

# Experiment Assignment on the Web

Jessica Stringham

[github.com/jessstringham/talks](https://github.com/jessstringham/talks)  
[@JessStringham](https://twitter.com/JessStringham)



In A/B Testing:

Should we show a visitor A or B?



In A/B Testing:

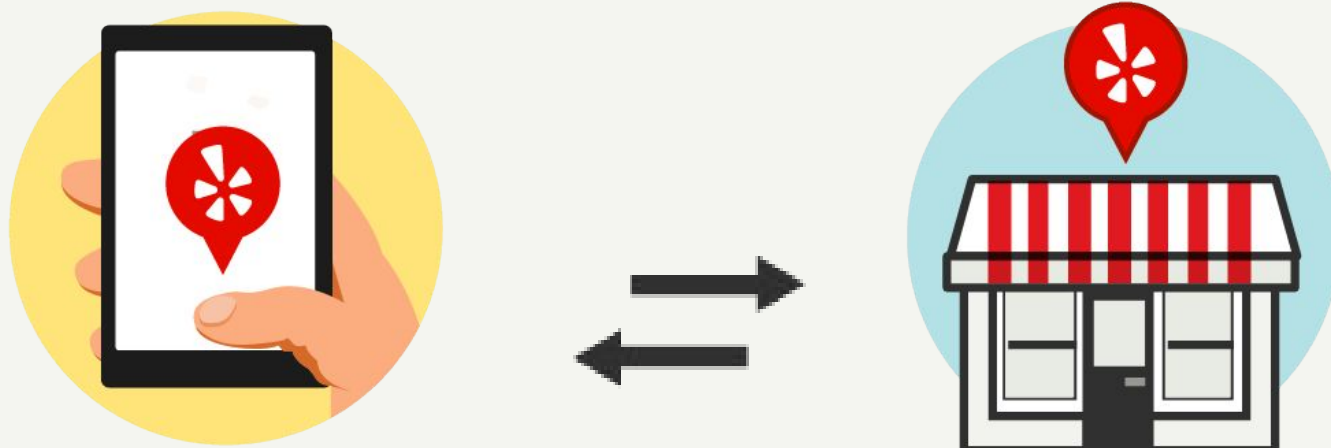
Should we show a visitor A or B?

random.choice?



# Yelp's Mission

Connecting people with great local businesses.



# Experiment assignment on the web

- Experiments on the web
- Random assignment from scratch
- Assignment in practice

# Experiment assignment on the web

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# Experiment assignment on the web

- **Experiments on the web**
- Random assignment from scratch
- Assignment in practice

# Experiments on the web

- Design
- Implementation
  - Assignment
- Data collection and analysis



Rule: Follow experiment design

# Experiments on the web

- **Design**
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which is disappointing but the taste was excellent. I would probably go back again if I was in the area to try breakfast.

Was this review ...?



**Jessica S.**  
Seattle, WA

👥 416 friends  
★ 90 reviews  
📷 493 photos

★★★★★ 8/15/2015

📍 3 check-ins

I've been going to Bob's Red Mill since I was little. After moving away from Clackamas and Oregon, I was so excited to find Bob's Red Mill products on the other side of the country. I'm so proud of this place!

Often, you'll see Bob himself here! Super cool!

Was this review ...?



**Andrew L.**  
Gresham, OR

👥 76 friends  
★ 154 reviews  
📷 104 photos

★★★★★ 9/9/2015

📍 1 check-in

1st time here . A friend told me about here so we were compelled to try.. I had a steak and eggs for 12\$ and it was as amazing!!! The biscuits are really great and Brittany brought our food really really fast. They have seating

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Was this review ...?

 Useful

 Funny

 Cool



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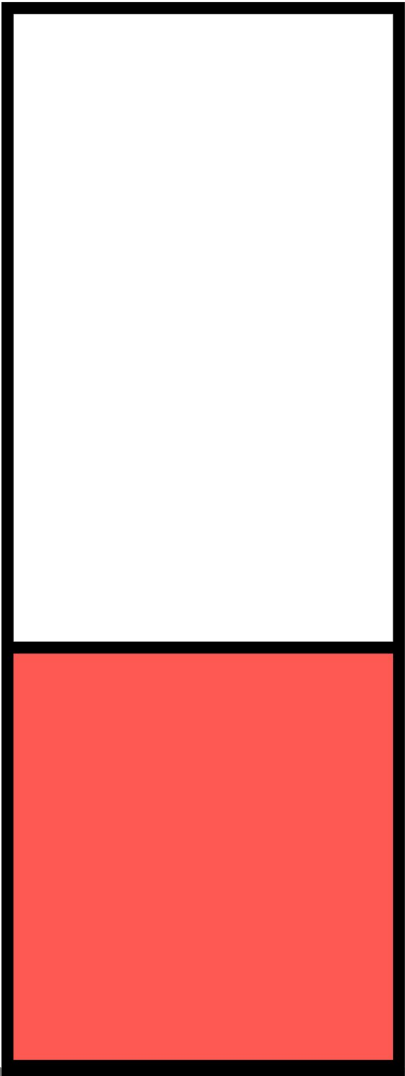
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100% visitors

0% visitors



40% visitors love it



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Does the color make a difference?



# A/B Test


## 50% red

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# Implement variants

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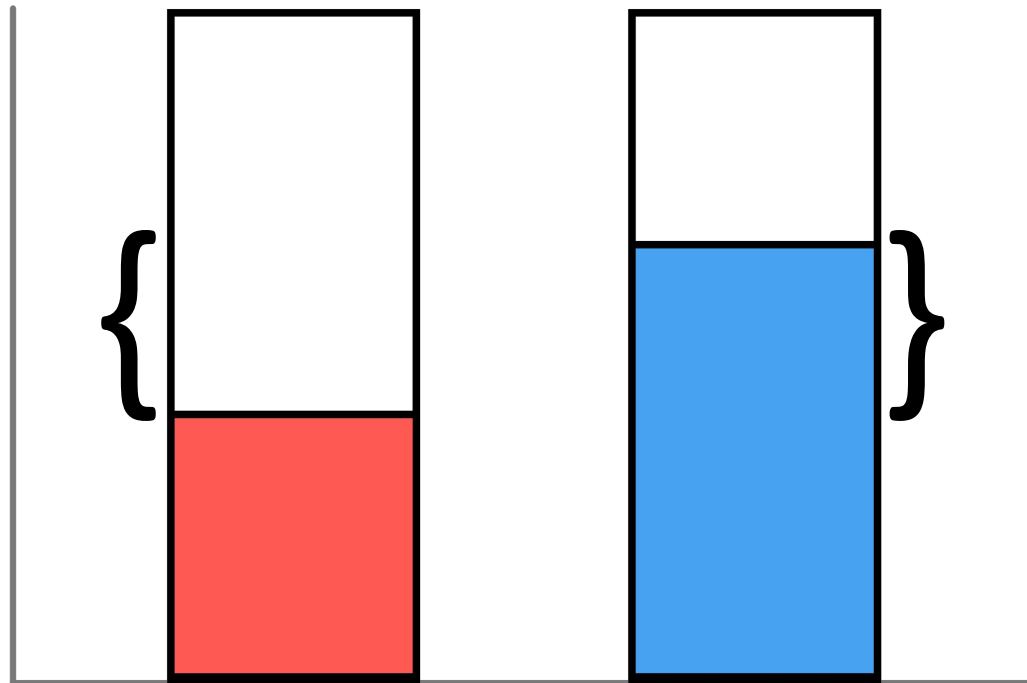
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# Does the color make a difference?



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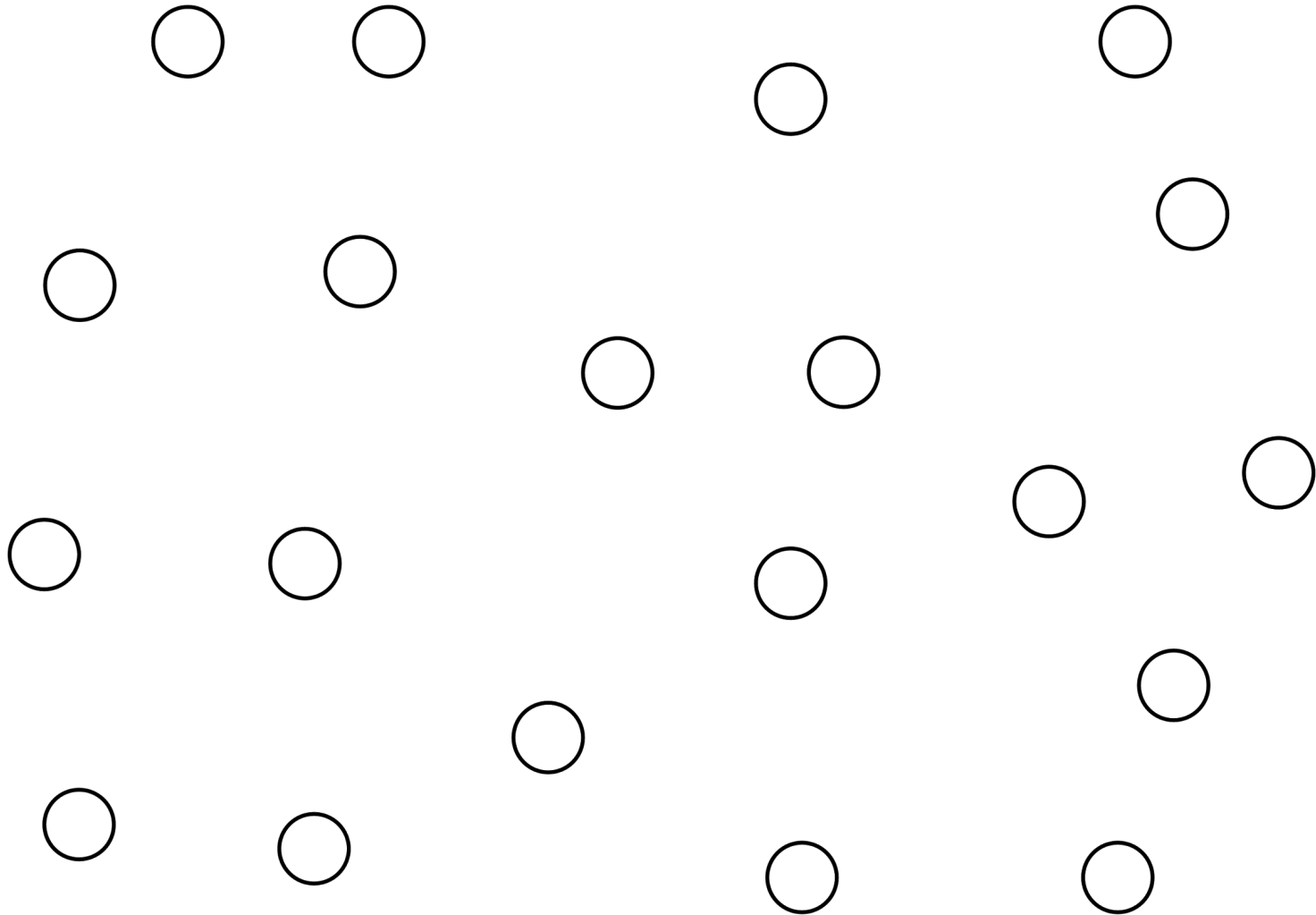
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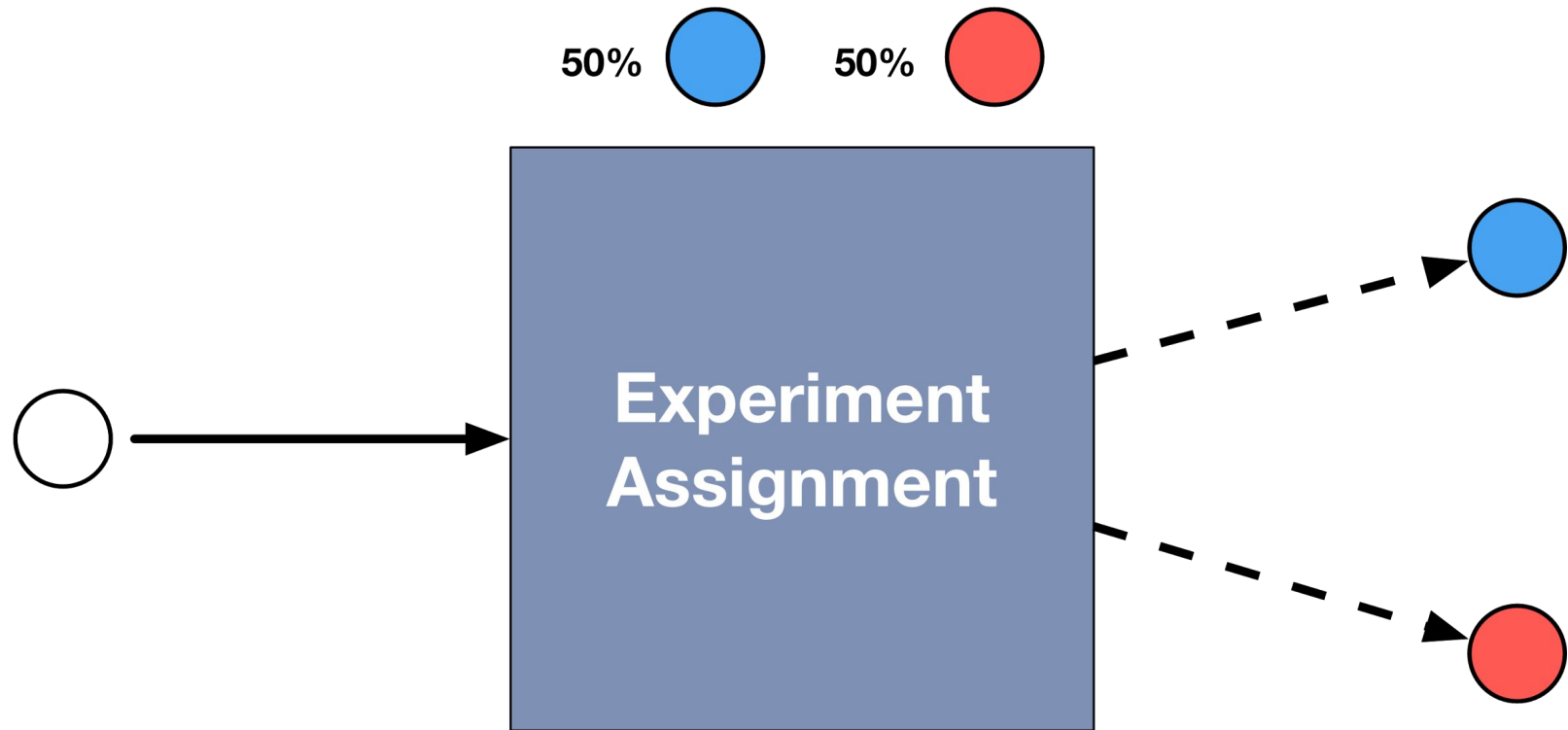
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# Randomly assign

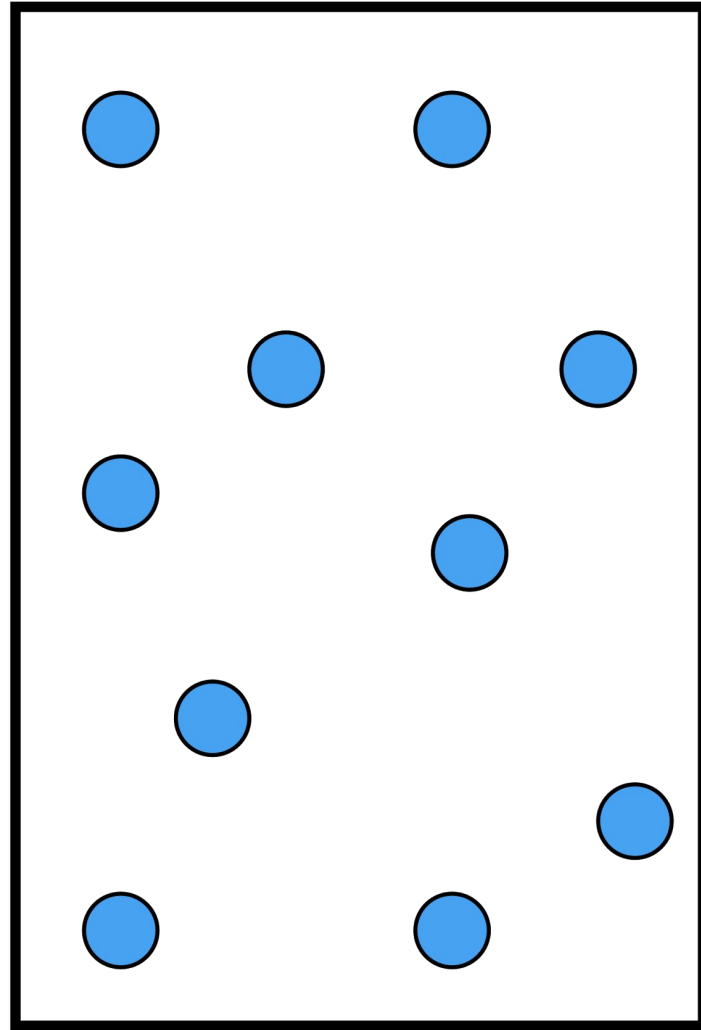
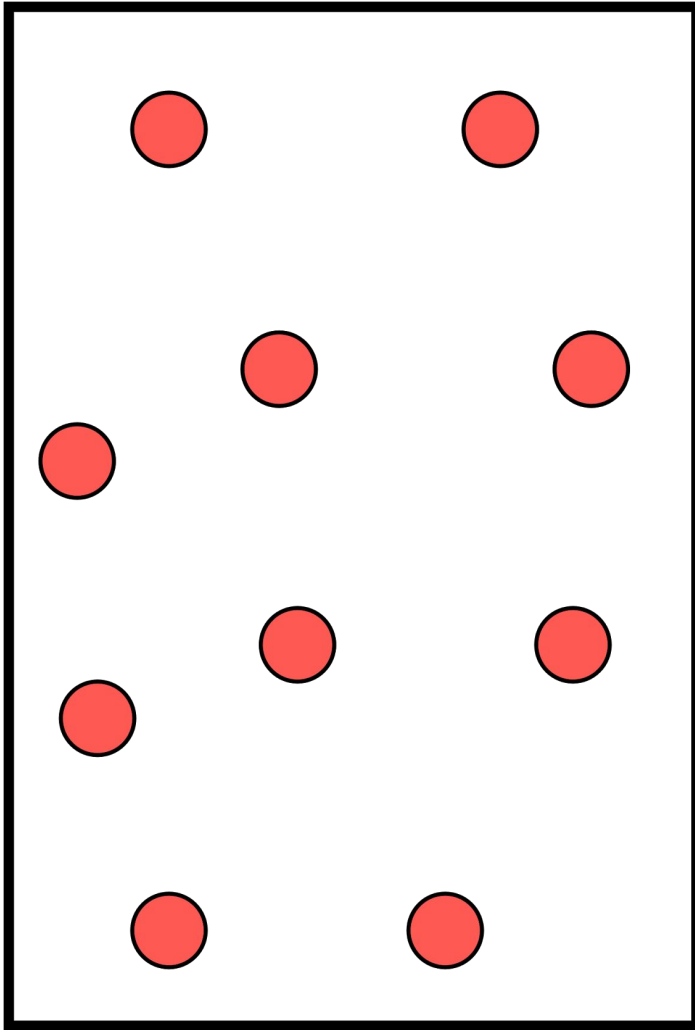


# Randomly assign

\*with enough traffic



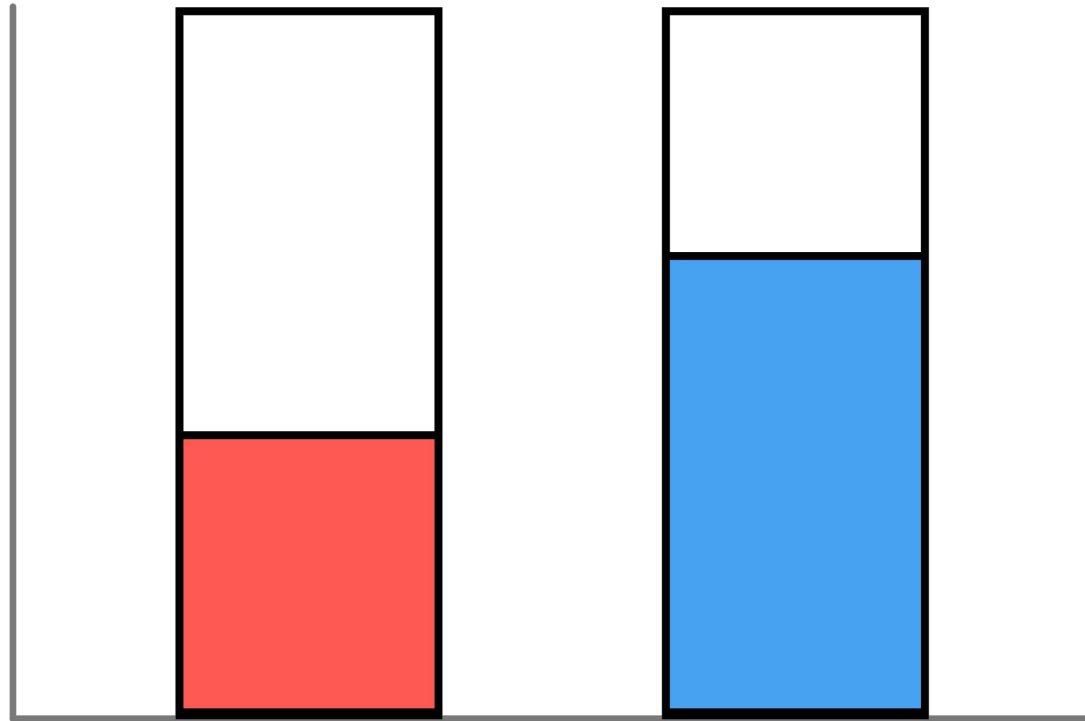
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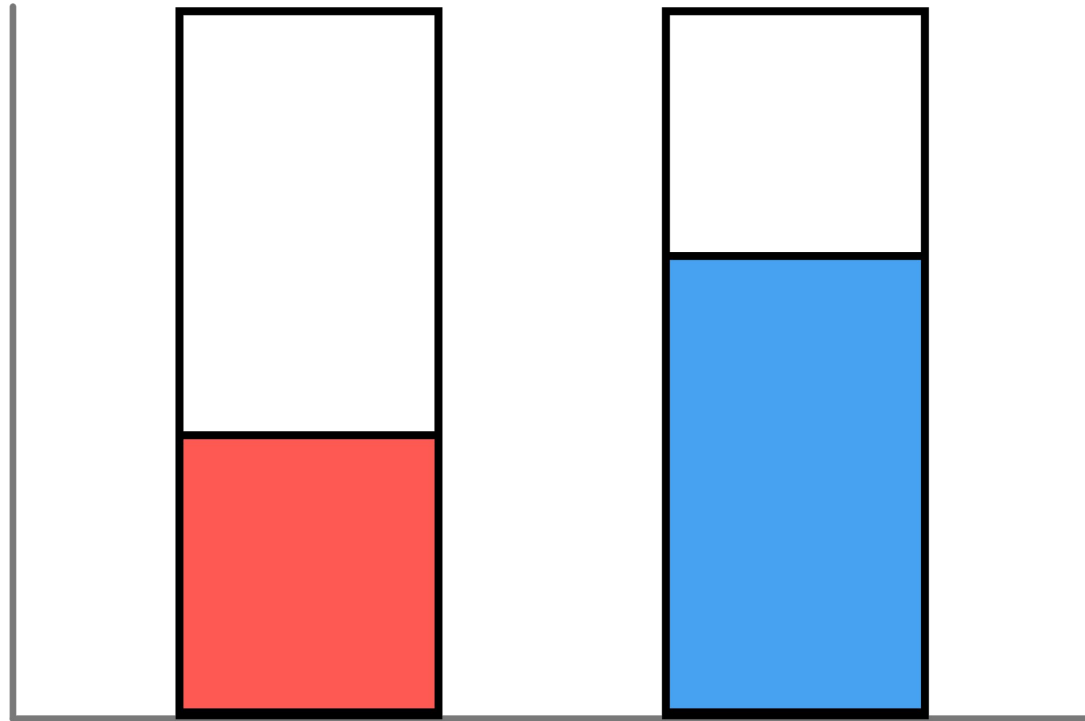
Rule: *Avoid introducing bias*

Goal of A/B Test:

Does the color make a difference?

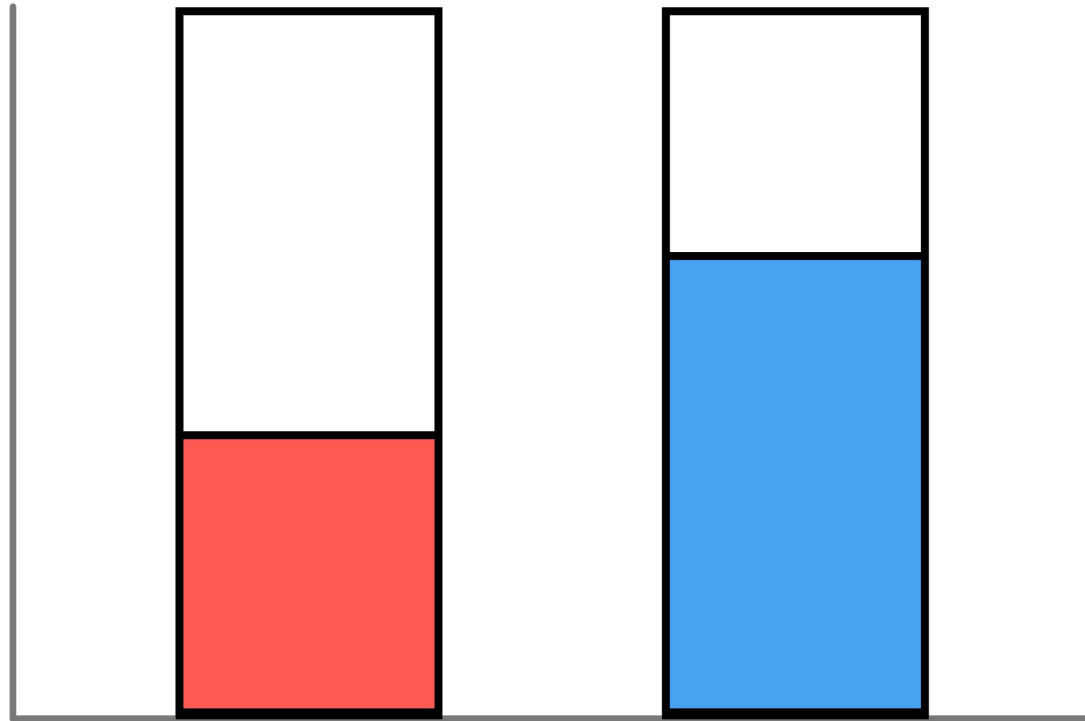


# Are we comparing just the effects of color?



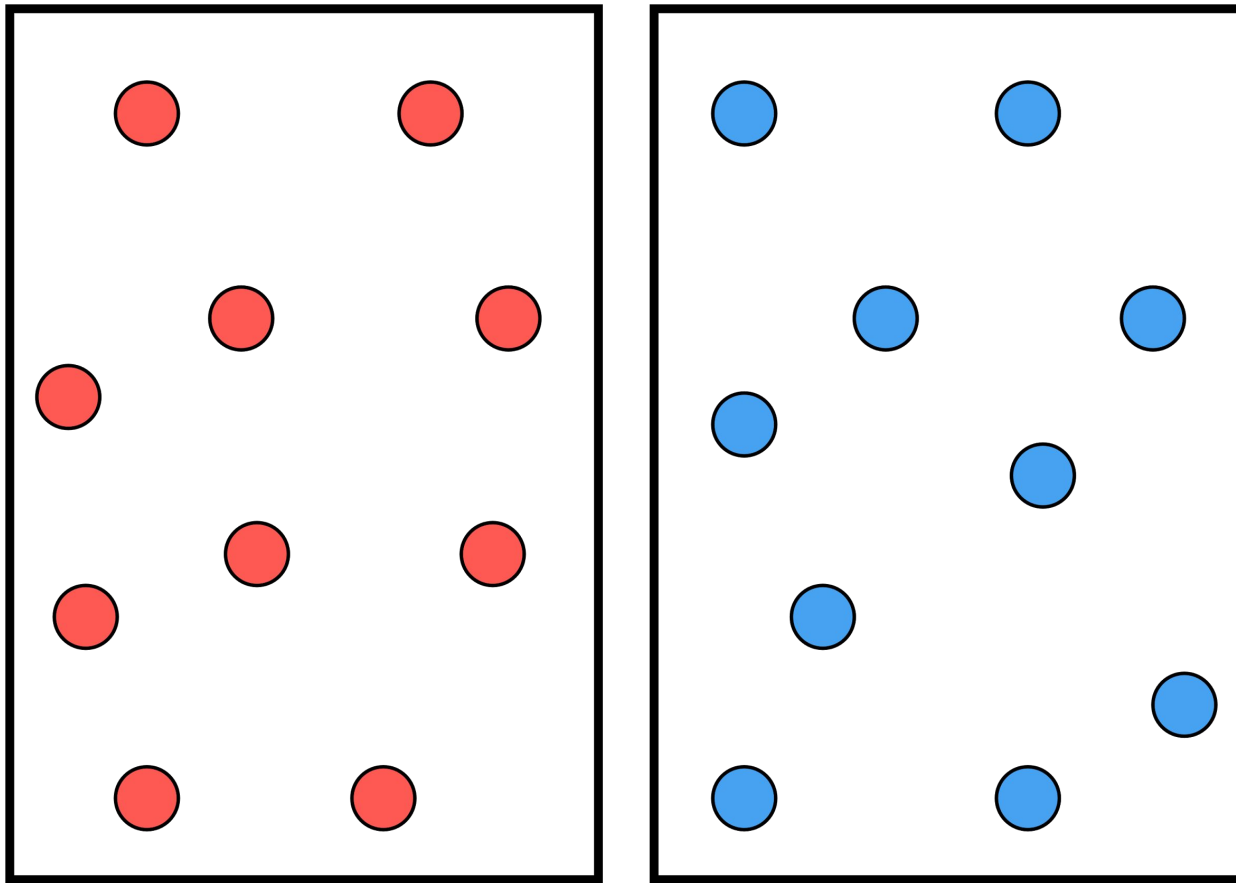
# Are we comparing just the effects of color?

