

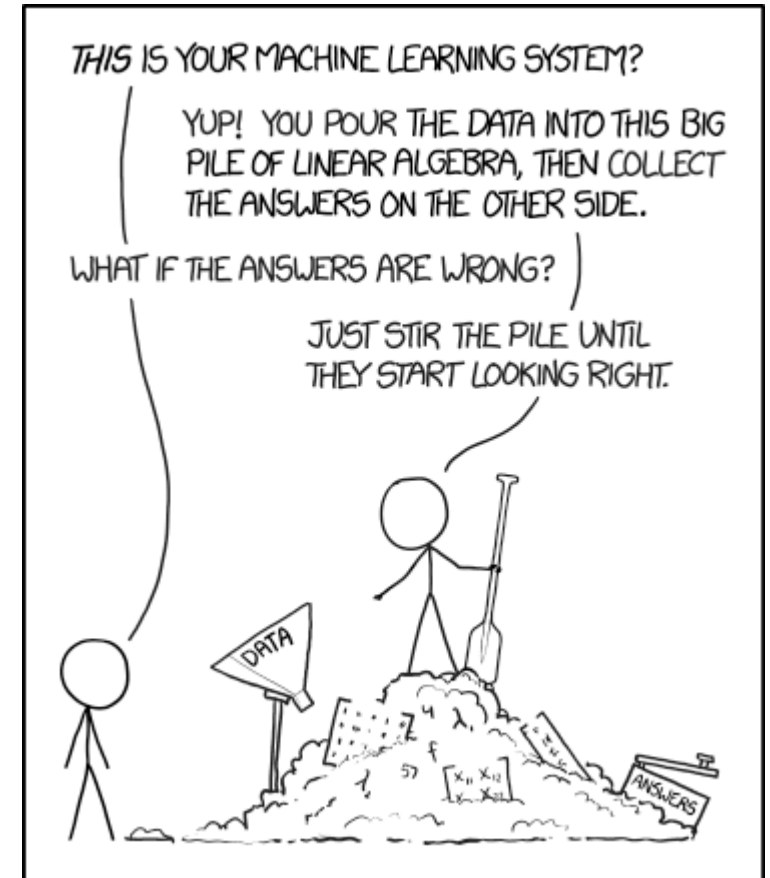
How I learned to stop worrying and model the diffusion

Pavan

<https://github.com/pavanGurazada>

Who am I?

- Sales guy
- Tinker with data for fun
- Right of the middle in $y = f(X)$



Go grab a coffee, if this code seems obvious

```
#define ARMA_64BIT_WORD
#include <RcppArmadillo.h>
//[[Rcpp::depends(RcppArmadillo)]]
using namespace Rcpp;

// [[Rcpp::export]]
arma::vec mat_mult(arma::sp_mat& A,
                   arma::vec& n) {

  return A * n;
}
```

```
mat_mult <- function(A, n) {
  return (A %*% n)
}
```

```
benchmark(mat_mult(A, n), mat_mult(A, n))
```

	test	replications	elapsed	relative
2	mat_mult(A, n)	2000	243.92	1.000
1	mat_mult(A, n)	2000	462.14	1.895

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What was my problem?



EDWARD WAS DISAPPOINTED THAT NONE OF HIS KIDS LIKED HIS DINNER ON FACEBOOK.

Why should you bother?



Uber
Like This Page · 9 December · 🌐

We make the holidays fabulously festive with [#UberTreesDXB](#). Order yours today from 2 PM - 8 PM!

👍 Like 💬 Comment ➦ Share 🗨️

👍❤️ 7 [Top comments](#) ▾

Karl Sarah Costello Uber has charged my credit card 3 times today (480+480+450), yet no tree was ever confirmed or delivered and DM with Uber was never answered! Dubai Uber very poor!
Like · Reply · 9 December at 21:50

Uber 🟦 Hi Karl, we've replied to your private message. Please check your messages for our response.
Like · Reply · 9 December at 21:56

Write a comment... 😊 📷 GIF 🗨️

So, does anyone read anything we
post on social media ever?

Poll

Do you find your social media
newsfeed interesting?

Okay, but why should you bother?



Uber 
@Uber

Follow 

When your driver drops you at the airport and tells you to have a safe flight, don't say "you too!" [#WednesdayWisdom](#)

1:48 PM - 7 Feb 2018

72 Retweets 330 Likes



 63  72  330 

Okay, but why should you bother?



