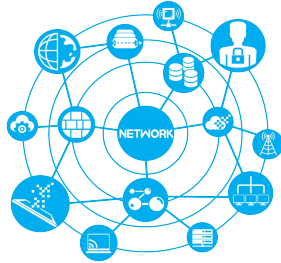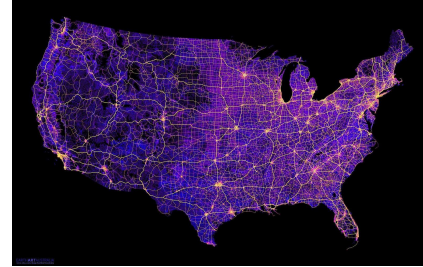# **Confidence estimation for network propagation-based biological studies**

Winston Chen
University of Washington, ECE
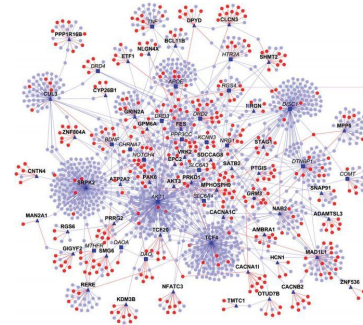
Networks are common in science and everyday life

Web network
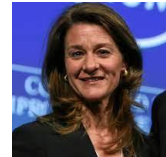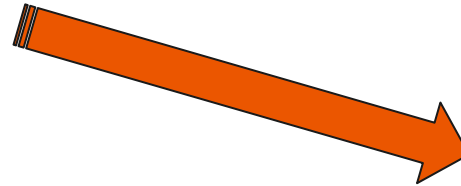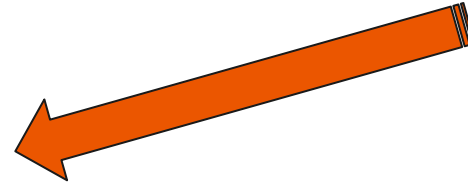

