The interplay between Content Quality and Recommender Systems in Social Network Dynamics

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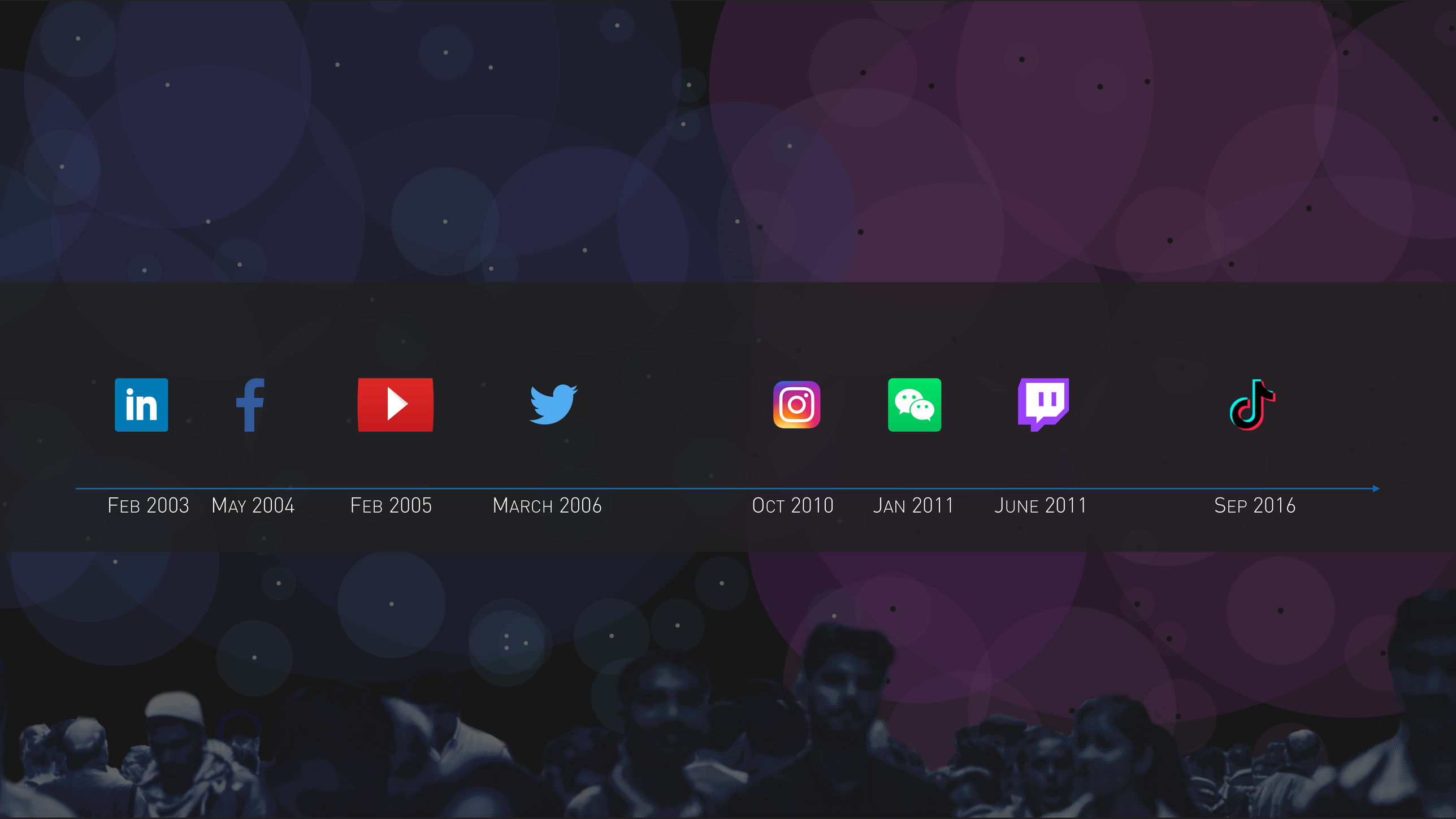
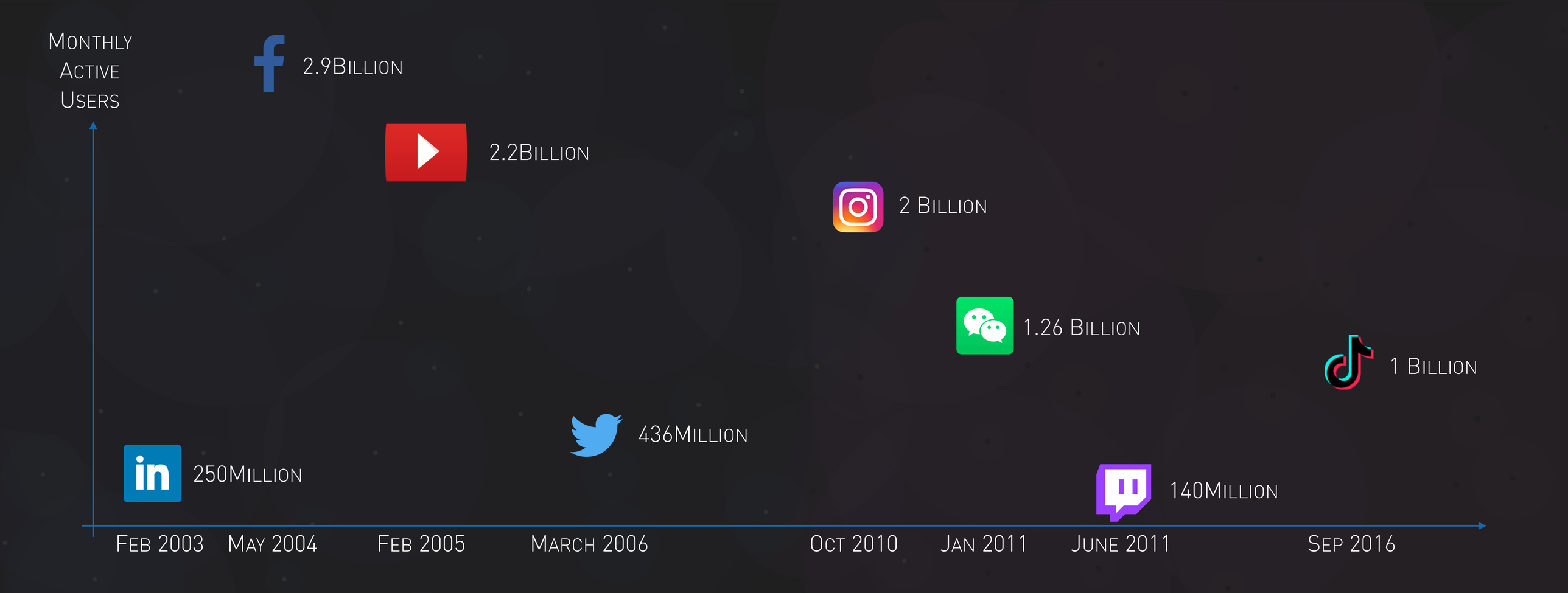
University of Zürich

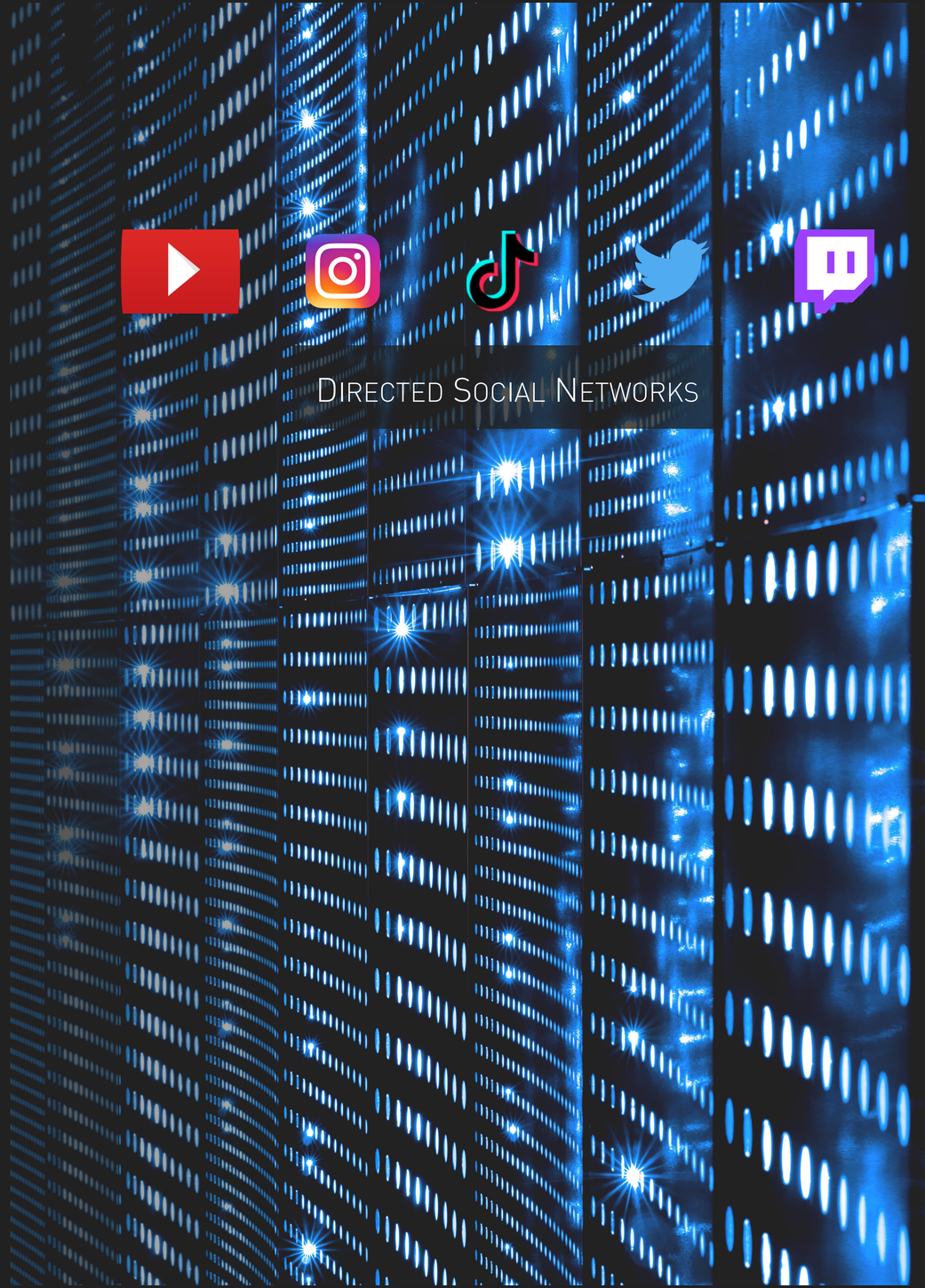
EANA Workshop: Zürich, September 30, 2022


