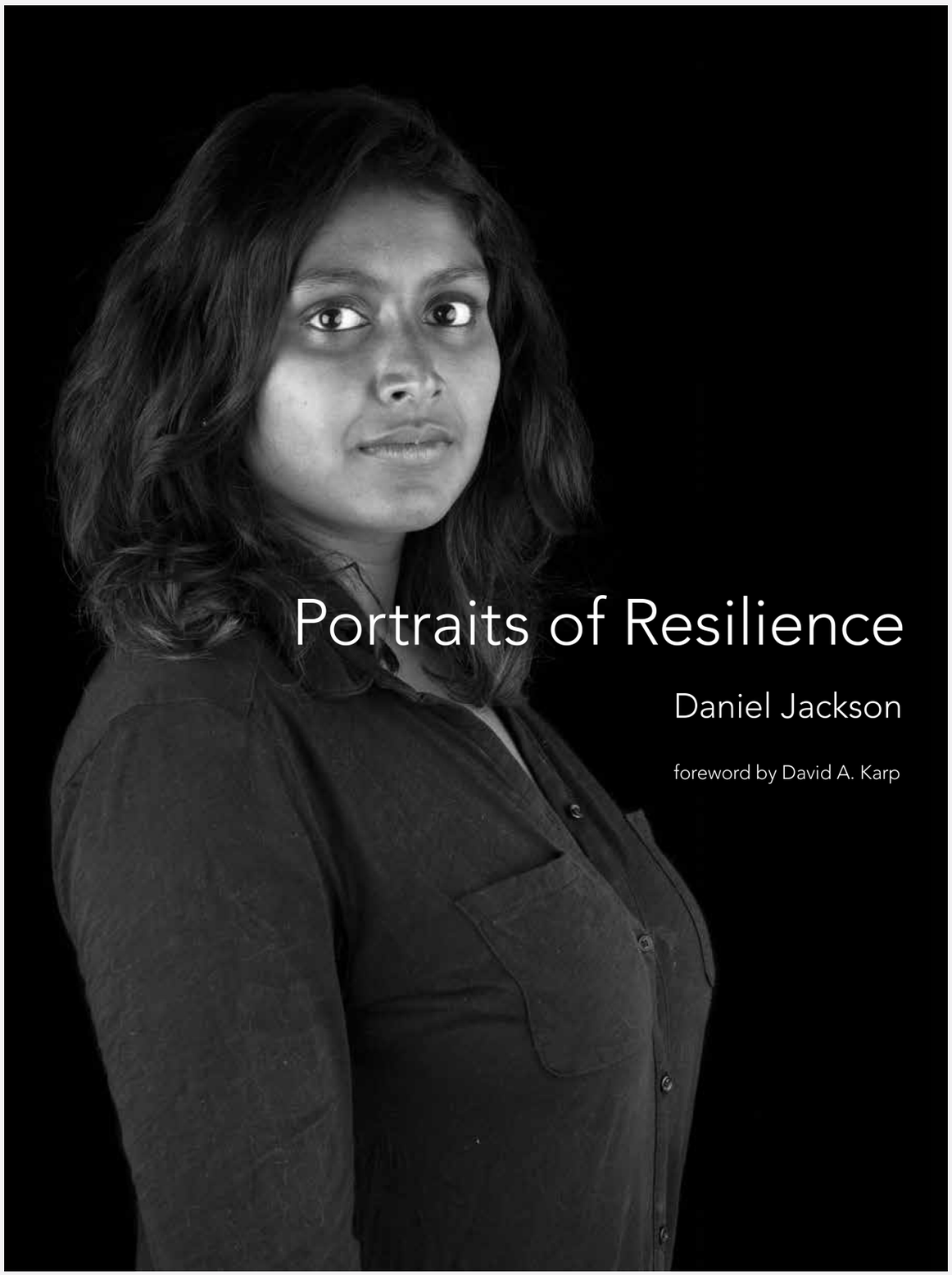
The key diagram for this pattern summarizes the relations between parts of the house and the morning, the afternoon and

concepts: more like Alexander's patterns?

https://tinyurl.com/conceptproject

to be notified about release of book & platform

a different project



http://portraitsofresilience.com