





**Personalized content blending
In the Pinterest home feed**
**Stephanie deWet,
Pinterest Engineer**

Pinterest

Agenda

- 1. What is a home feed?**
- 2. Blending model.**

What is a home feed?



**Pinterest is a
personalized
catalog of ideas.**



Men's blue jacket

End Clothing



Jacob Hinmon
men's style

Pin
A visual bookmark
saved from the
internet by a user.

We serve
more than 3 trillion
Pins every year,
or about
10 billion a day.

Followed users



Pink Butterflies using Huckleberry Hooch by Top Shelf...

Ann @ Mani On...
Nail Art



Julep Laure:
Blazing red-orange stardust

Julep
Orange You Glad



Halloween Nail Art

Roberta Gunnell
Nail Art



Spider web nails – cool idea to decorate your nails on...

Luulla Fashion
Nail Art



Point Break

Julep
Going Green

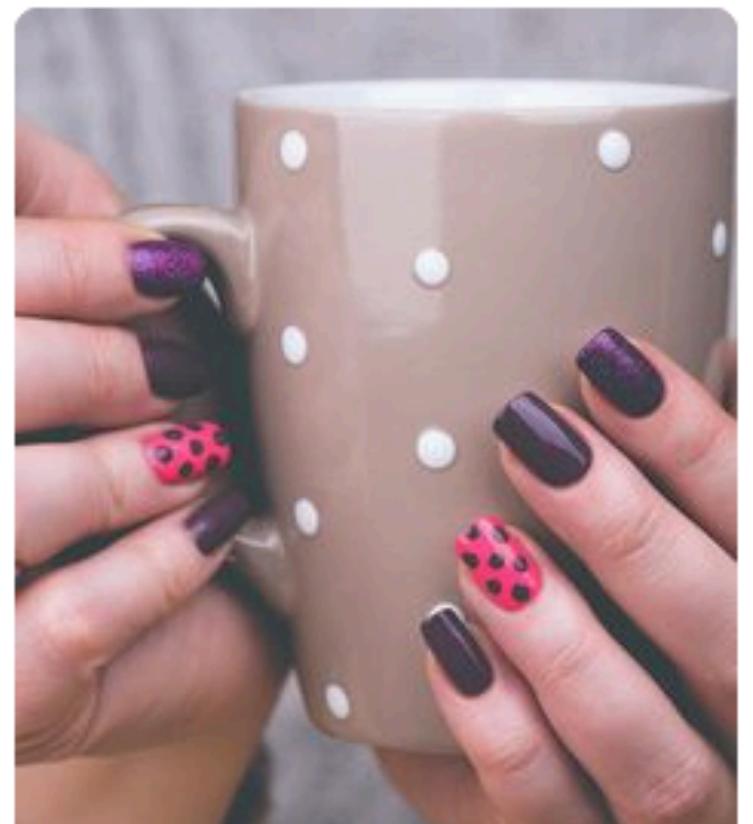


Más de 45 ideas de decoración de uñas 2016 | Decoración de...

salinasalicia
Nail Art



WHITE HOT



50 Lovely Spring

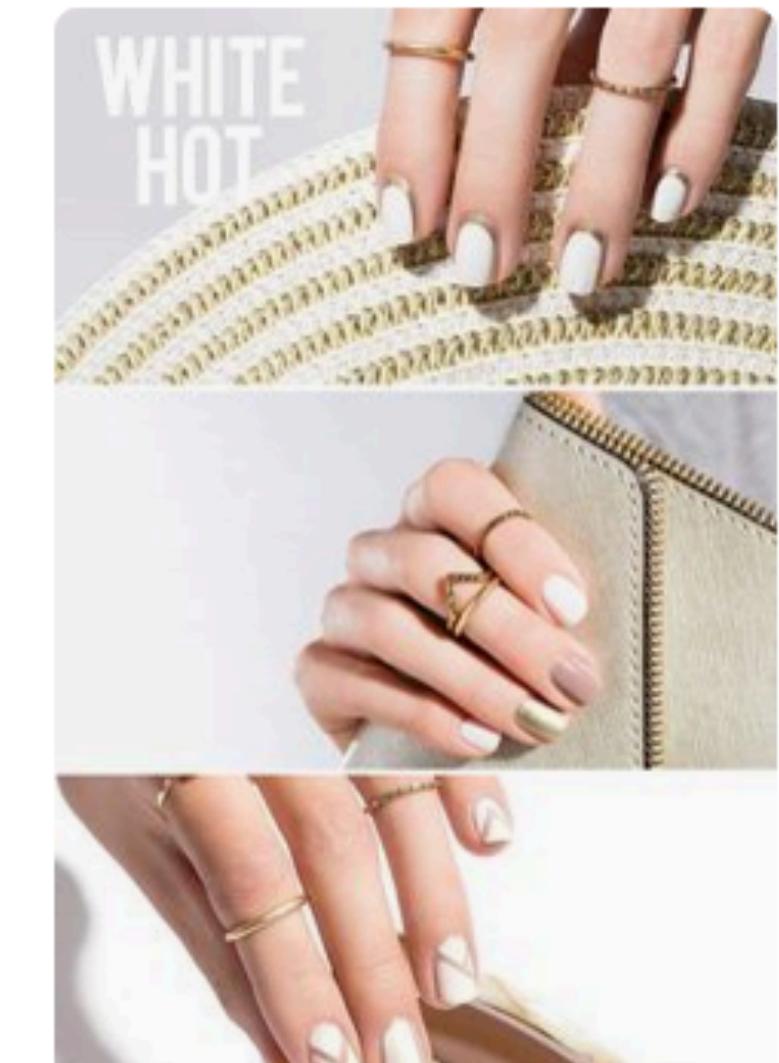


5 Fall Manicures To Try Now
Metallic mini moons
Glitter Guide



Suse - Bombshell | Coral blaze crème

Julep
Orange You Glad



Recommendations



Blue water

+ 1.2k

Picked for you
Meer



Water by Cuba
Gallery

+ 11.6k

Picked for you
mavi(blue)



Leahi Bottom -
Noir

underwater
adventure

Elle Mer Swim

Picked for you
Adventures-

+ 3.7k



Love the scent of
the ocean? You'll
love Aesthetic
Content's...