Transportation network

Social network
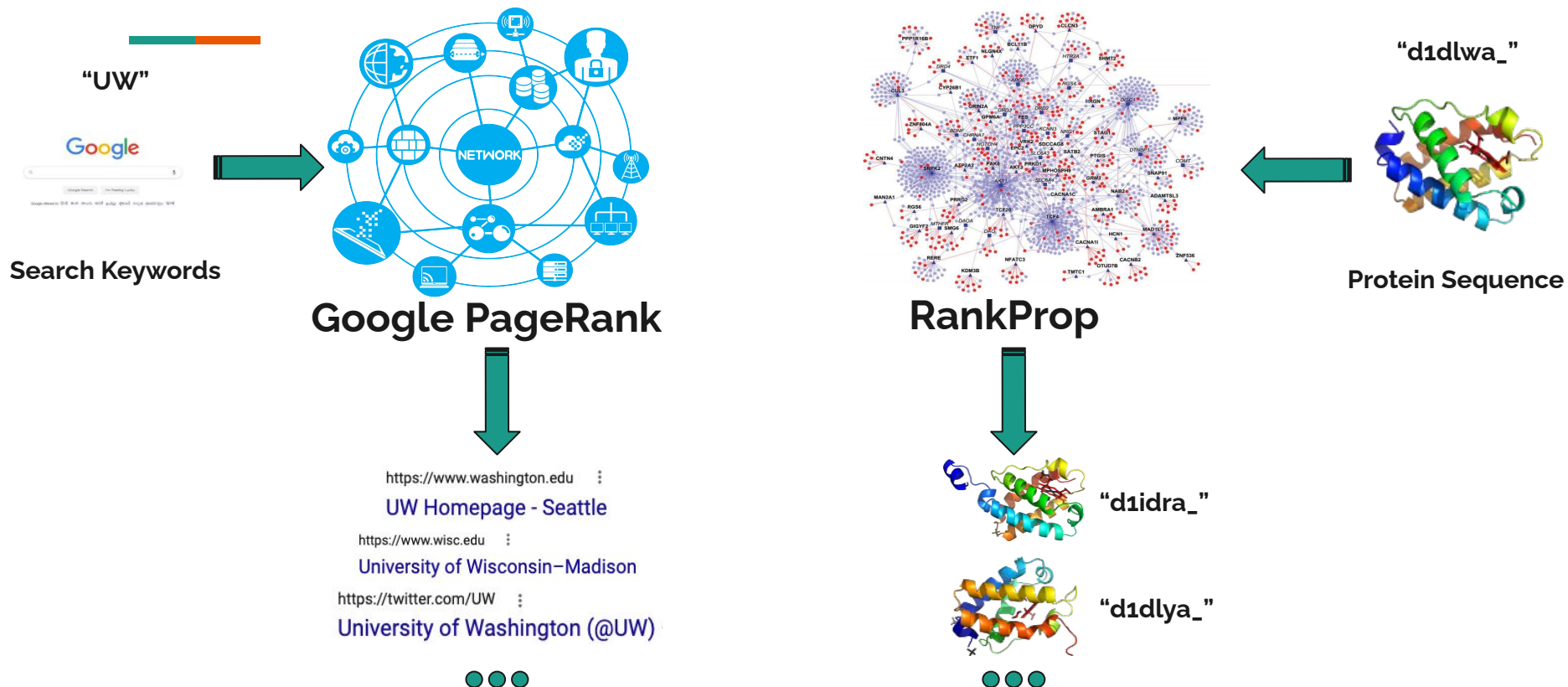

Protein-protein interaction network

Network search

Social Network

3

Network propagation ranks nodes relative to a query

"UW"

Search Keywords

Google PageRank

https://www.washington.edu
UW Homepage - Seattle

https://www.wisc.edu
University of Wisconsin–Madison

https://twitter.com/UW
University of Washington (@UW)

"d1dlwa_"

Protein Sequence

RankProp

"d1idra_"

"d1dlya_"

Weston, Jason, et al. "Protein ranking: from local to global structure in the protein similarity network." *Proceedings of the National Academy of Sciences* 101.17 (2004): 6559-6563.

The cutoff selection problem

"d1dlwa_" **"d1uvya_"** **"1mwba_"** **"d1rtxa_"** **"d1dlya_"** **"d1uvxa_"** **"d1idra_"**

Top 3?   Top 5?   Or base on Ranking Score?
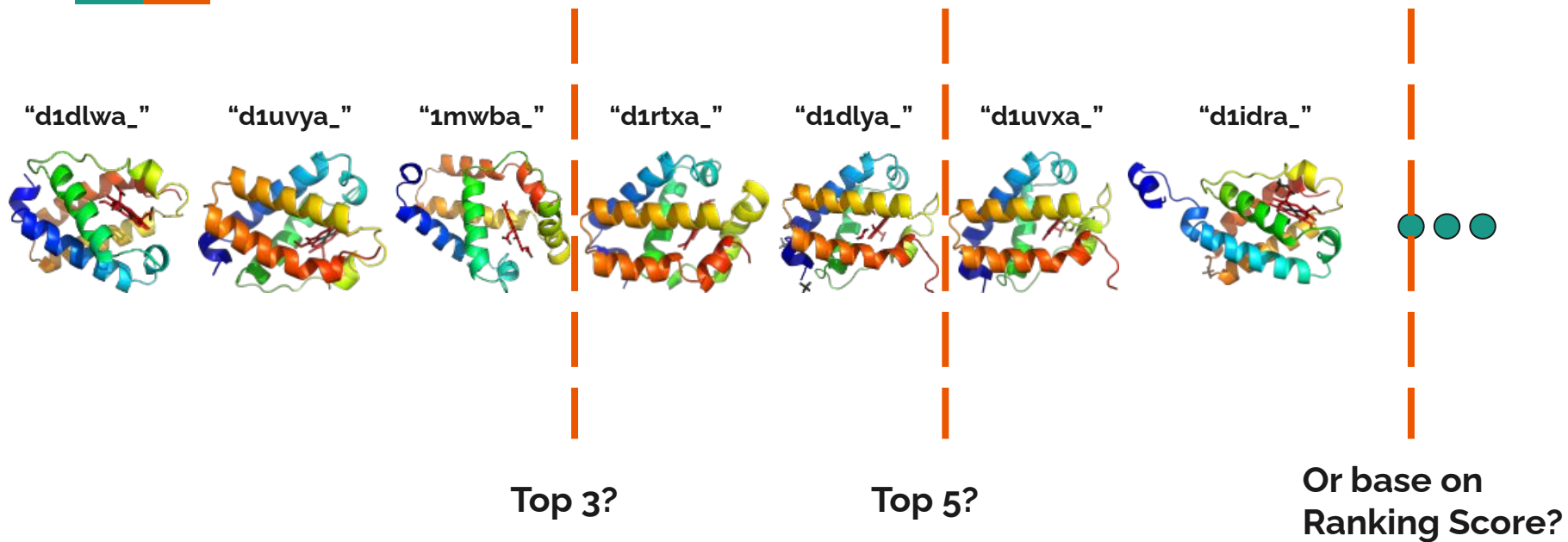
False discovery rate (FDR) estimates help choose a threshold