(Spoilers: probably not without random assignment)



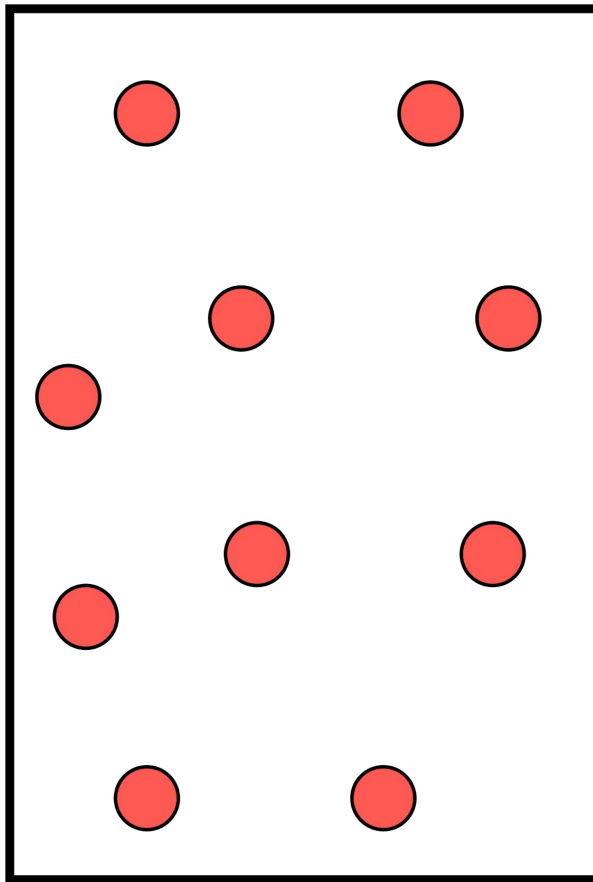


# What if we don't randomly assign?

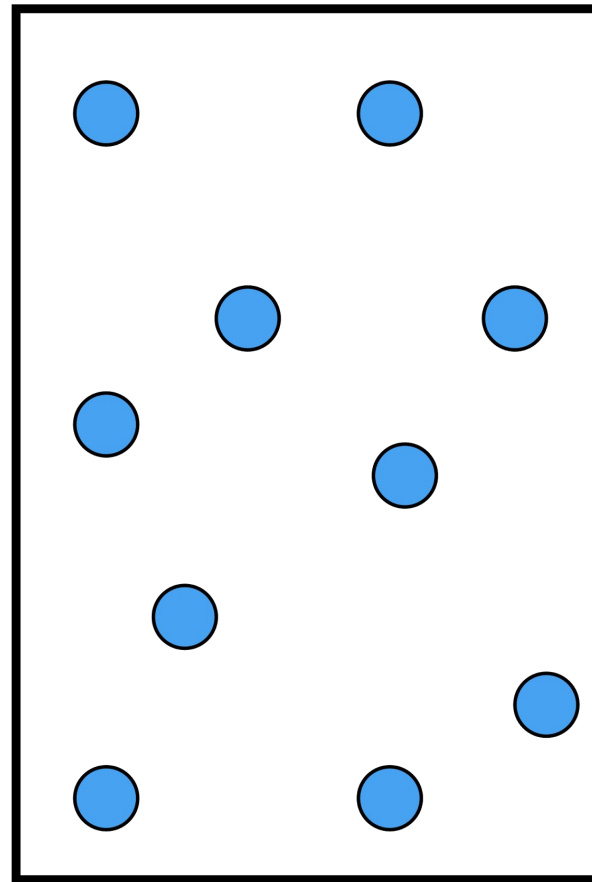


# Assign based on time (not random)

**Week 1**

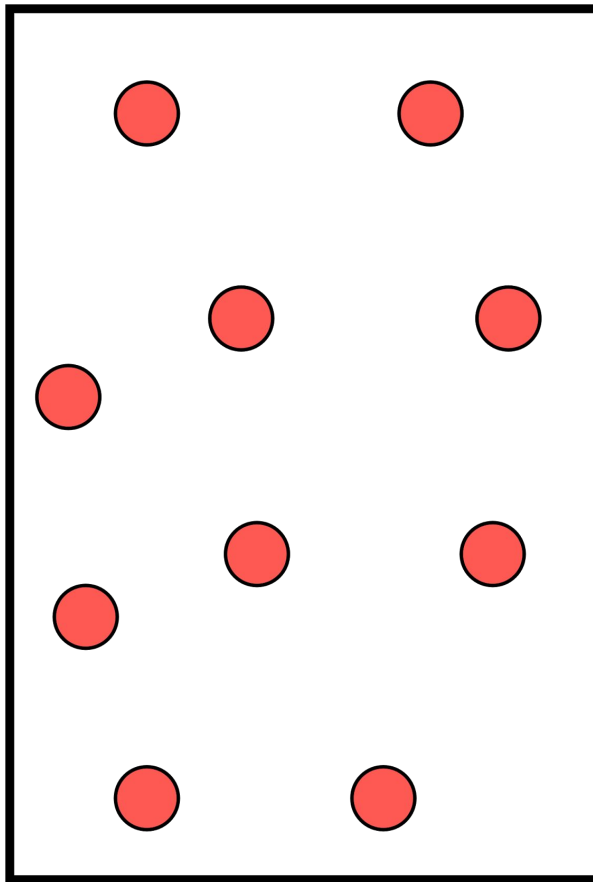


**Week 2**

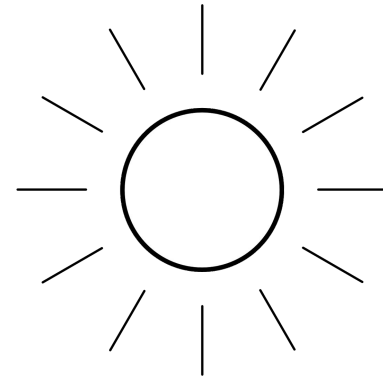
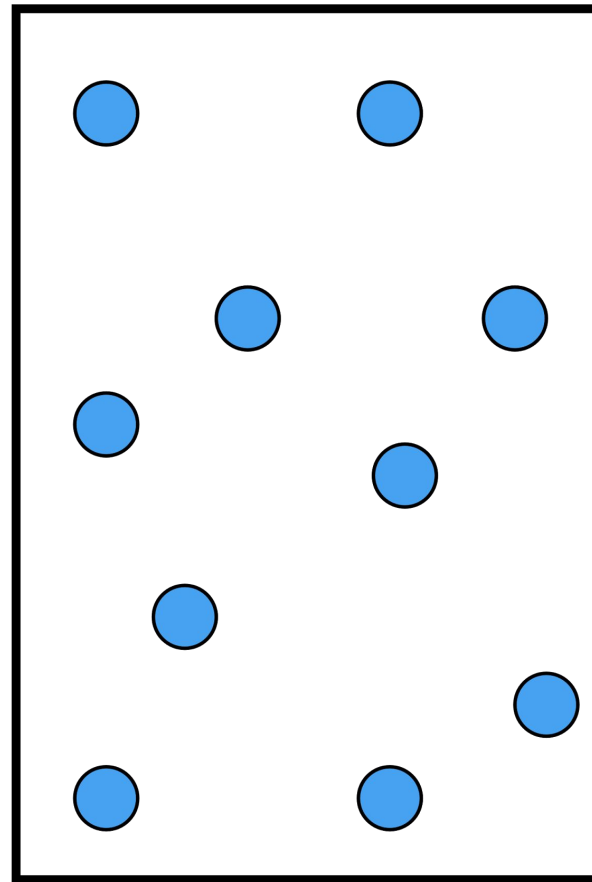


# Unknown variables

**Week 1**

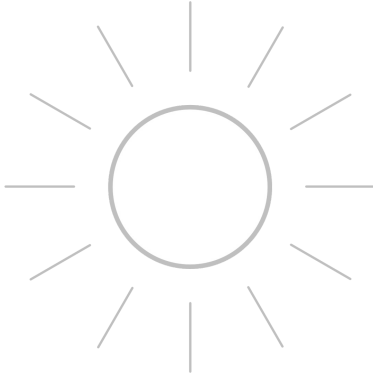
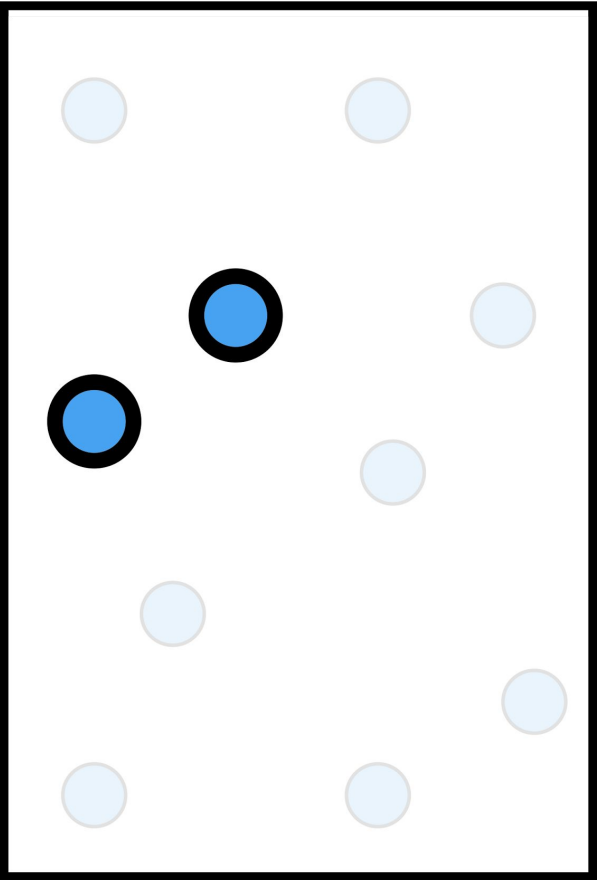
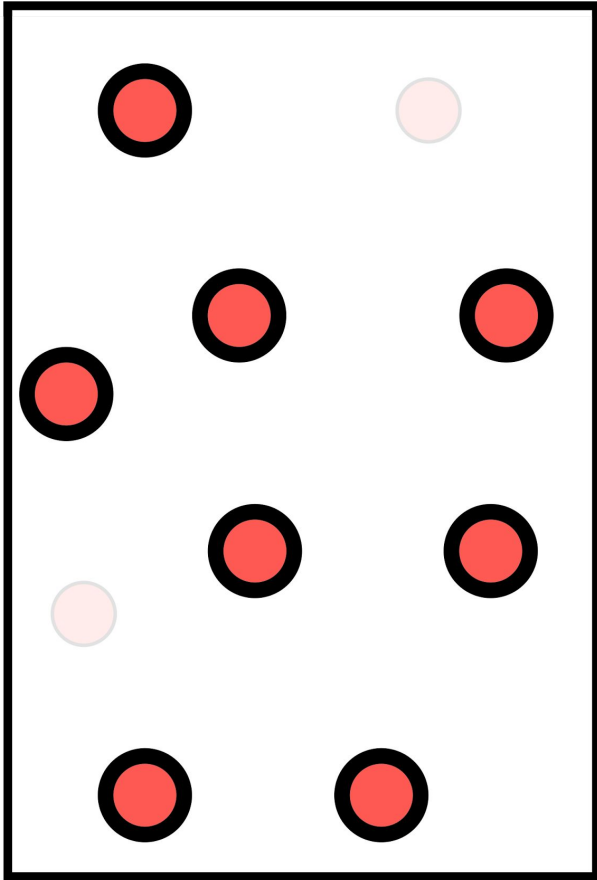


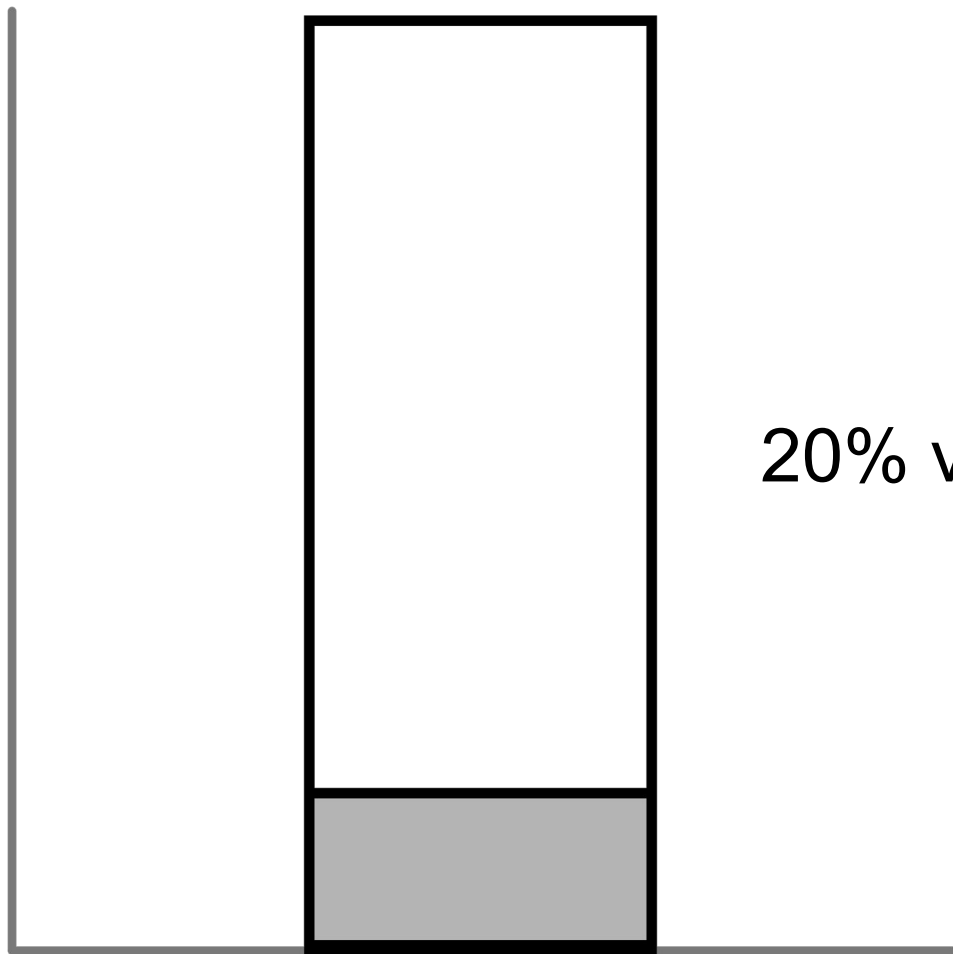
**Week 2**



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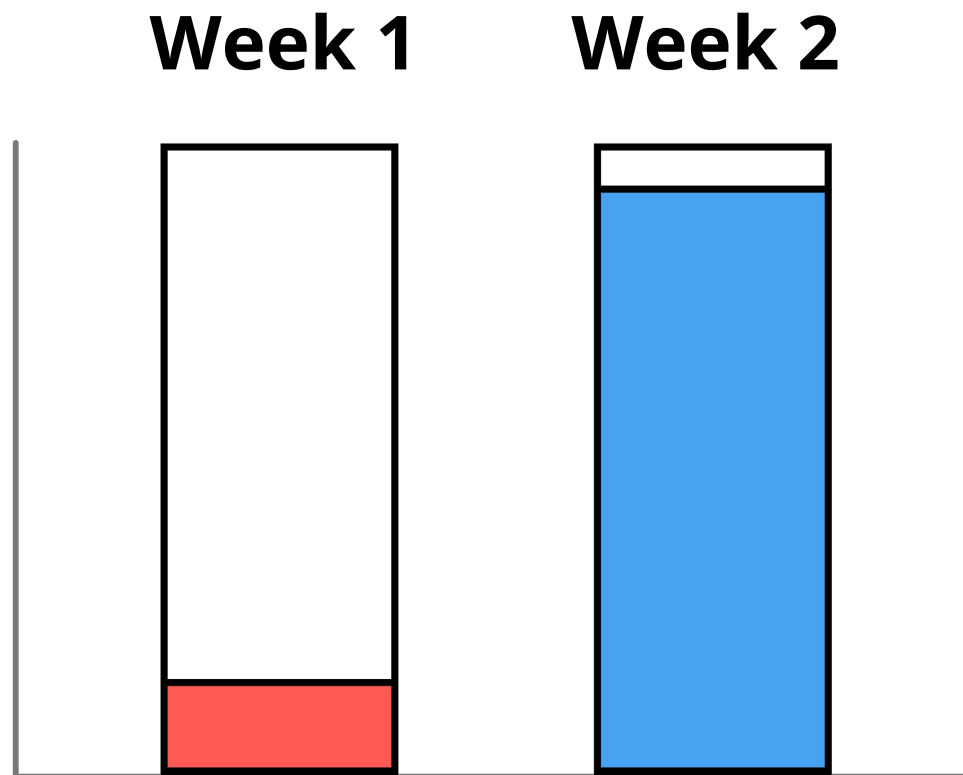
**Week 2**





20% visitors love it

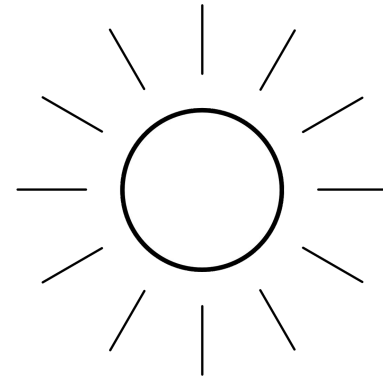
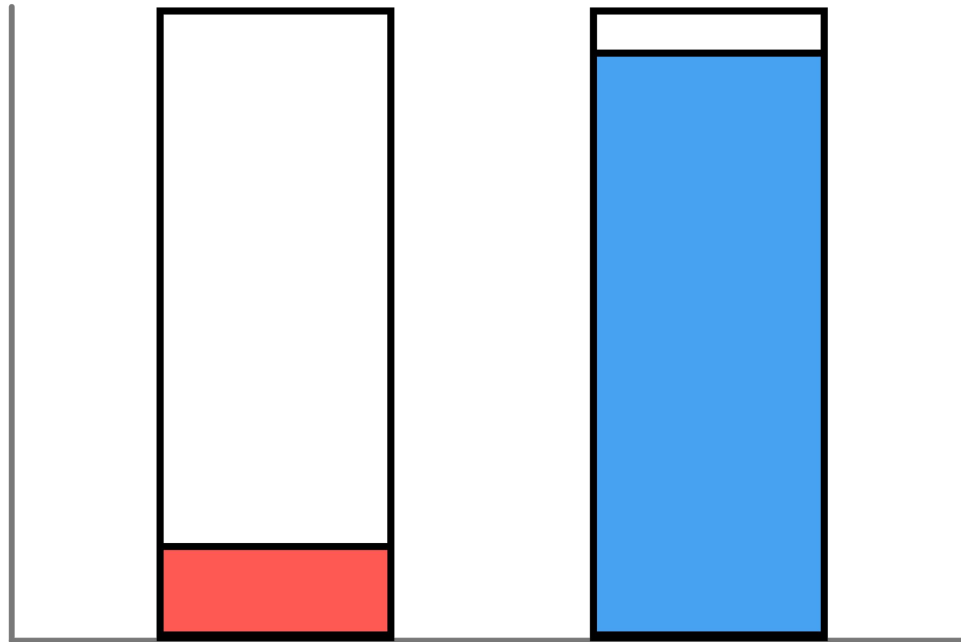
# Are we comparing just the effects of color?



# No, because of unknown variables

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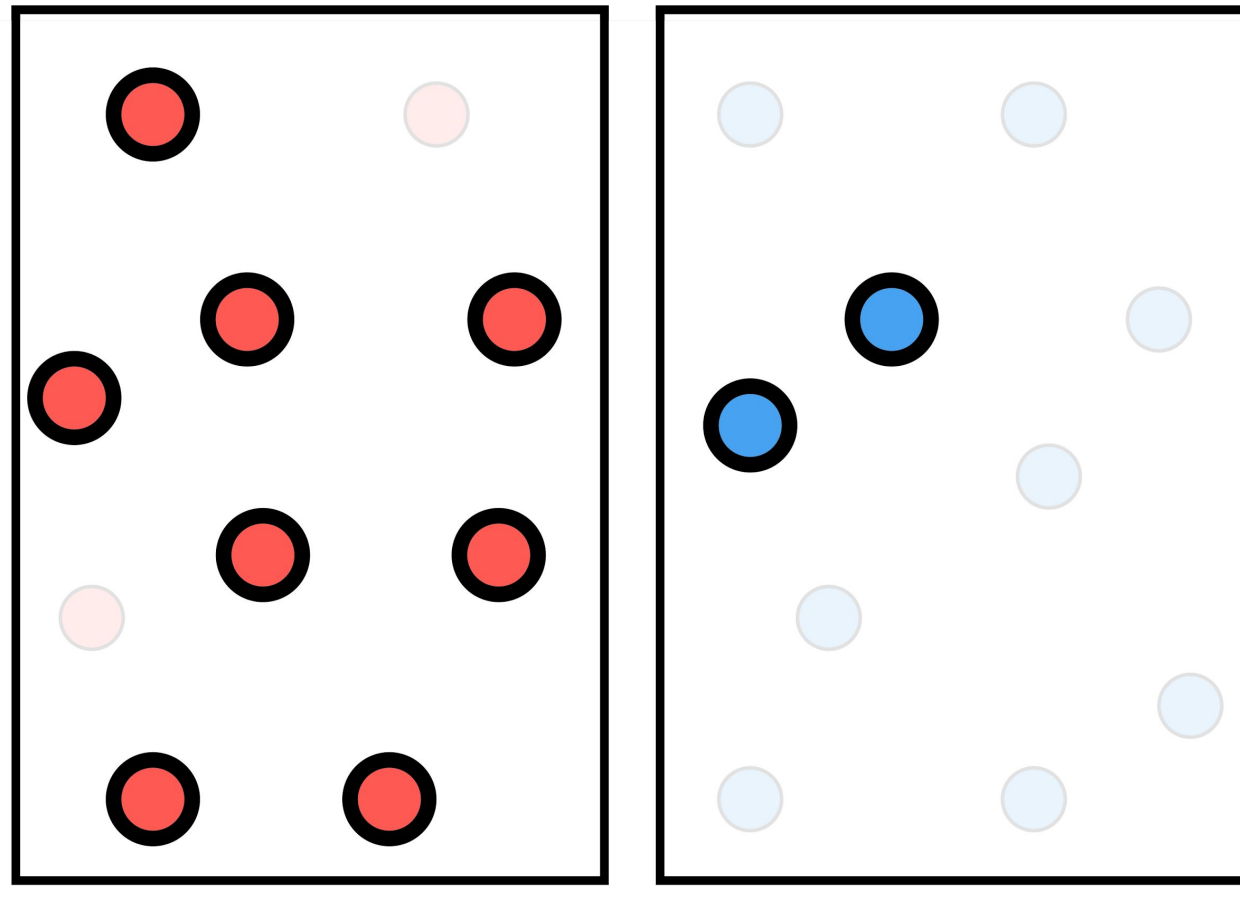
**Week 2**



# Bias

Week 1

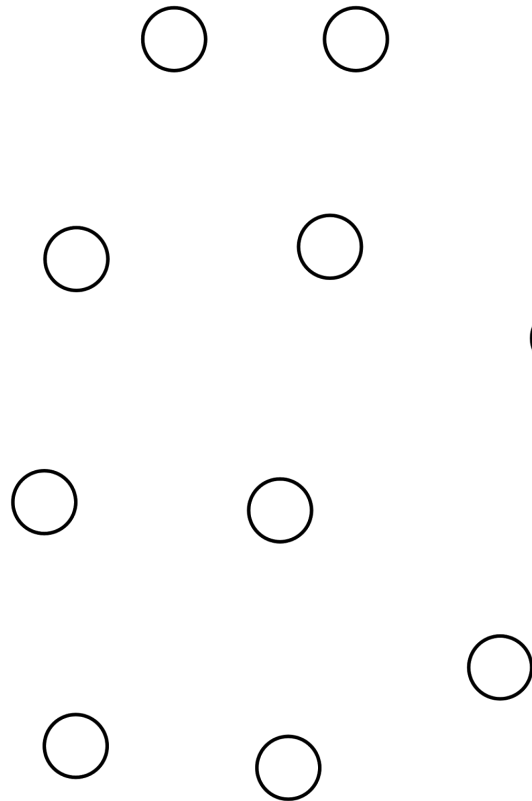
Week 2



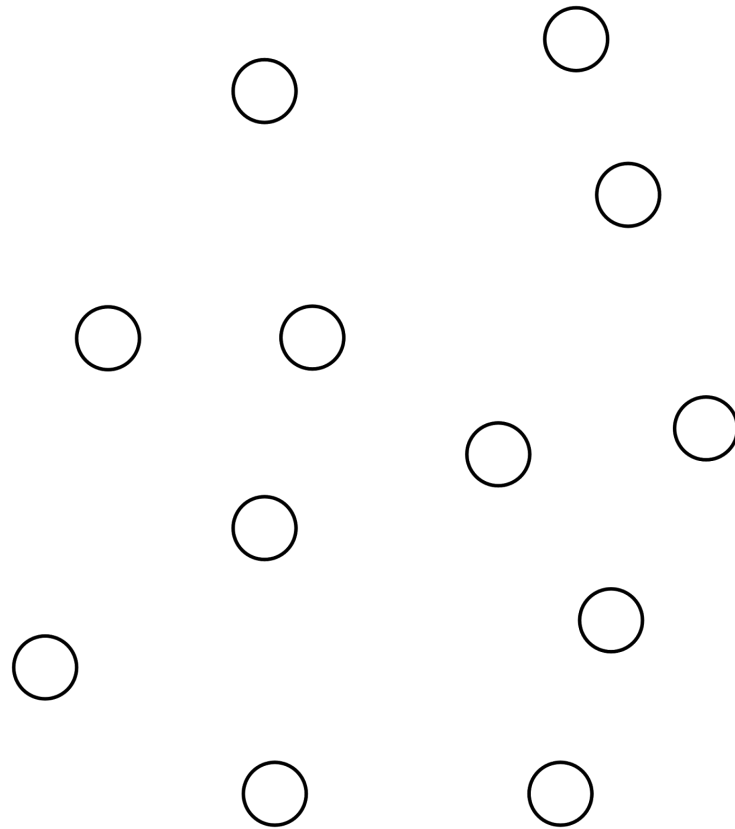


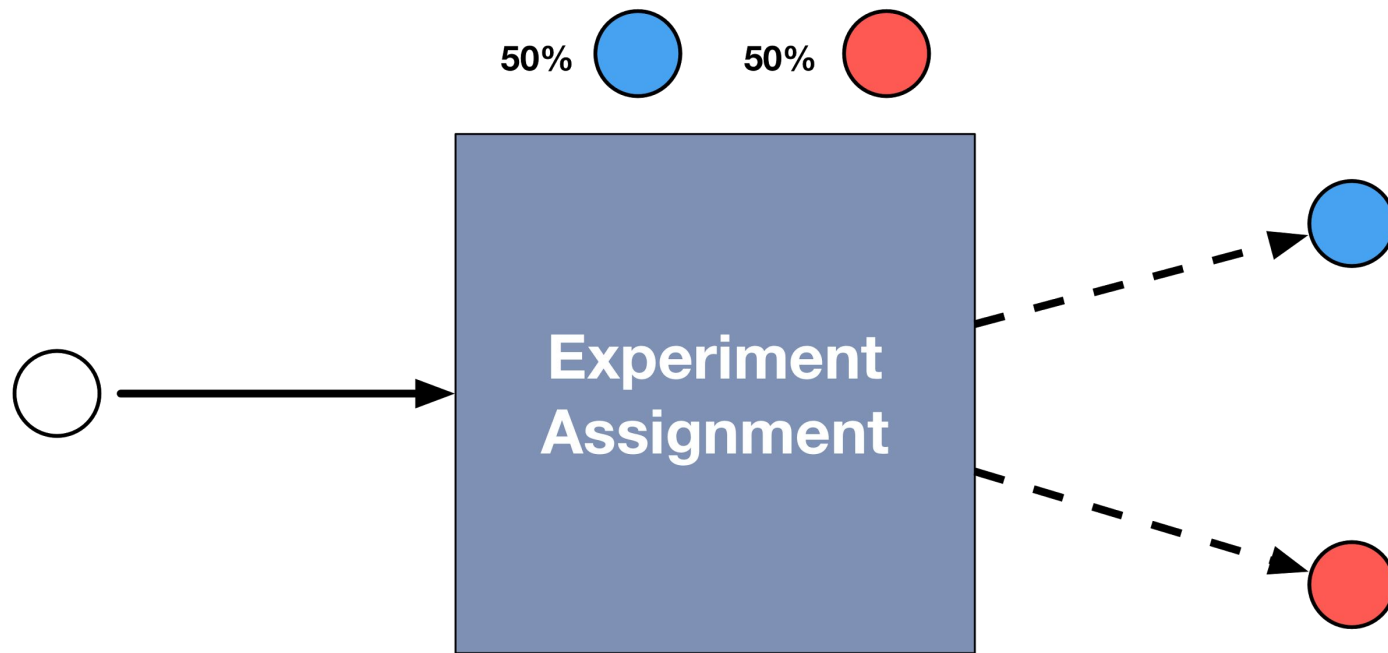
# How can we avoid bias here?