+ 18.2k

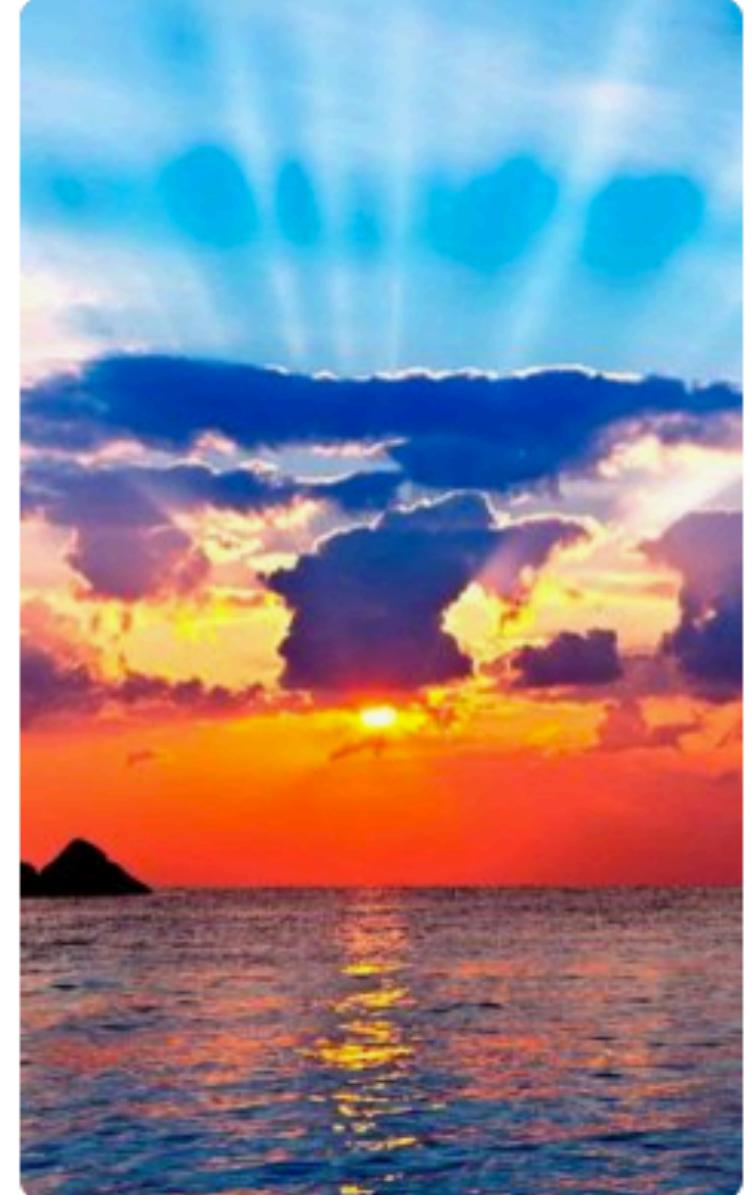
Picked for you
sea



I will never get
tired of ocean
photography -E
Vetica

+ 9.3k

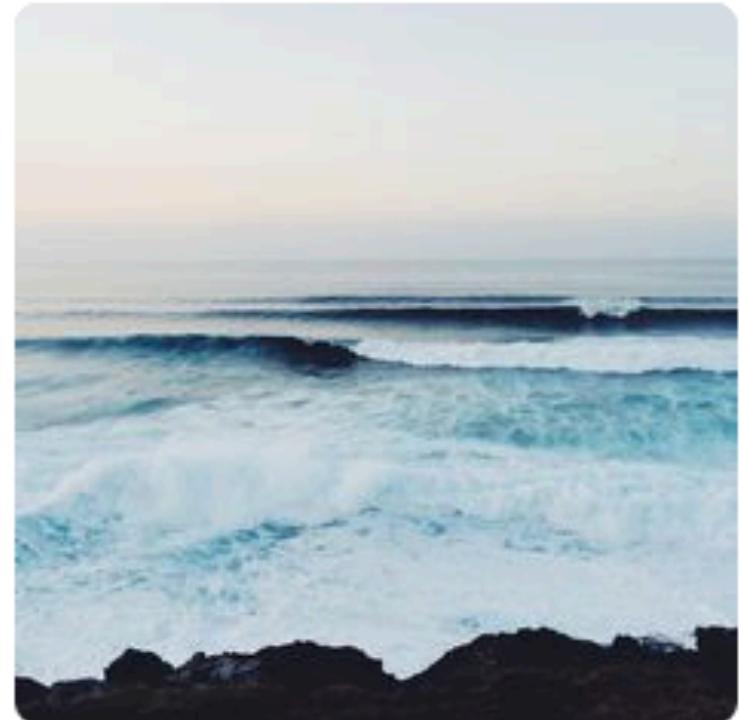
Picked for you
Places and A...



Beautiful sunset
over ocean - blue,
purple, orange.

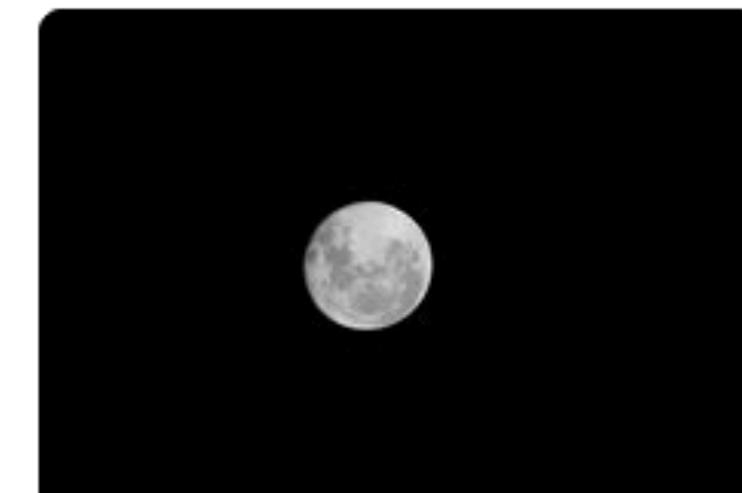
+ 22.9k

Picked for you
SUNRISE & ...



pinterest:
kyracamilon

+ 36



The result is...



Julep Laure:
Blazing red-
orange stardust

Julep
Orange You Glad



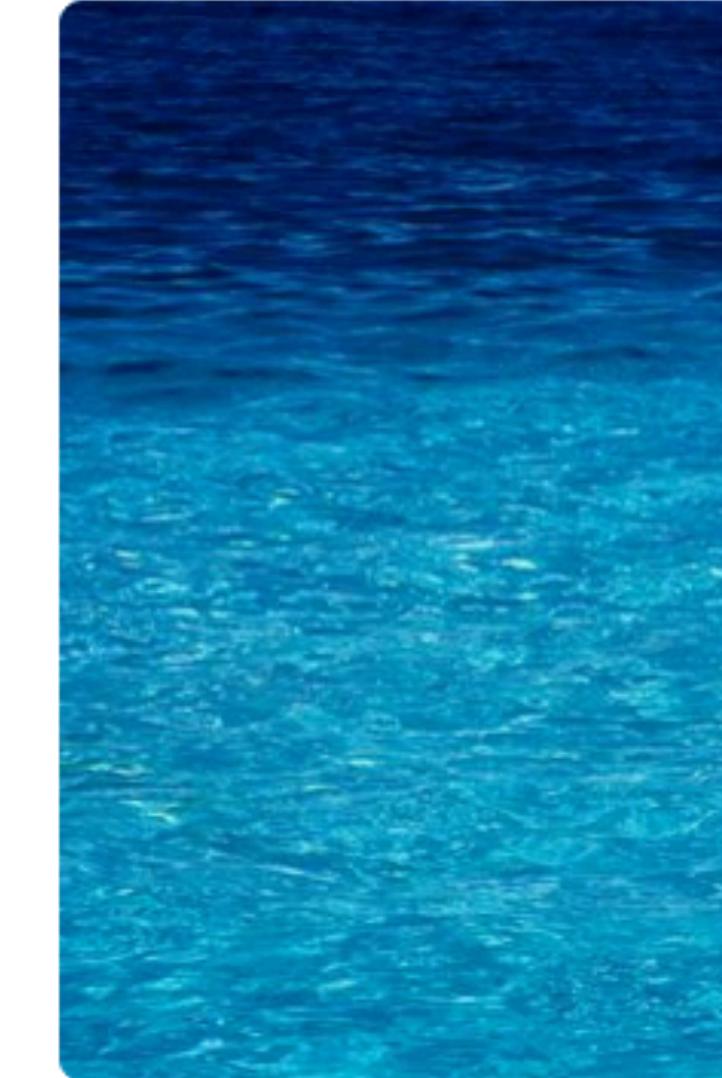
Halloween Nail
Art ❤️

Roberta Gunnell
Nail Art



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Blue water

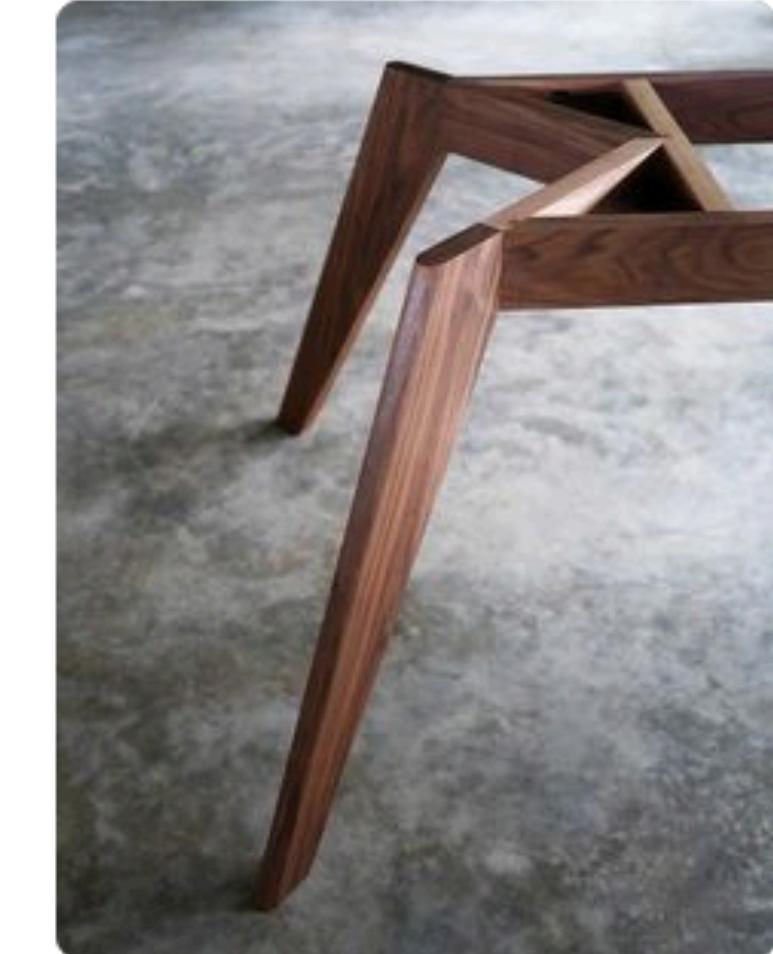
Picked for you

Meer



Water by Cuba
Gallery

Picked for you
mavi(blue)