"d1dlwa_"

"d1uvya_"

"1mwba_"

"d1rtxa_"

FDR

FDR

FDR

FDR

34%   34%

0.15%   2.35%   13.5%   13.5%   2.35%   0.15%

Distribution of random ranking scores

FDR threshold as cutoff (e.g. 5%)
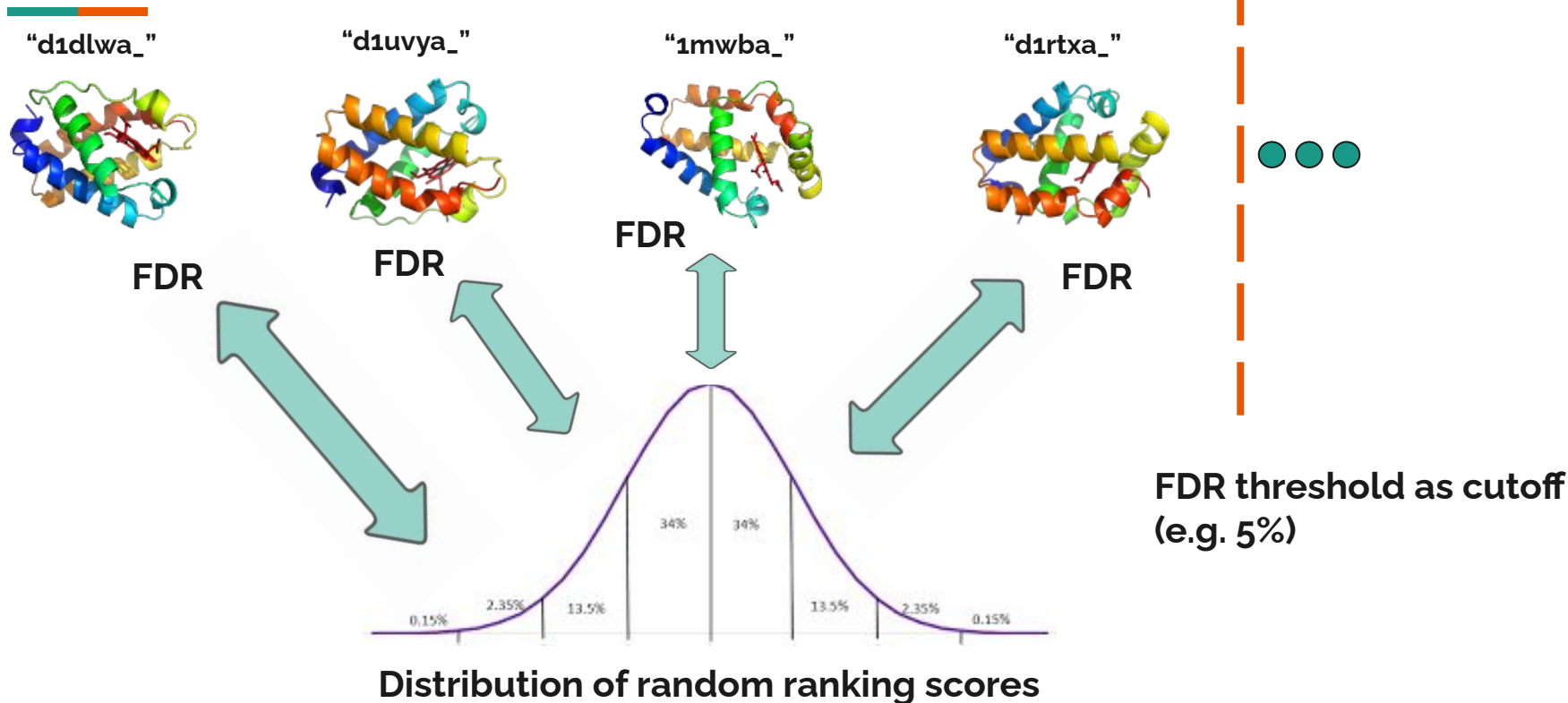
FDR estimation for Rankprop - the naive baseline