**Week 1**



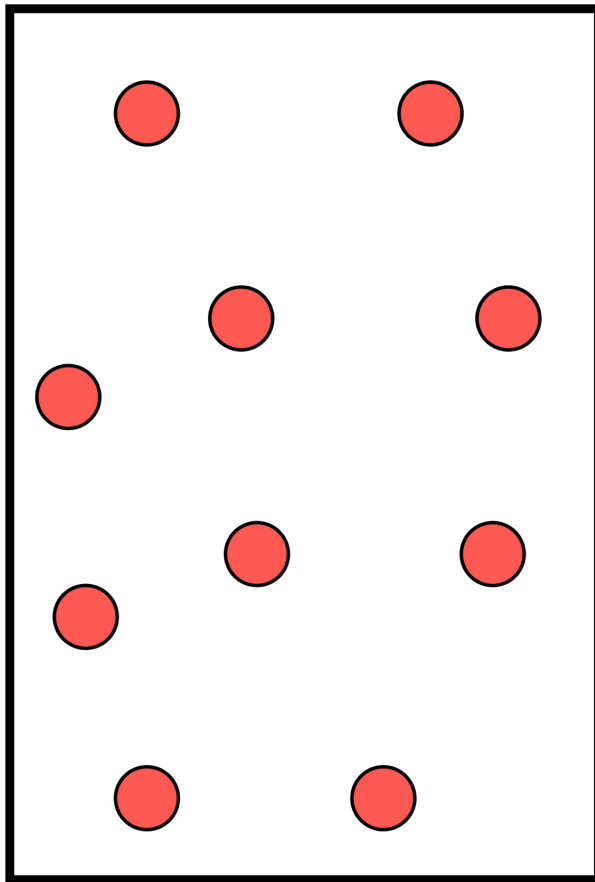
**Week 2**



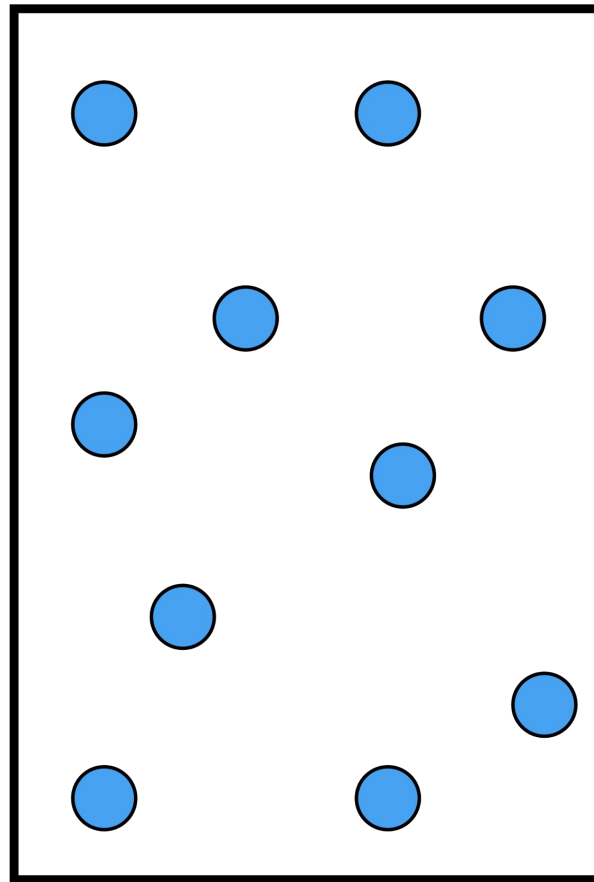


# Random assignment

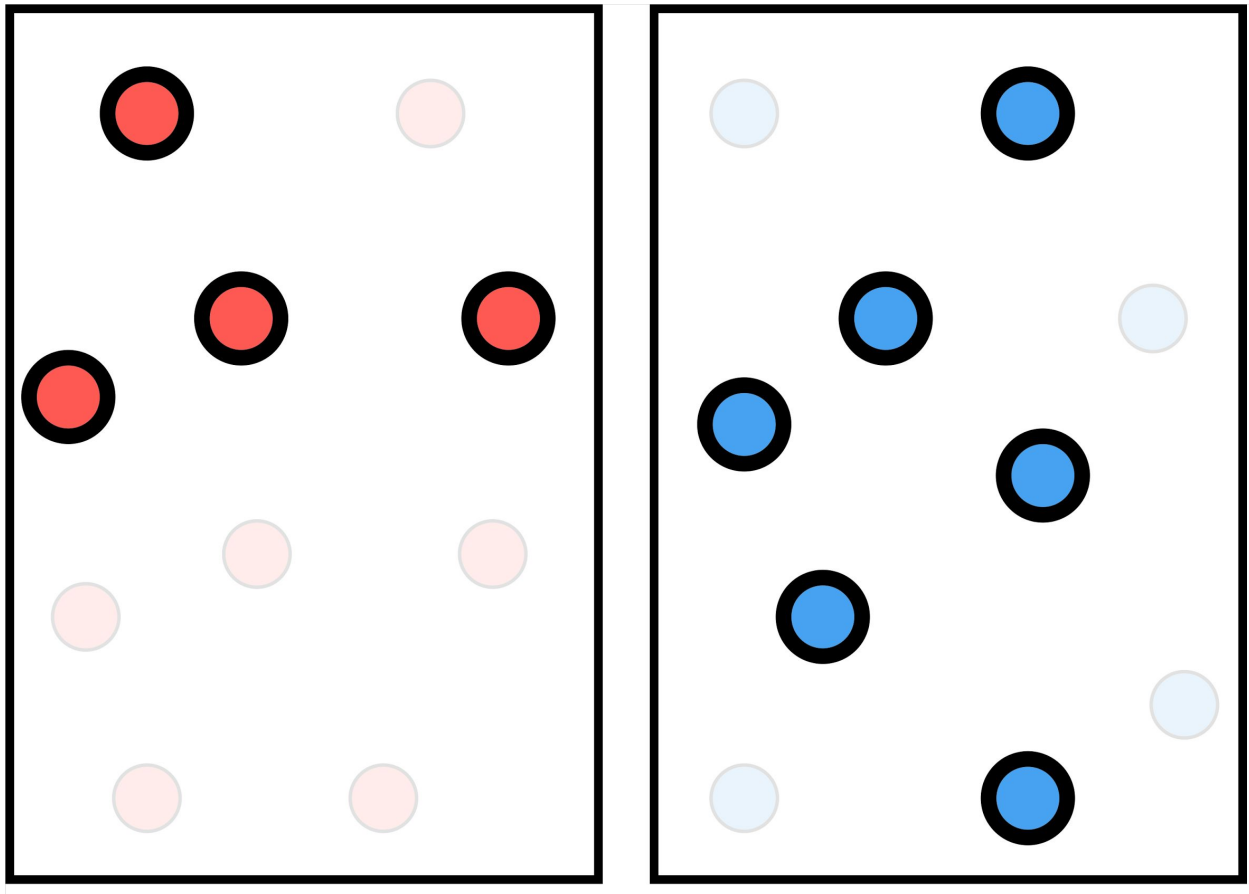
= red



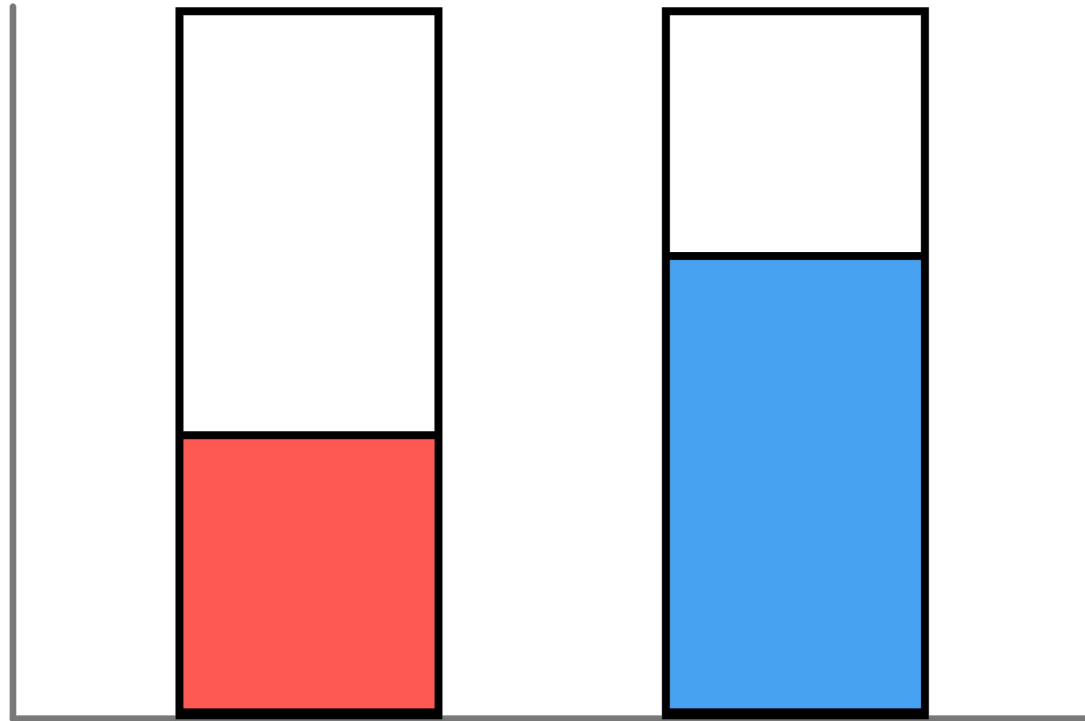
= blue



# Unknown variable

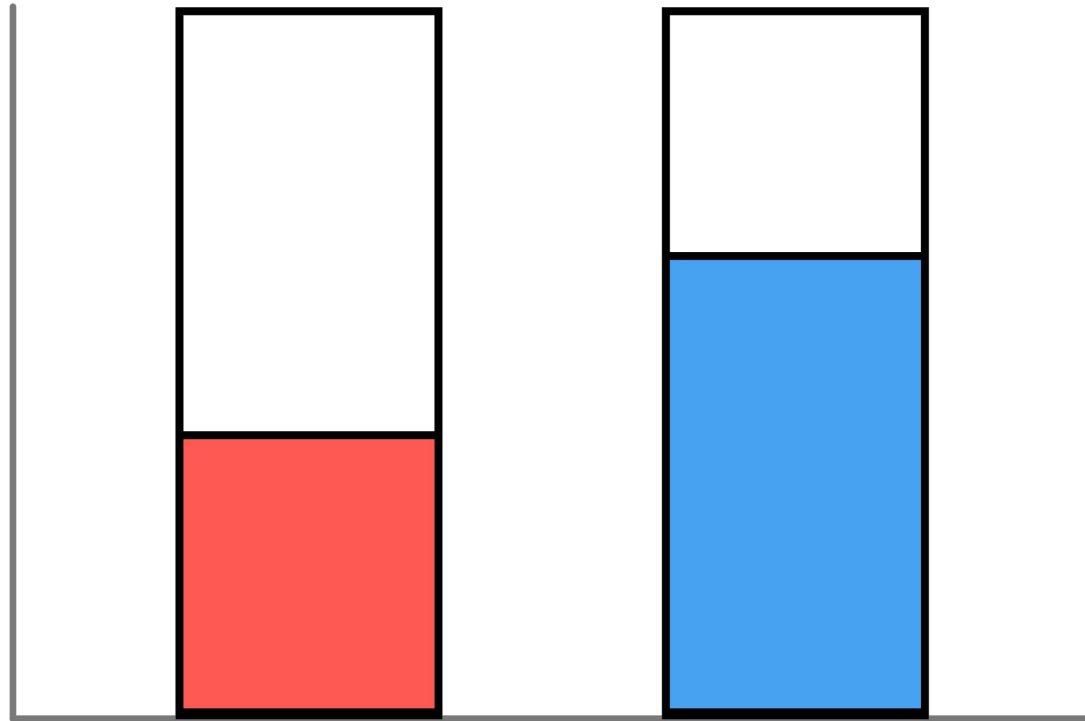


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# Are we comparing just the effects of color?

Mostly...

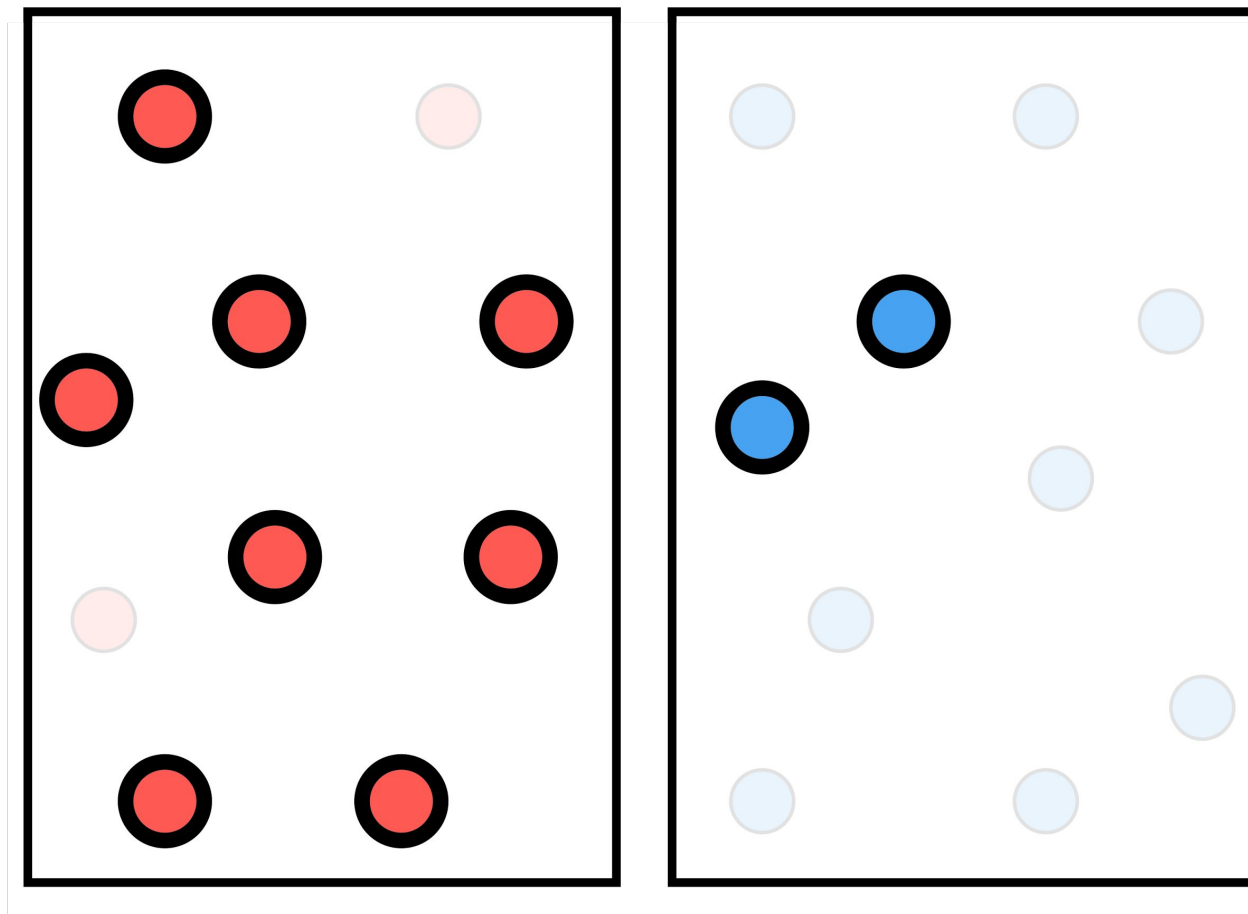


# Why random?

Avoid bias from unknown variables

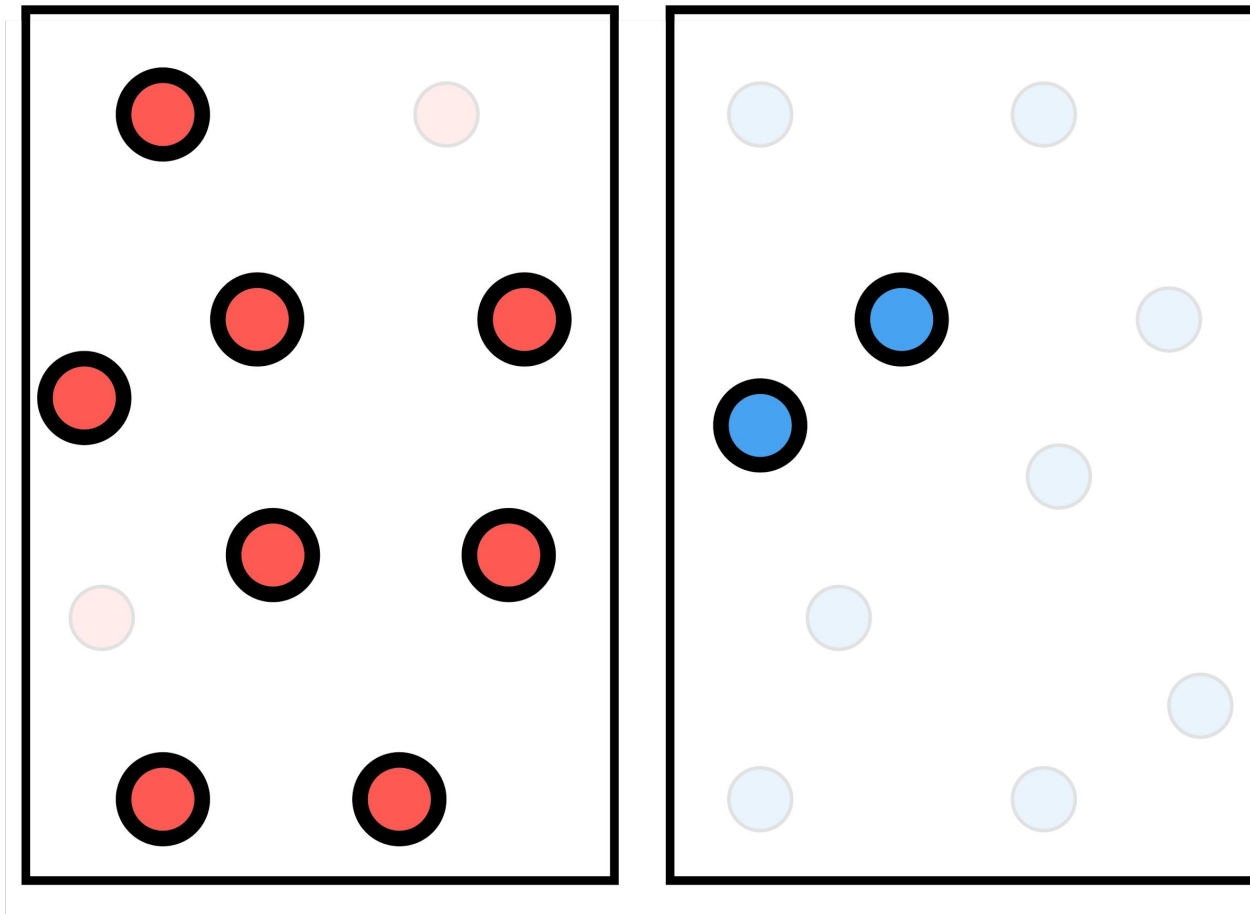
**Week 1**

**Week 2**



# Can introduce bias in other ways

???





Rule: *Avoid introducing bias*

# Assignment Rules

Follow experiment design

Avoid introducing bias

# Experiment assignment on the web

- **Experiments on the web**
- Random assignment from scratch
- Assignment in practice

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- **Random assignment from scratch**
- Assignment in practice

# Random assignment from scratch

- `random.choice`
- Experimental units
- Deterministic assignment

# Random assignment from scratch

- **random.choice**
- Experimental units
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Was this review ...?

 Useful

 Funny

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```
@app.route('/reviews/<page_id>')
def reviews(...):
    ...
    color = 'red'
    ...
```



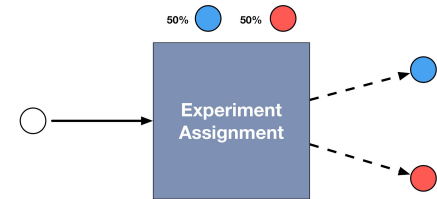
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@app.route('/reviews/<page_id>')  
def reviews(...):
```

```
    ...
```

```
-     color = 'red'
```

```
+     color = choose_color_assignment()
```

```
    ...
```

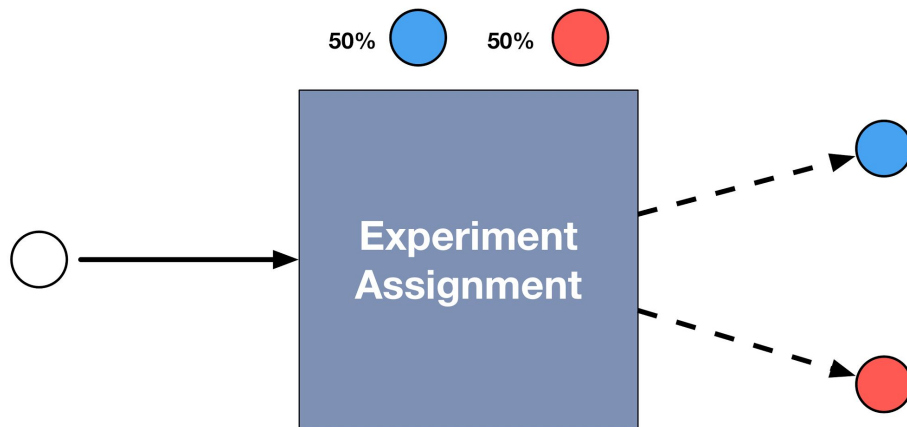


```
>>> choose_color_assignment()  
red
```

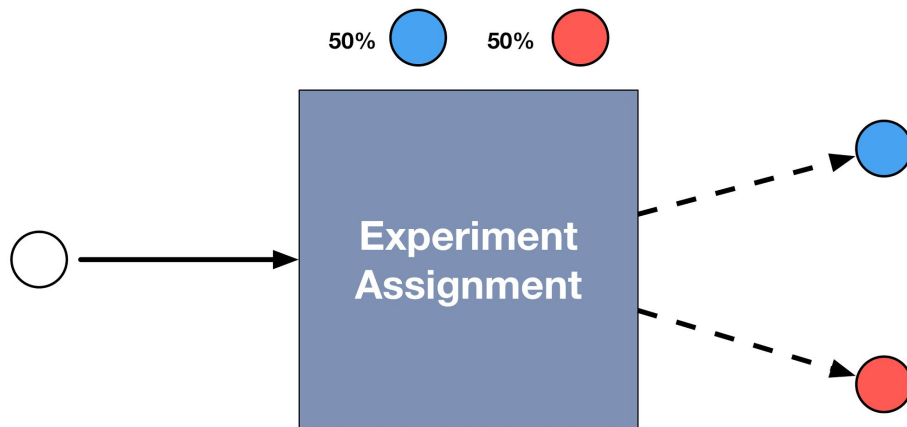
```
>>> choose_color_assignment()  
blue
```

```
def choose_color_assignment():
```

```
    ...
```



```
def choose_color_assignment():  
    return random.choice(['red', 'blue'])
```



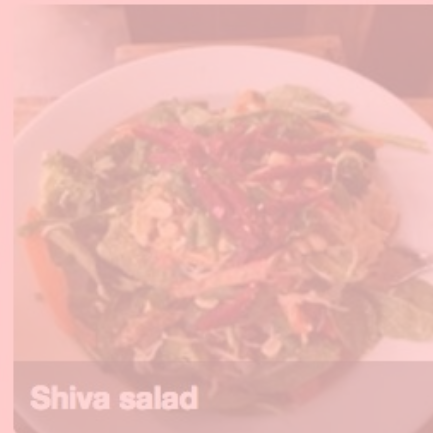
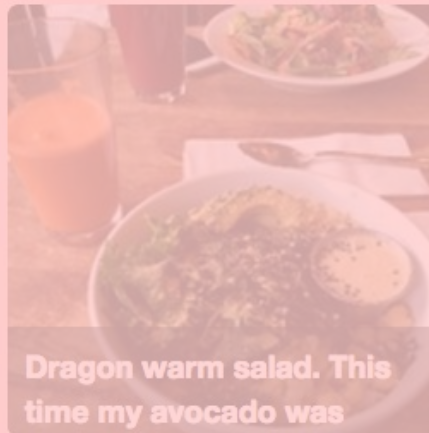
# /reviews/1

.75 cents for additional salad dressing. Took a star off for that! I personally need a bit more dressing, otherwise too bland for me.