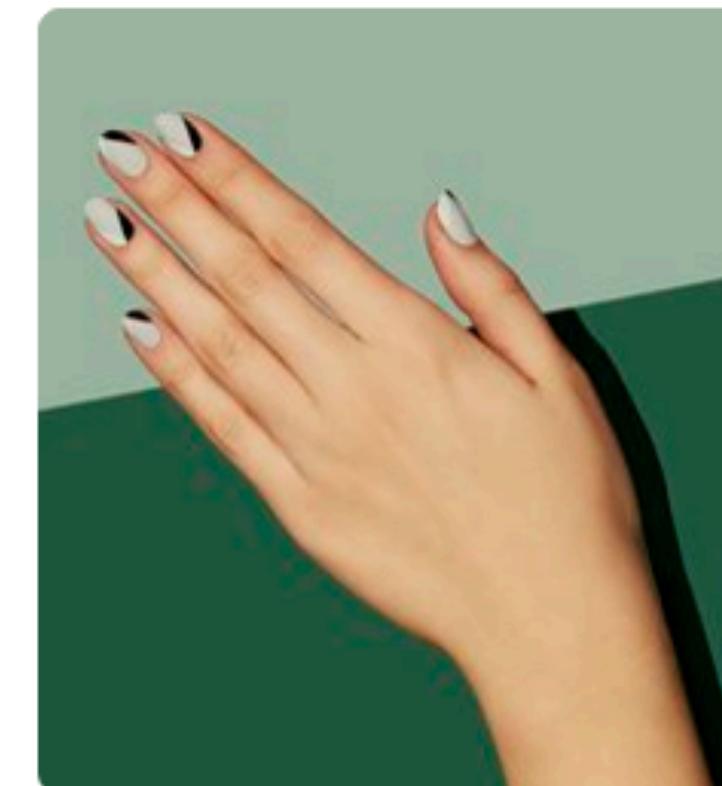
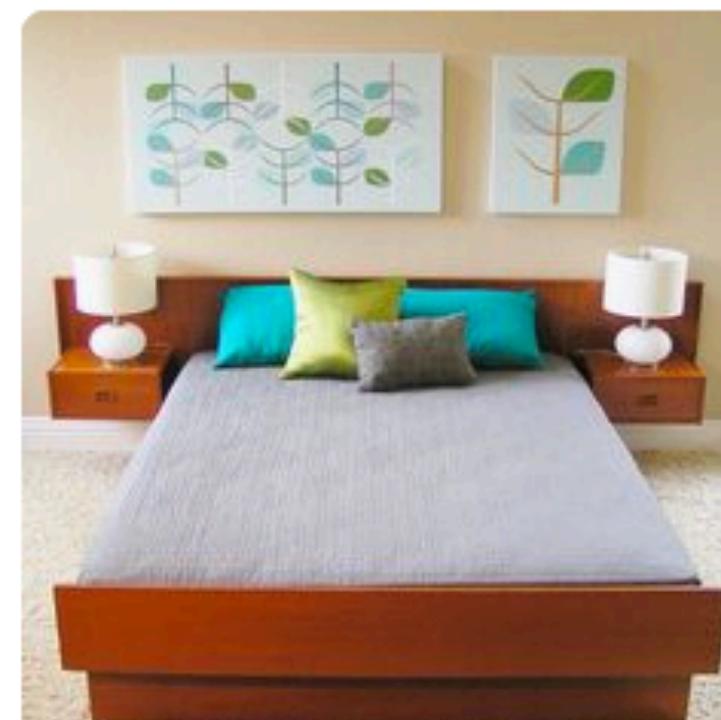
Vista St Dining
Table by Nathan
Day - Dining
Table...

Found in
Danish Modern



Handmade Coffee
Table Mid Century
Modern TEAL
by...

Etsy
Found in
Danish Modern



Point Break
Julep
Going Green



Más de 45 ideas
de decoración de



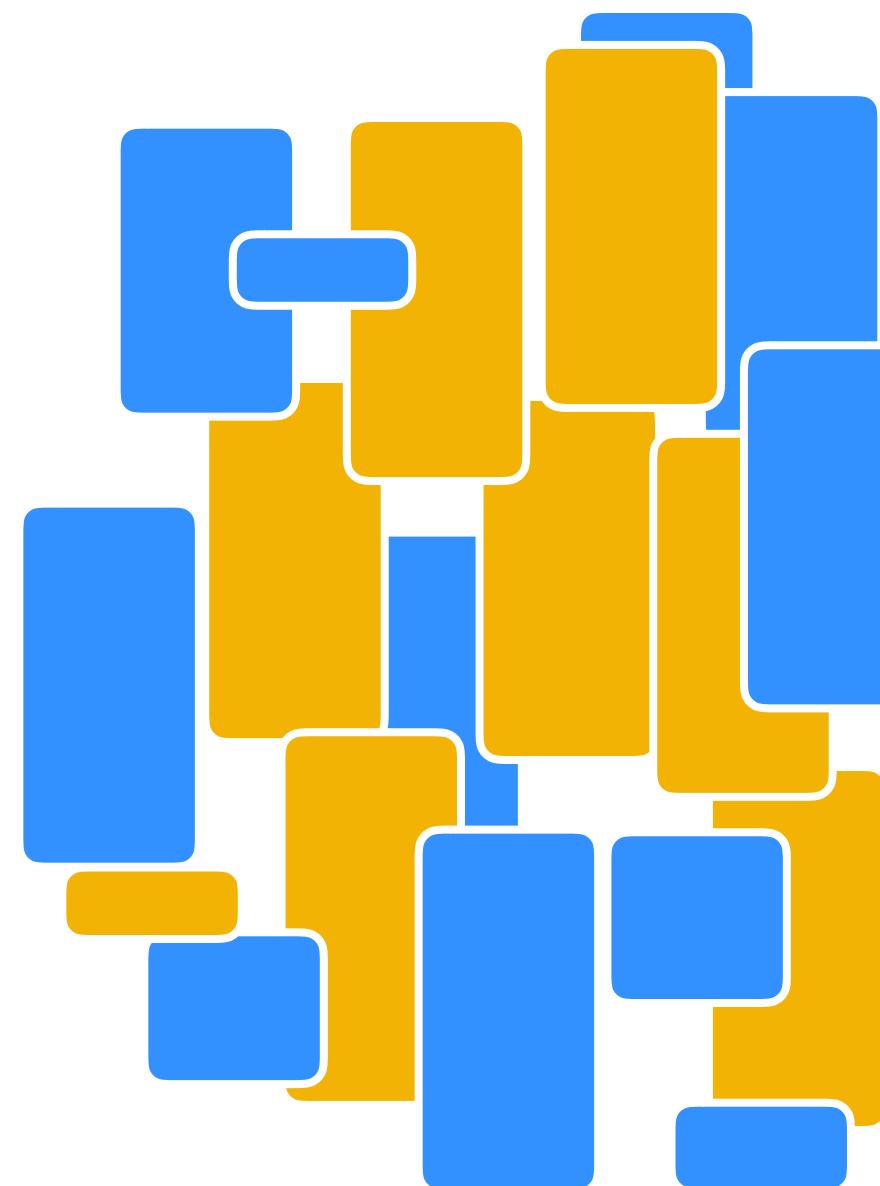
Suse - Bombshell



How does the home feed work?