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63 72 330



Austin Hoffman
@reallyhoffman

Follow

Uber driver:

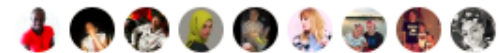
Me:

Uber driver:

Me: 5 stars..would choose this driver again

8:05 AM - 6 Feb 2018

45,203 Retweets 176,532 Likes



117 45K 177K

Okay, but why should you bother?



Cost-to-marketer: \$0



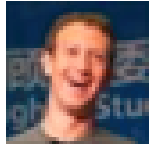
Cost-to-marketer: \$10,000

As a business, should I:

1. Place ads, or

2. Co-create content

It turns out, even Facebook had
the same problem!

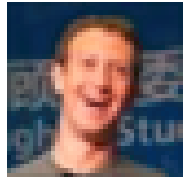


Mark Zuckerberg ✓

about 2 weeks ago



We just announced our quarterly results and community update. Our focus in 2018 is making sure Facebook isn't just fun, but also good for people's well-being and for society. We're doing this by encouraging meaningful connections between people rather than passive consumption of content. Already last quarter, we made changes to show fewer viral videos to make sure people's time is well spent. In total, we made changes that reduced time spent on Facebook by roughly 50 million hours every day. By focusing on meaningful connections, our community and business will be stronger over the long term.