Feb 2003
May 2004
Feb 2005
March 2006
Oct 2010
Jan 2011
June 2011
Sep 2016


Monthly Active Users
2.9Billion
2.2Billion
2 Billion
1.26 Billion
1 Billion
436Million
250Million
140Million
Feb 2003
May 2004
Feb 2005
March 2006
Oct 2010
Jan 2011
June 2011
Sep 2016

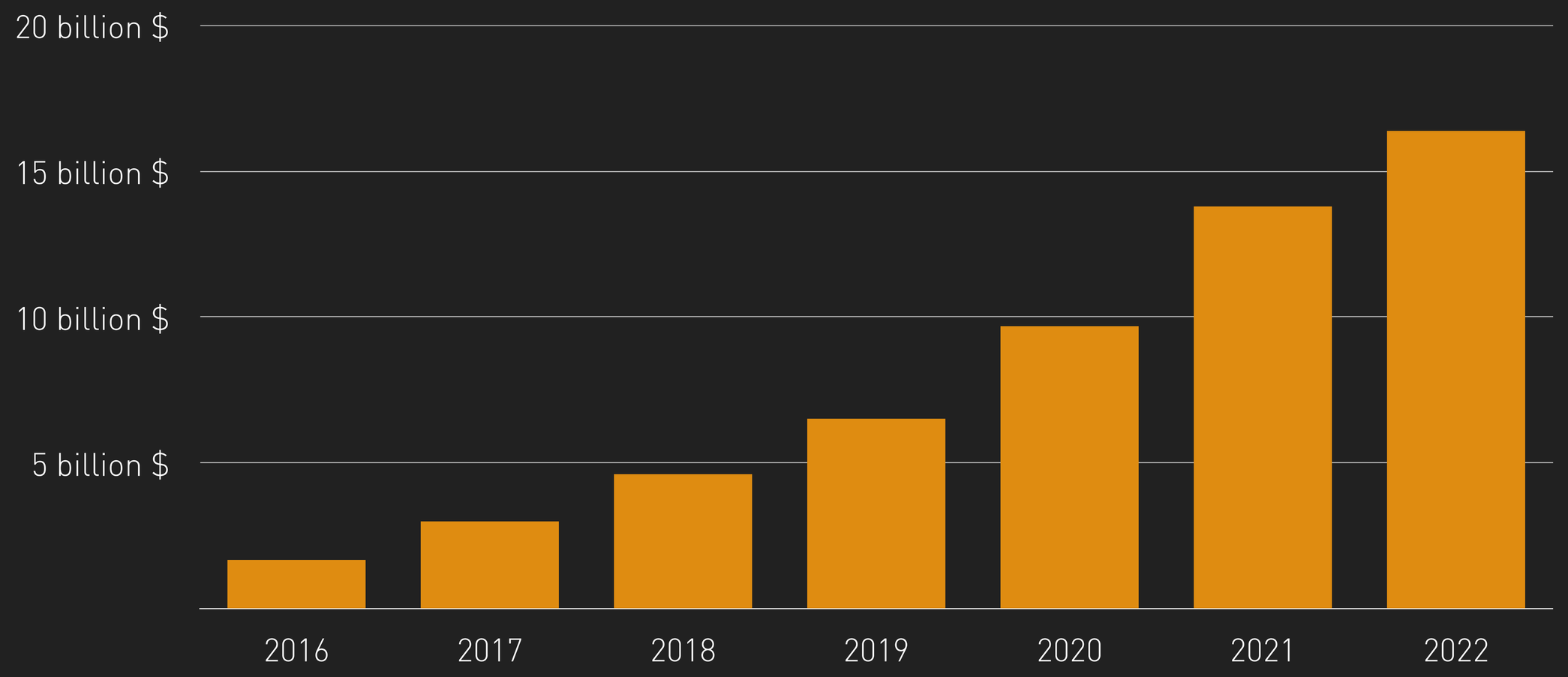
Undirected Social Networks
Directed Social Networks

Undirected Social Networks


Directed Social Networks

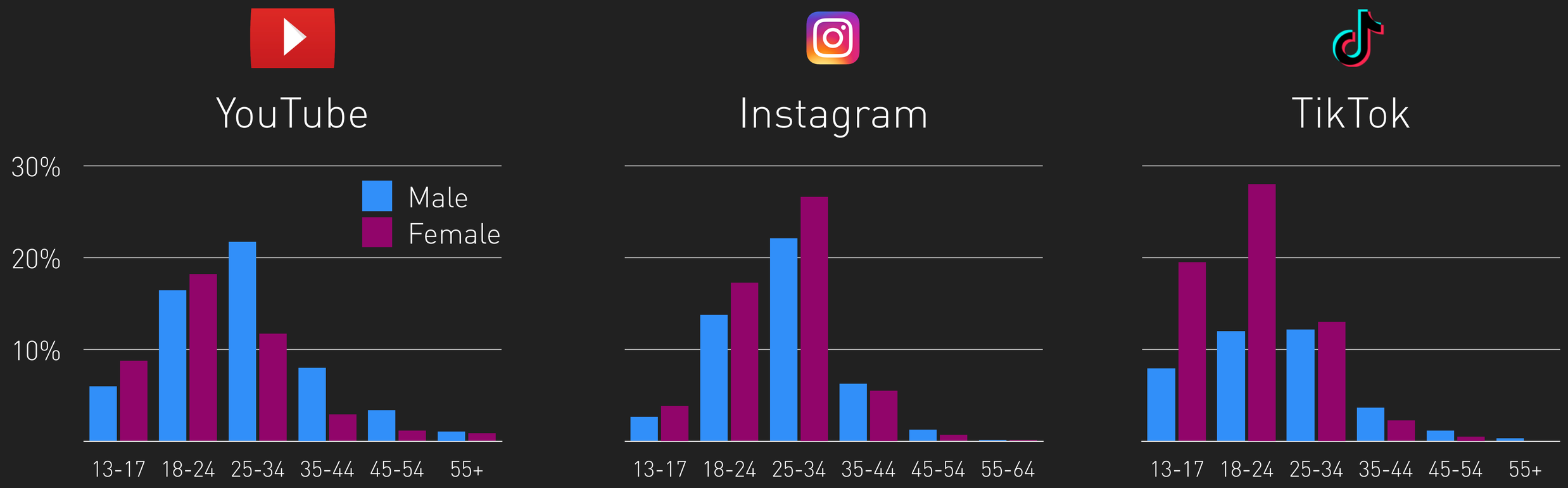
Opportunity for the rise of Social Media Influencers