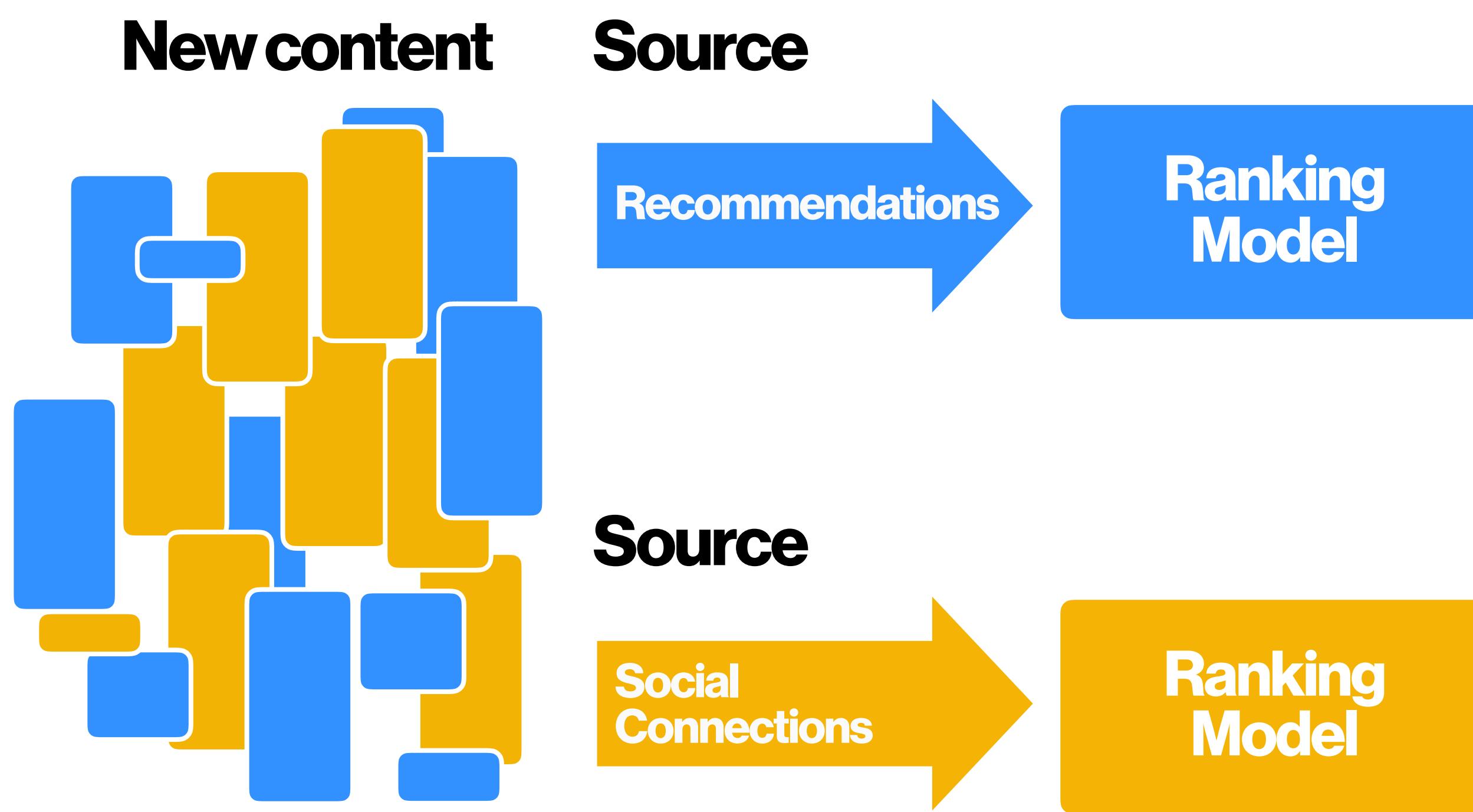
■ Recommendation
■ Social

New content



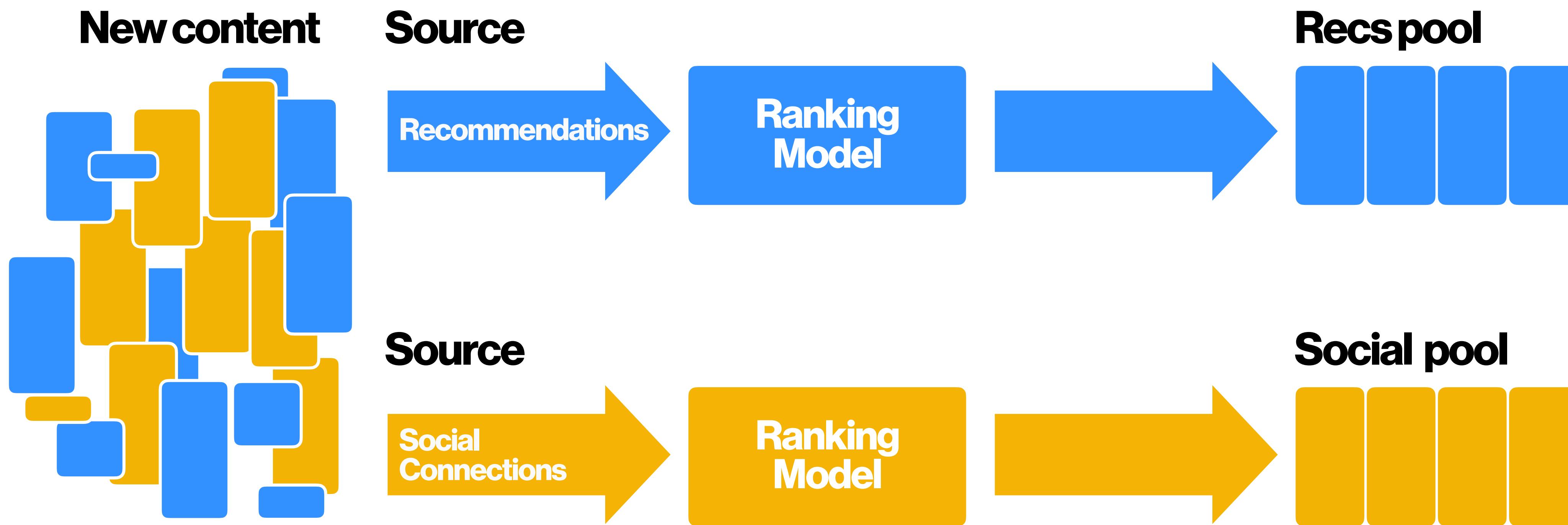
How does the home feed work?

■ Recommendation
■ Social



How does the home feed work?

■ Recommendation
■ Social



Content ranking

We have different models for each type of content.

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Why?

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- Parallelizes model development

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- Different content types may have different objective functions
- Easy to add new types of content

Content ranking

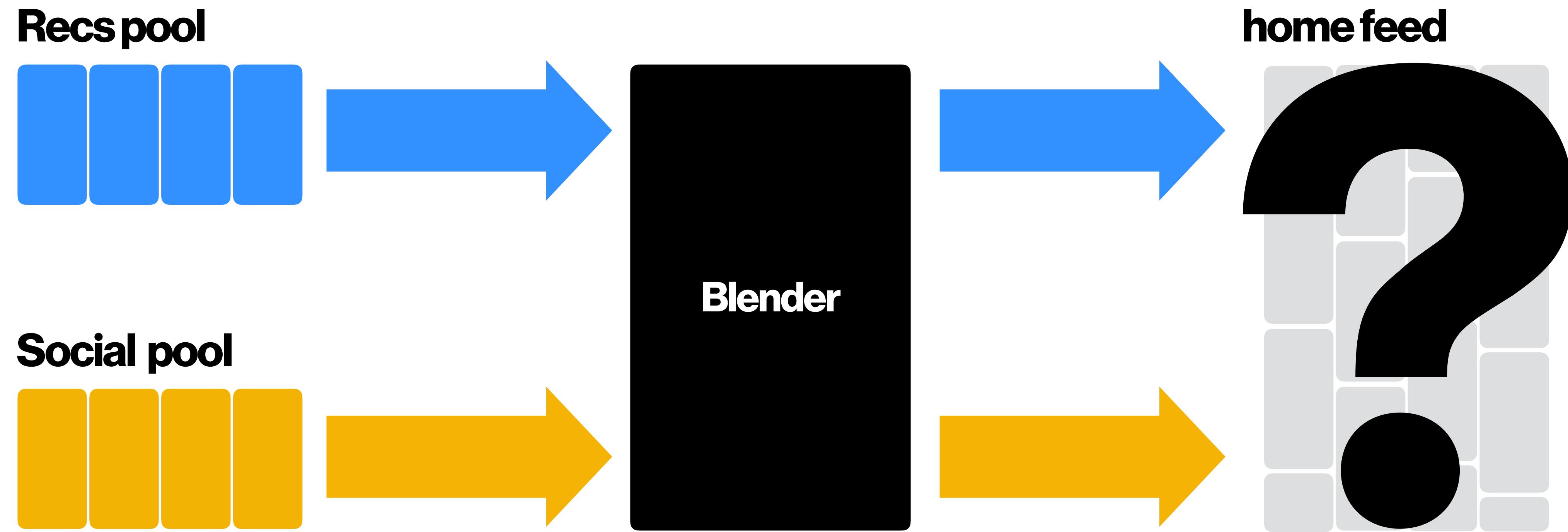
We have different models for each type of content.

Why?

- Parallelizes model development
- Different content types may have different important features
- Different content types may have different objective functions
- Easy to add new types of content
- Works well in practice

The blending problem

Goal: Combine the results from the pools into one sorted feed.



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- Users with significant prior history should see more of the content types they prefer.

The blending problem

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Desired traits

- Users with significant prior history should see more of the content types they prefer.
- We should be able to control the blending rate for users with little prior history; these users should see some of all types of content.

Blending model



Which model?

Which model?

- Fixed ratio

Which model?