Great service at the cashier.

They bring the food to you.

You bus your own table afterwards.



Was this review ...?



Useful 1



Funny



Cool

# /reviews/2



👥 227 friends  
★ 112 reviews  
📷 174 photos  
Elite '17

If you like clean, healthy eating this place is for you. The menu is all vegetarian but that doesn't mean it's not filling. Each dish has different flavors and consistencies to become a unique items on the menu.

The staff here is very nice, quick, and helpful with recommendations. The best thing about it is the price. For the location and the type of food, it is very reasonable. This type of food is amazing and doesn't weigh you down for lunch. If I lived / worked closer I would eat here multiple times a week.

Was this review ...?



Useful 2



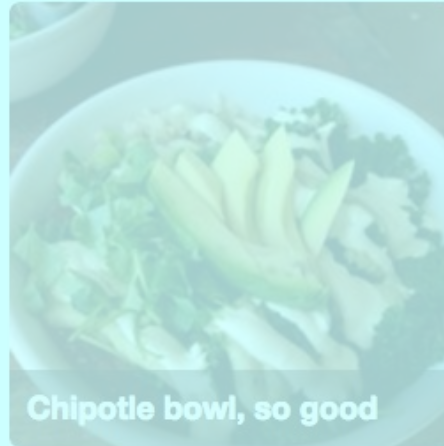
Funny



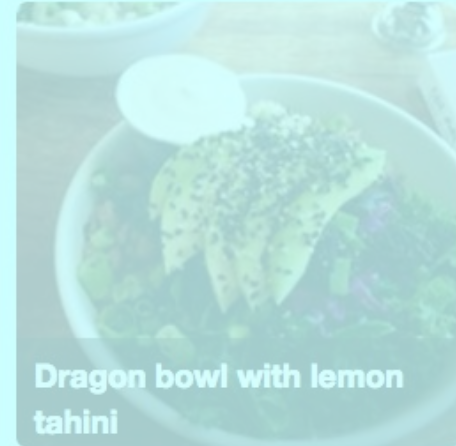
Cool 1

# /reviews/3

After a class at Yoga Pearl, or after one too many toxins, Prasad is the perfect way to stay on the healthy train... or hop on it for a few hours. THANK YOU Prasad for making good-for-you taste so darn good.



Chipotle bowl, so good



Dragon bowl with lemon tahini

Was this review ...?



Useful 12



Funny 8



Cool 14

# /reviews/4



**Jessica S.**  
Seattle, WA  
👥 416 friends  
📄 90 reviews  
📷 493 photos

★ ★ ★ ★ ★ 8/15/2015  
📍 3 check-ins

I've been going to Bob's Red Mill since I was little. After moving away from Clackamas and Oregon, I was so excited to find Bob's Red Mill products on the other side of the country. I'm so proud of this place!

Often, you'll see Bob himself here! Super cool!

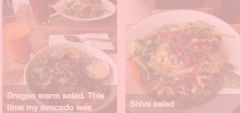
Was this review ...?

💡 Useful 4   😄 Funny 1   😎 Cool 3



/reviews/1

...I came for someone else's review of this place and that I personally need a bit more dressing, otherwise too bland for me.  
Great service at the cashier.  
They bring the food to you.  
You bus your own table afterwards.



Was this review ...?

Useful 1 Funny Cool

Page 1 of 27 1 2 3 4 5 6 7 8 9 Next >

/reviews/2

112 friends  
112 reviews  
174 photos  
Elite '17

If you like clean, healthy eating this place is for you. The menu is all vegetarian but that doesn't mean it's not filling. Each dish has different flavors and consistencies to become a unique item on the menu.

The staff here is very nice, quick, and helpful with recommendations. The best thing about it is the price. For the location and the type of food, it is very reasonable. This type of food is amazing and doesn't weigh you down for lunch. If I lived / worked closer I would eat here multiple times a week.

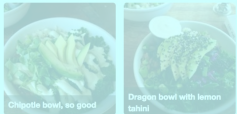
Was this review ...?

Useful 2 Funny Cool 1

Page 2 of 27 < Previous 1 2 3 4 5 6 7 8 9 Next >

/reviews/3

After a class at Yoga Pearl, or after one too many toxins, Prasad is the perfect way to stay on the healthy train... or hop on it for a few hours. THANK YOU Prasad for making good-for-you taste so darn good.



Was this review ...?

Useful 12 Funny 8 Cool 14

Page 3 of 27 < Previous 1 2 3 4 5 6 7 8 9 Next >

/reviews/4

Jessica S.  
Seattle, WA  
416 friends  
90 reviews  
493 photos

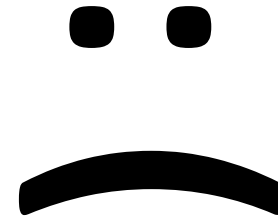
8/15/2015  
3 check-ins

I've been going to Bob's Red Mill since I was little. After moving away from Clackamas and Oregon, I was so excited to find Bob's Red Mill products on the other side of the country. I'm so proud of this place!

Often, you'll see Bob himself here! Super cool!

Was this review ...?

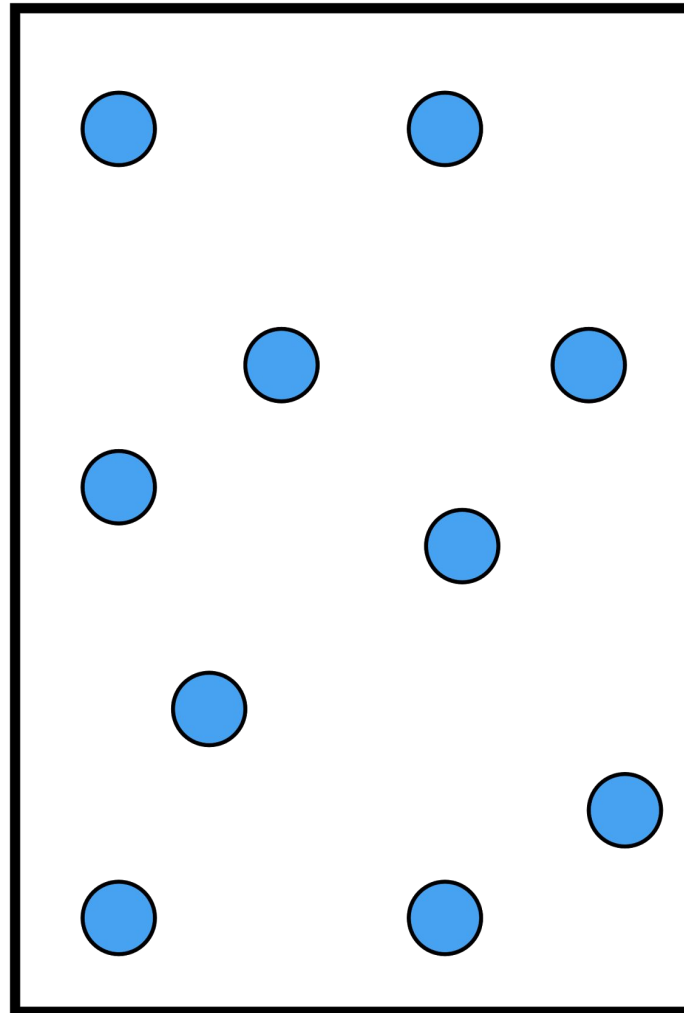
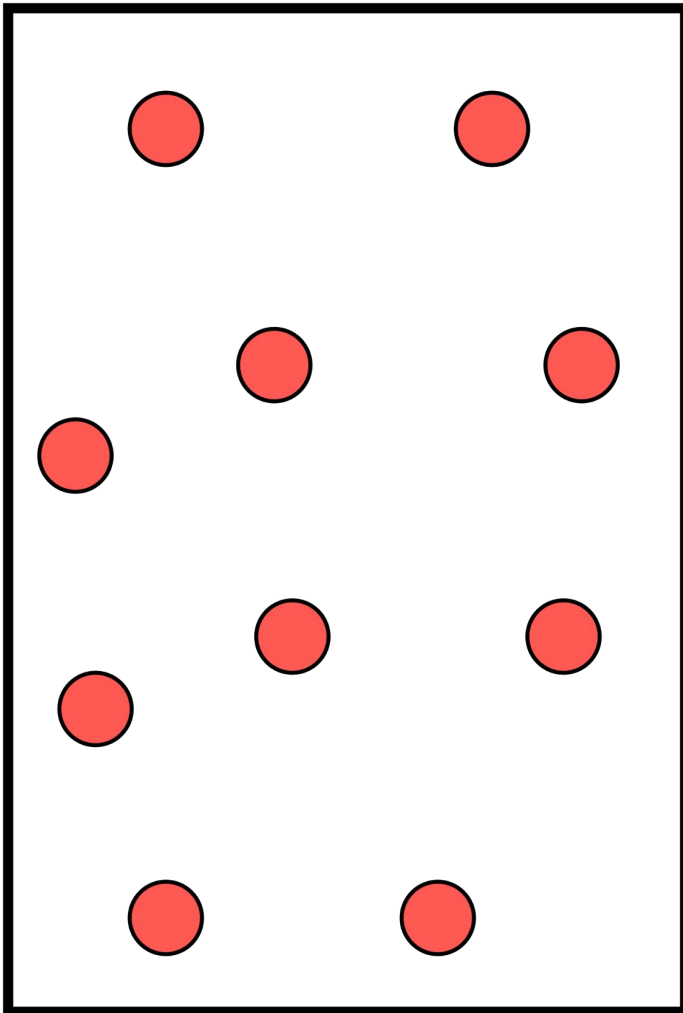
Useful 4 Funny 1 Cool 3



# Random assignment from scratch

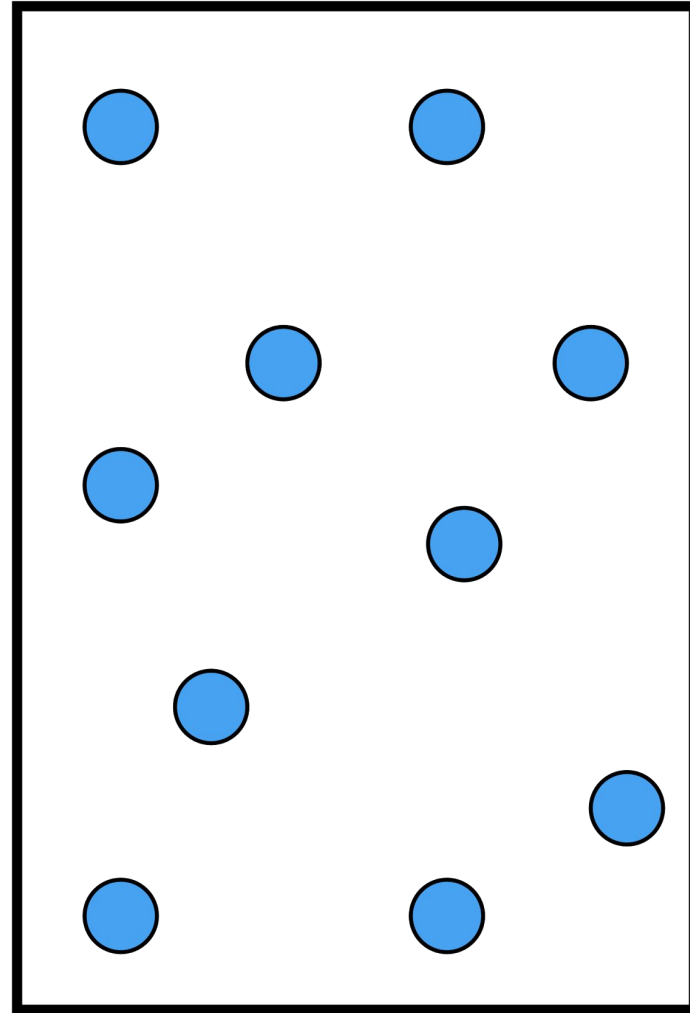
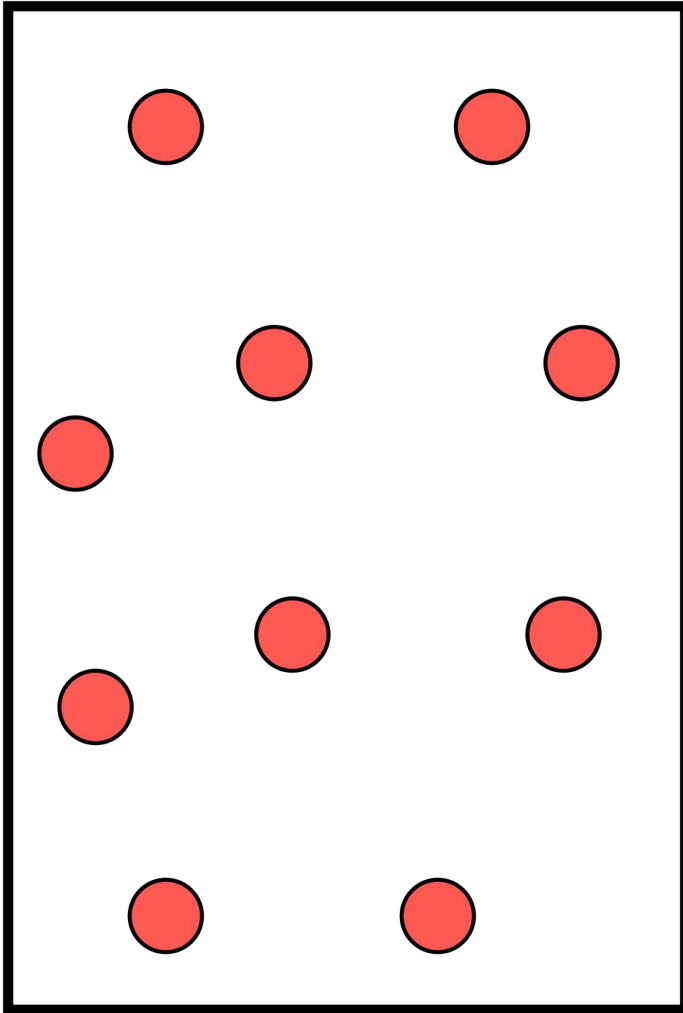
- `random.choice`
- **Experimental units**
- Deterministic assignment

○ **experimental unit**

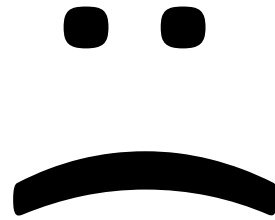
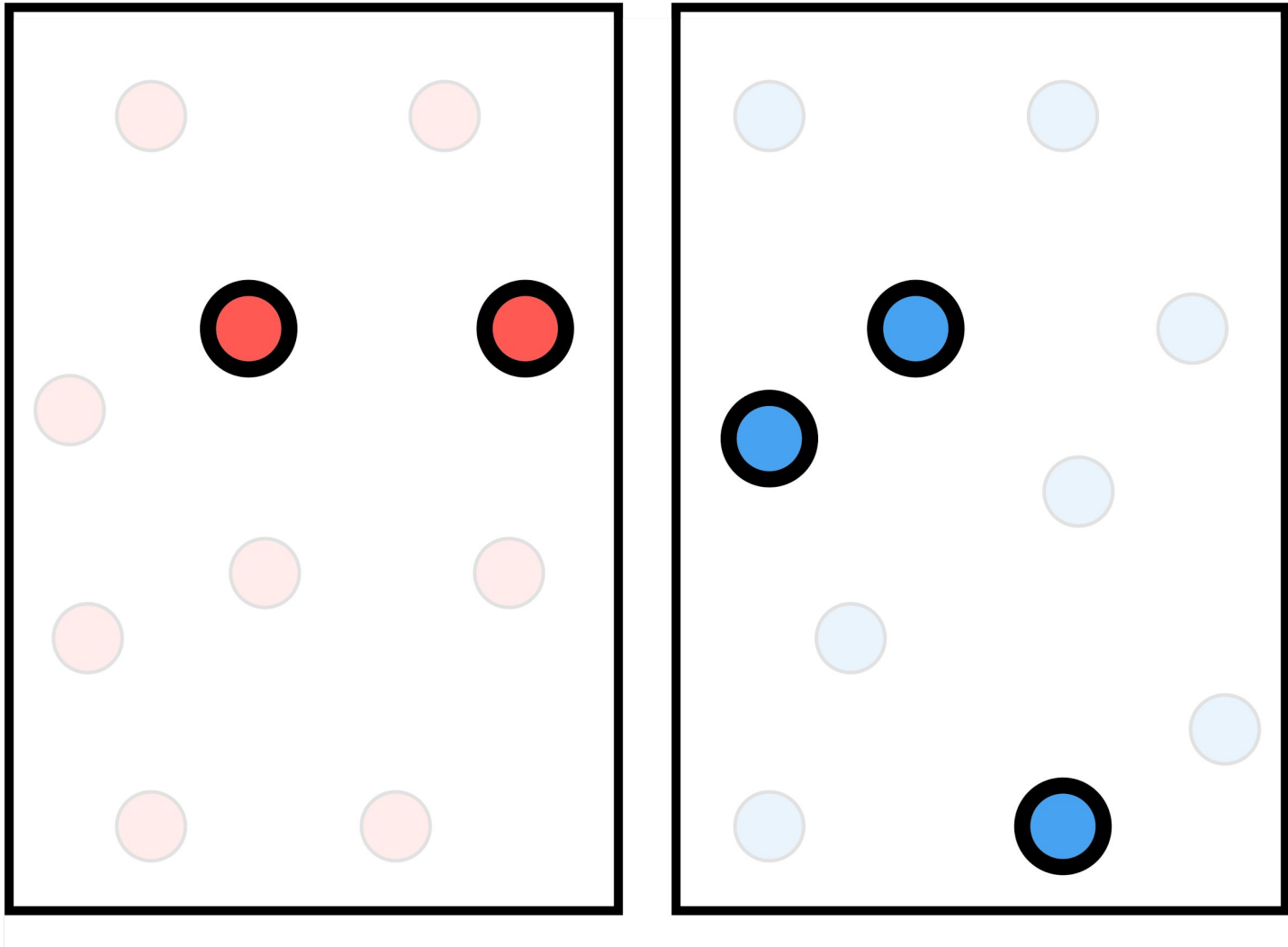


```
@app.route('/reviews/<page_id>')
def reviews(...):
    ...
    color = choose_color_assignment()
    ...
```

○ = review page request

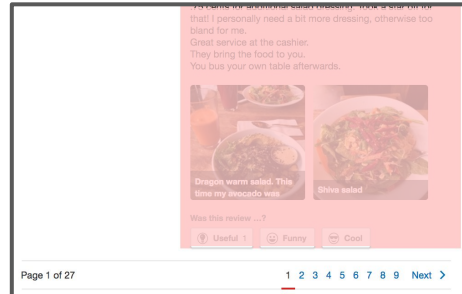


A visitor will be assigned to multiple colors!

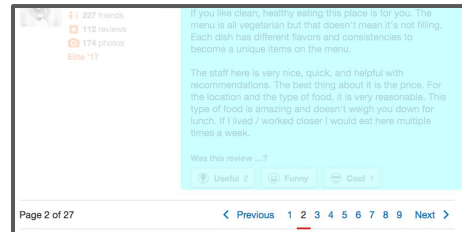


# That doesn't work for this experiment

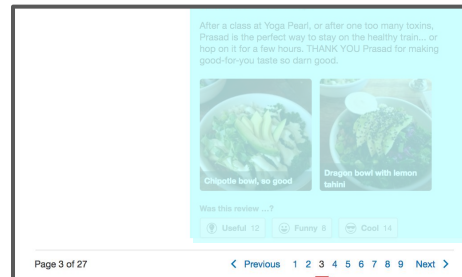
/reviews/1



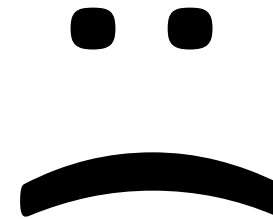
/reviews/2



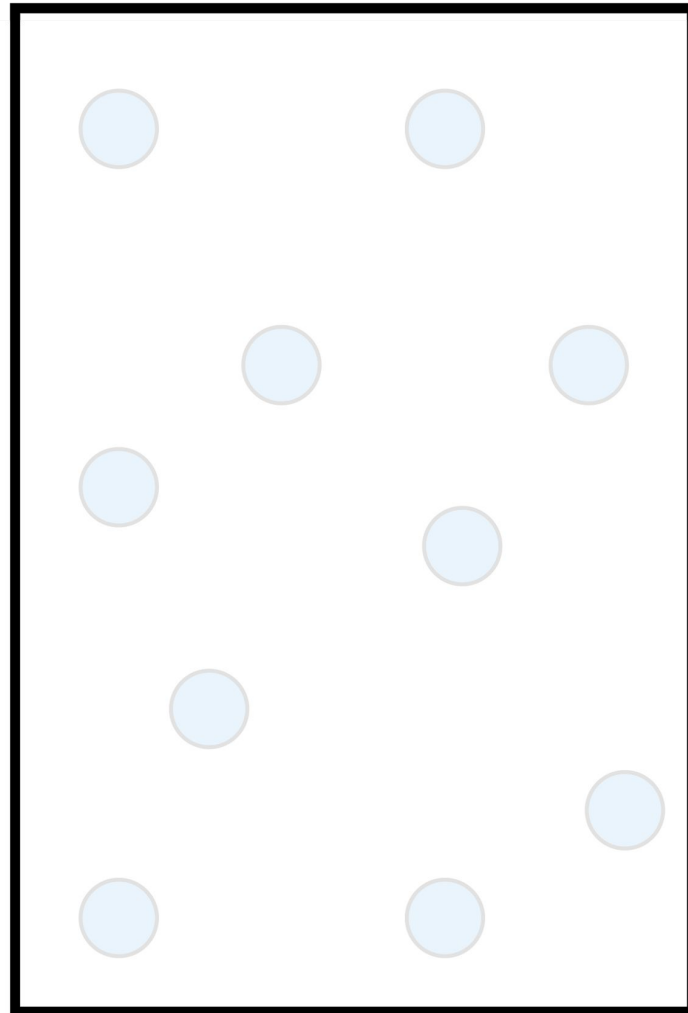
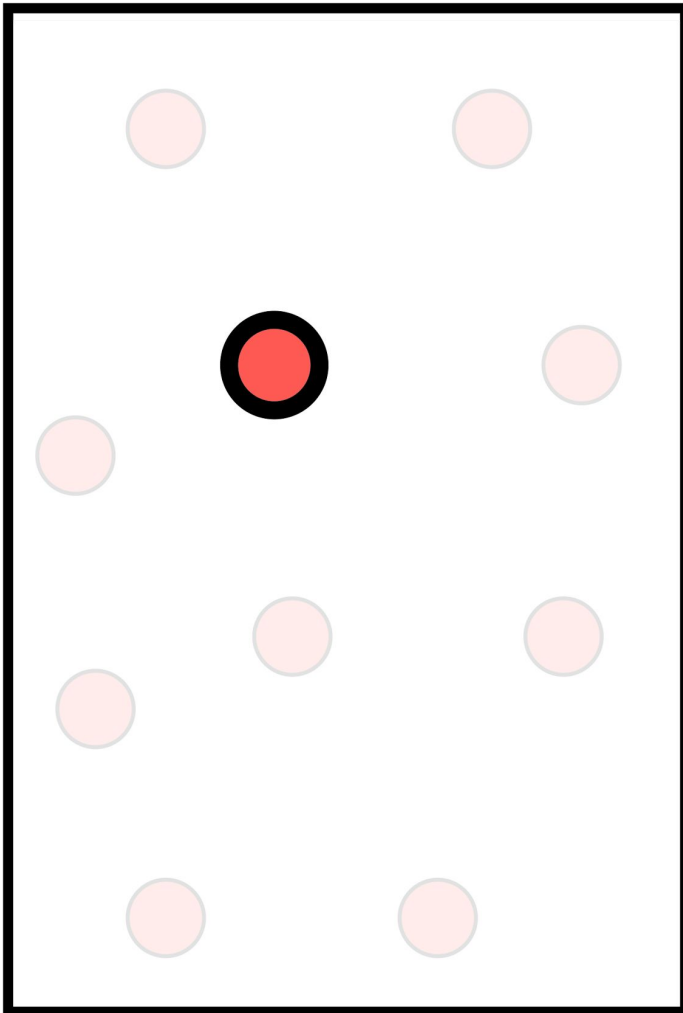
/reviews/3



/reviews/4



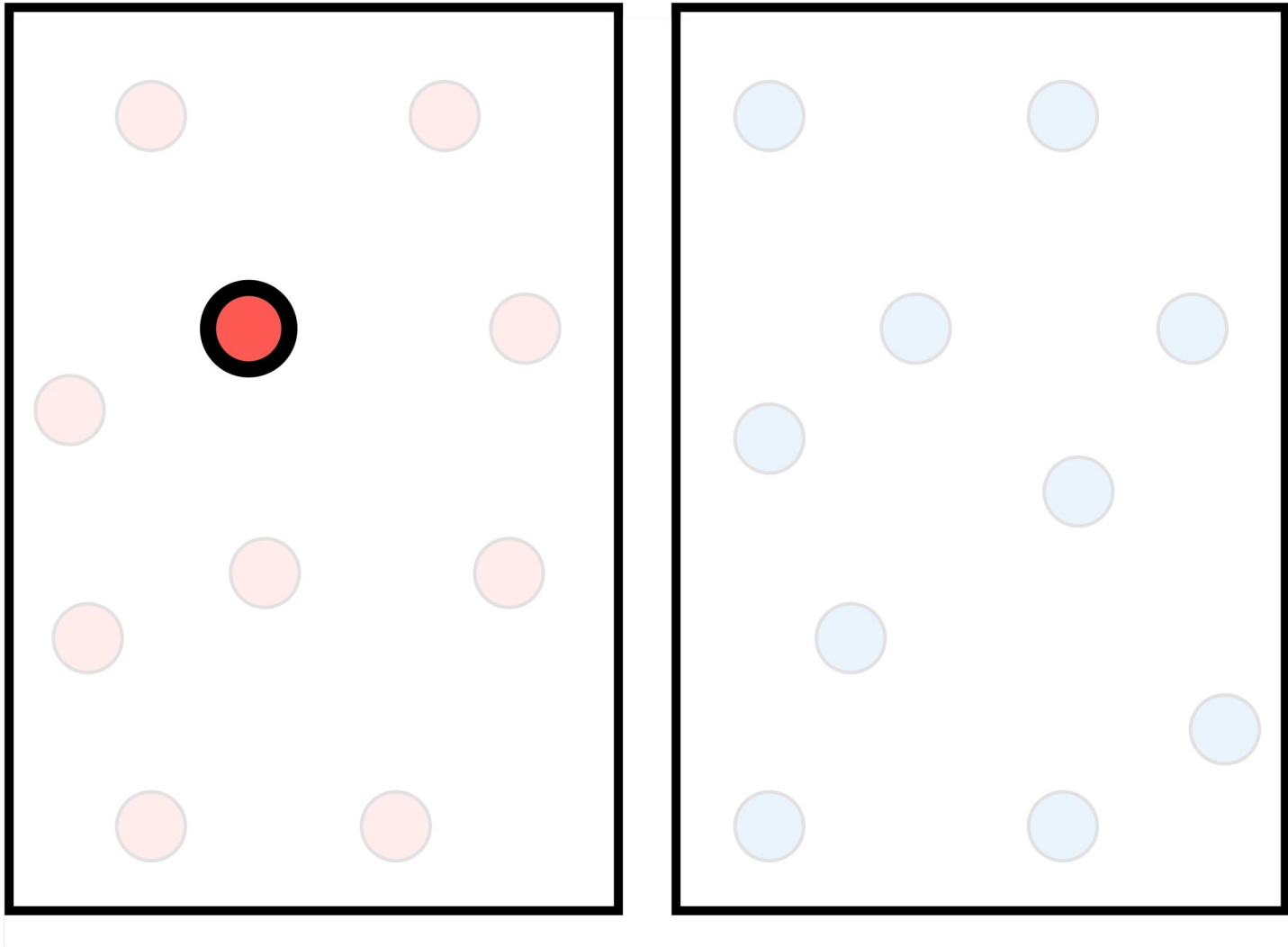
○ = person?





```
@app.route('/reviews/<page_id>')
def reviews(...):
    ...
    color = choose_color_assignment()
    ...
```