Influencer Marketing Market Size



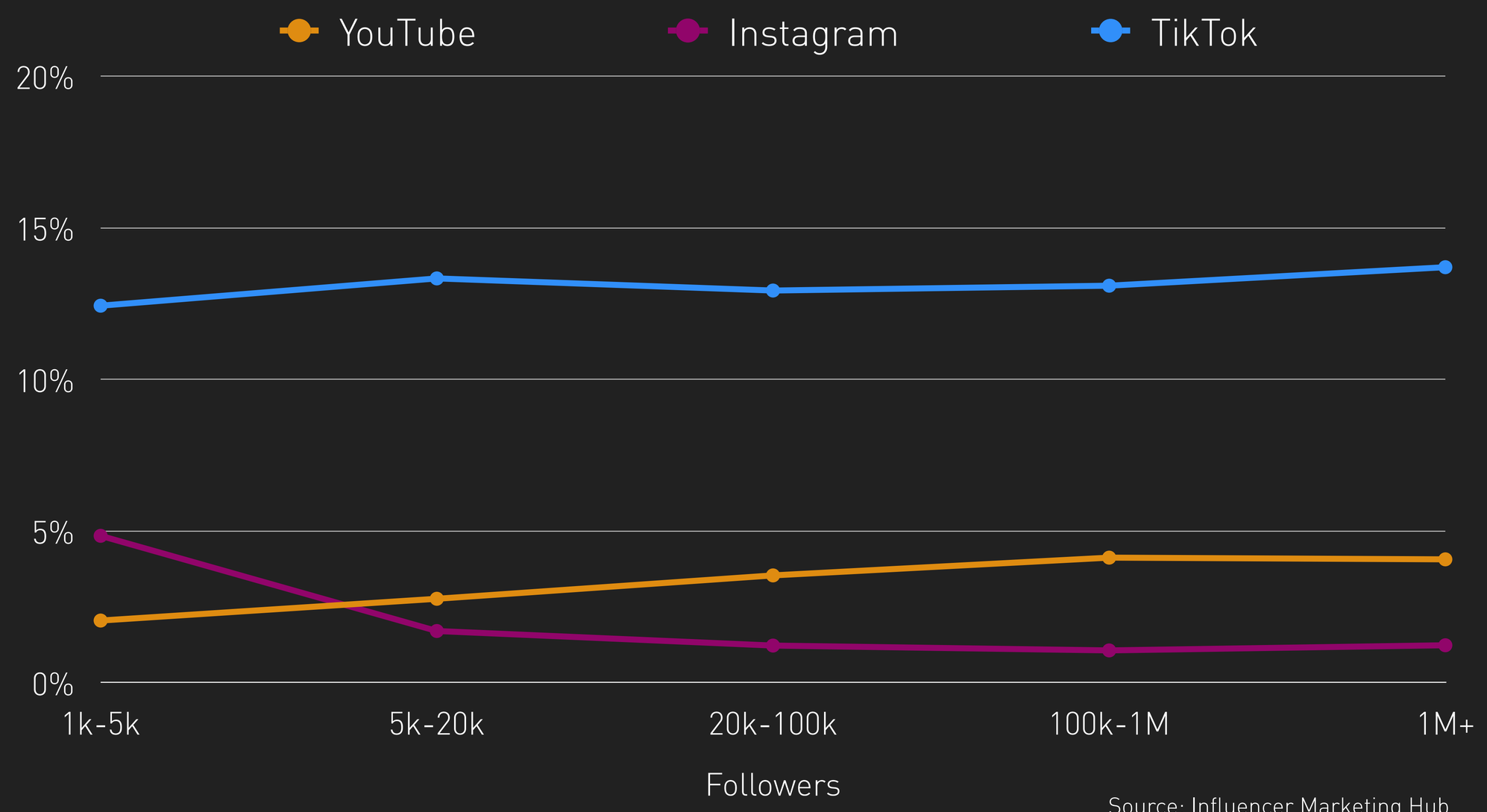
Source: Influencer Marketing Hub

Users Demographics



Source: Influencer Marketing Hub

Average Engagement Rate



Source: Influencer Marketing Hub

Research Questions:

- How do social media influencers emerge?
- What is the effect of the Recommendation Systems?

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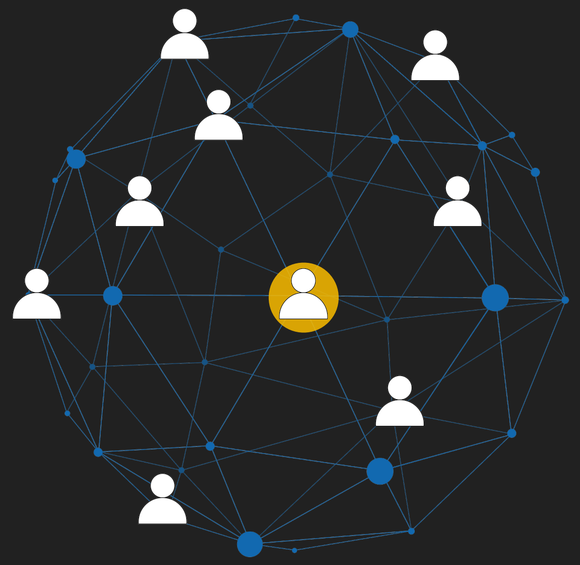
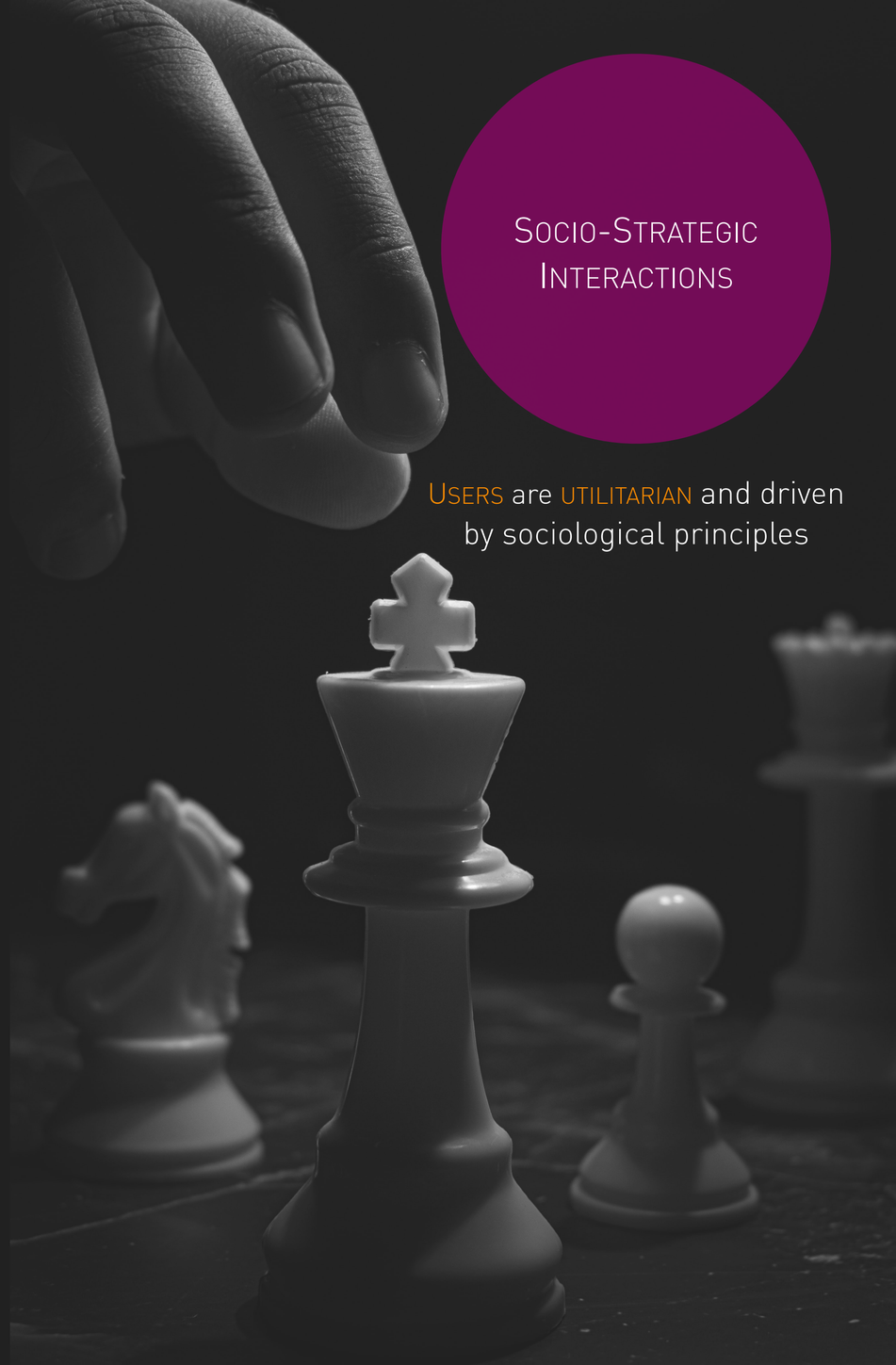
Impact of Recommendation Systems

Summary





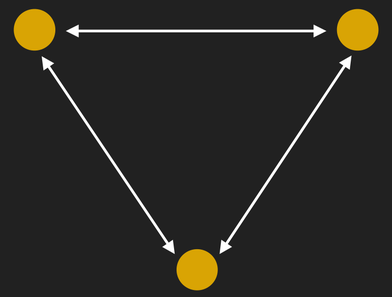
Probabilistic Interactions

Users are not utilitarian and follow statistical rules

Socio-Strategic Interactions

Users are utilitarian and driven by sociological principles

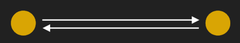
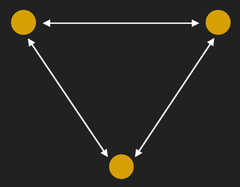
Real-world social connections tend to be
RECIPROCATED and in TRIADIC STRUCTURES



Socio-Strategic Interactions

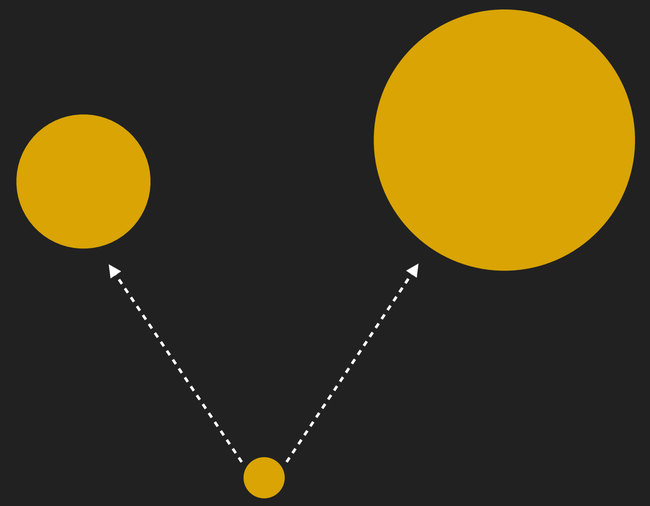
Socio-Strategic Interactions

These motifs are NOT significantly present on DIRECTED SOCIAL NETWORKS because people can follow STRANGERS

	100%	22%	14%
	40%	23%	8%

Probabilistic Interactions

Preferential attachment model:
The probability of following an other user is proportional to their number of followers