- Fixed ratio
- Calibrate ranking models

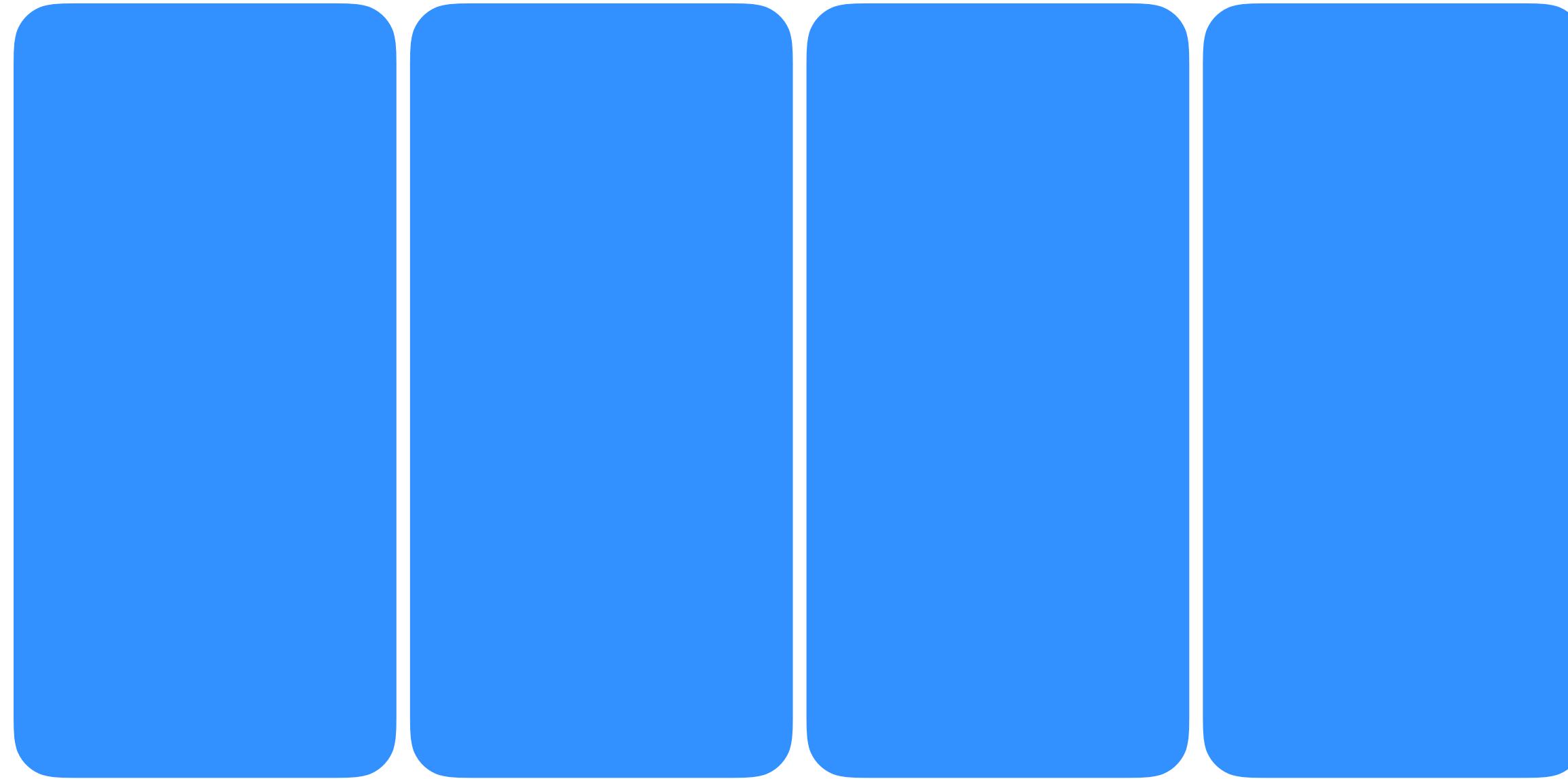
Which model?

- Fixed ratio
- Calibrate ranking models
- Multi-armed bandit approach

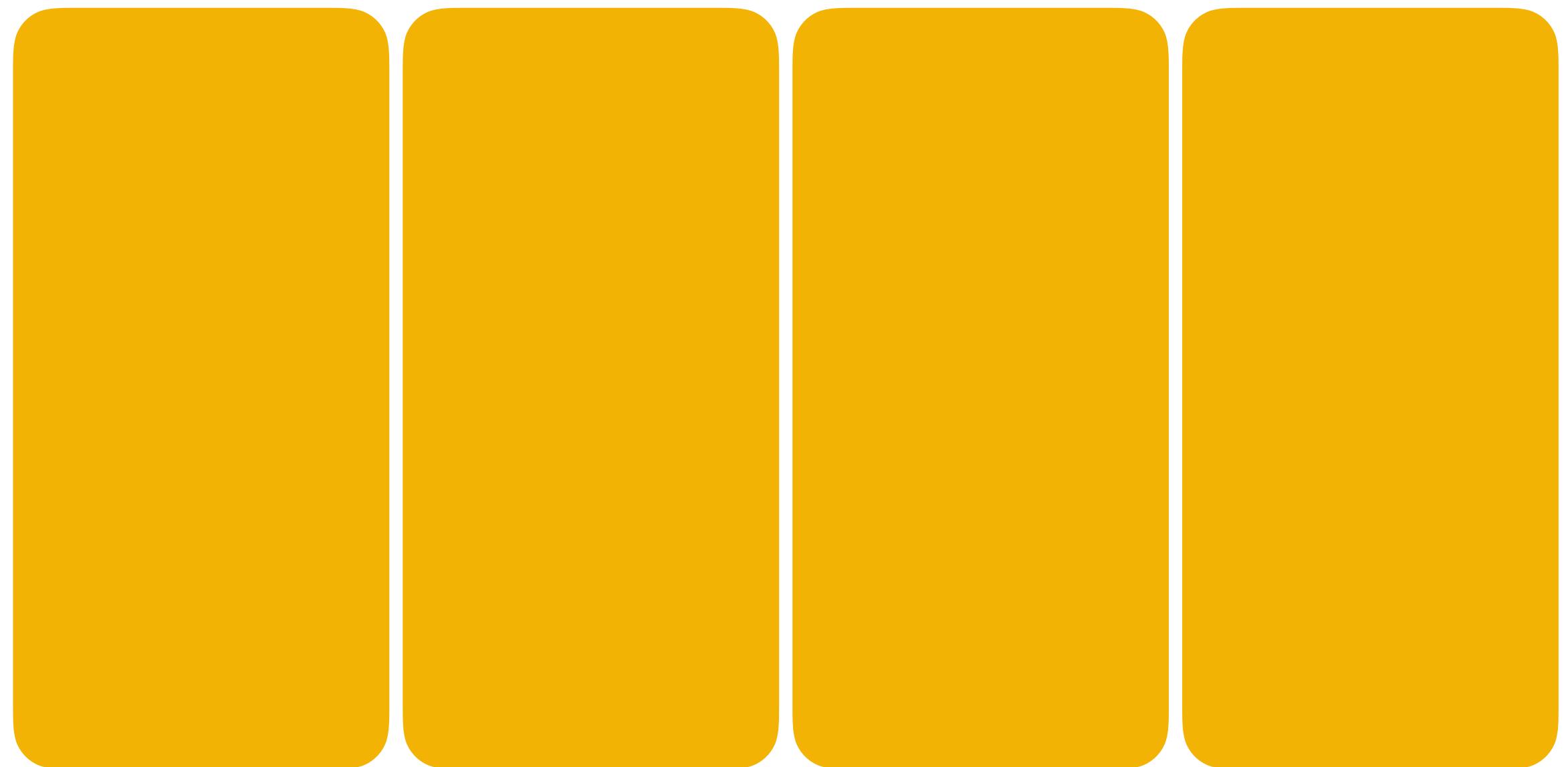
Model: Multi-armed bandit

Each arm of the bandit represents one of the pools.

Recommendations



Friends



Sampling technique

- Unlike the classical bandit problem, we do not get feedback after every sample.
- Instead, we will sample content in batches.
- In each round, we will map the pool affinities onto an integer ratio.

Data

For each user and pool, we have historic engagement data.

Total number of:

- Positive Actions (Clickthroughs, Repins, Closeups,...)
- Negative Actions (Hides)
- Views

Beta distribution

$\text{Beta}(\# \text{ actions}, \# \text{views} - \# \text{ actions})$

E(Beta) = # actions / # views

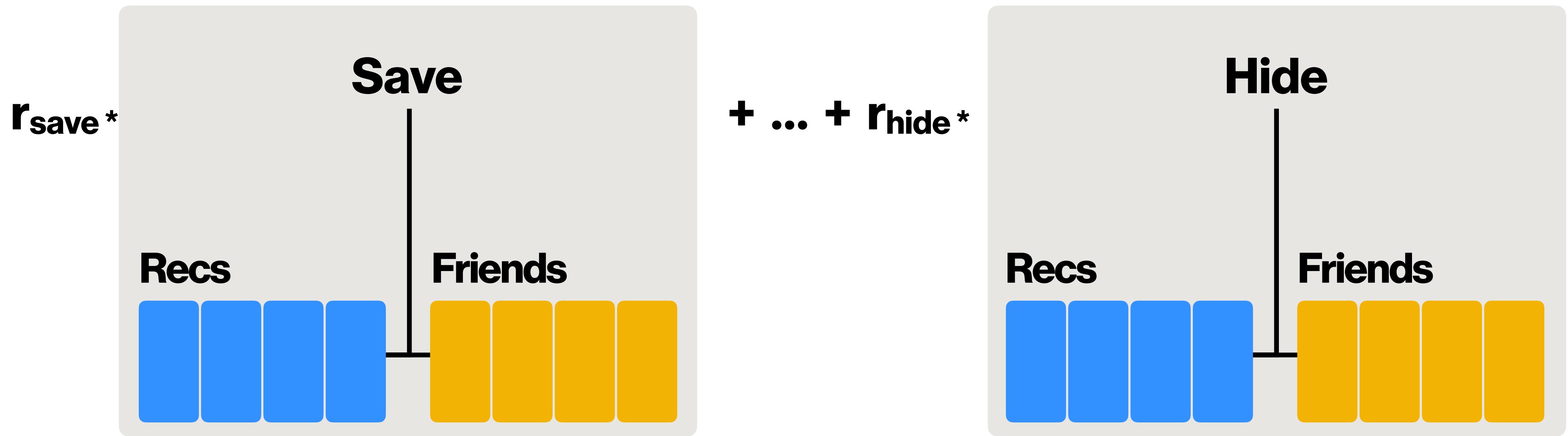
- █ Beta(5, 10)
- █ Beta(10, 5)
- █ Beta(50, 50)



Response distribution

We should represent each type of action with its own beta distribution, and its own reward.