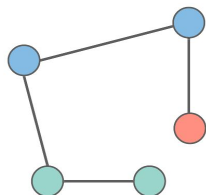Distribution of random ranking scores
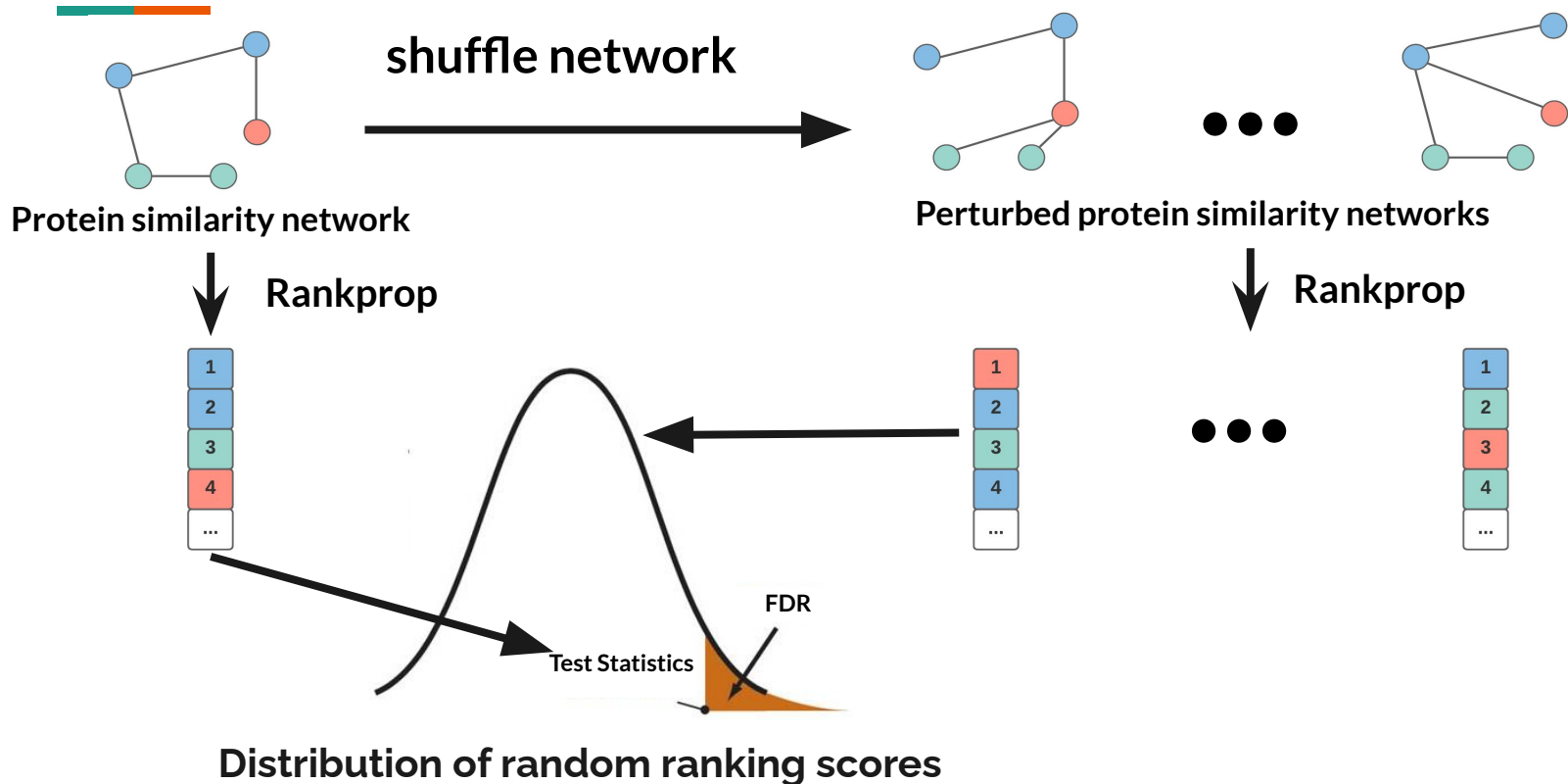