Probabilistic Interactions

Preferential attachment model:
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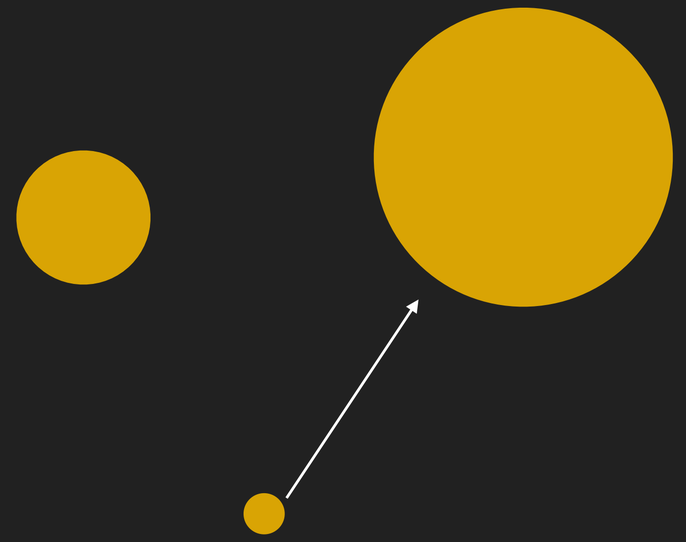


Leads to the "rich-get-richer" effect
but leaves no space to exploration

WE NEED A DIFFERENT MODEL

Probabilistic Interactions

Quality-Based Model

Socio-Strategic Interactions

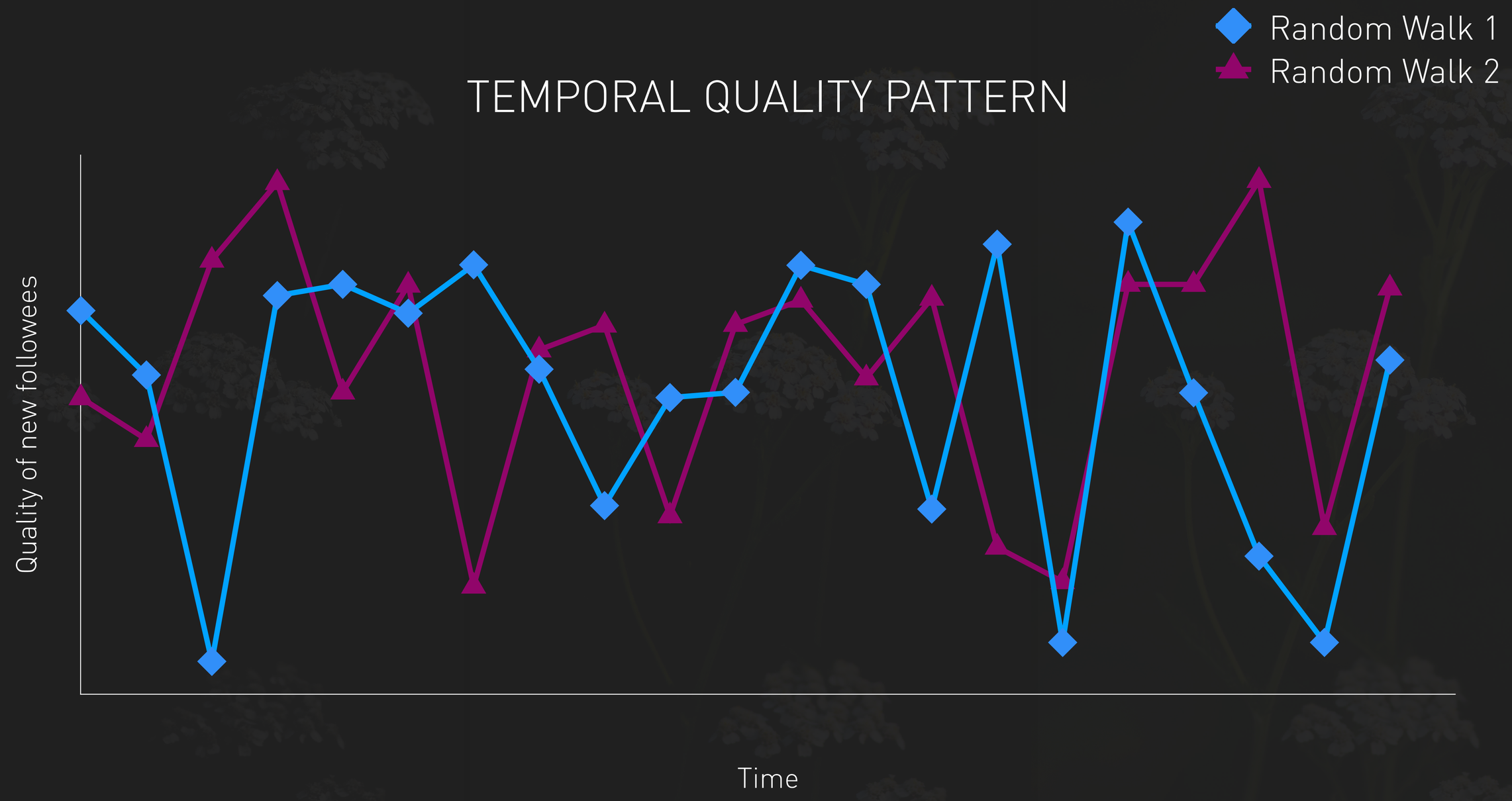
Users maximise the "Quality" of the content they receive