We have a linear combination of responses from each bandit.



Response distribution

We should represent each type of action with its own beta distribution, and its own reward.

In essence, we have a linear combination of bandits.

So we end up with the full utility of a pool:

$$U = \sum_{a \in Actions} \text{reward}_a * \text{Beta}(\# \text{ actions}_a, \# \text{ views} - \text{actions}_a)$$

How did we do?

Goal: Combine the results from the pools into one sorted feed.

Constraints

- Must maintain the ranking of each pool.
- Scores are not comparable across pools.

Desired traits

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- We should be able to control the blending rate for users with little prior history; these users should see some of all types of content.

Prior distribution

For users with little data, we want to enforce that “they should see some of each of the types of content in every page.”

We can enforce this with additional prior action counts.

$$U = \sum_{a \in Actions} \text{reward}_a * B(A_a + A_{a,0}, (V_a + V_{a,0}) - (A_a + A_{a,0}))$$

Prior actions can be selected to give us the desired initial blend for new users, and the desired rate of change.

Sampling technique

- In each round, we will map the expected values of the pool utilities onto an integer ratio.

$$E(U) = \sum_{a \in Actions} \text{reward}_a * \frac{A_a + A_{a,0}}{V_a + V_{a,0}}$$

How did we do?

Goal: Combine the results from the pools into one sorted feed.

Constraints

- Must maintain the ranking of each pool.
- Scores are not comparable across pools.

Desired traits

- Users with significant prior history should see more of the content types they prefer.
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Example

Rewards

Positive action

1

Negative action

-1

Example

Prior Values

Positive action

50

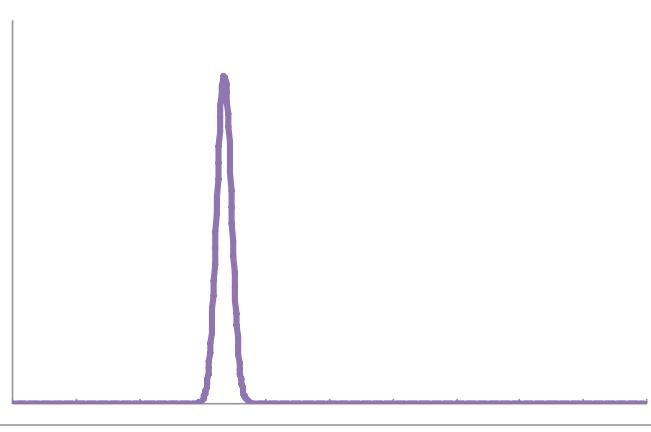
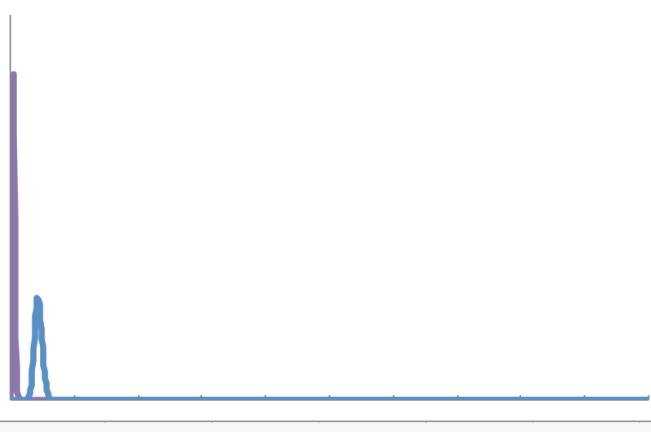
Negative action

0

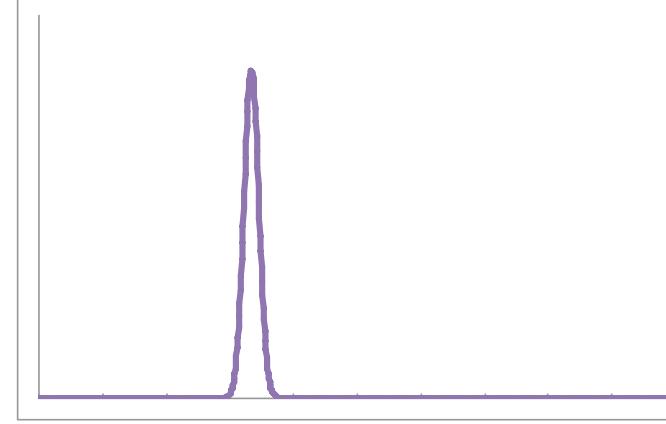
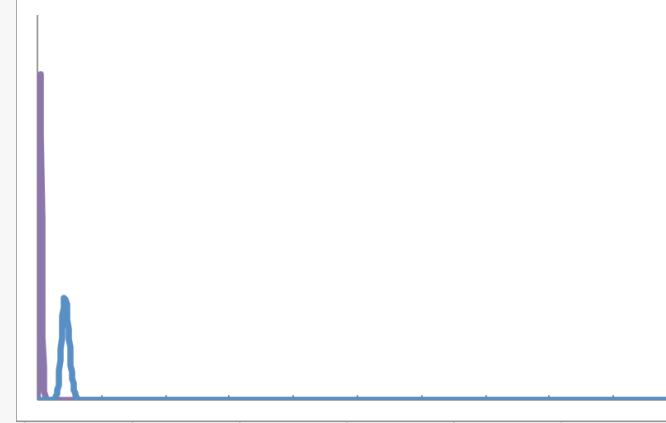
View