○ = user\_id ≈ person



# Assignment Rules

Follow experiment design

Avoid introducing bias

# Assignment Rules

Follow experiment design

Avoid introducing bias

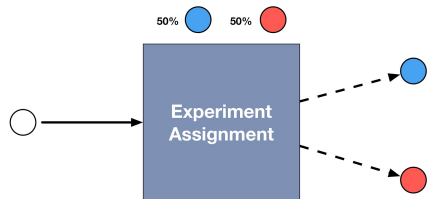
# Random assignment from scratch

- `random.choice`
- **Experimental units**
- Deterministic assignment

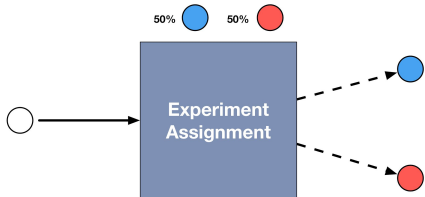
# Random assignment from scratch

- `random.choice`
- Experimental units
- **Deterministic assignment**

```
def choose_color_assignment()
```



```
def choose_color_assignment(user_id)
```





```
>>> choose_color_assignment(user_id=1)
red
```

```
>>> choose_color_assignment(user_id=1)
red
```

```
>>> choose_color_assignment(user_id=1)  
red
```

```
>>> choose_color_assignment(user_id=4)  
blue
```

```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 2  
    return ['red', 'blue'][assignment_i]
```

```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 2  
    return ['red', 'blue'][assignment_i]
```

```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 2  
    return ['red', 'blue'][assignment_i]
```

```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 2  
    return ['red', 'blue'][assignment_i]
```

**hashlib.md5**

```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 2  
    return ['red', 'blue'][assignment_i]
```

```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 2  
    return ['red', 'blue'][assignment_i]
```



```
# Same user_id -> same value
```

```
>>> choose_color_assignment(user_id=1)
```

```
red
```

```
>>> choose_color_assignment(user_id=1)
```

```
red
```

```
# Different ids get different values.
```

```
>>> choose_color_assignment(user_id=100)
```

```
red
```

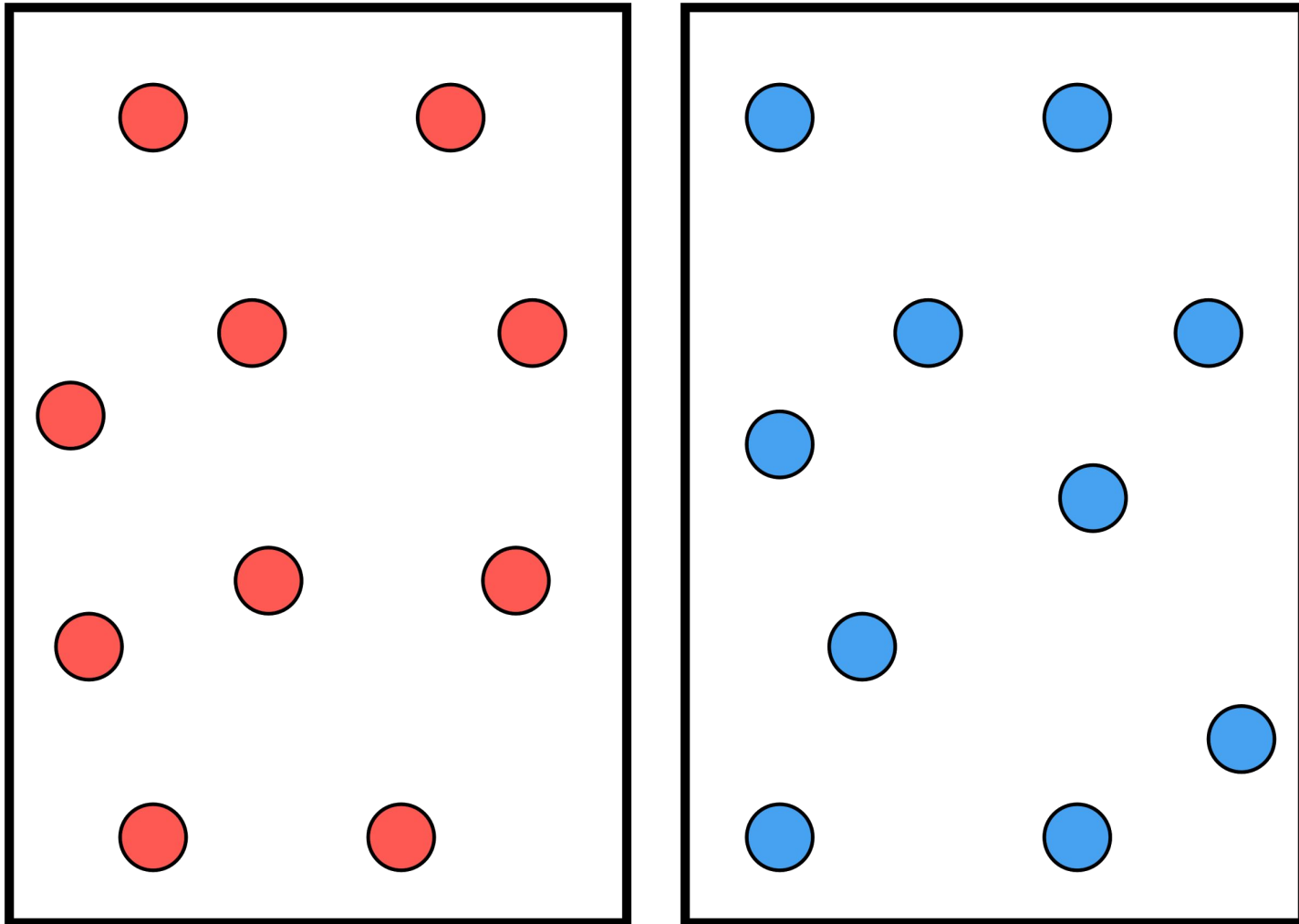
```
>>> choose_color_assignment(user_id=101)
```

```
blue
```

```
>>> choose_color_assignment(user_id=102)
```

```
red
```

# Random assignment from scratch



# Experiment assignment on the web

- Experiments on the web
- **Random assignment from scratch**
- Assignment in practice

# Experiment assignment on the web

- Experiments on the web
- Random assignment from scratch
- **Assignment in practice**

# Assignment in practice

- Independence with salts
- Assignment groups
- Additional logic

# Assignment in practice

- **Independence with salts**
- Assignment groups
- Additional logic

```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 2  
    return ['red', 'blue'][assignment_i]
```



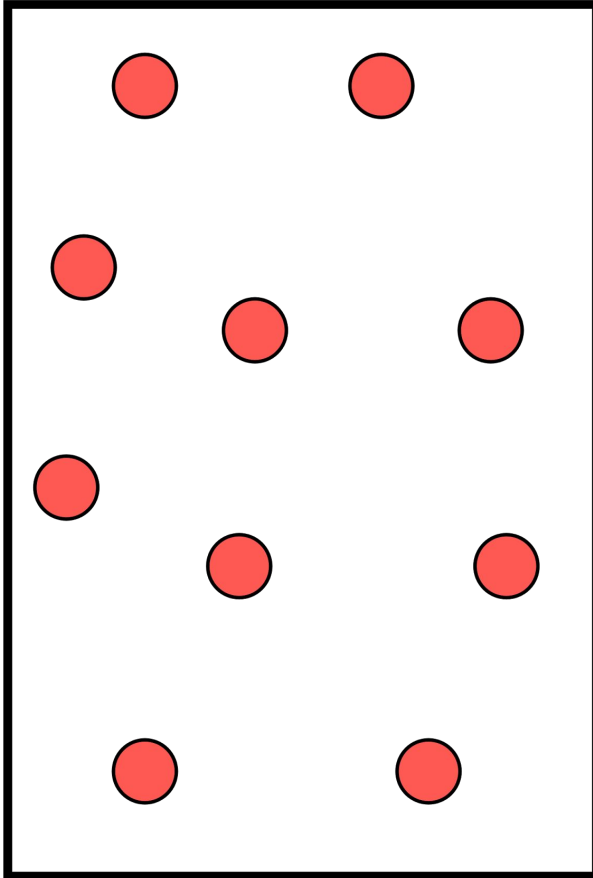
```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 2  
    return ['red', 'blue'][assignment_i]
```

```
def choose_size_assignment(user_id):  
    key = "{}|size".format(user_id)  
    assignment_i = hash_func(key) % 2  
    return ['big', 'small'][assignment_i]
```

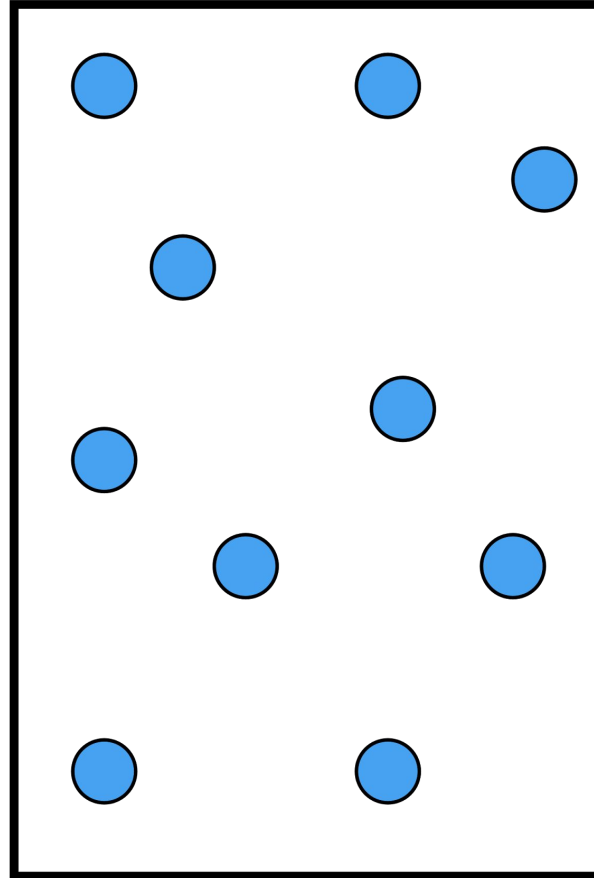
```
def choose_size_assignment(user_id):  
    key = "{}|size".format(user_id)  
    assignment_i = hash_func(key) % 2  
    return ['big', 'small'][assignment_i]
```

# color

red



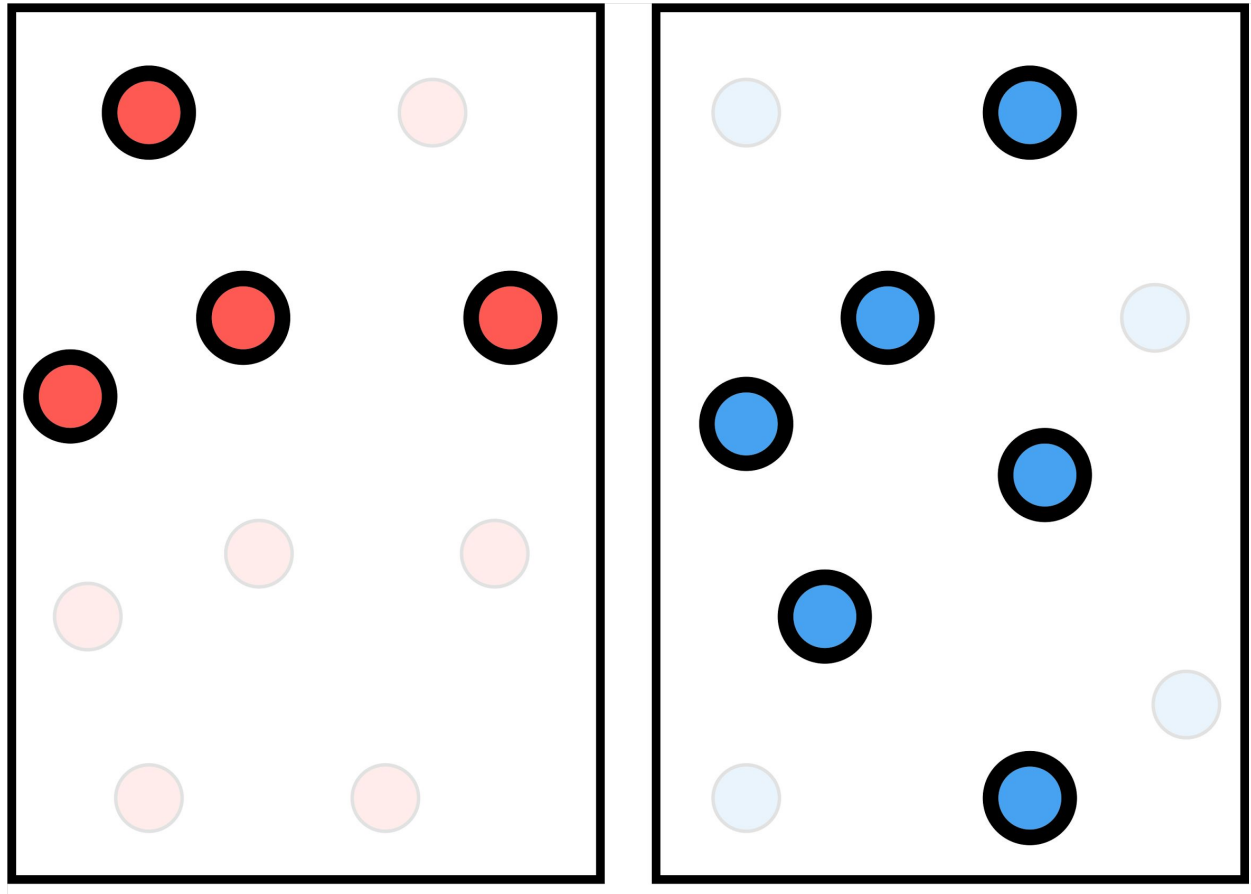
blue



# color

red

blue



Assigned  
to "big"

Shuffling is a tool that can help **avoid bias**

But watch out

- experiment interactions

# Assignment in practice

- Independence with salts
- **Assignment groups**
- Additional logic

```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 2  
    ...
```

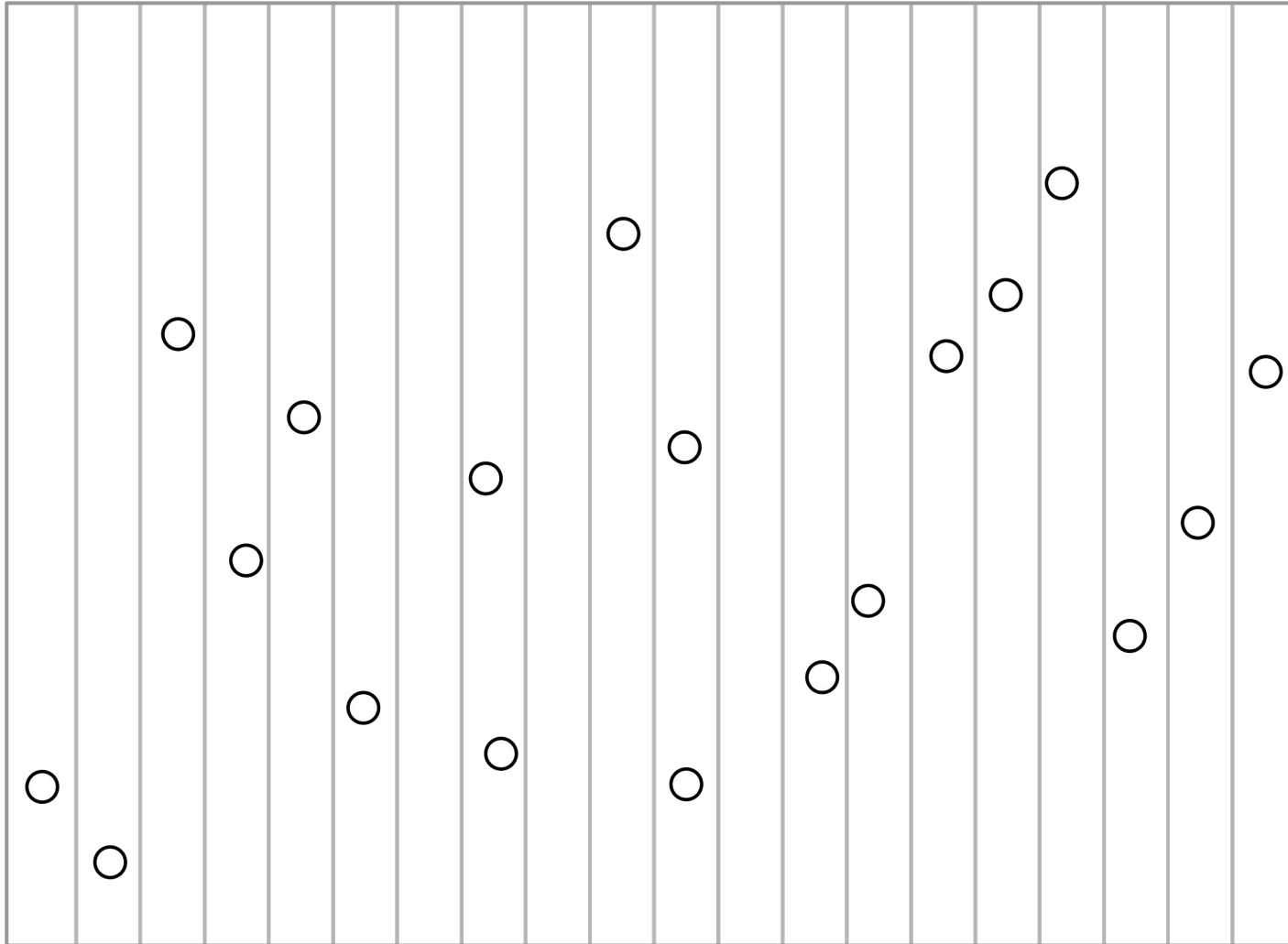


```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 2  
    ...
```

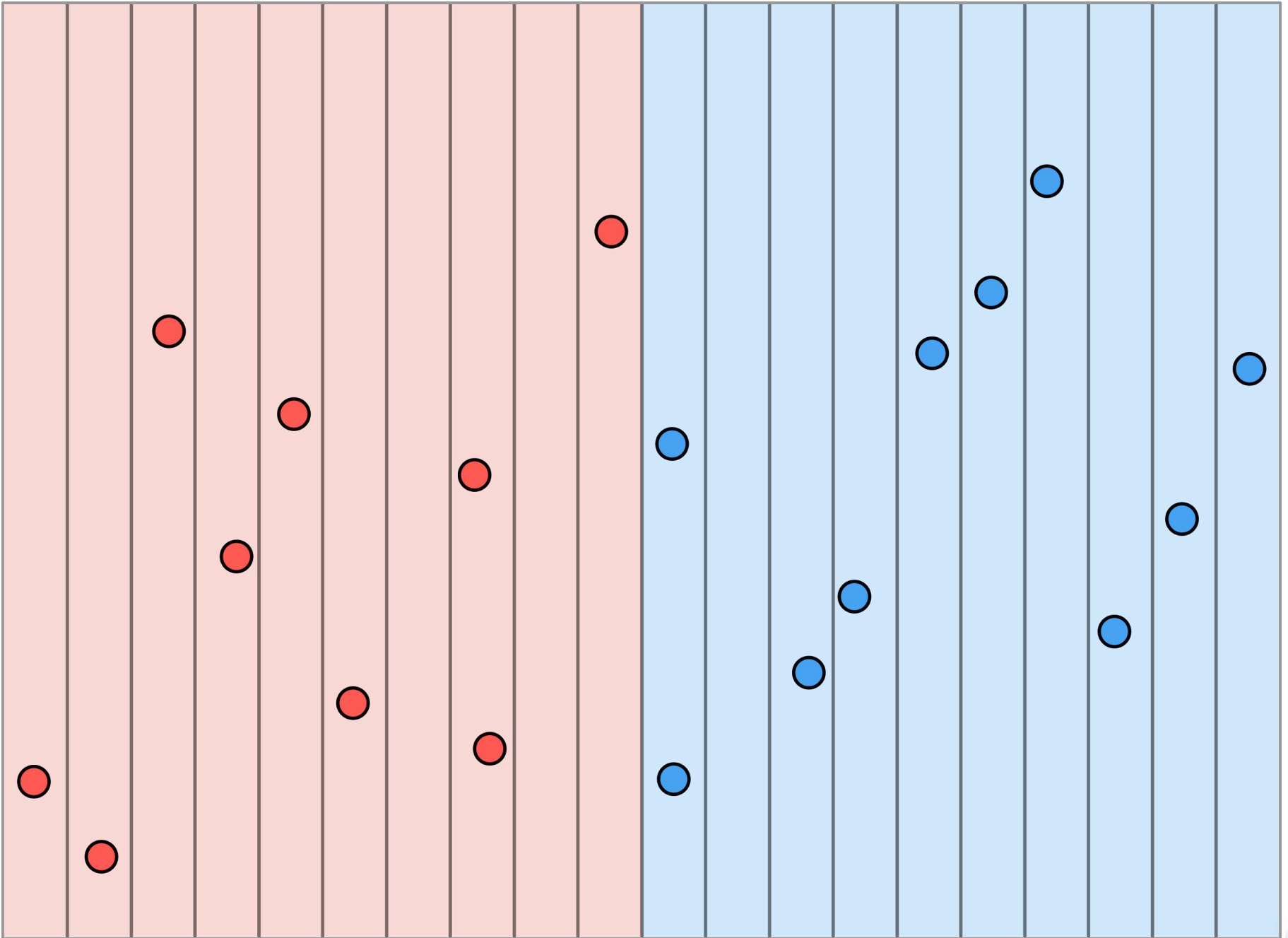
```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 20  
    ...
```