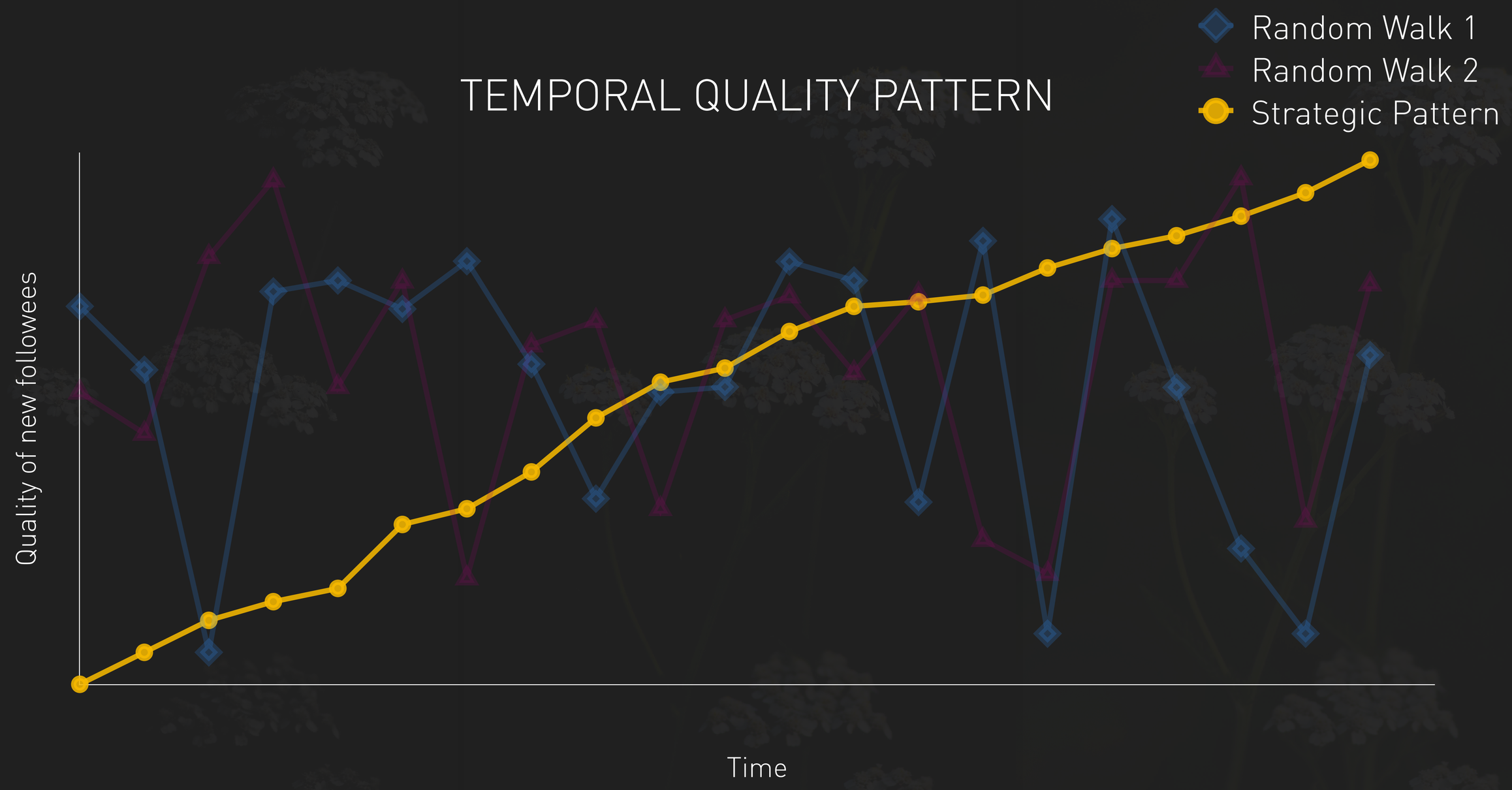
Quality-Based Model

The Recommendation System governs the "visibility" of the users

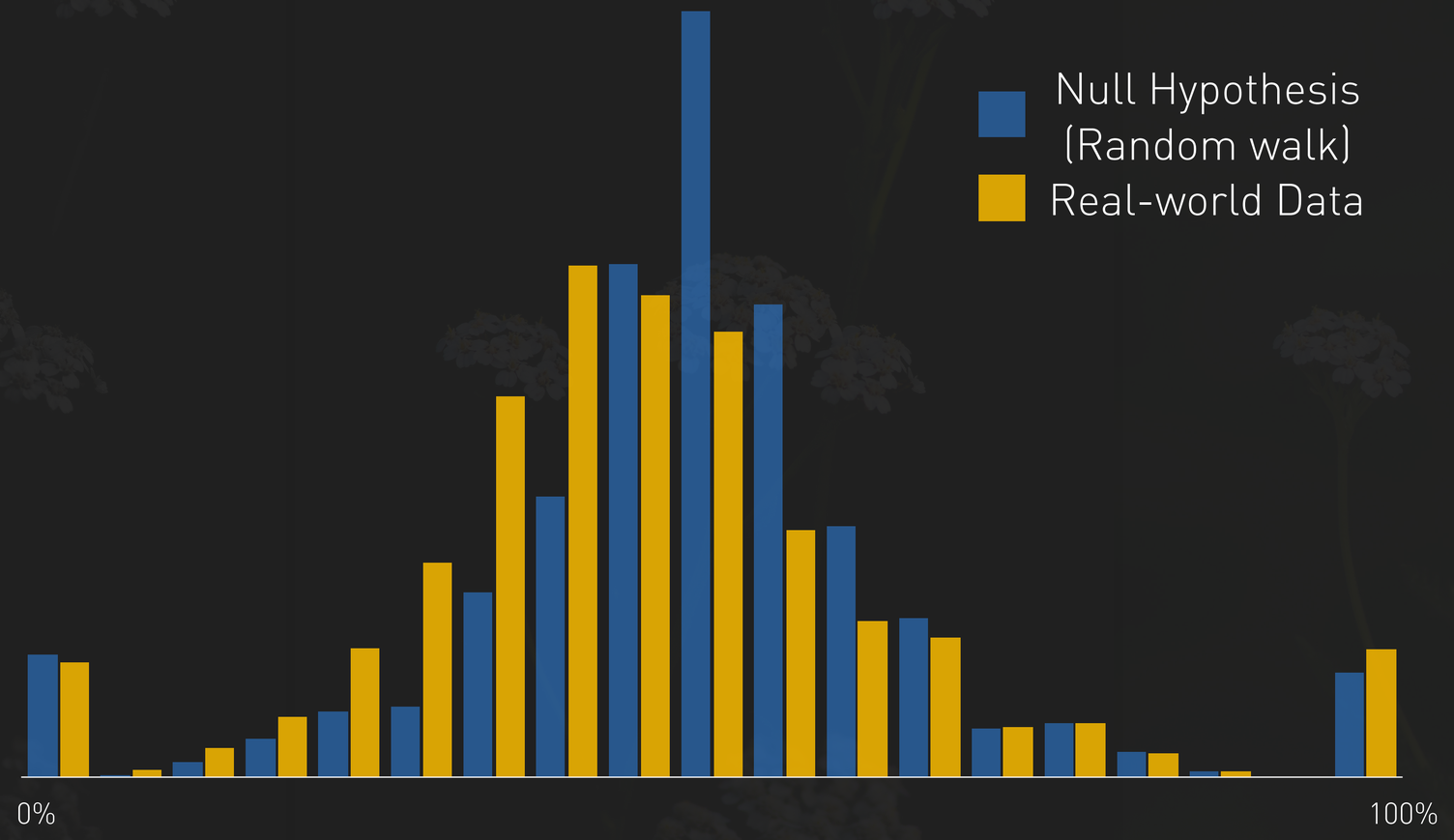
Do users try to optimise the UGC-quality received over time?

TEMPORAL QUALITY PATTERN




TEMPORAL QUALITY PATTERN
Random Walk 1
Random Walk 2
Strategic Pattern
Quality of new followees
Time

TWITTER DATA-SET ON NETWORK SCIENTISTS



Probability of violating quality maximizing pattern

Do users try to optimise the UGC-quality received over time?

YES, users tend to follow other users according to increasing levels of UGC-quality

Phase 1:
The recommendation system suggests
a new possible connection
based on its popularity

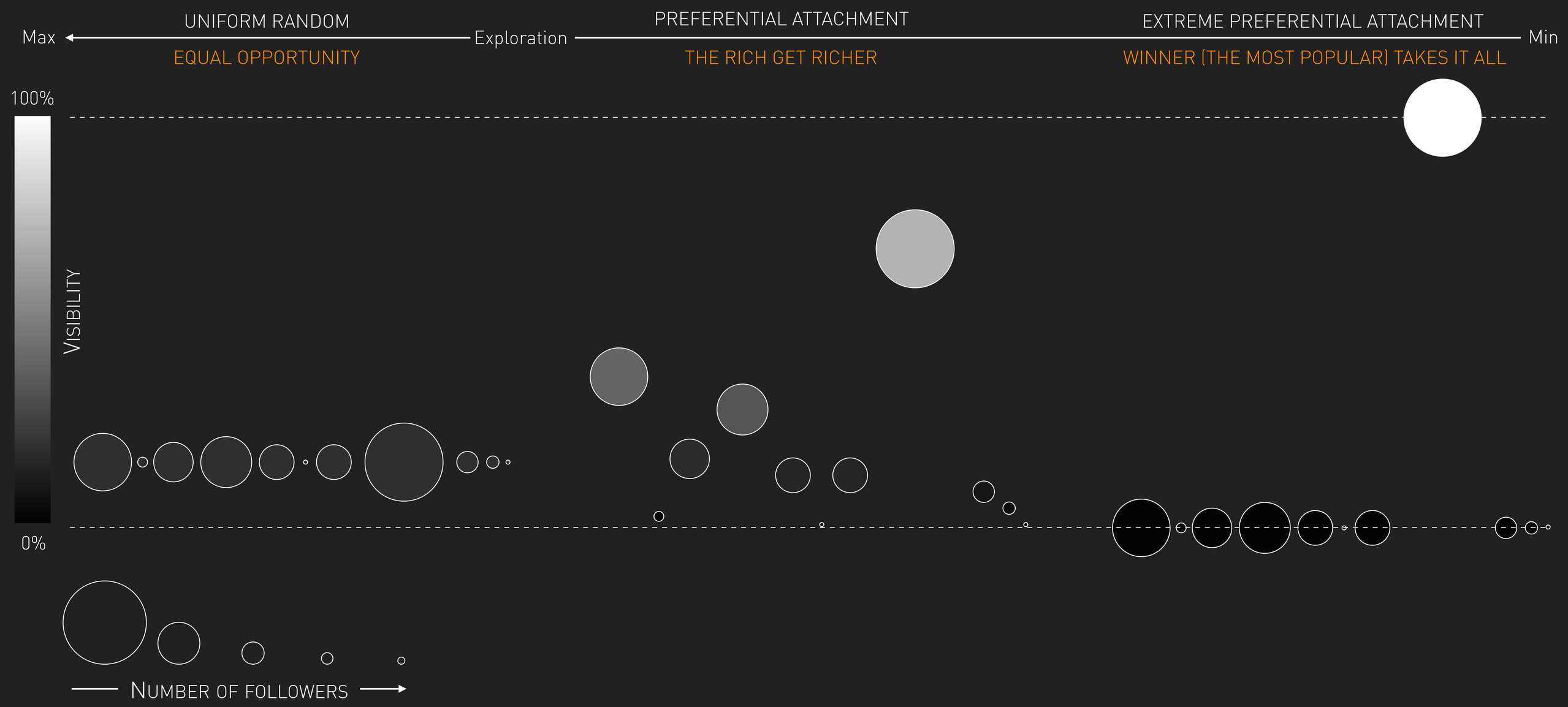
Probabilistic
Interactions

Quality-Based
Model

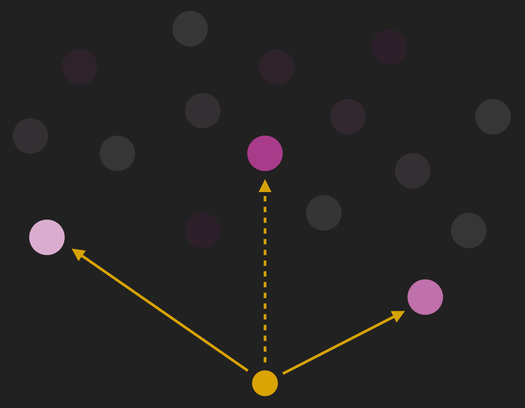
Phase 2:
The users decide whether to
accept or not the recommendation
based on its quality

Socio-Strategic
Interactions

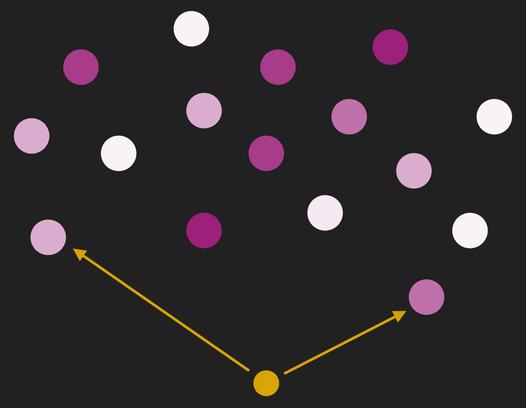
Phase 1: Recommender Systems



Phase 2: Strategic Decision



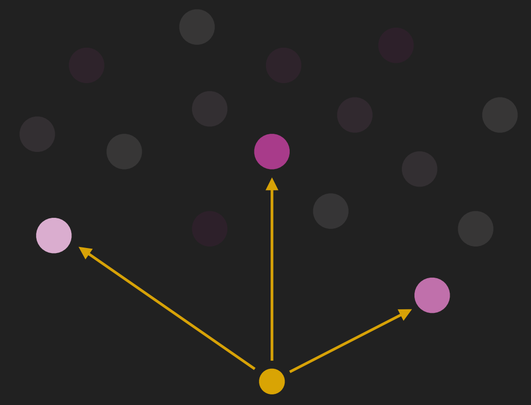
Phase 1
(Recommendation)