1000

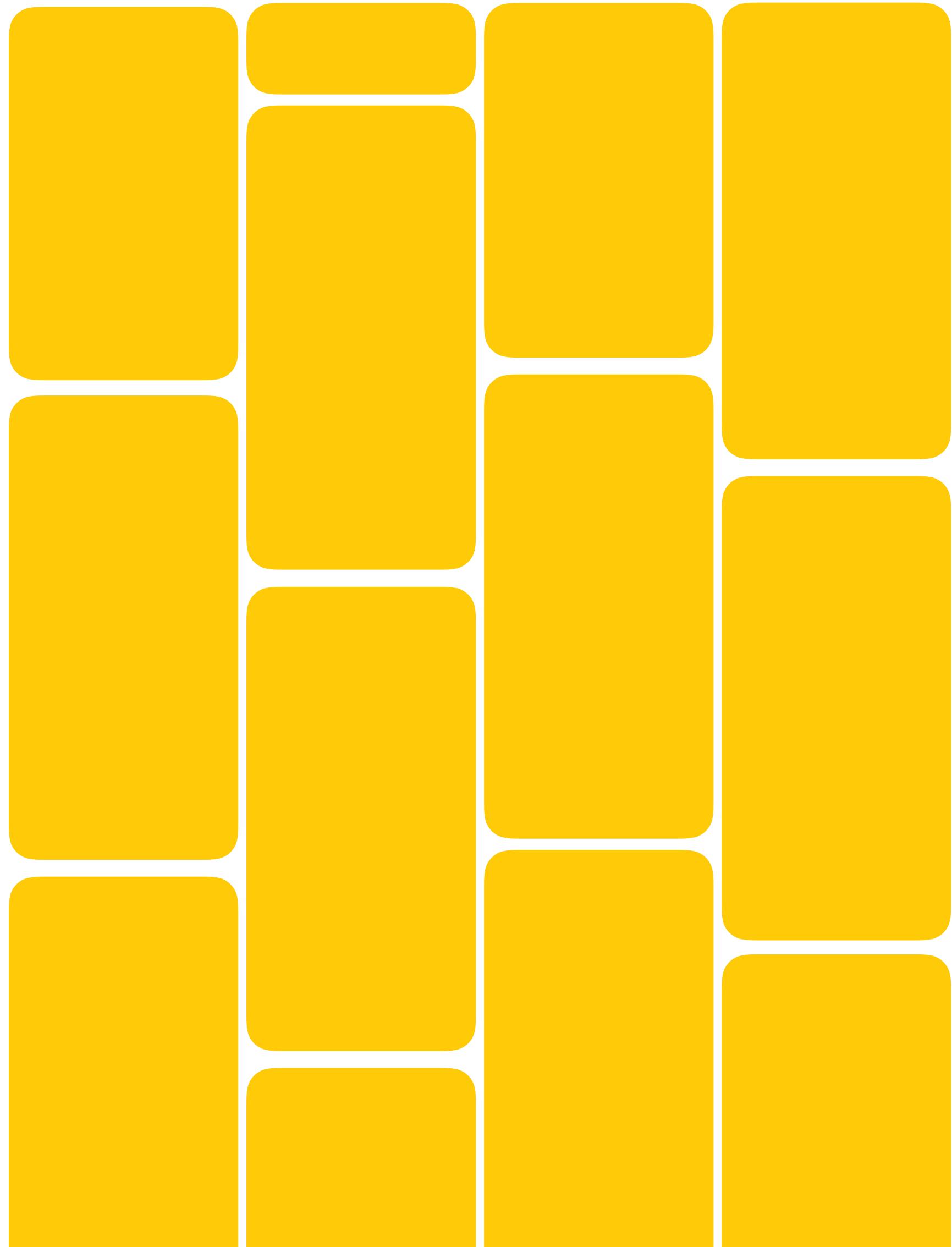
User with history

Pool	# Positive Actions	# Negative Actions	# Views	Utility Function
Friends 	5000 + 50	0 + 0	10000 + 1000	
Recommendation 	0 + 50	500 + 0	10000 + 1000	

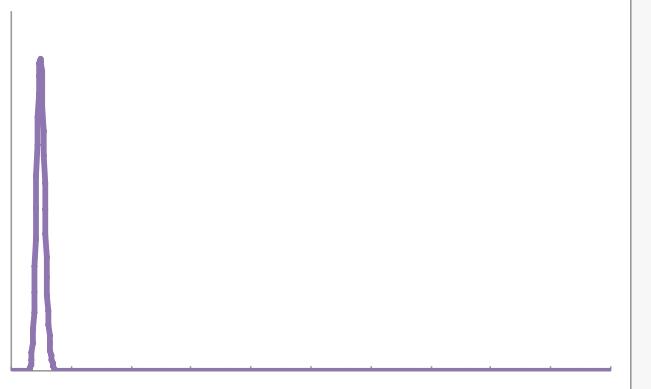
User with history

Pool	Utility Function	Expected Utility	Mapped To Ratio
Friends		0.46	10
Recommendations		-0.04	0

User with history



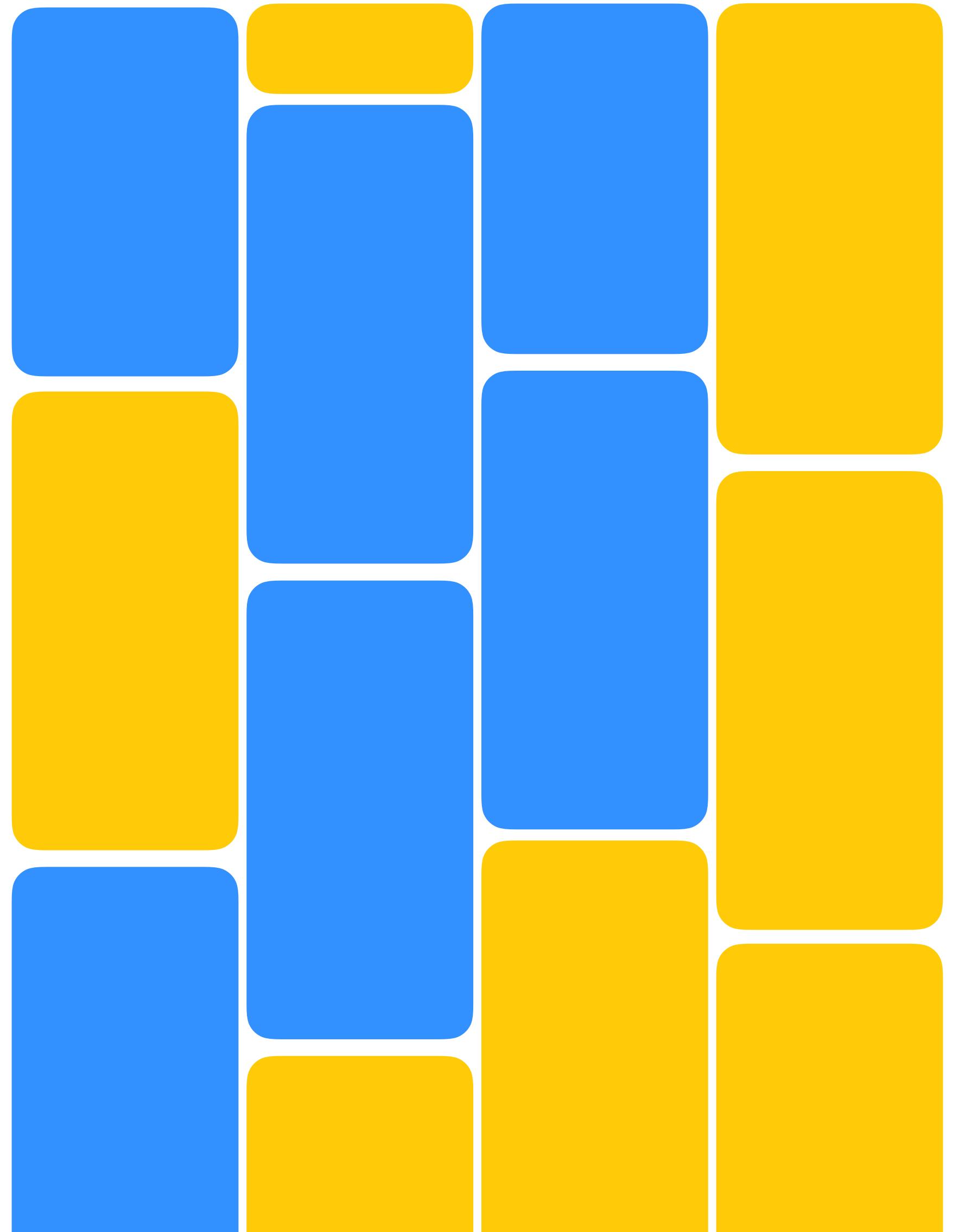
New user

Pool	# Positive Actions	# Negative Actions	# Views	Utility Function
Friends 	2 + 50	0 + 0	100 + 1000	
Recommendations 	2 + 50	0 + 0	10 + 1000	

New user

Pool	Utility Function	Expected Utility	Mapped To Ratio
Friends	 A small purple line graph showing a single sharp peak at the left end of the horizontal axis, indicating a highly skewed distribution where most utility is concentrated in a few items.	0.047	5
Recommendations	 A small purple line graph showing a single sharp peak at the left end of the horizontal axis, similar to the 'Friends' plot, indicating a highly skewed distribution.	0.051	5