Problem with the baseline method
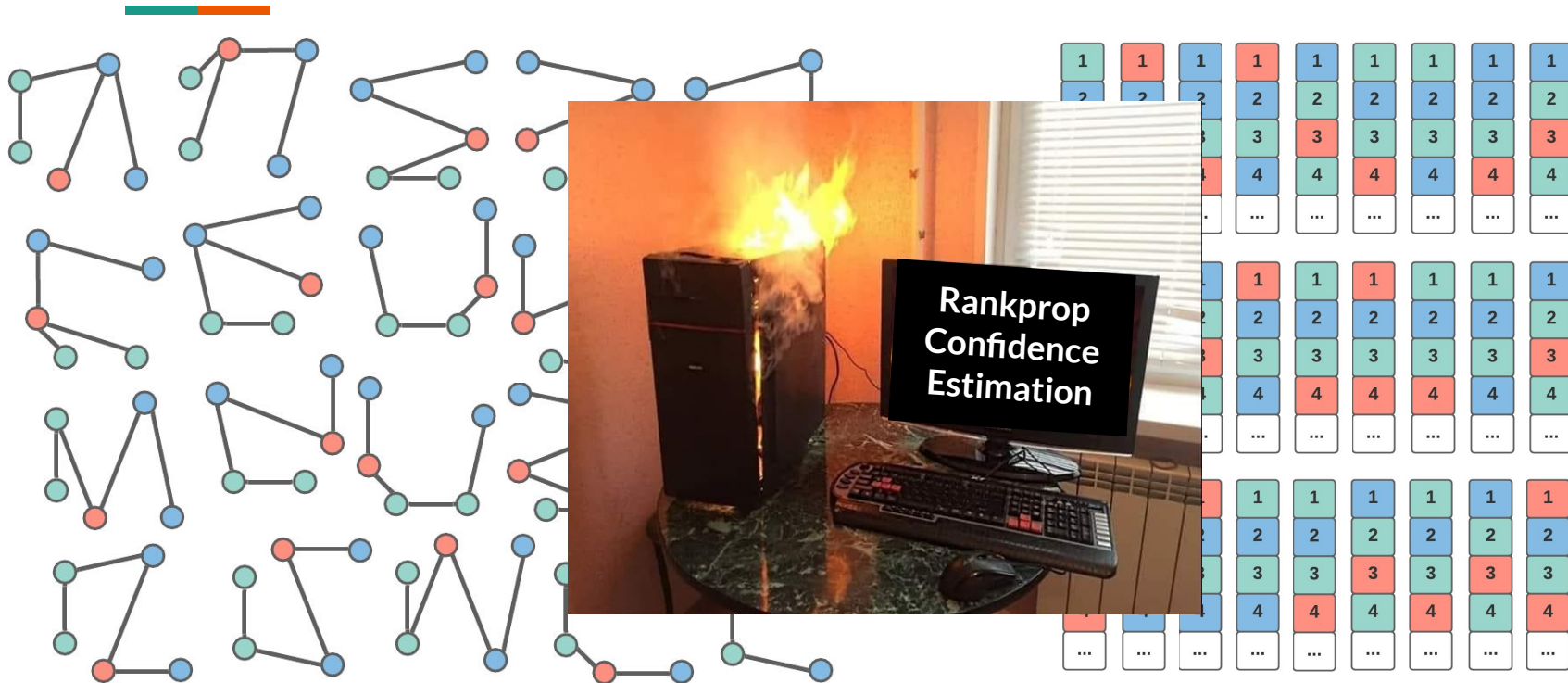
The knockoff filter