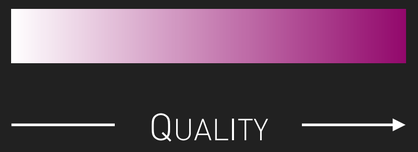
User

Phase 2
(Decision)

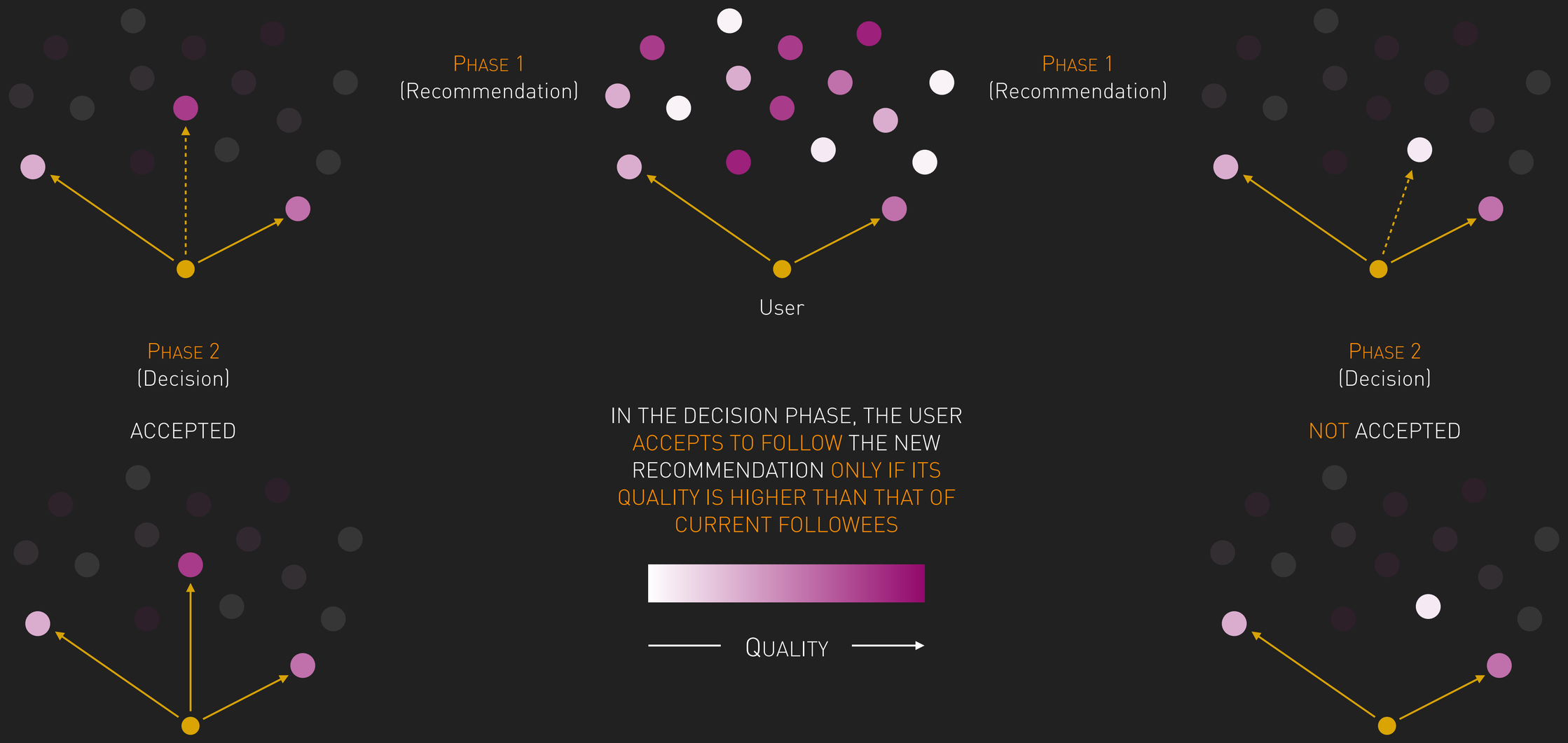
ACCEPTED



IN THE DECISION PHASE, THE USER ACCEPTS TO FOLLOW THE NEW RECOMMENDATION ONLY IF ITS QUALITY IS HIGHER THAN THAT OF CURRENT FOLLOWEES



Phase 2: Strategic Decision



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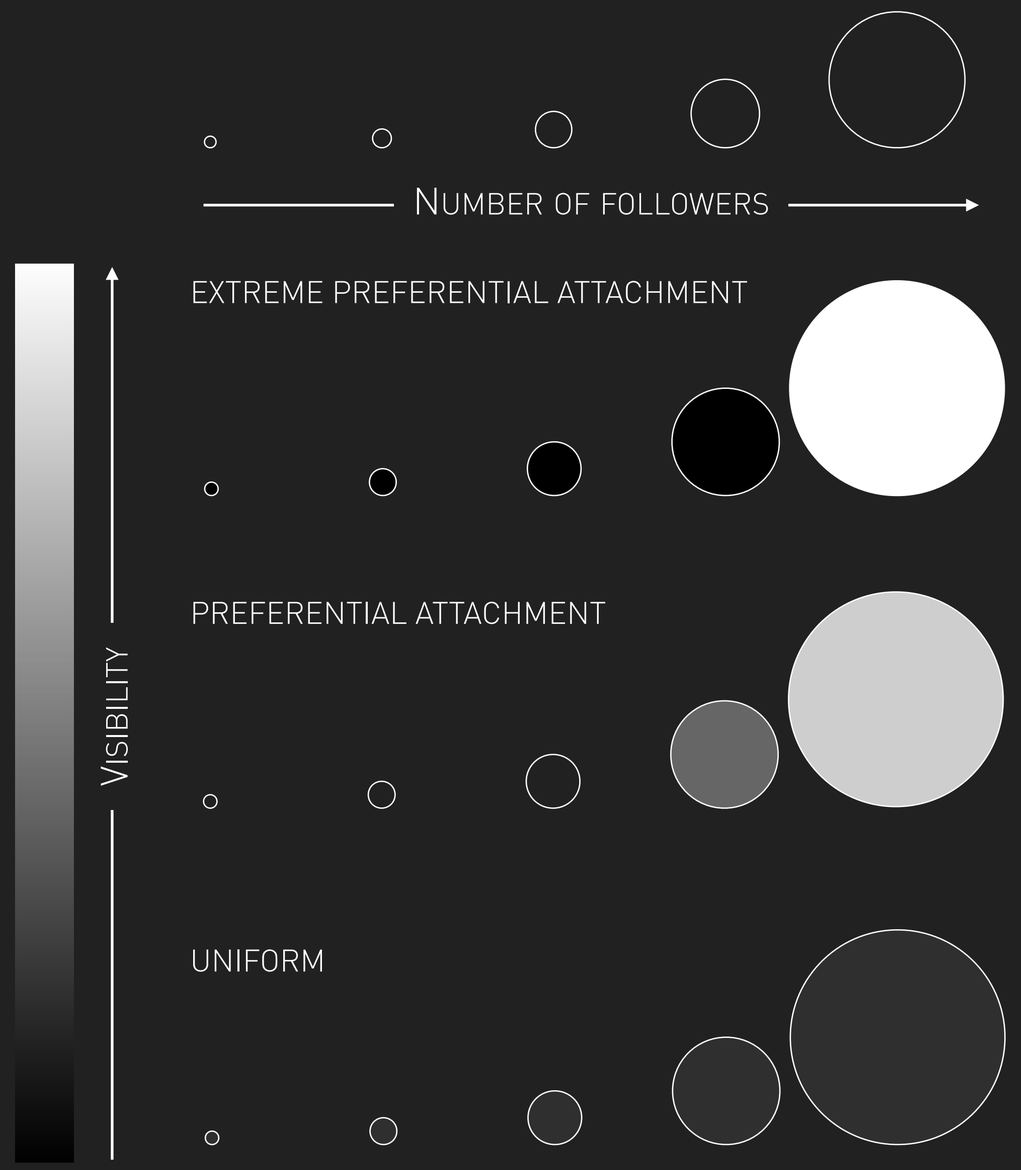
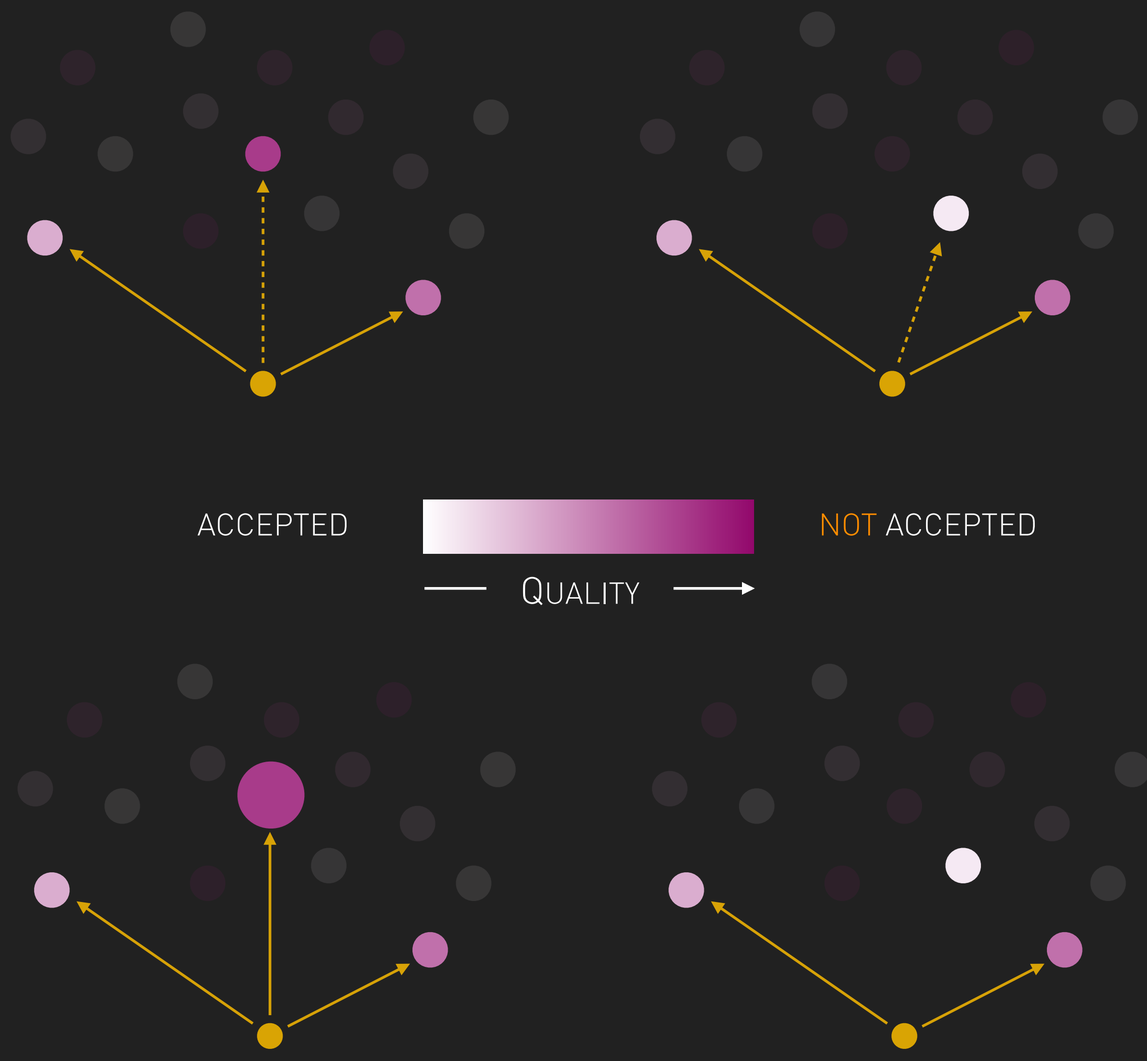
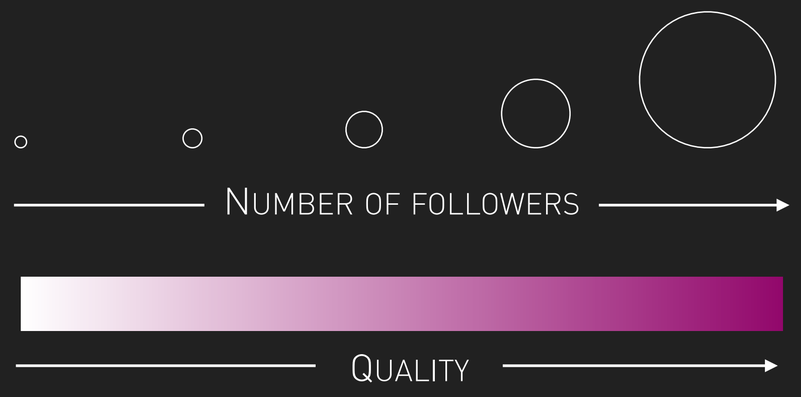
Phase 1: Recommendation System