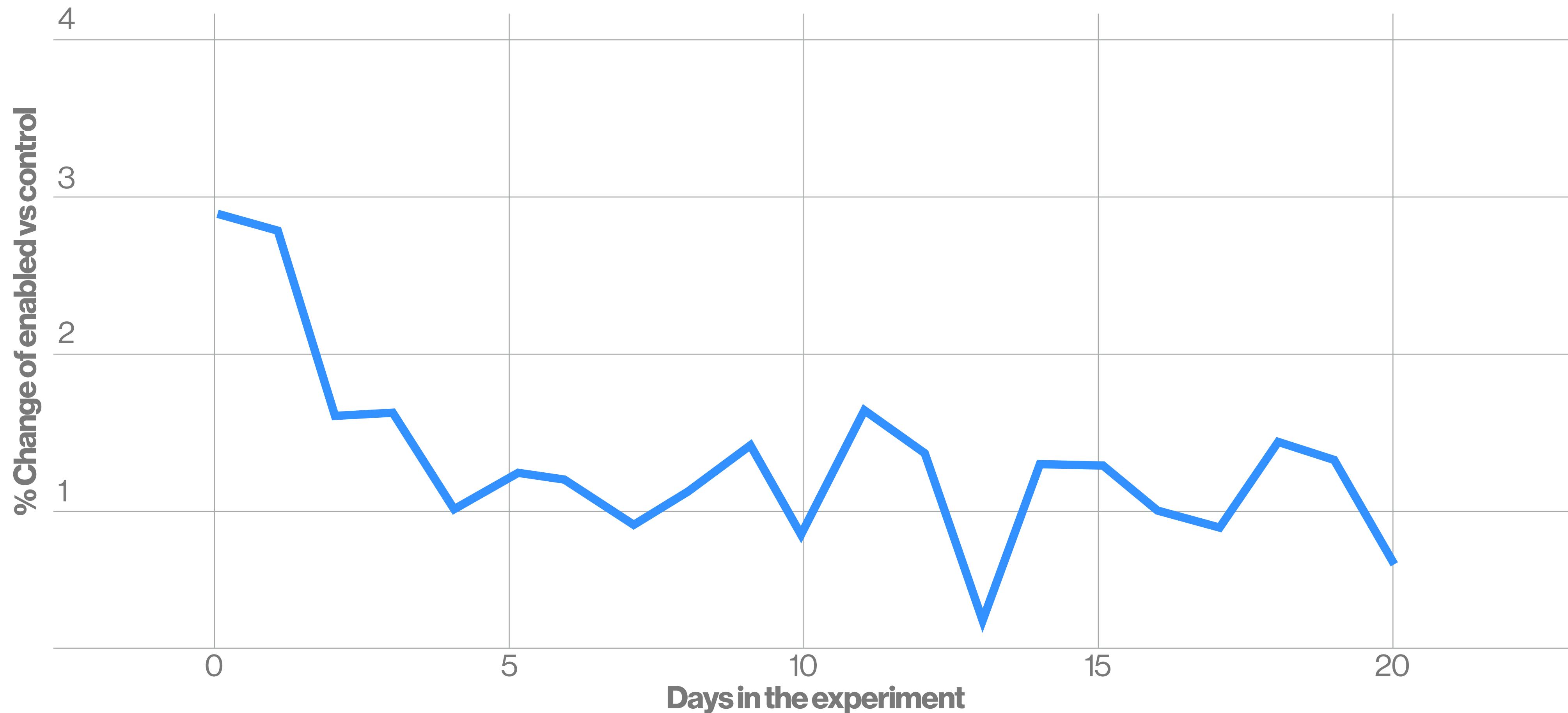
New user



How did we do?

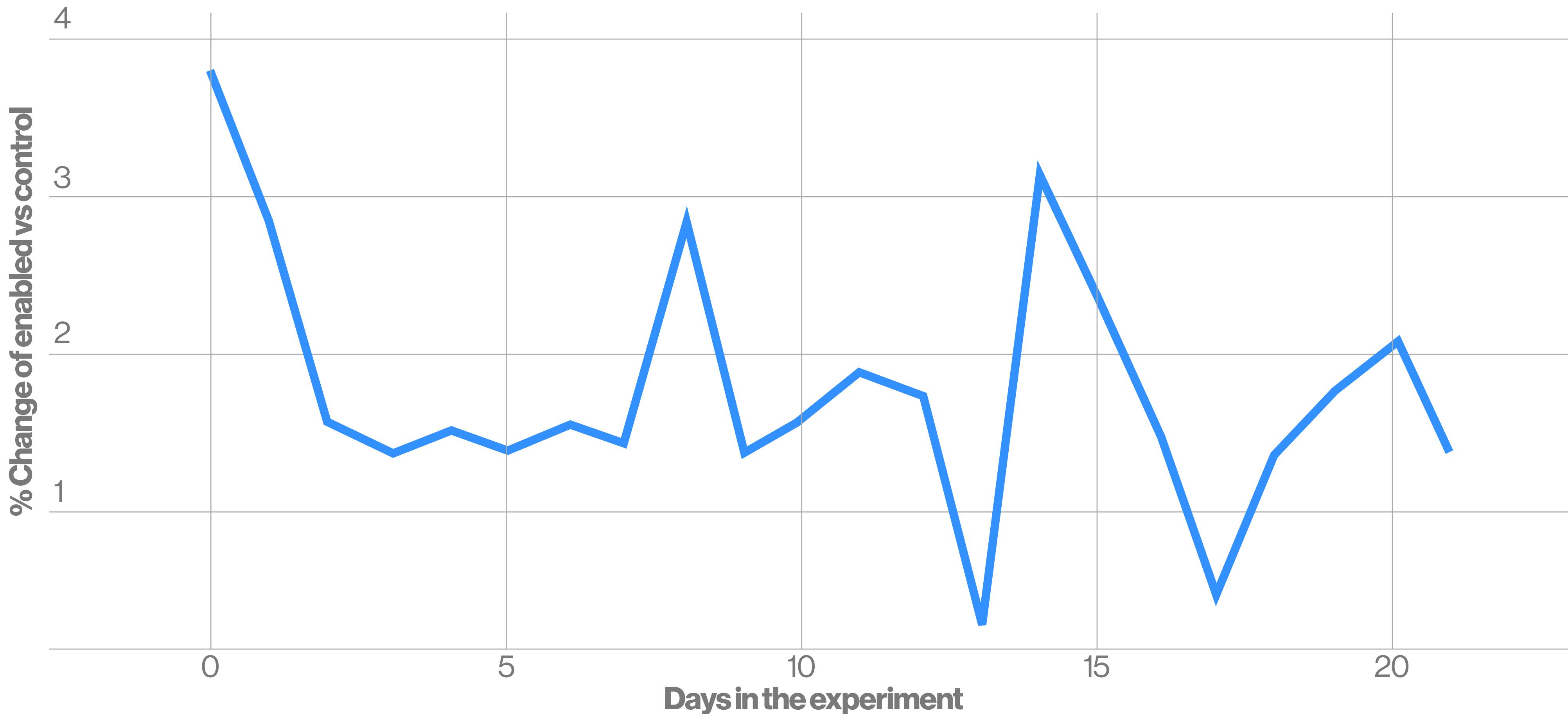
A/B experiment results

Fraction of users who take 1+ positive action

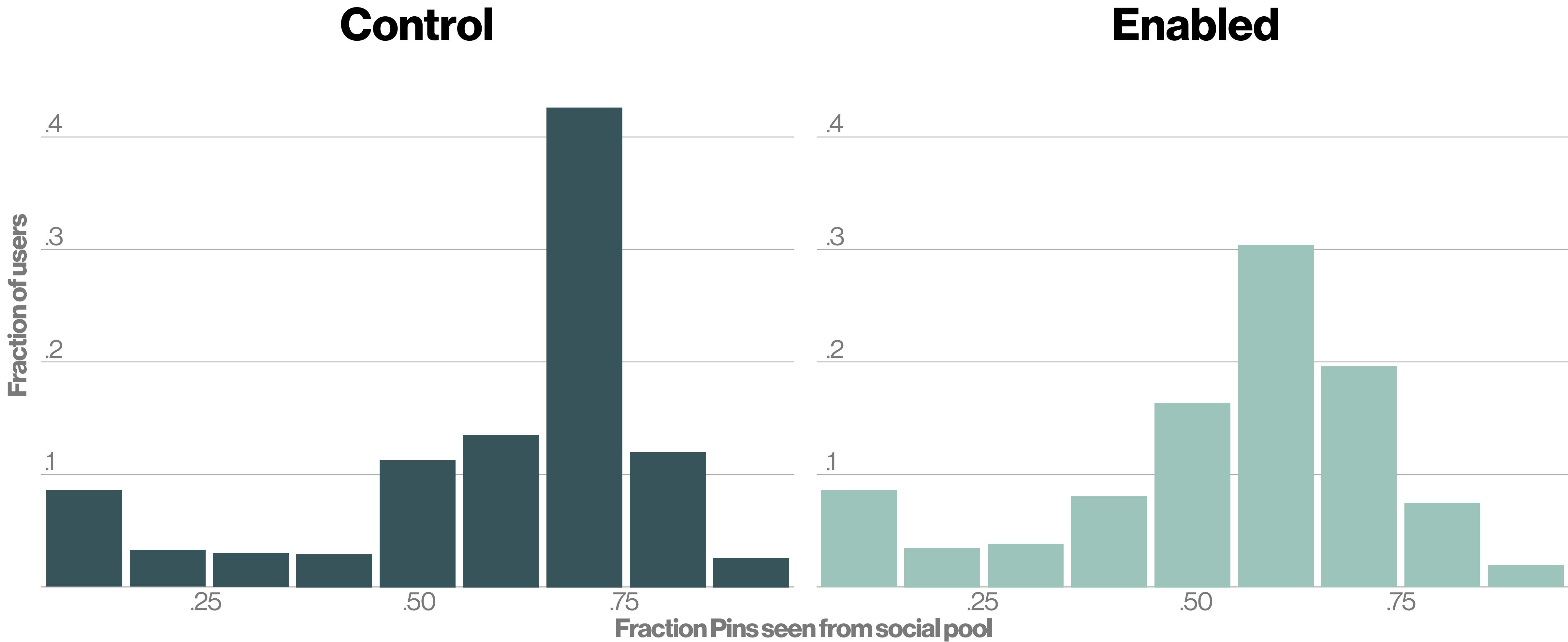


A/B experiment results

Rate of positive actions on viewed content



Personalizing the ratio



Conclusions

This model seems simple, but it worked incredibly well in practice.

Why was it successful?

- Tunable variables give us control over business objectives.
- Easy to add new pools of content.
- Didn't rely on any information from the ranking models.

thanks!

We're hiring
sdewet@pinterest.com