The original network   **The knockoff network**

Knockoff Generator
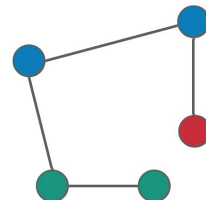
Preserves each node's second-order network structure

Barber and Candès. Controlling the false discovery rate via knockoffs. The Annals of Statistics, 43(5):2055–2085, 2015.

Confidence estimation for Rankprop - the knockoff method

Protein similarity network

↓ **Rankprop**

| 0.8 |
| 0.7 |
| 0.4 |
| 0.4 |
| ... |
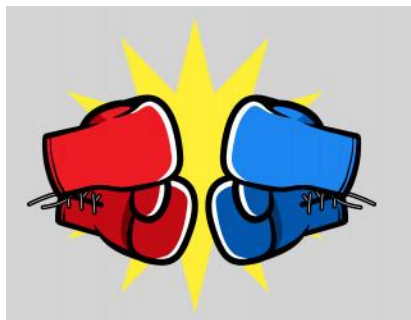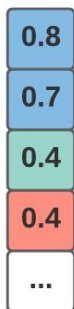
Knockoff protein similarity network

↓ **Rankprop**

| 0.3 |
| 0.1 |
| 0.5 |
| 0.45 |
| ... |
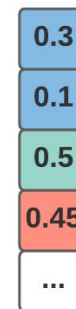
Initial results: We still have work to do

FDR with knockoff method

For low confidence proteins, the knockoff is not so successful so far

Knockoff method successfully identifies a protein with high confidence

FDR with classical method
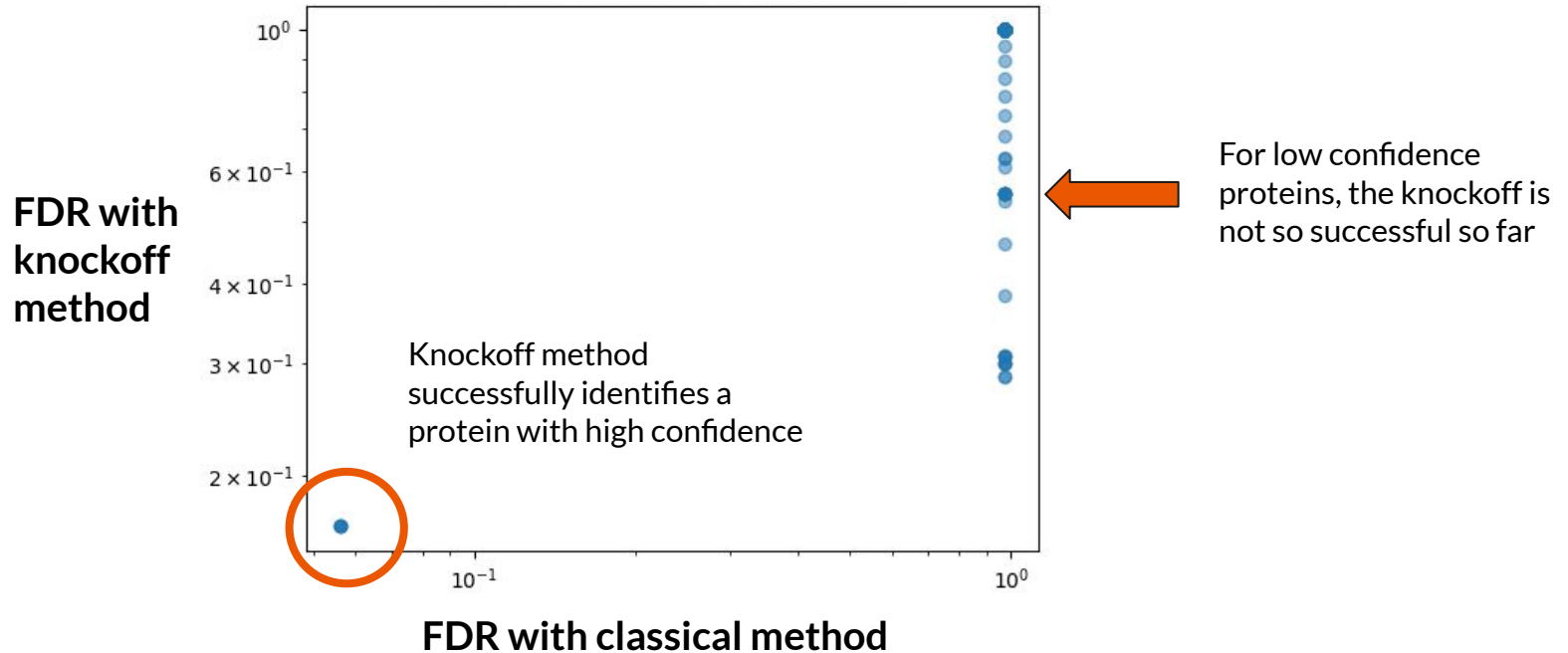
Thanks for listening!
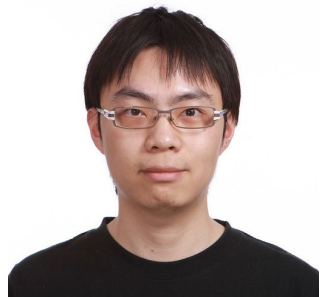
Dr. Yang Lu   **Professor William Noble**

Mary Gates Research Scholarship

Herschel Roman Scholarship