Phase 2: Strategic Decision





Meritocracy: is the number of followers correlated with the quality?

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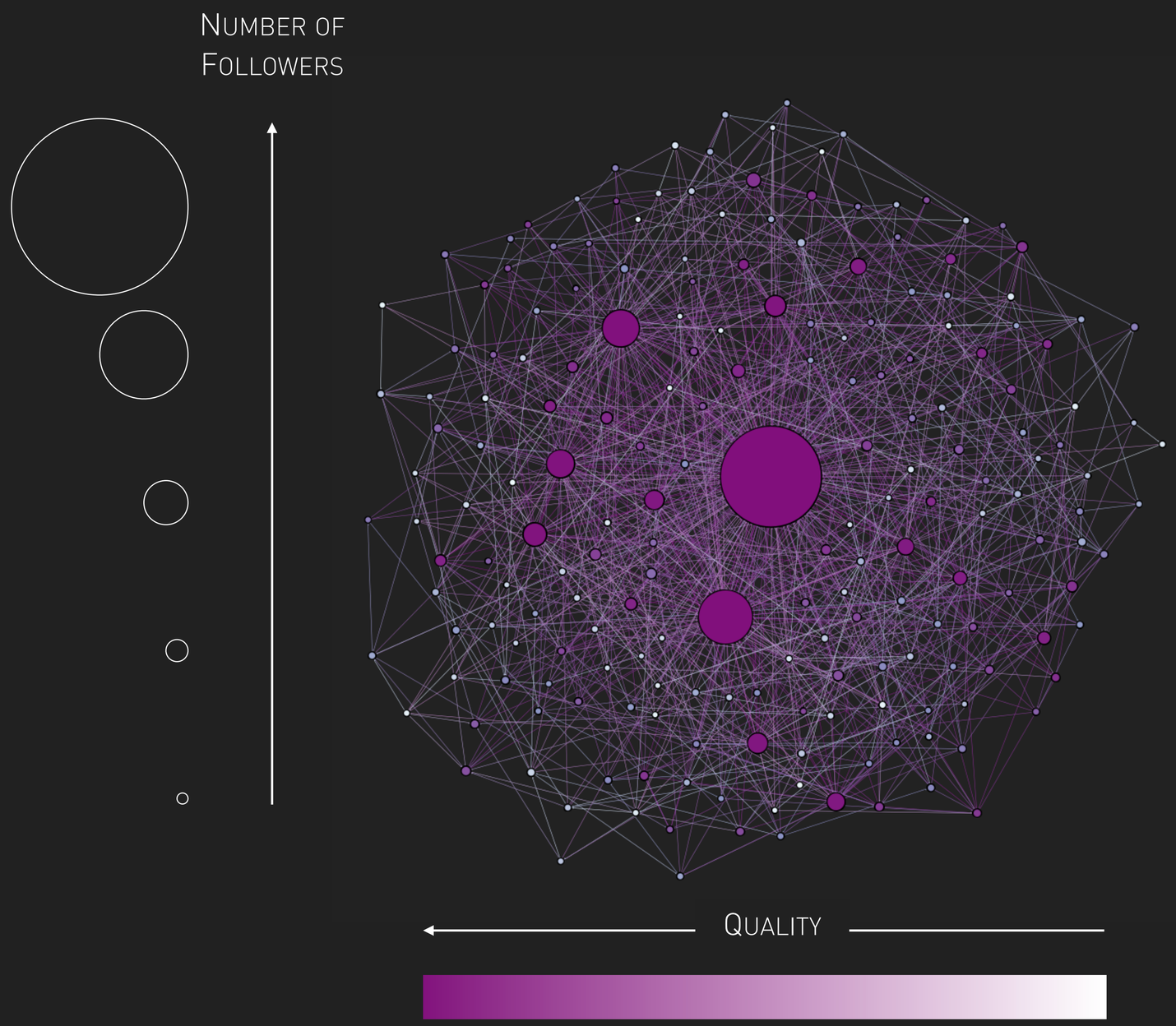
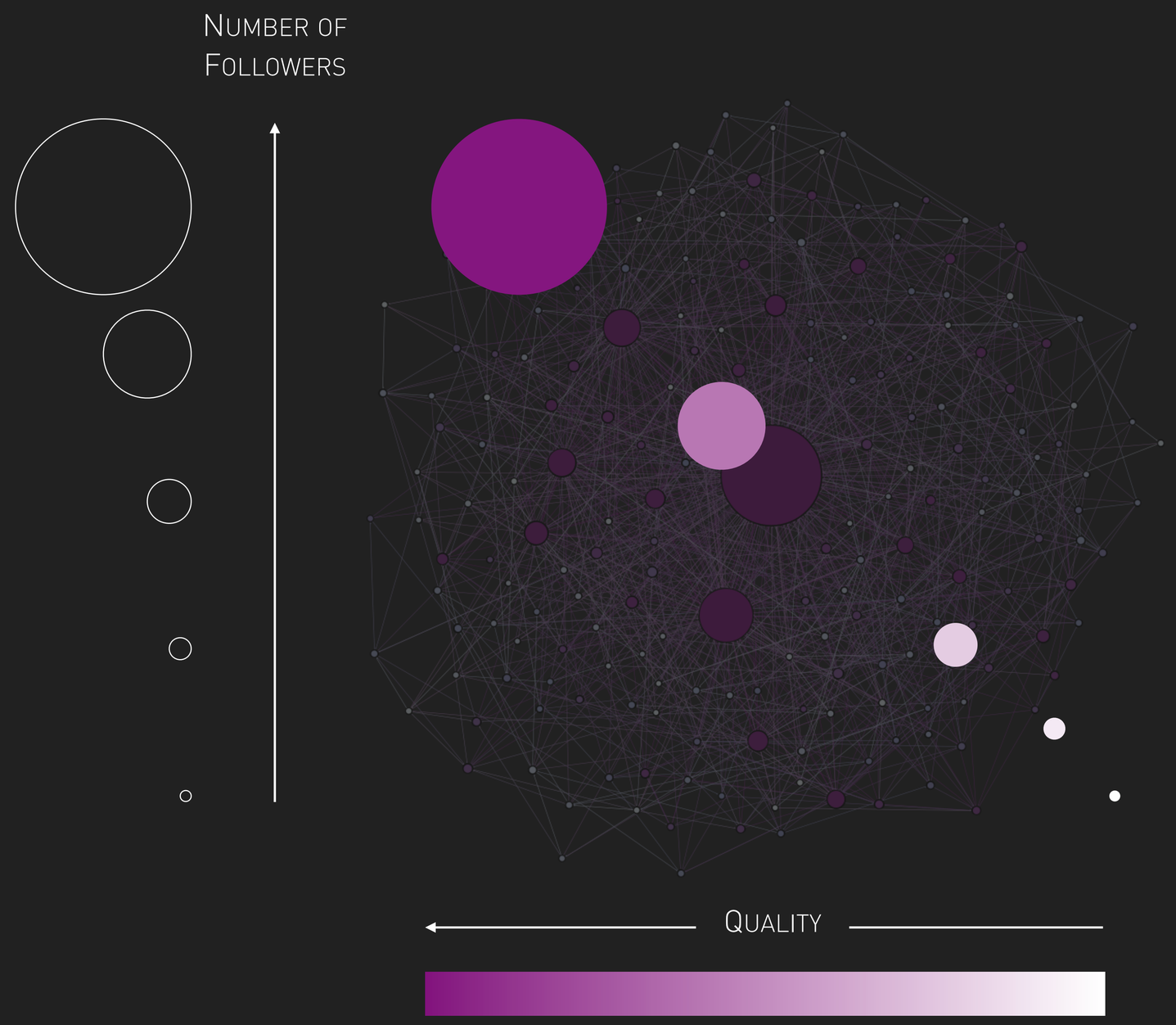
Uniform Random Recommendation System