Mark Zuckerberg ✓

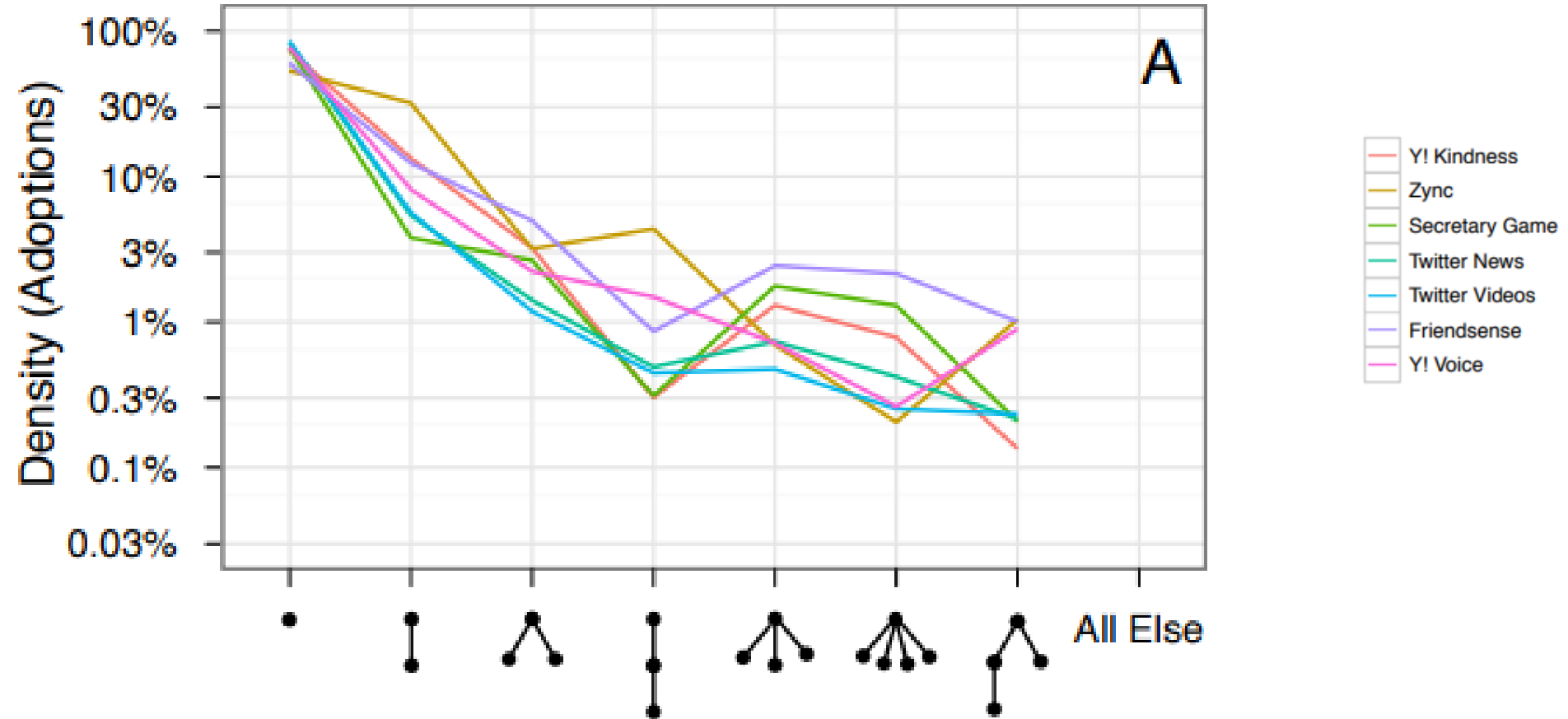
about 2 weeks ago



rather than passive consumption of content. Already last quarter, we made changes to show fewer viral videos to make sure people's time is well spent. In total, we made changes that reduced time spent on Facebook by roughly 50 million hours every day.

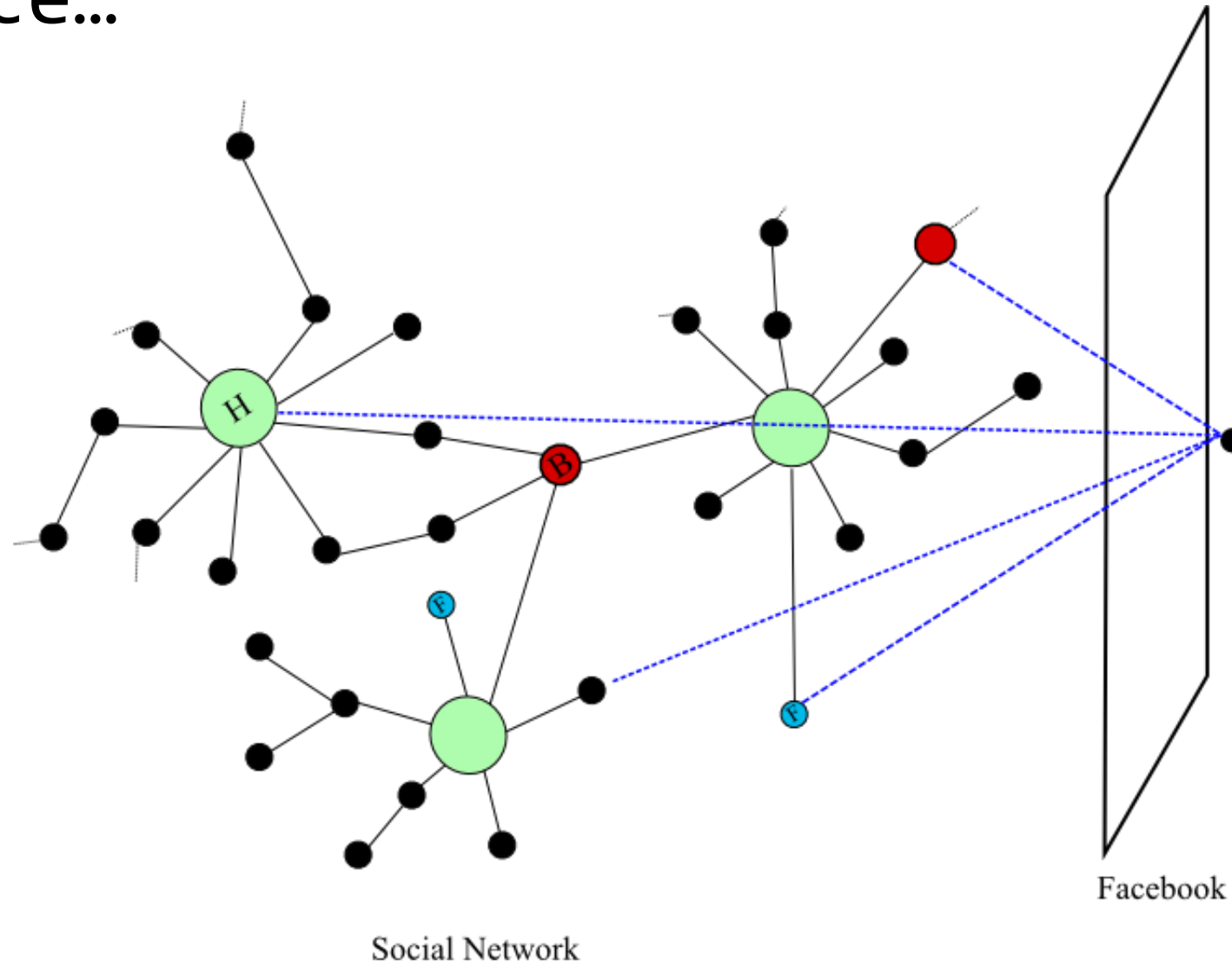
What do scholars say about
social media?