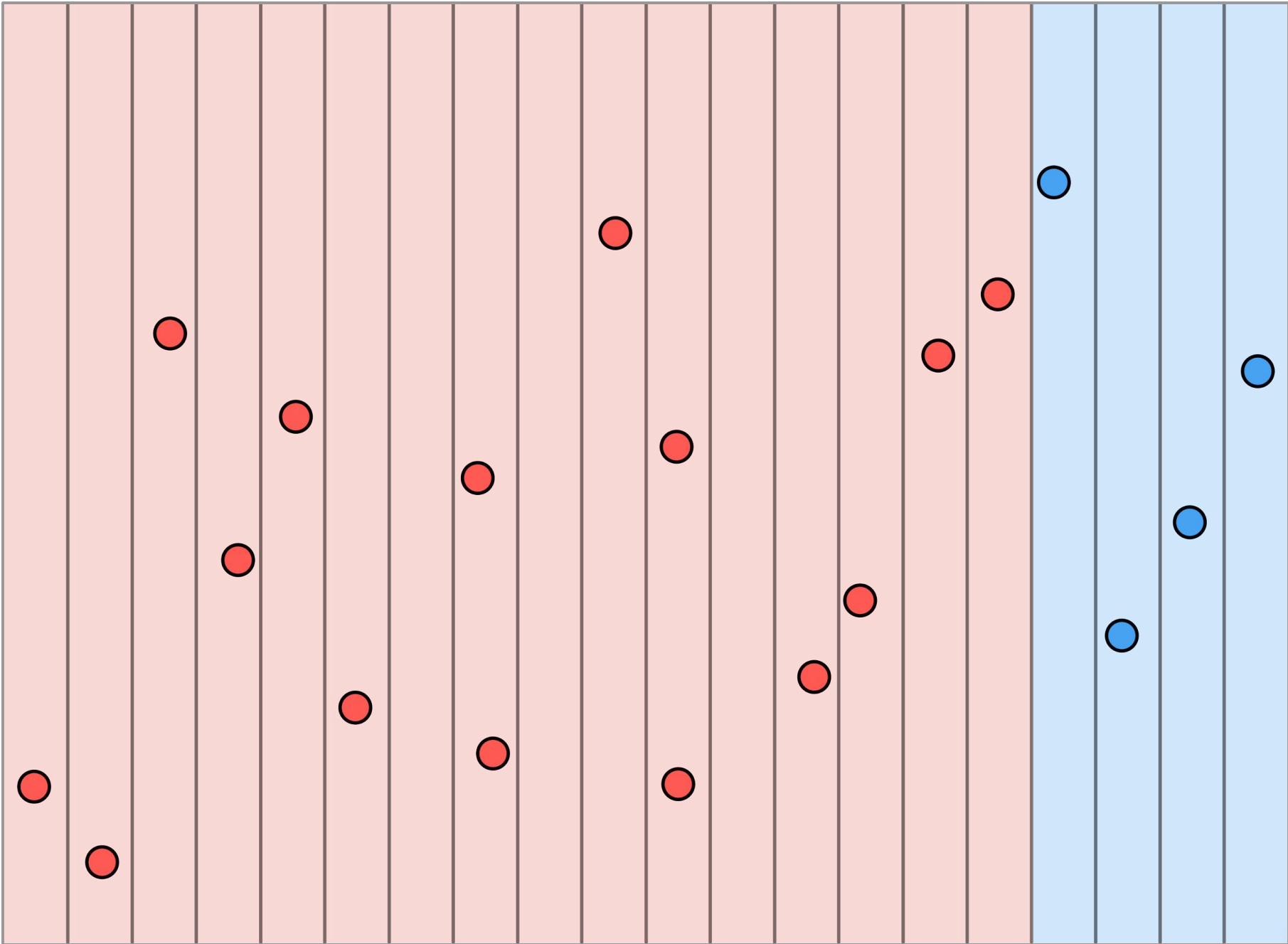
# Divide users\* into 20 groups

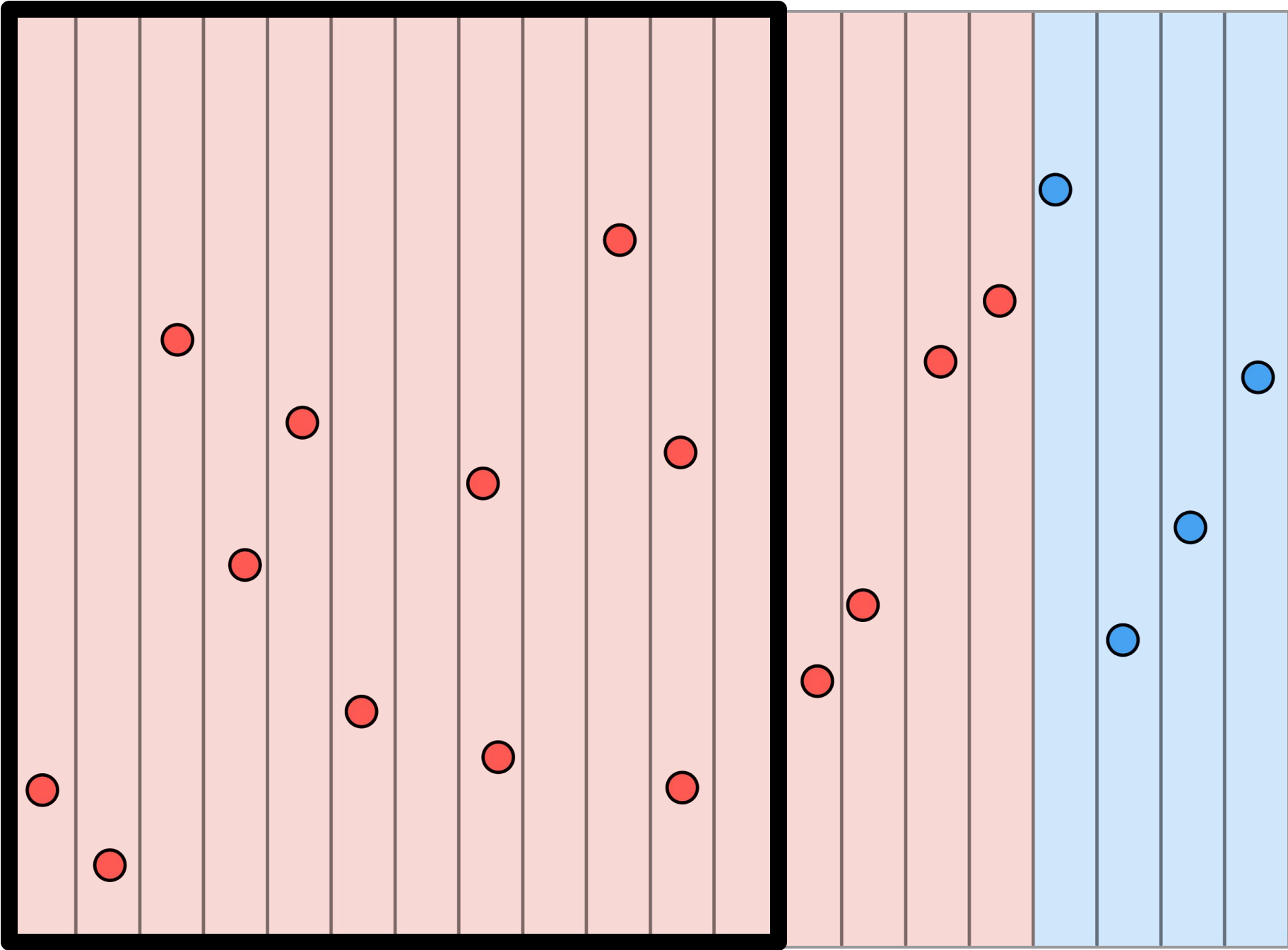
\*or experimental units

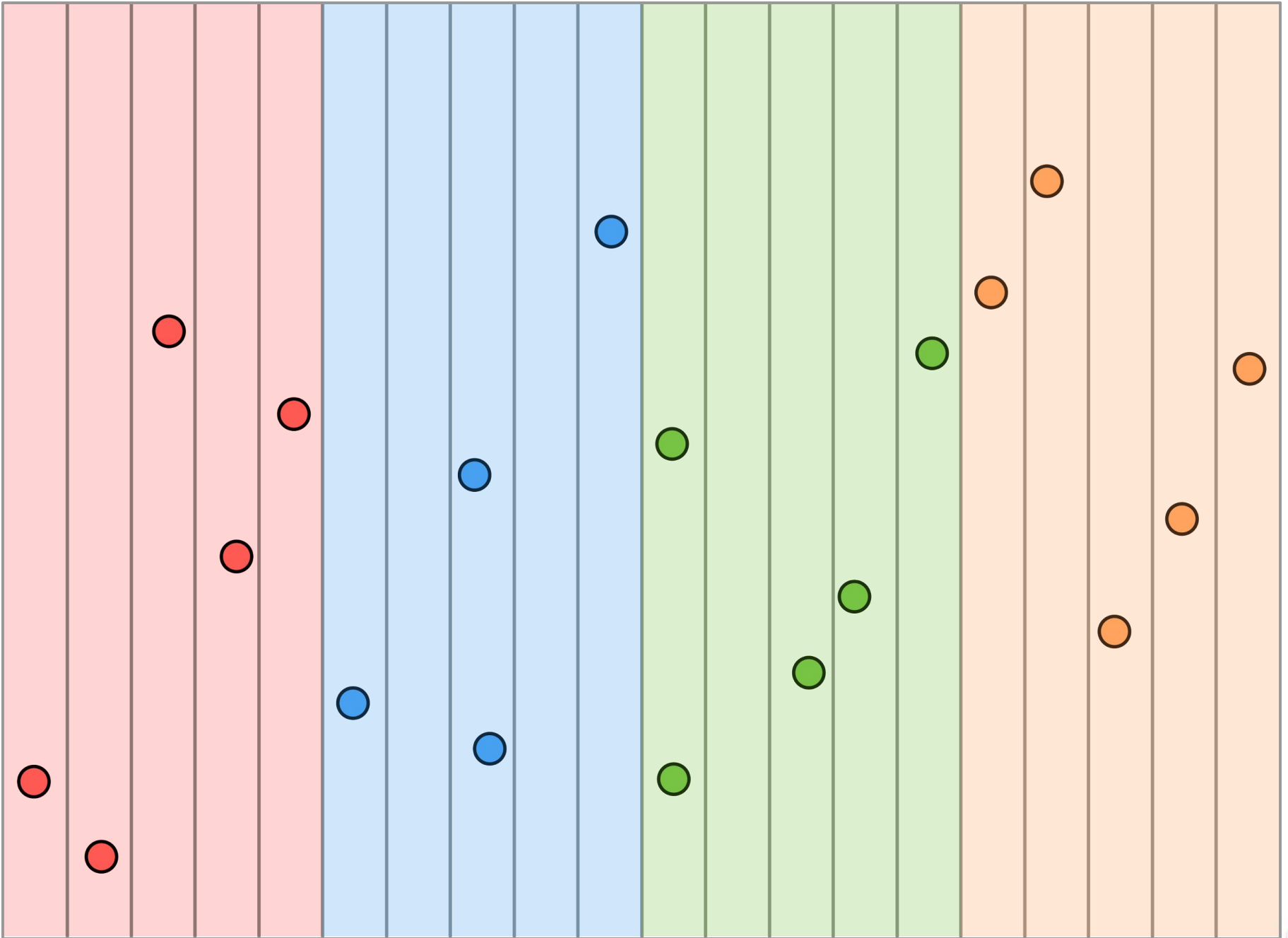


```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 20  
  
    if assignment_i < 10:  
        return 'red'  
    else:  
        return 'blue'
```

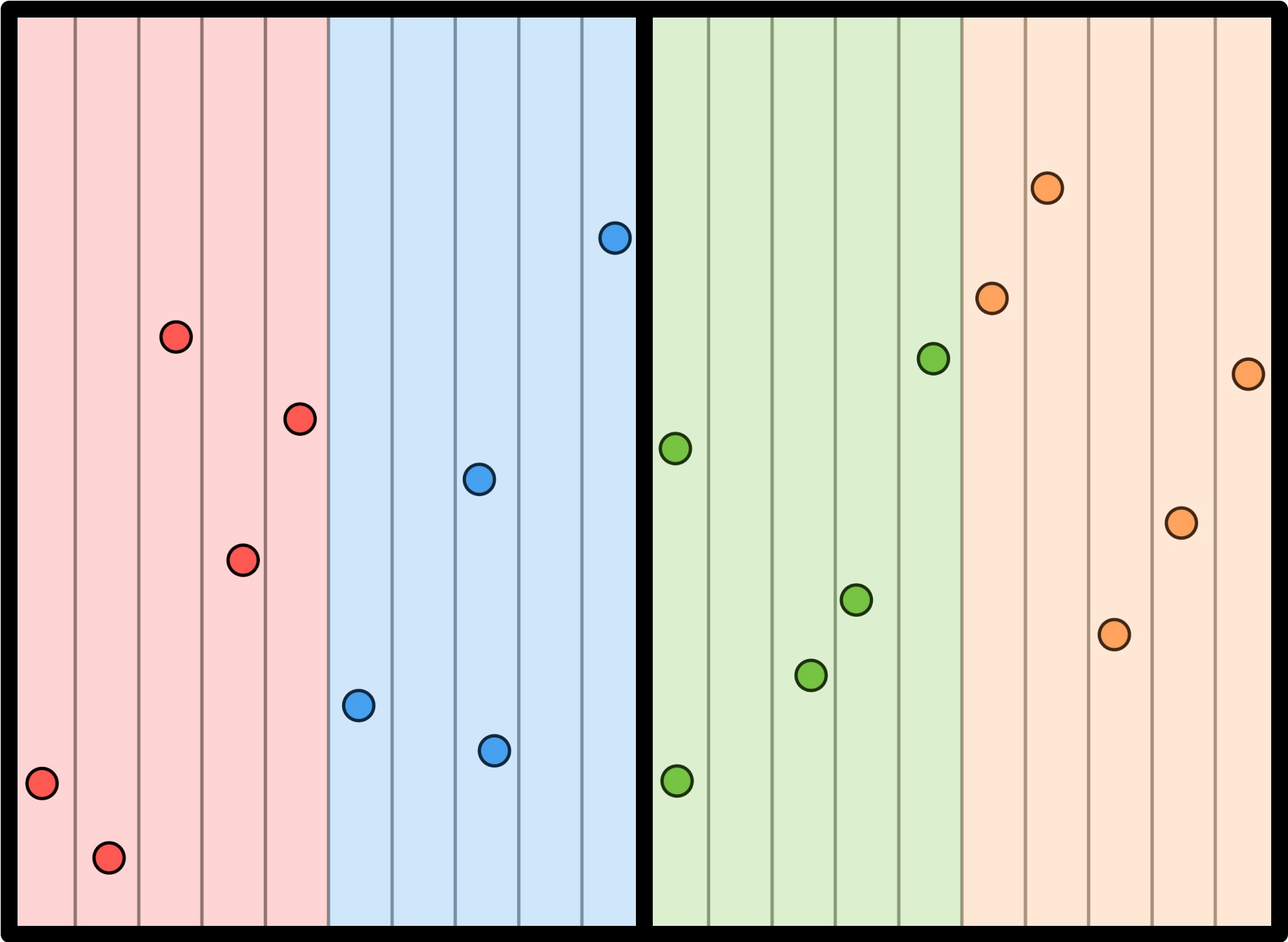




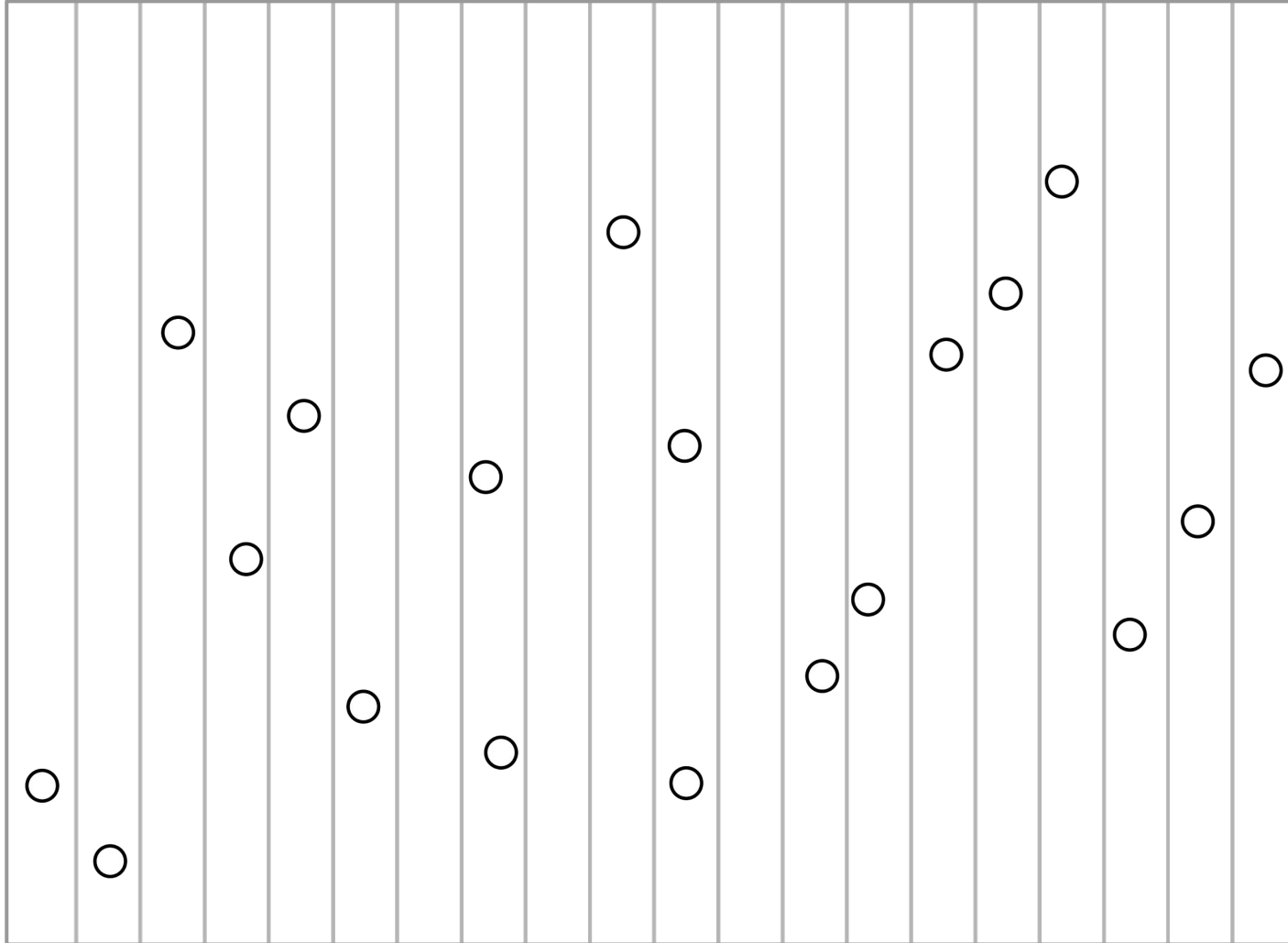








# Assignment groups



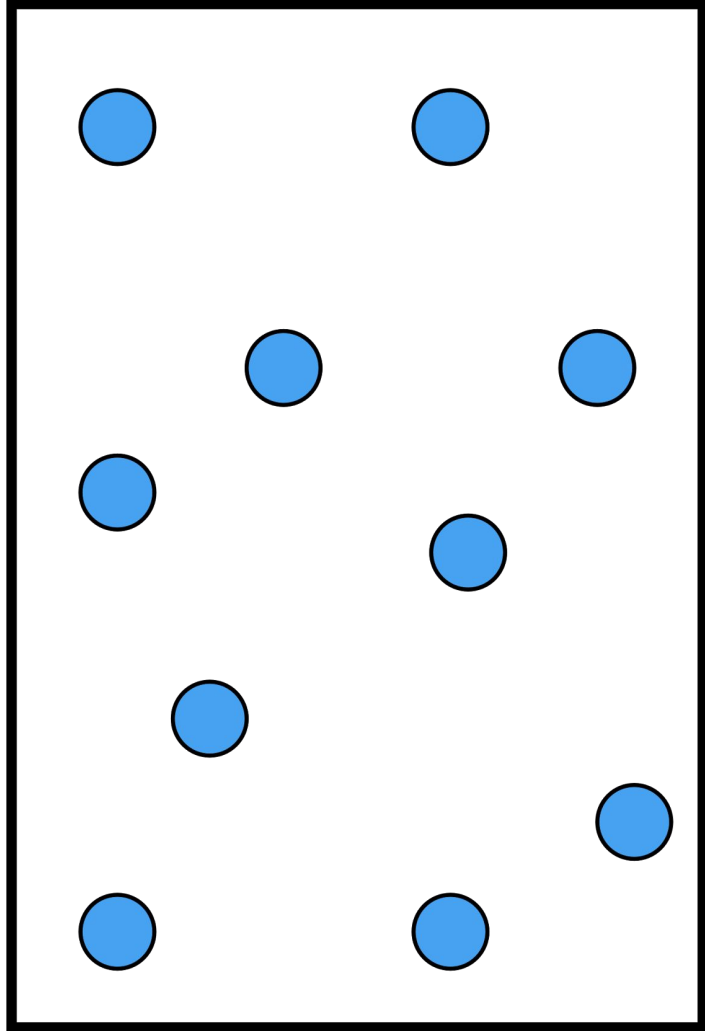
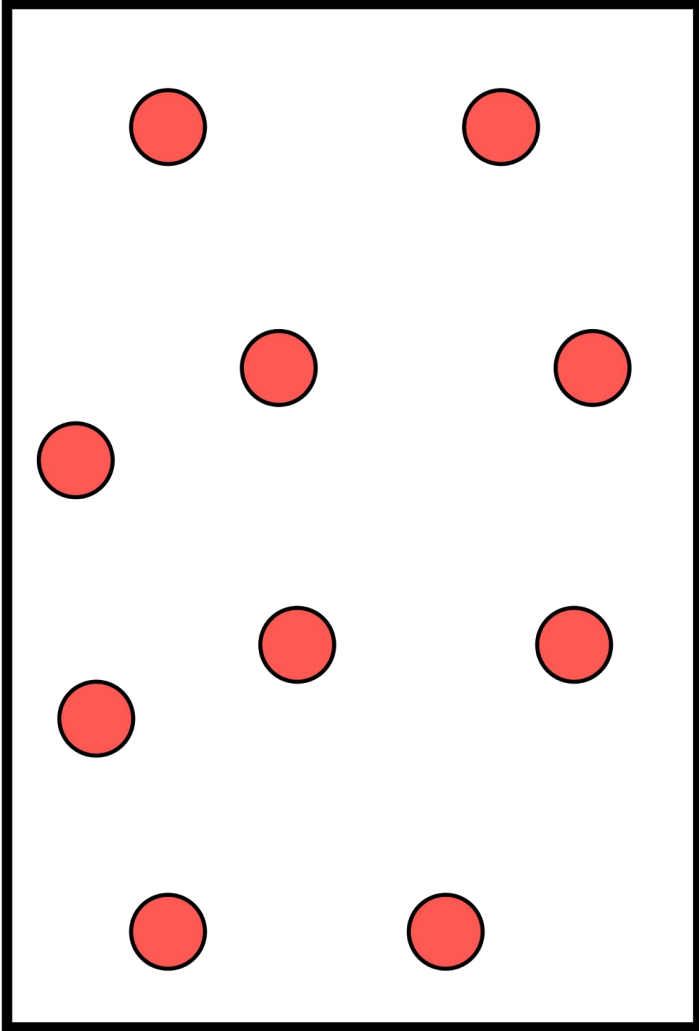
# Assignment in practice

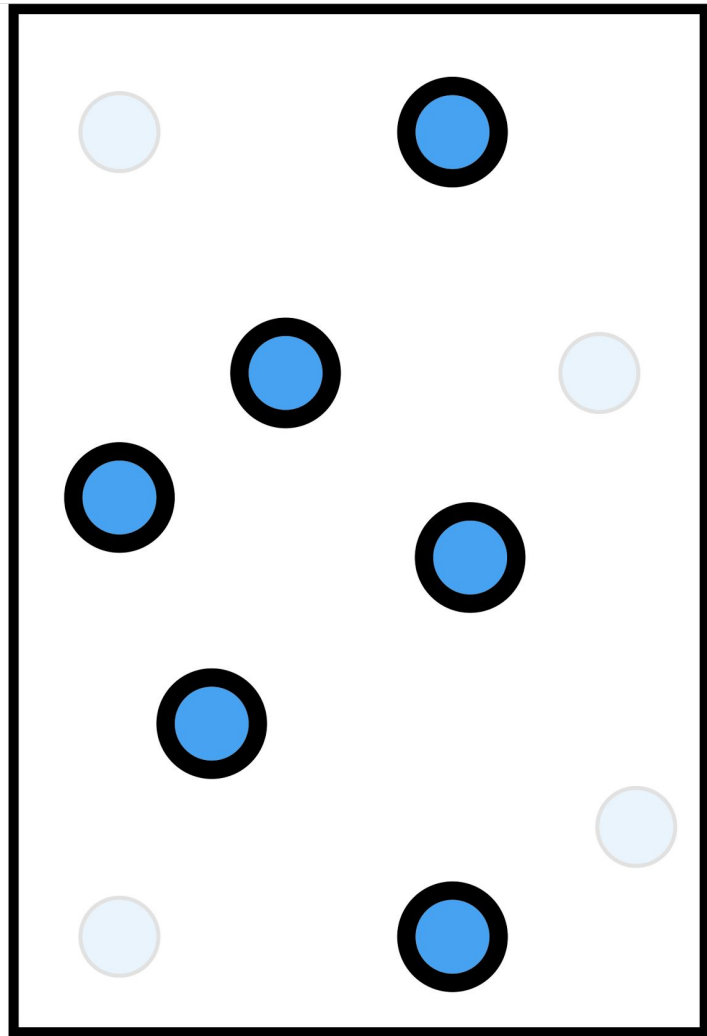
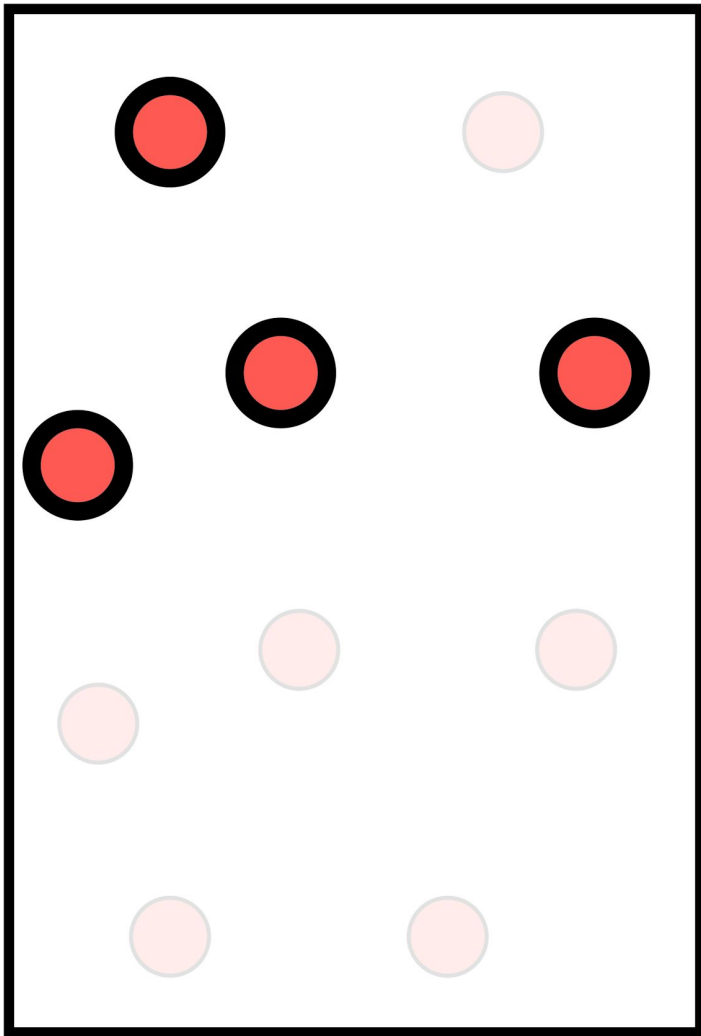
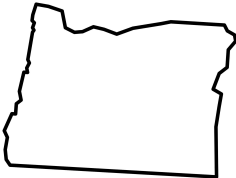
- **Independence with salts**
- **Assignment groups**
- Additional logic

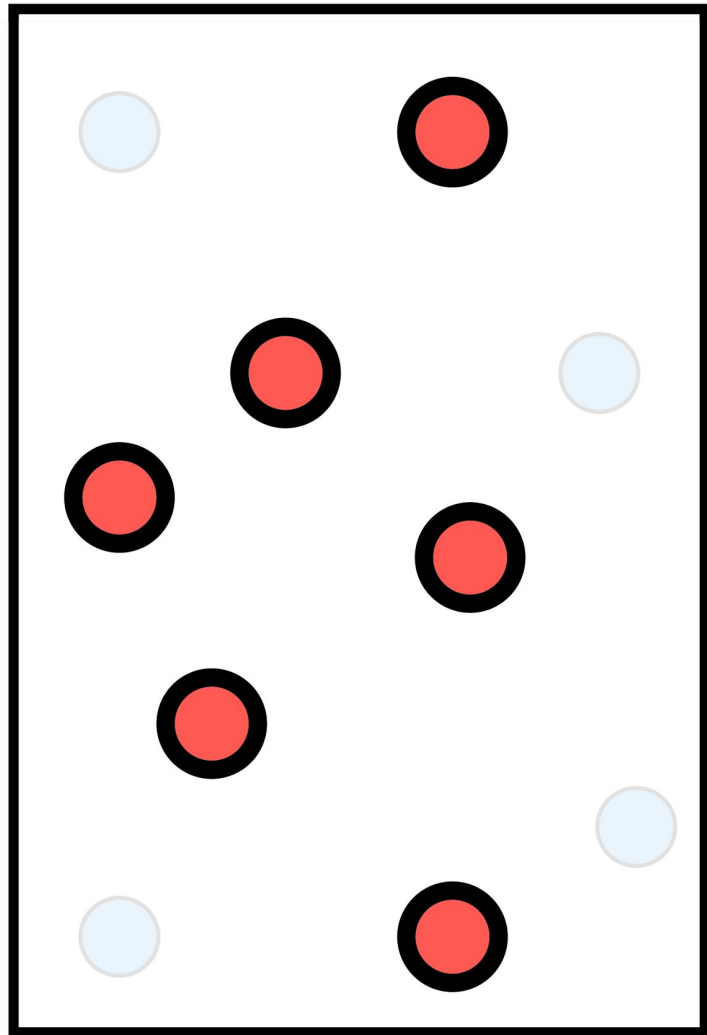
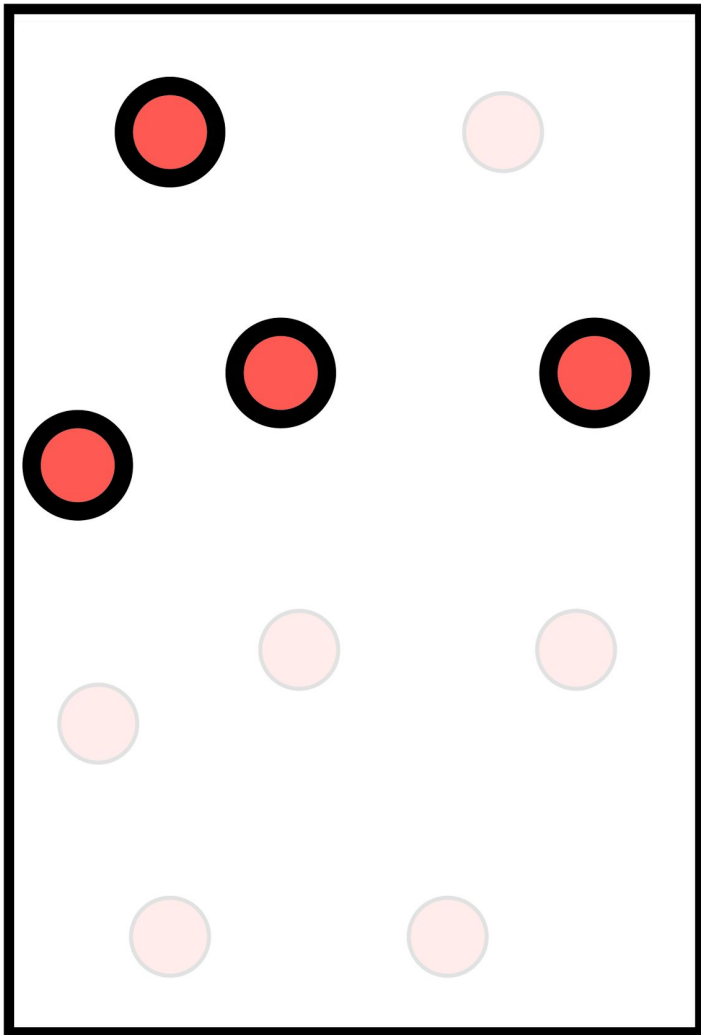
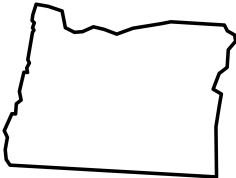
# Assignment in practice