The law of social media is...



Nothing happens most of the time!

But there is a lot cooking beneath the surface...



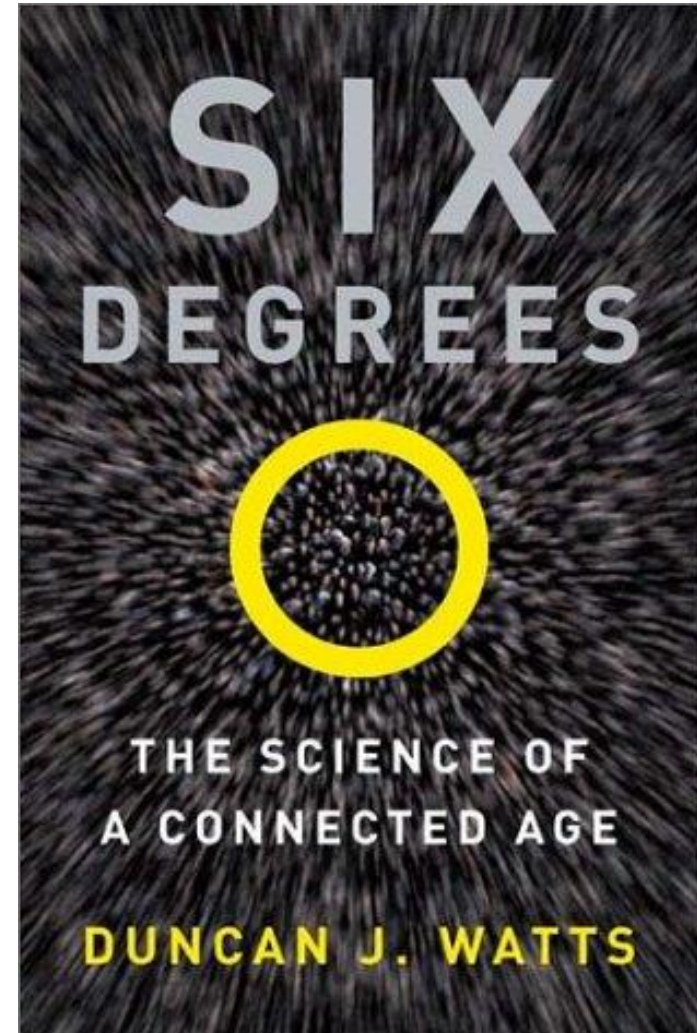
Co-create content (or) Place ads?

The International No.1 Bestseller
The
**TIPPING
POINT**



*HOW LITTLE THINGS CAN MAKE
A BIG DIFFERENCE*
**MALCOLM
GLADWELL**

(or)



Can we explore this?

Recipe

- Cook up a large social network
- Ask specifically chosen seeds to post content
- Track diffusion

$$P(\text{I respond}) = 1, \text{ if } \emptyset \text{ of my friends respond,} \\ \emptyset \in (0, 1)$$

Problem

Explicit time dependence \Rightarrow Fast simulations are difficult to execute

What did I do?

First, I rubbed R the wrong way

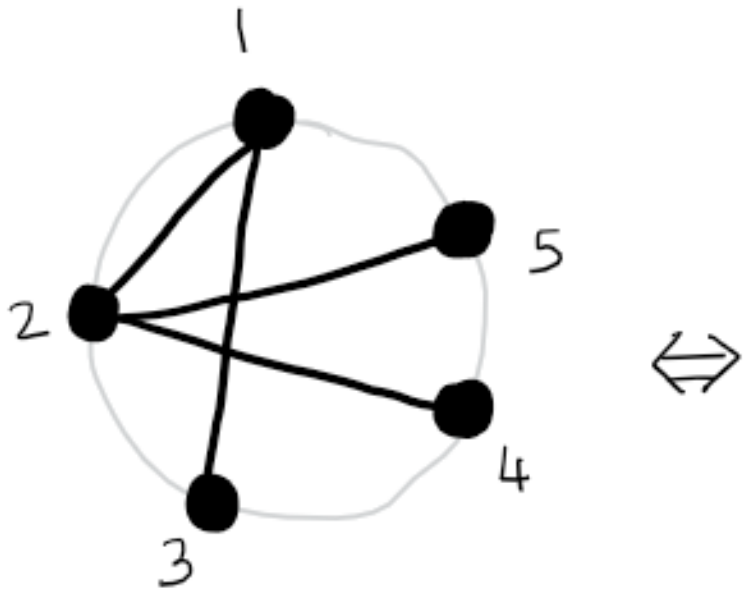
```
for (person in network) {  
  if (engagement_status[person] != 1) {  
    n_engaged_nbrs <- 0  
  
    for (nbr in neighbors(g, person)) {  
      if (engagement_status[nbr] == 1) n_engaged_nbrs <- n_engaged_nbrs + 1  
    }  
  
    if (n_engaged_nbrs > threshold[person]) engagement_status[person] = 1  
  }  
}
```



is a programming language

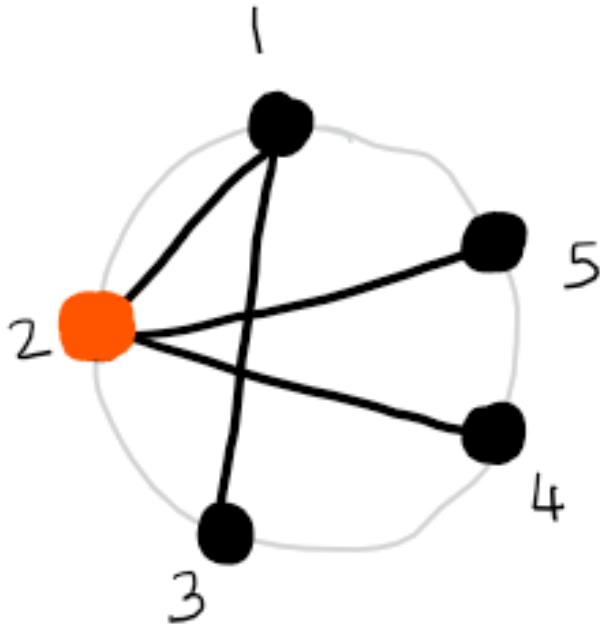
 has a ~~is a programming~~ language

So, I vectorized...



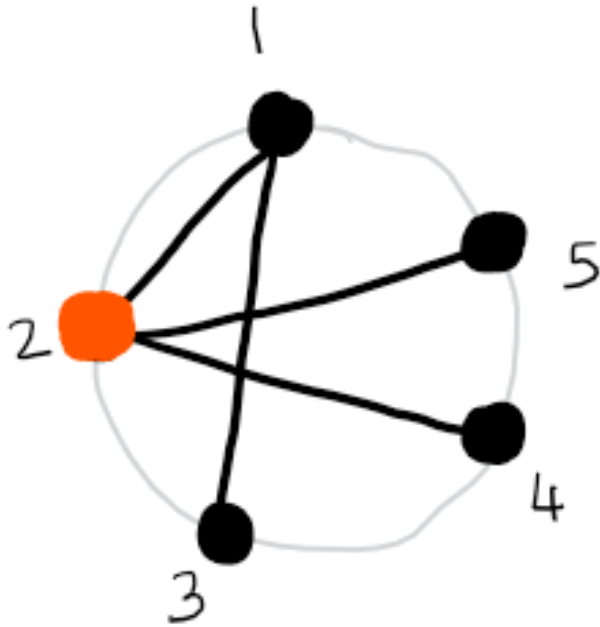
$$\Leftrightarrow \begin{matrix} & \begin{matrix} 1 & 2 & 3 & 4 & 5 \end{matrix} \\ \begin{matrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{matrix} & \begin{bmatrix} 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \end{bmatrix} \end{matrix}$$

How many neighbors for node 2?



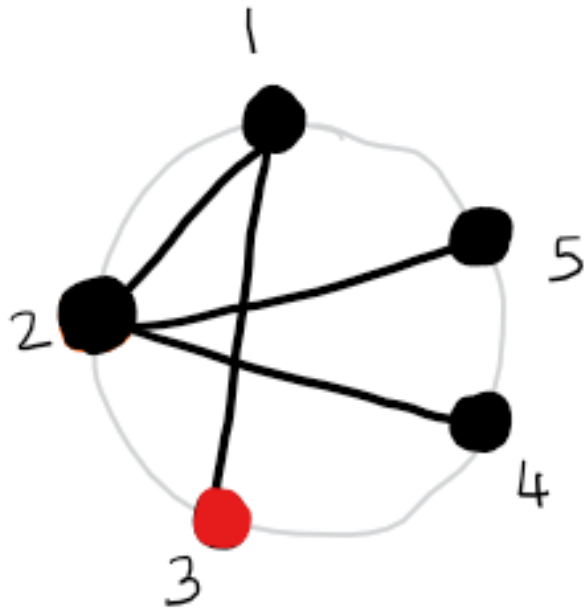
	1	2	3	4	5
1	0	1	1	0	0
2	1	0	0	1	1
3	1	0	0	0	0
4	0	1	0	0	0
5	0	1	0	0	0