- Independence with salts
- Assignment groups
- **Additional logic**

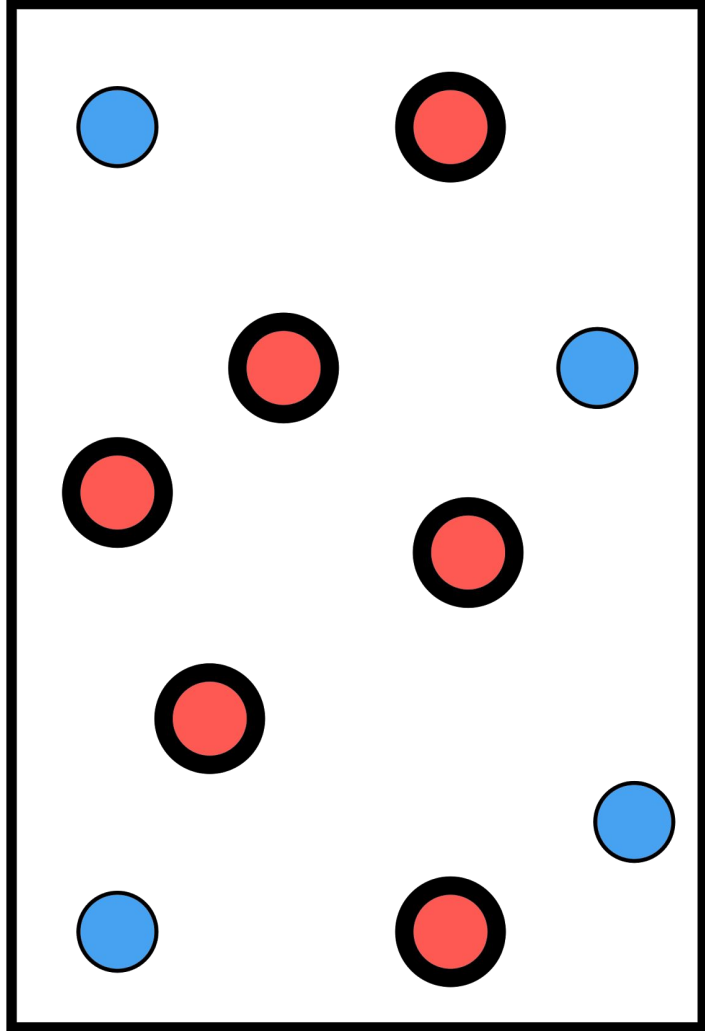
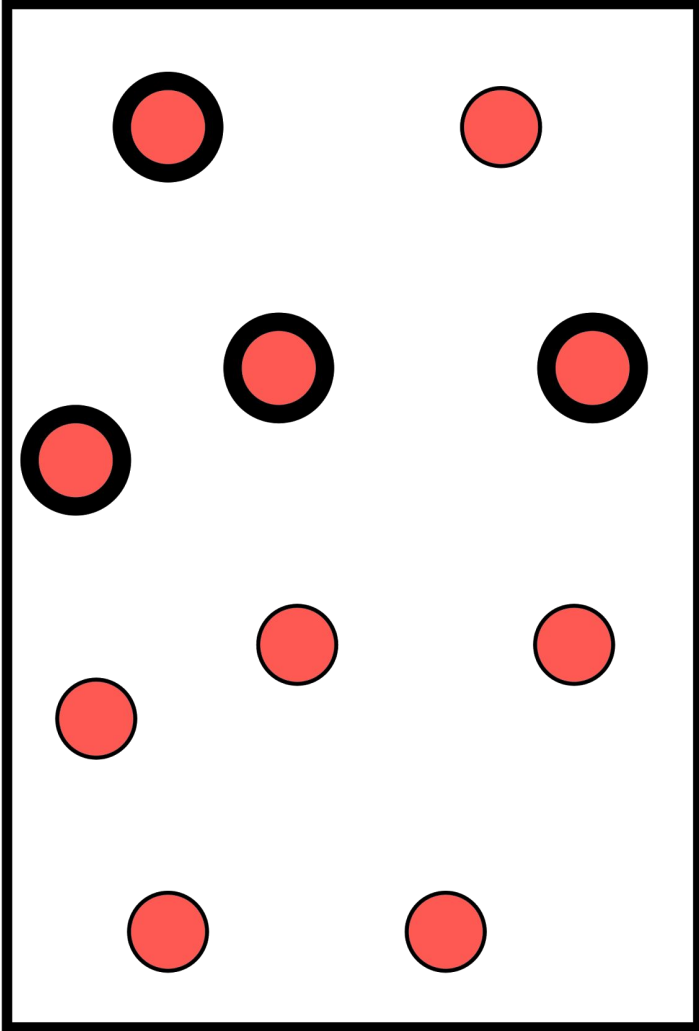
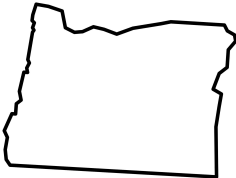
```
if request.user.state == 'OR':  
    color = 'red'  
else:  
    color = random_color_assignment(request)
```



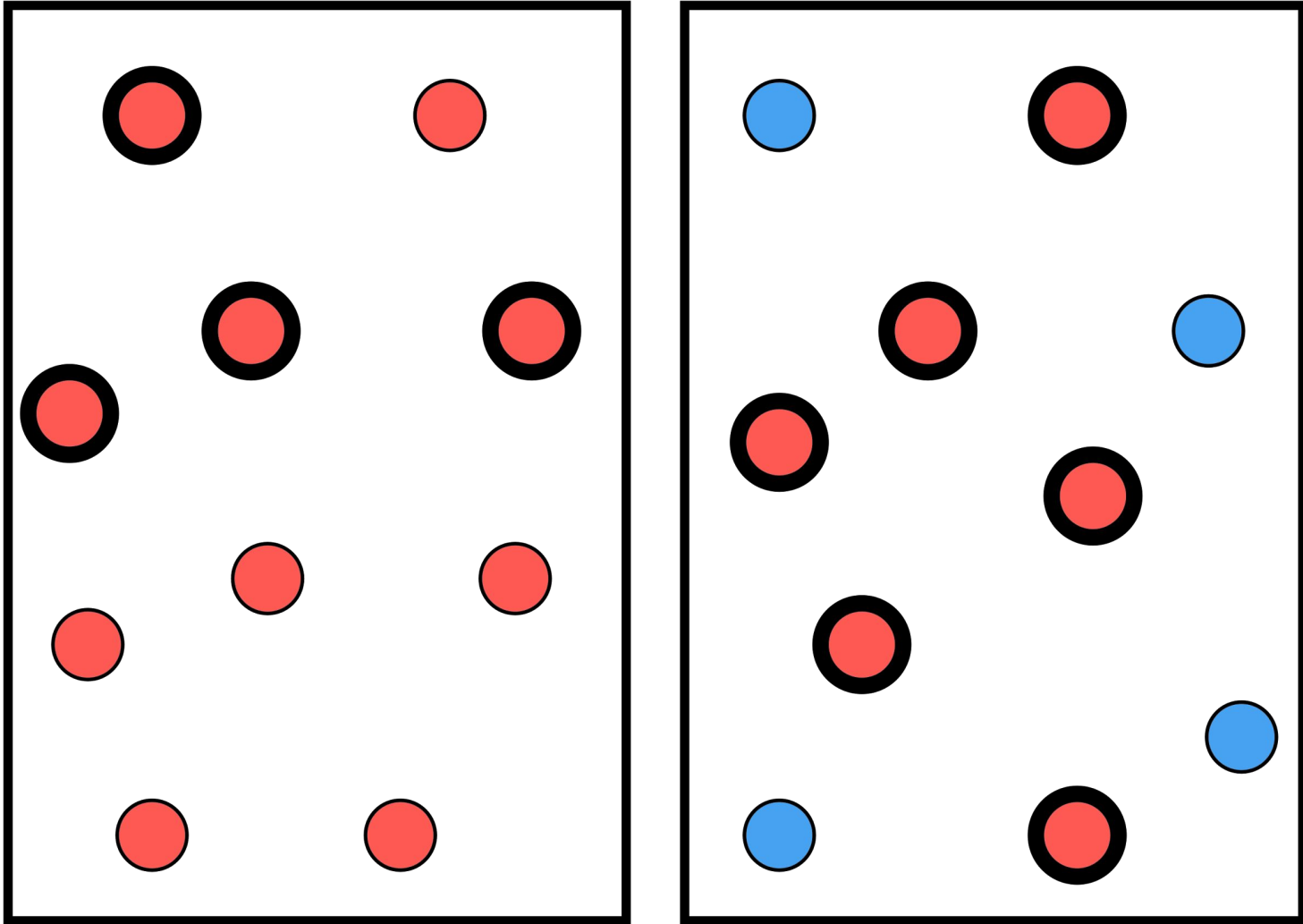




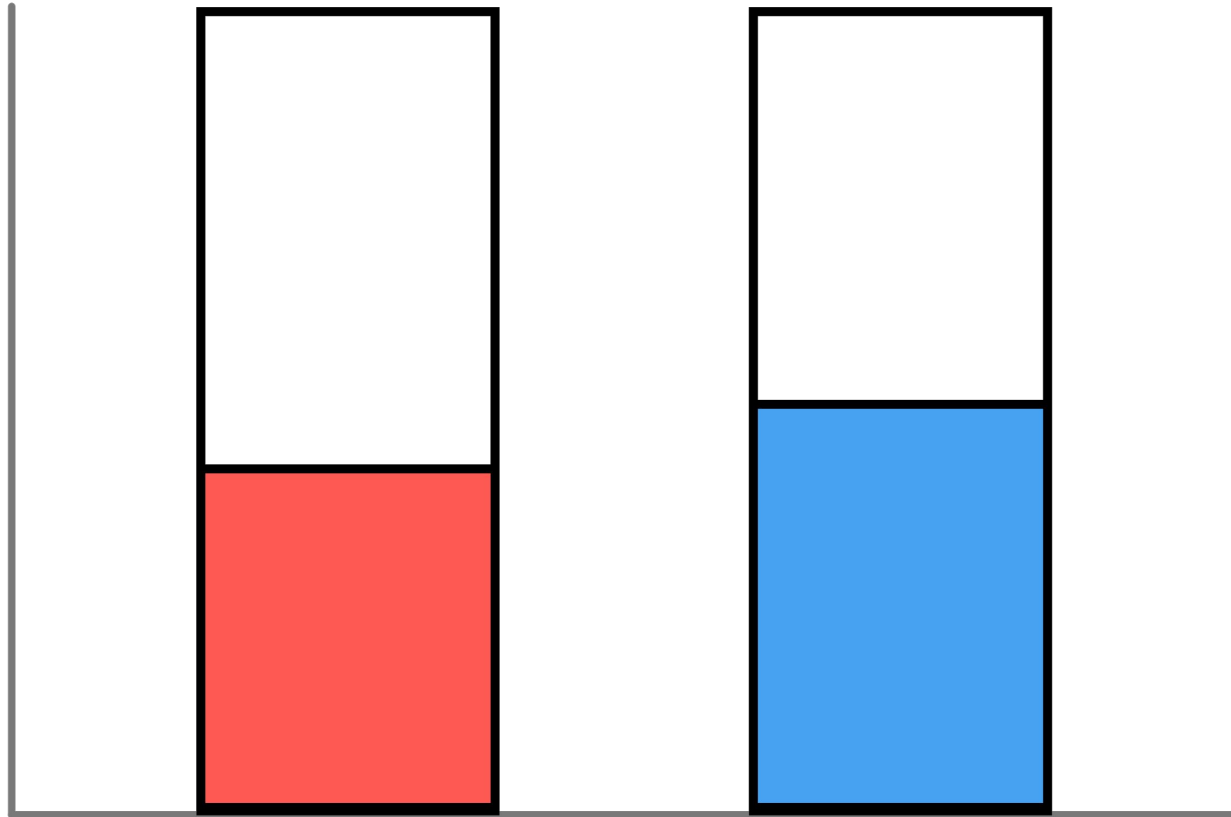




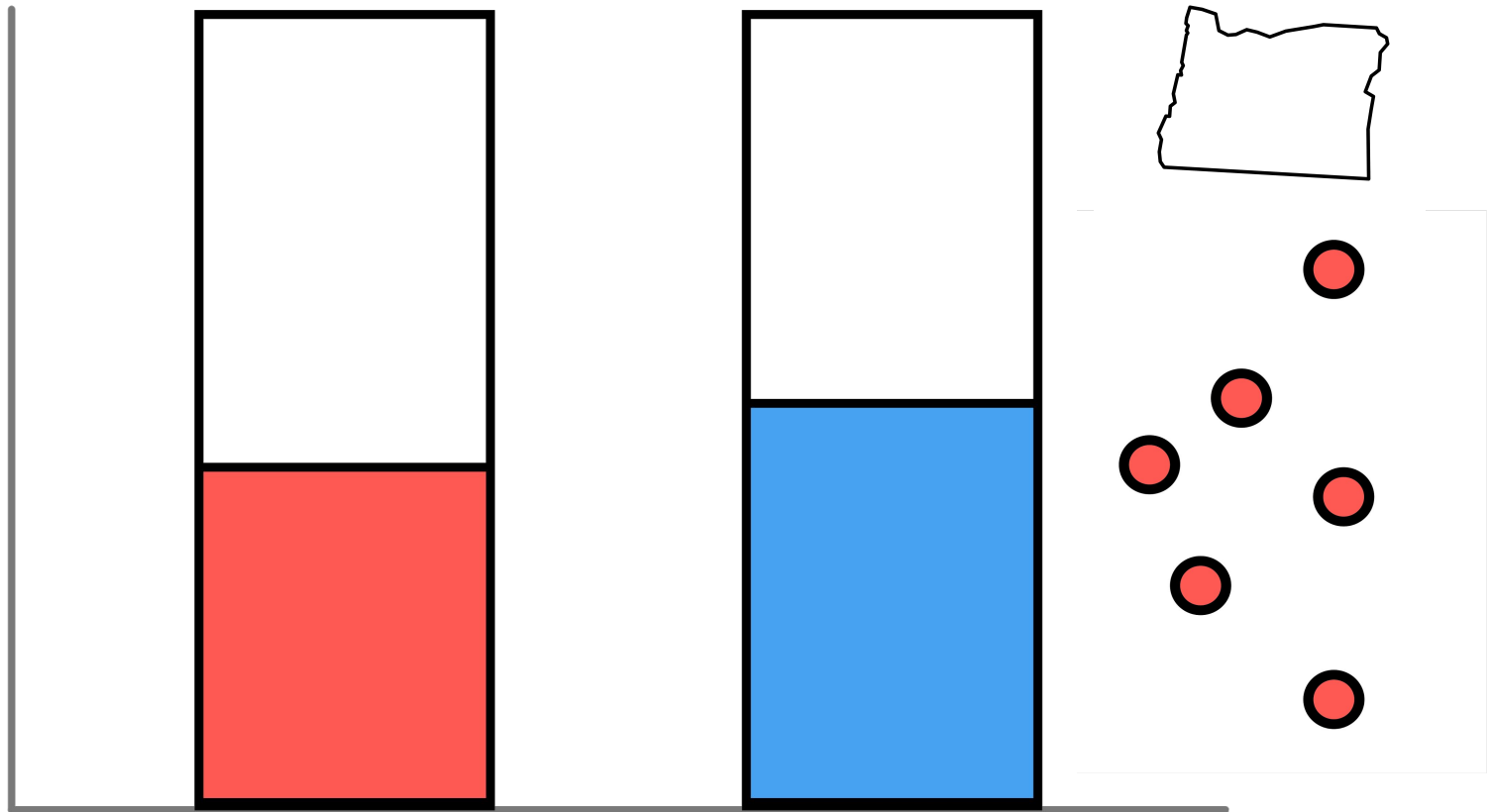
# random\_color\_assignment



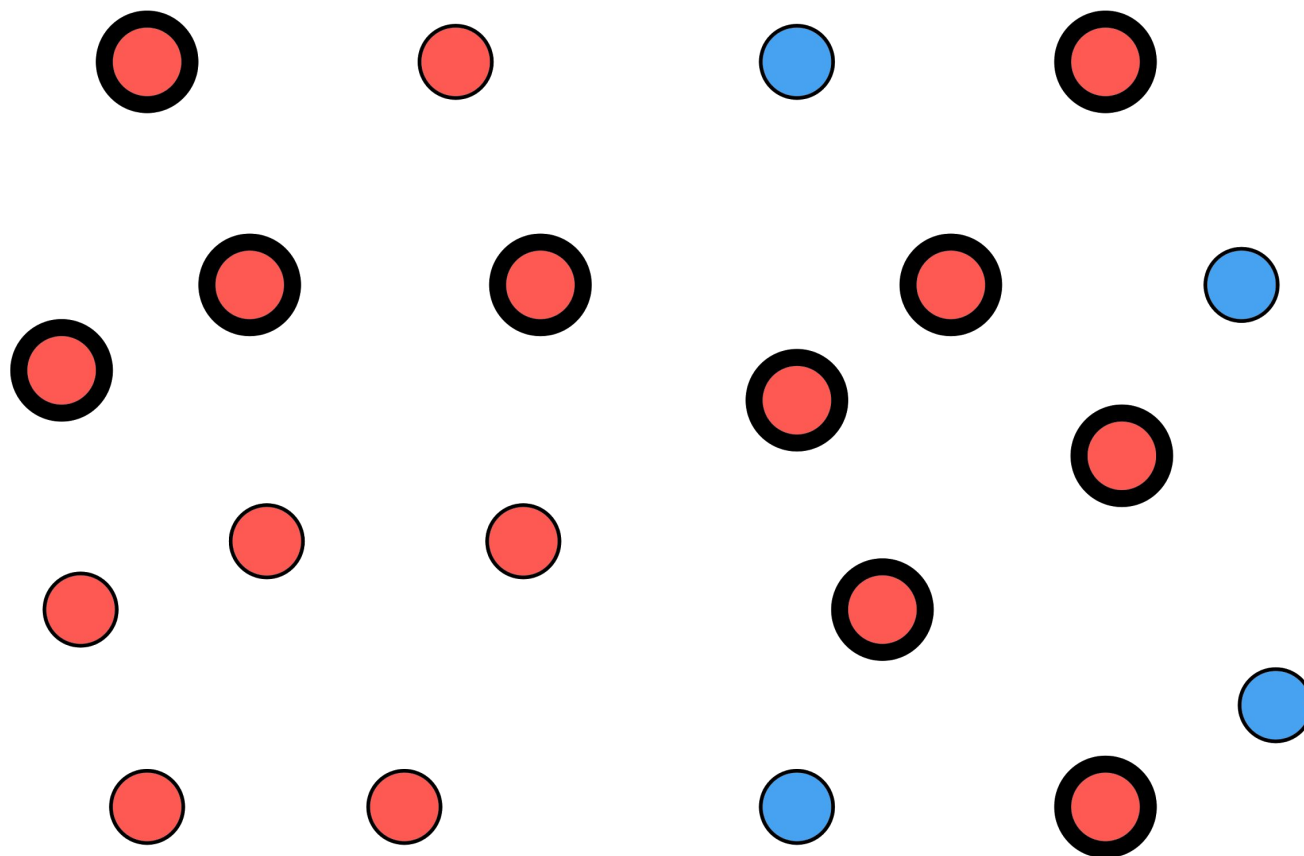
random\_color\_assignment



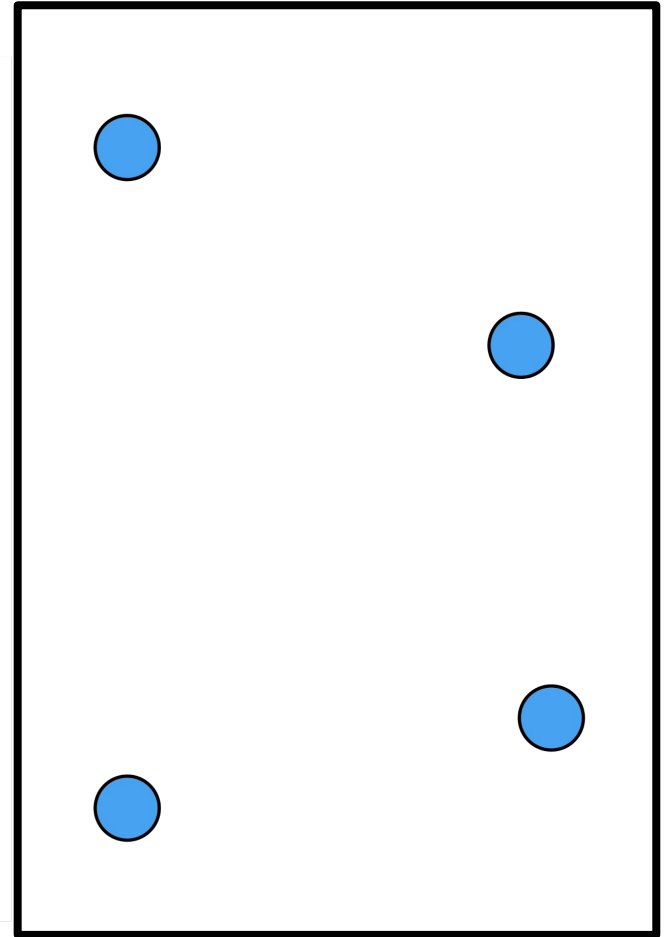
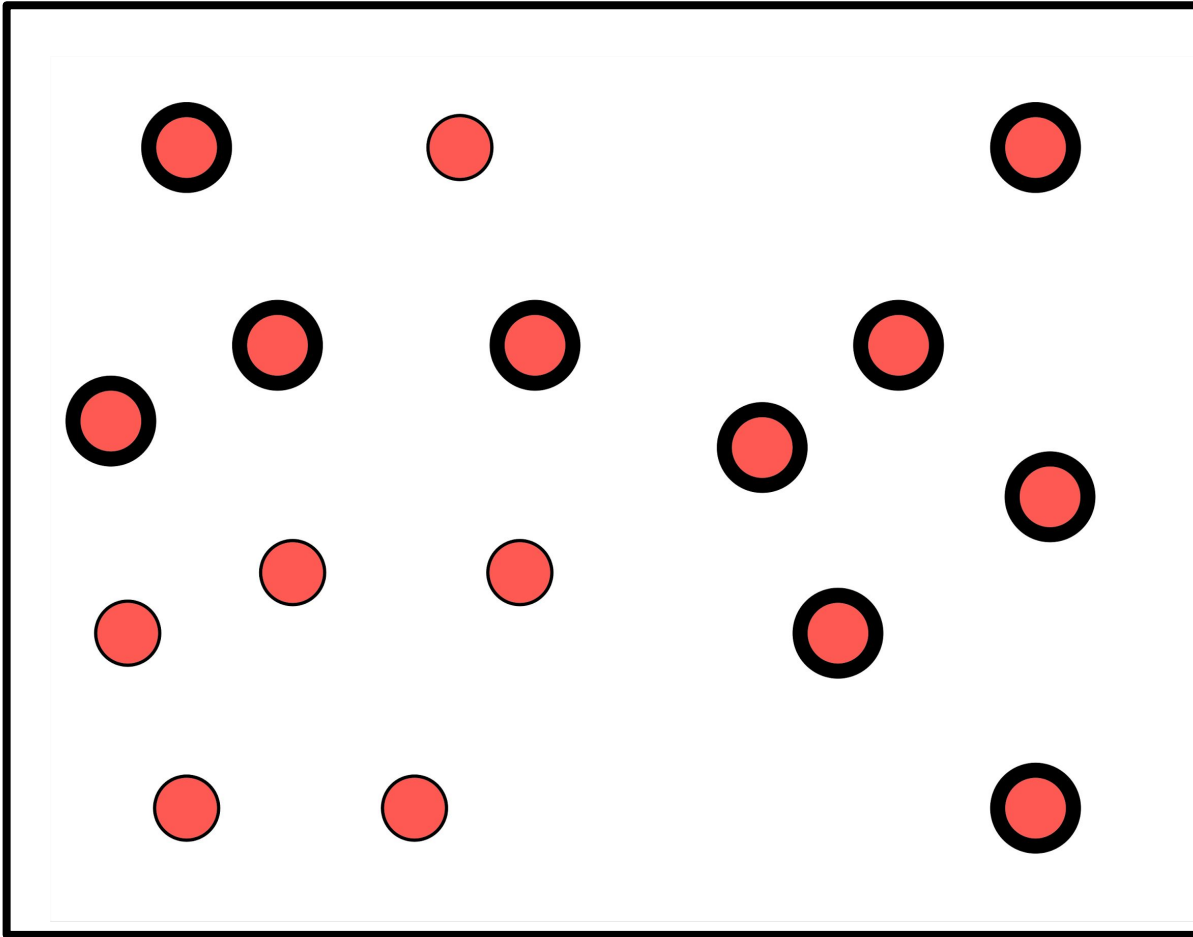
# random\_color\_assignment



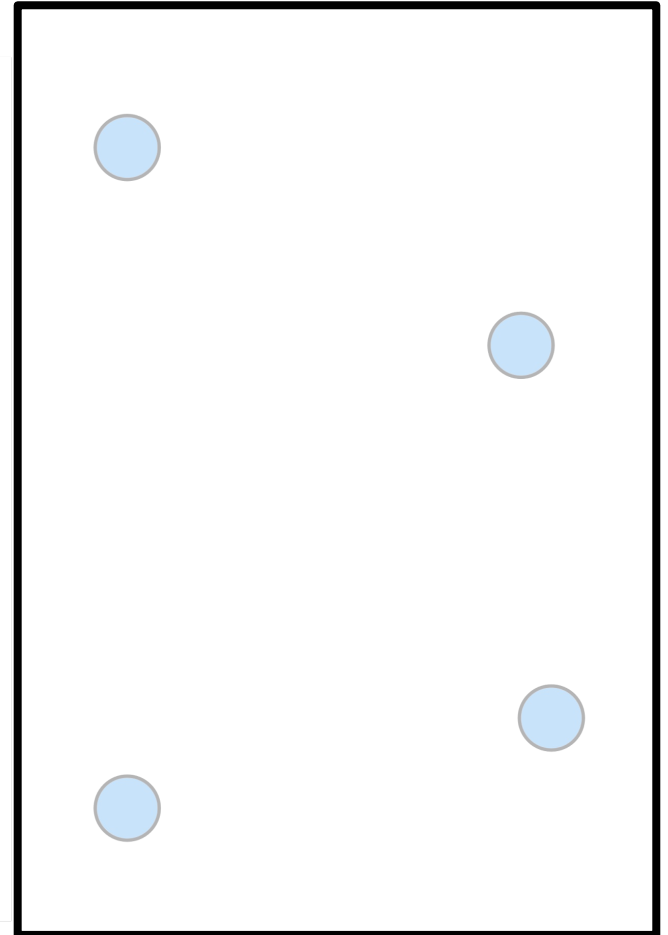
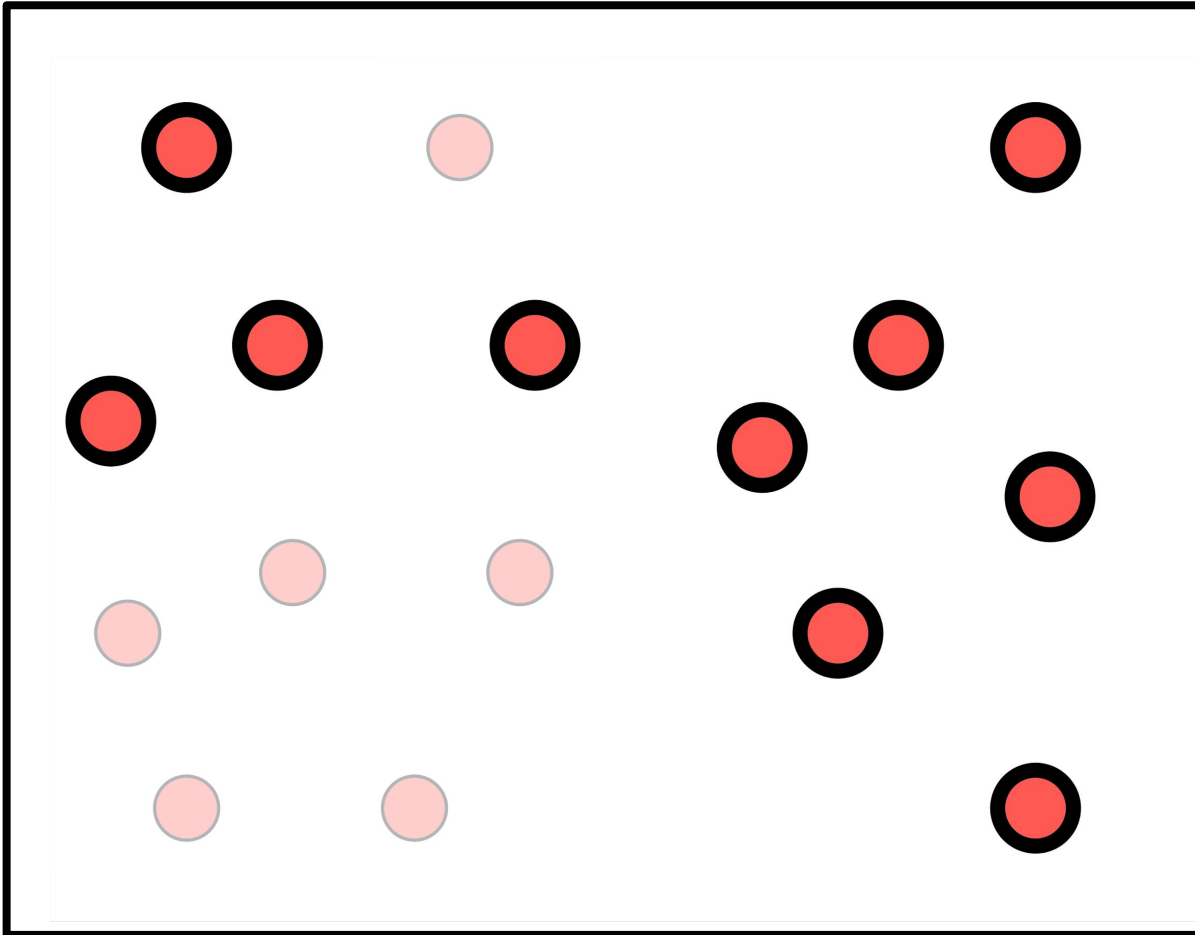
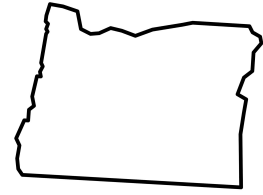
# Actually shown...