How many neighbors for node 2?



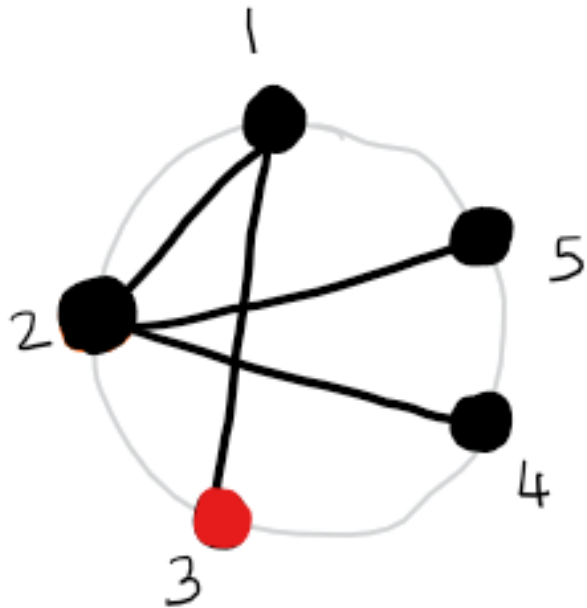
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If only node 3 engaged, how many engaged neighbors does each node have?



	1	2	3	4	5
1	0	1	1	0	0
2	1	0	0	1	1
3	1	0	0	0	0
4	0	1	0	0	0
5	0	1	0	0	0

If only node 3 engaged, how many engaged neighbors does each node have?



$$\begin{array}{c} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{array} \begin{array}{c} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{array} \begin{bmatrix} 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} 0 \\ 0 \\ 1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

So, this becomes...

```
for (person in network) {  
  if (engagement_status[person] != 1) {  
    n_engaged_nbrs <- 0  
  
    for (nbr in neighbors(g, person)) {  
      if (engagement_status[nbr] == 1) n_engaged_nbrs <- n_engaged_nbrs + 1  
    }  
  
    if (n_engaged_nbrs > threshold[person]) engagement_status[person] = 1  
  }  
}
```

...an order of magnitude faster...

```
n_engaged_nbrs <- as.vector(A %*% engagement_status)

# which nodes are ready to engage?

vuln_persons <- n_engaged_nbrs > threshold

# engage these persons

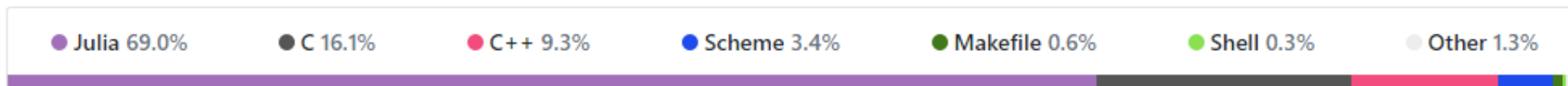
engagement_status[vuln_persons] <- 1
```

How to write fast R?

1. Solve problems on vectors
2. Follow 1, even when you don't need to

But, vectorization is unnatural,
aka, 'my head hurts'

Enter **julia**



Pythonic syntax + speed = Zen

```
function update_person_status!(g, engagement_status::BitArray, threshold::Vector{Int})  
  
    for person in vertices(g)  
        if engagement_status[person] == false  
            num_engaged_friends = sum([engagement_status[friend] for friend in neighbors(g, person)])  
        end  
  
        if num_engaged_friends > threshold[person]  
            engagement_status[person] = true  
        end  
    end  
  
    return nothing  
  
end
```

Enough pseudo-code, show me the
real stuff!

What did I learn?

- Social media users have thresholds to act
 - Never pay to push posts :P
-
- Don't write loops in R, even when it seems impossible 😊
 - Julia is a productive C, keep an eye

Questions?

Pavan

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