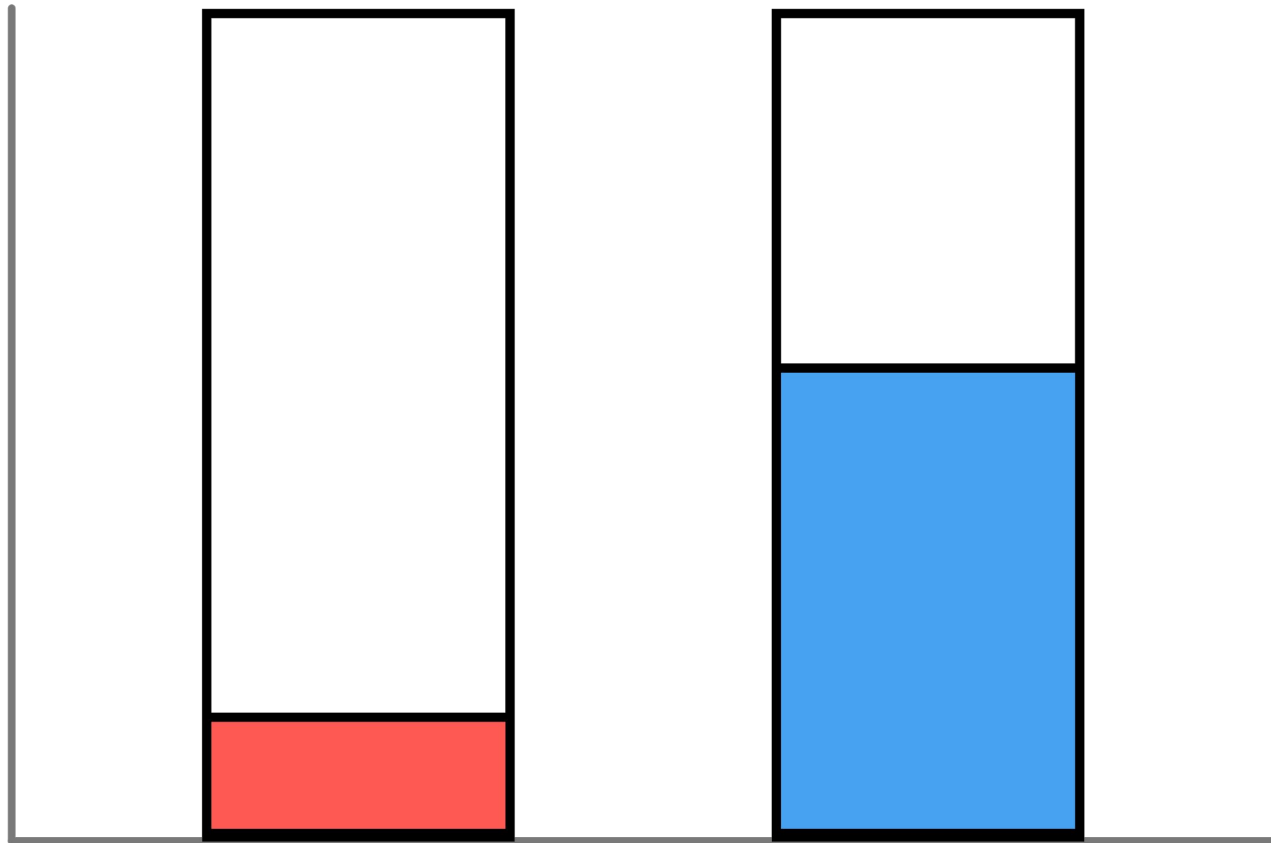
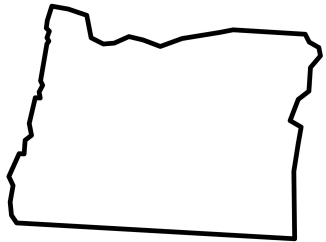
# Actually shown...



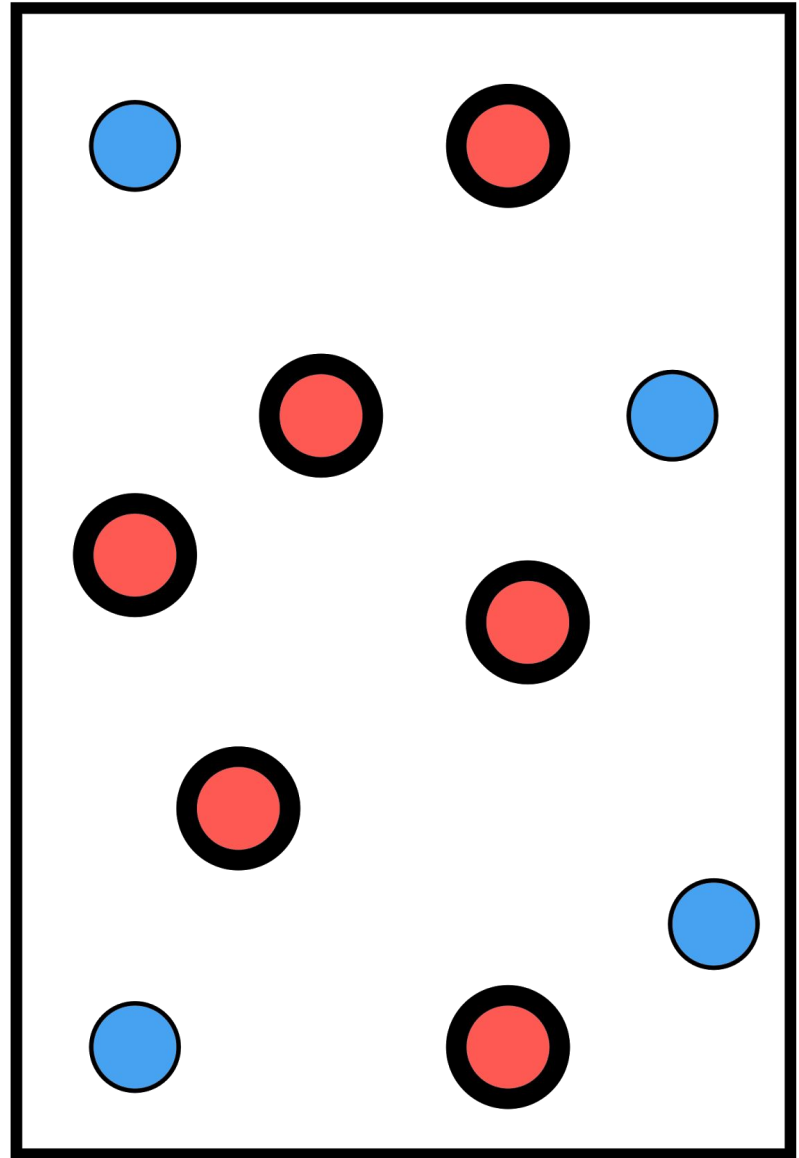
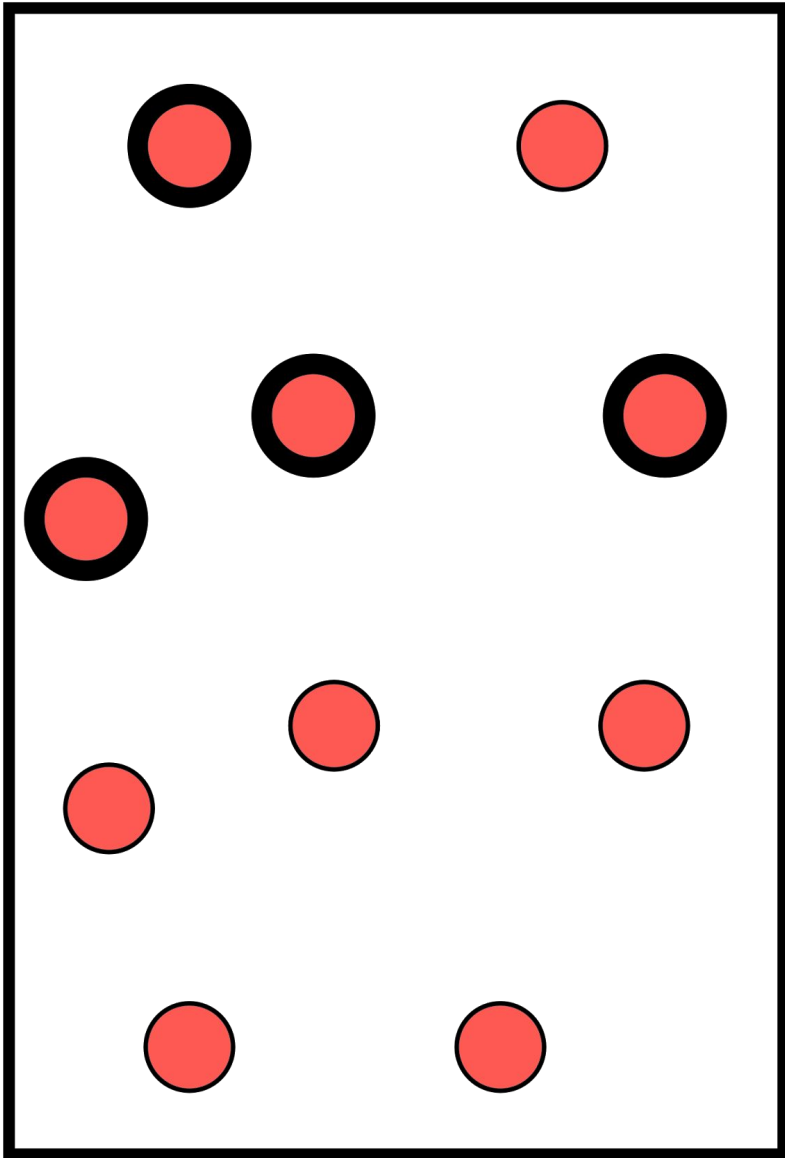
# Bias!

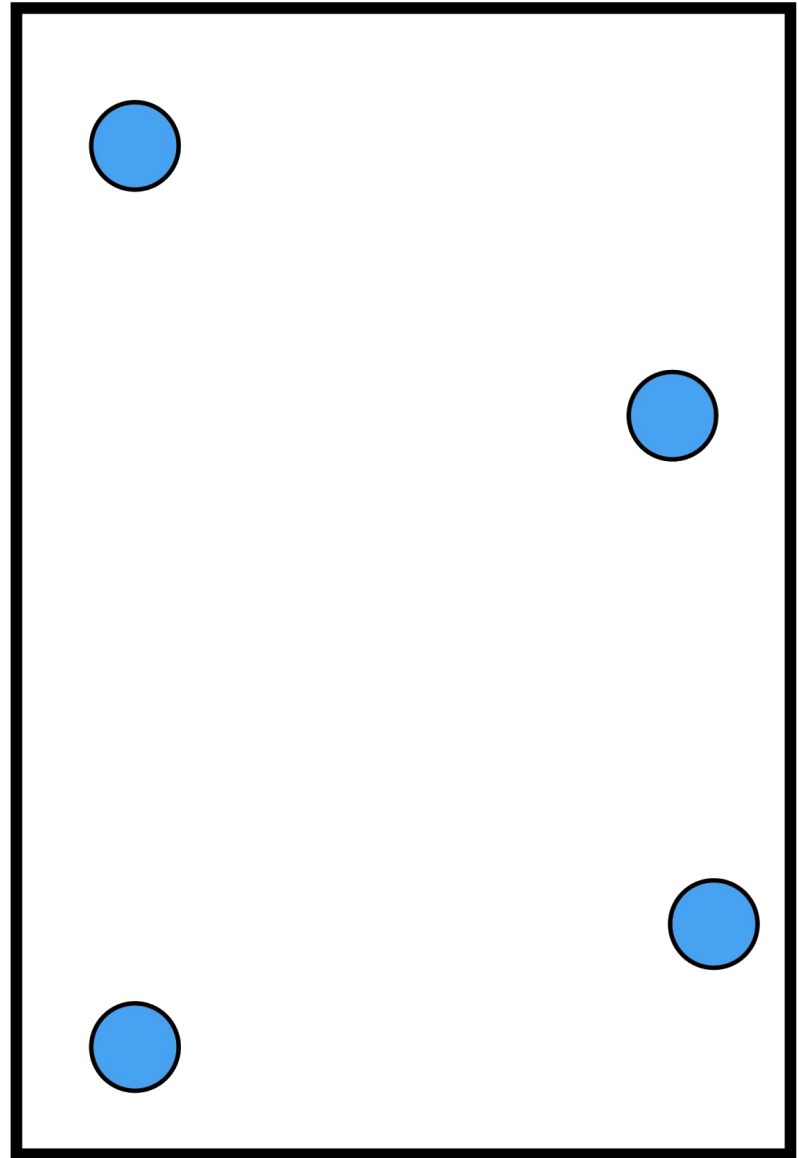
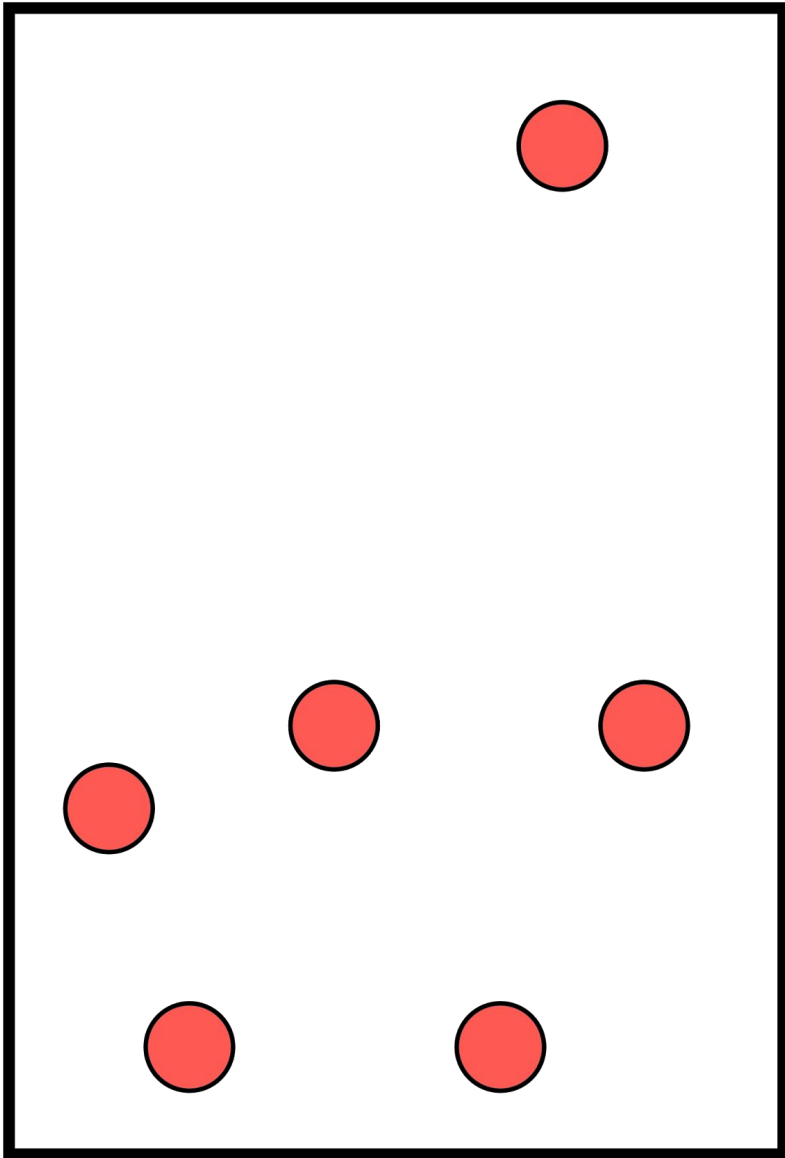


# Actually shown...









# Assignment in practice

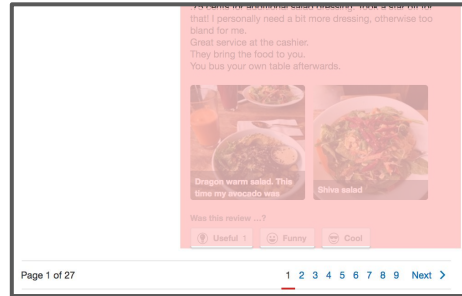
- Independence with salts
- Abstraction
- Additional logic

This got complicated! A/A tests are a good idea.

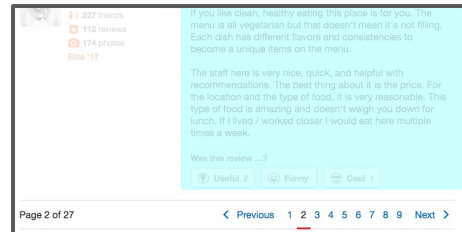
# Summary

# Consider experimental units

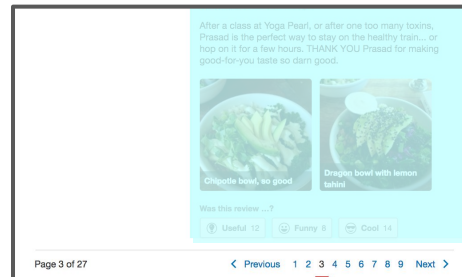
/reviews/1



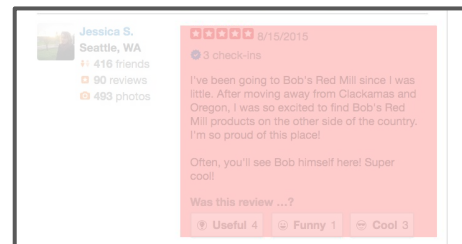
/reviews/2



/reviews/3

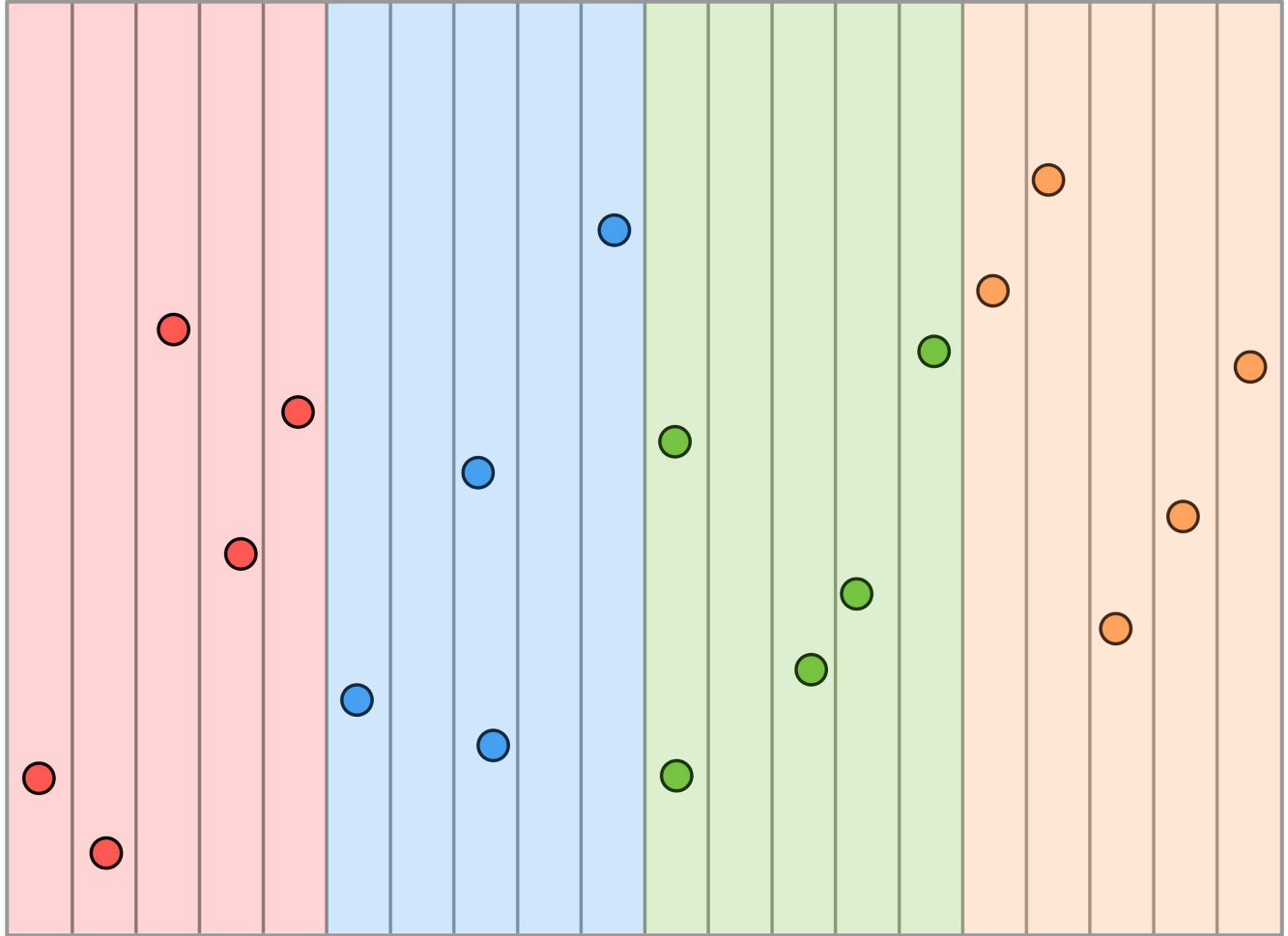


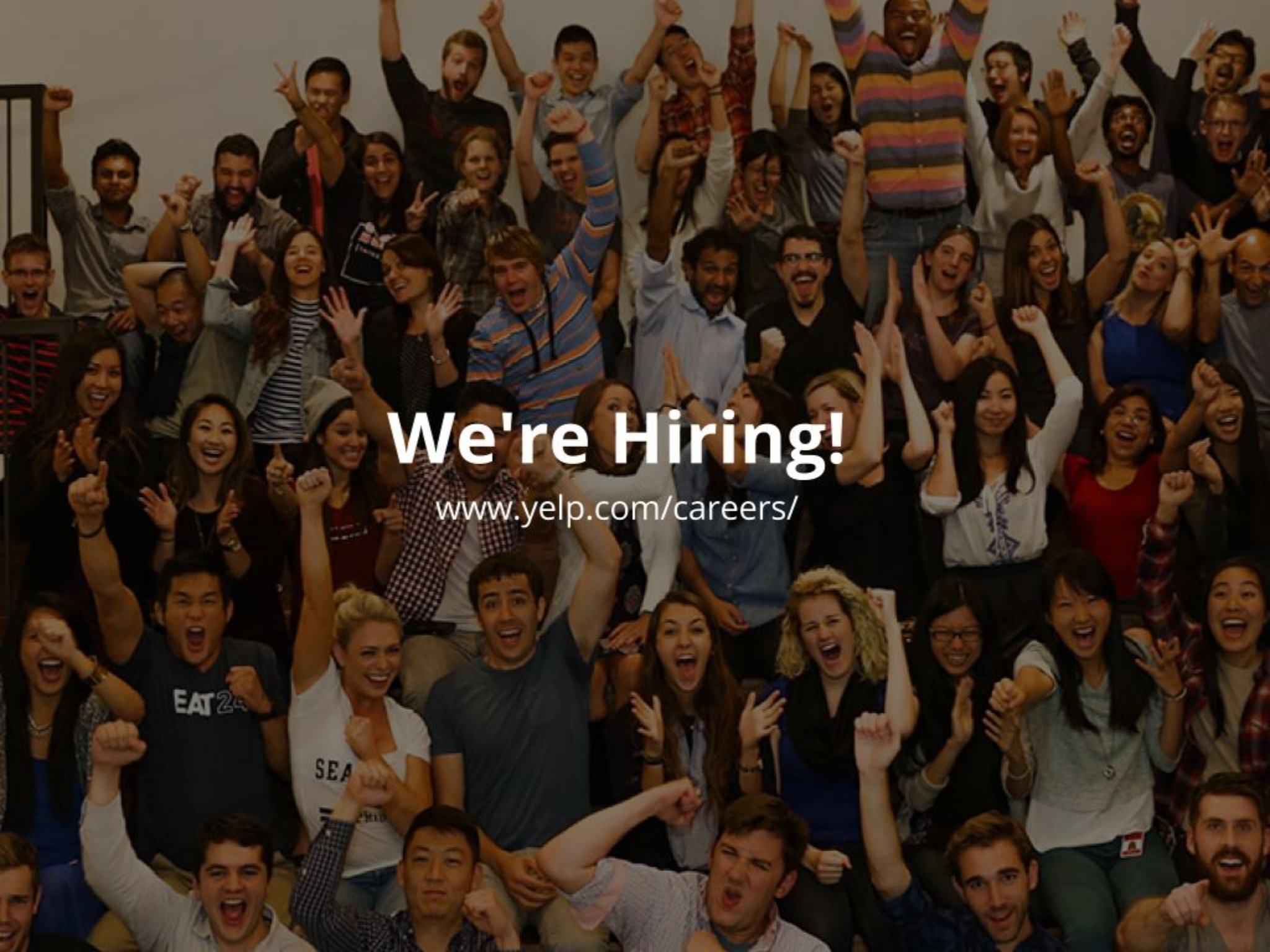
/reviews/4



# Assignment from scratch

```
def choose_color_assignment(user_id):  
    key = "{}|color".format(user_id)  
    assignment_i = hash_func(key) % 20  
  
    if assignment_i < 10:  
        return 'red'  
    else:  
        return 'blue'
```





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# Questions?