Impact of Recommendation Systems

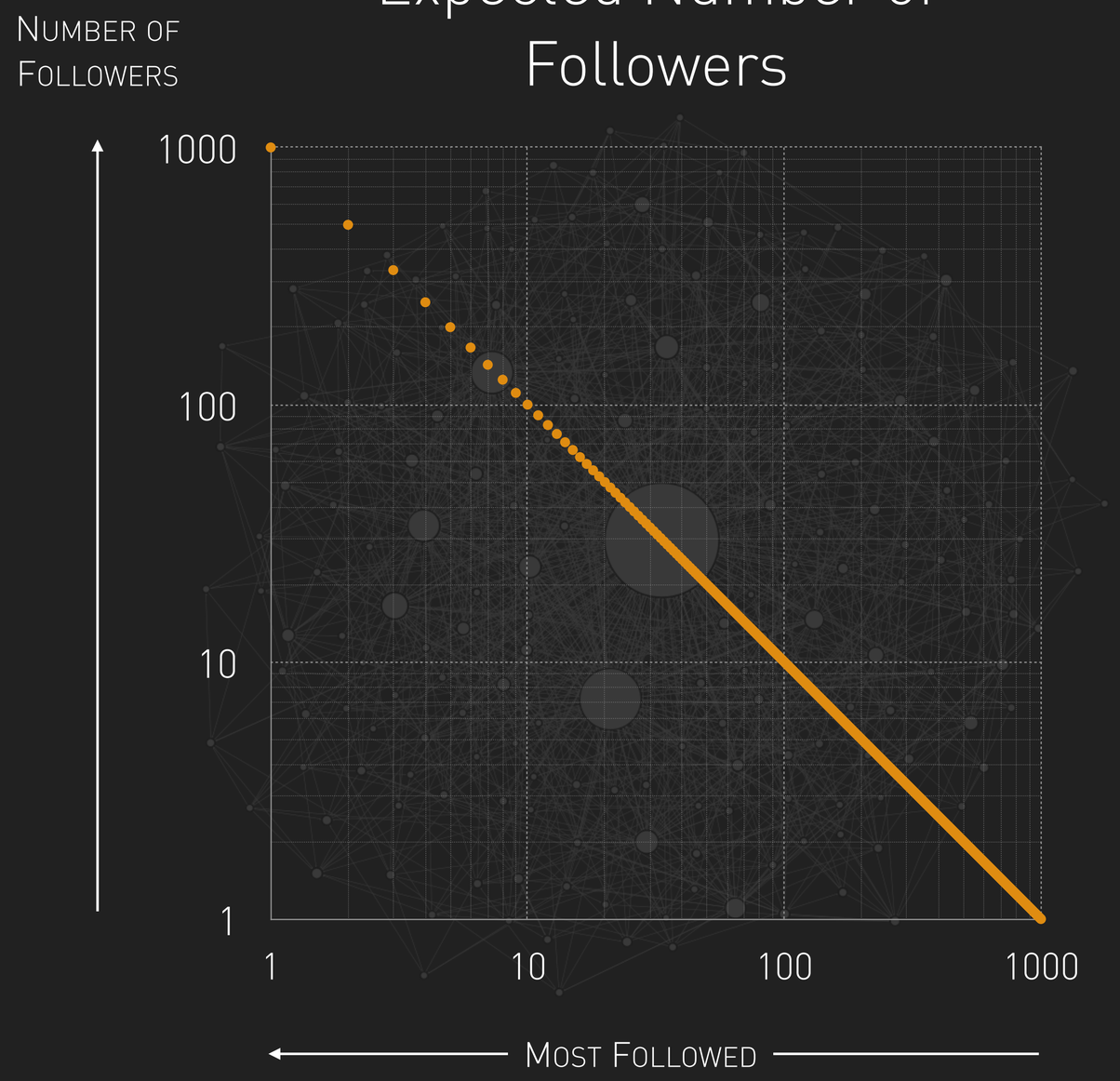
Summary


Number of Followers
Quality



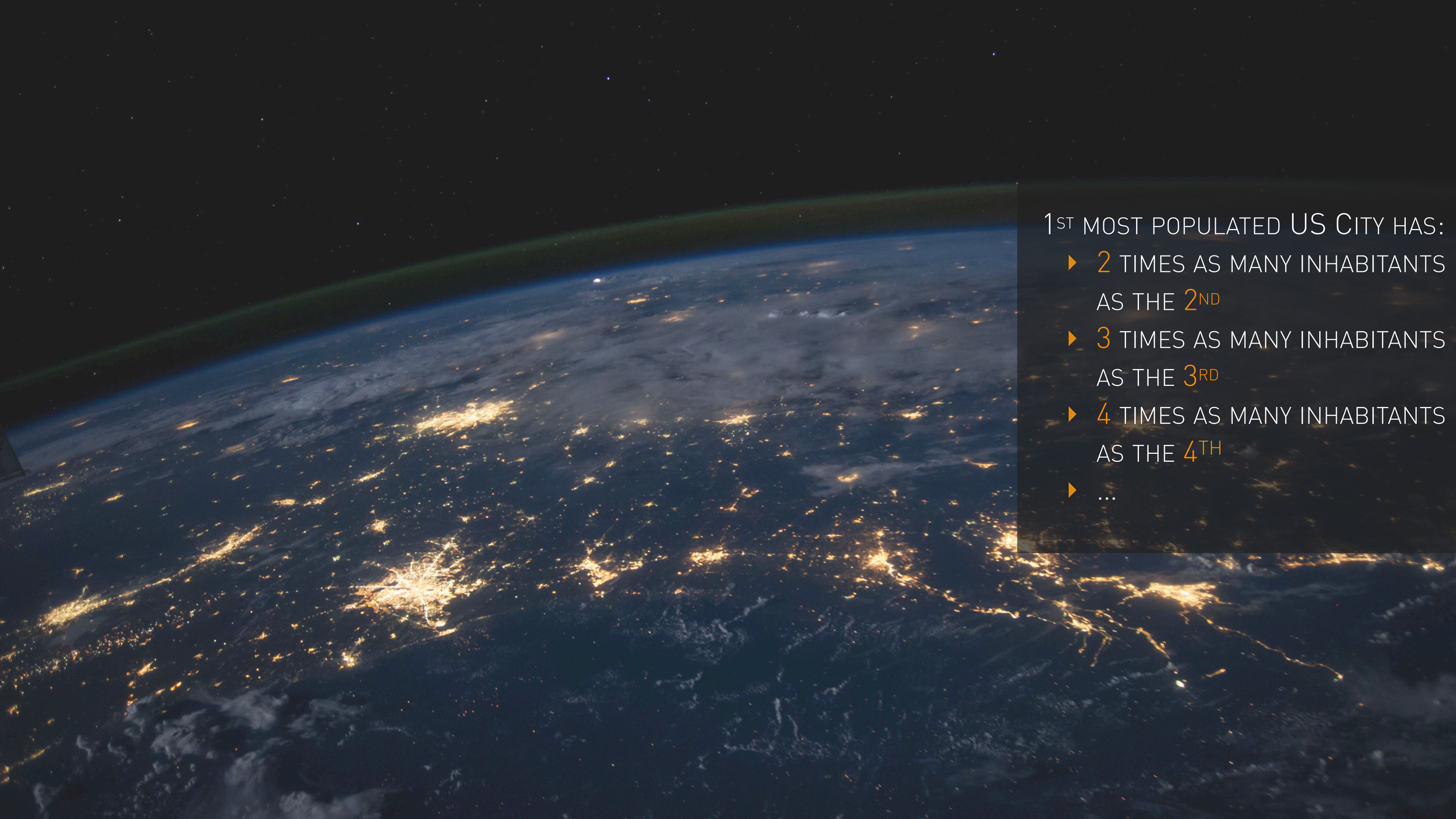
Number of Followers correlates with UGC-quality

Expected Number of Followers



1ST MOST FOLLOWED USER HAS:

- 2 TIMES AS MANY FOLLOWERS AS THE 2ND
- 3 TIMES AS MANY FOLLOWERS AS THE 3RD
- 4 TIMES AS MANY FOLLOWERS AS THE 4TH
- ...



1ST MOST POPULATED US CITY HAS:

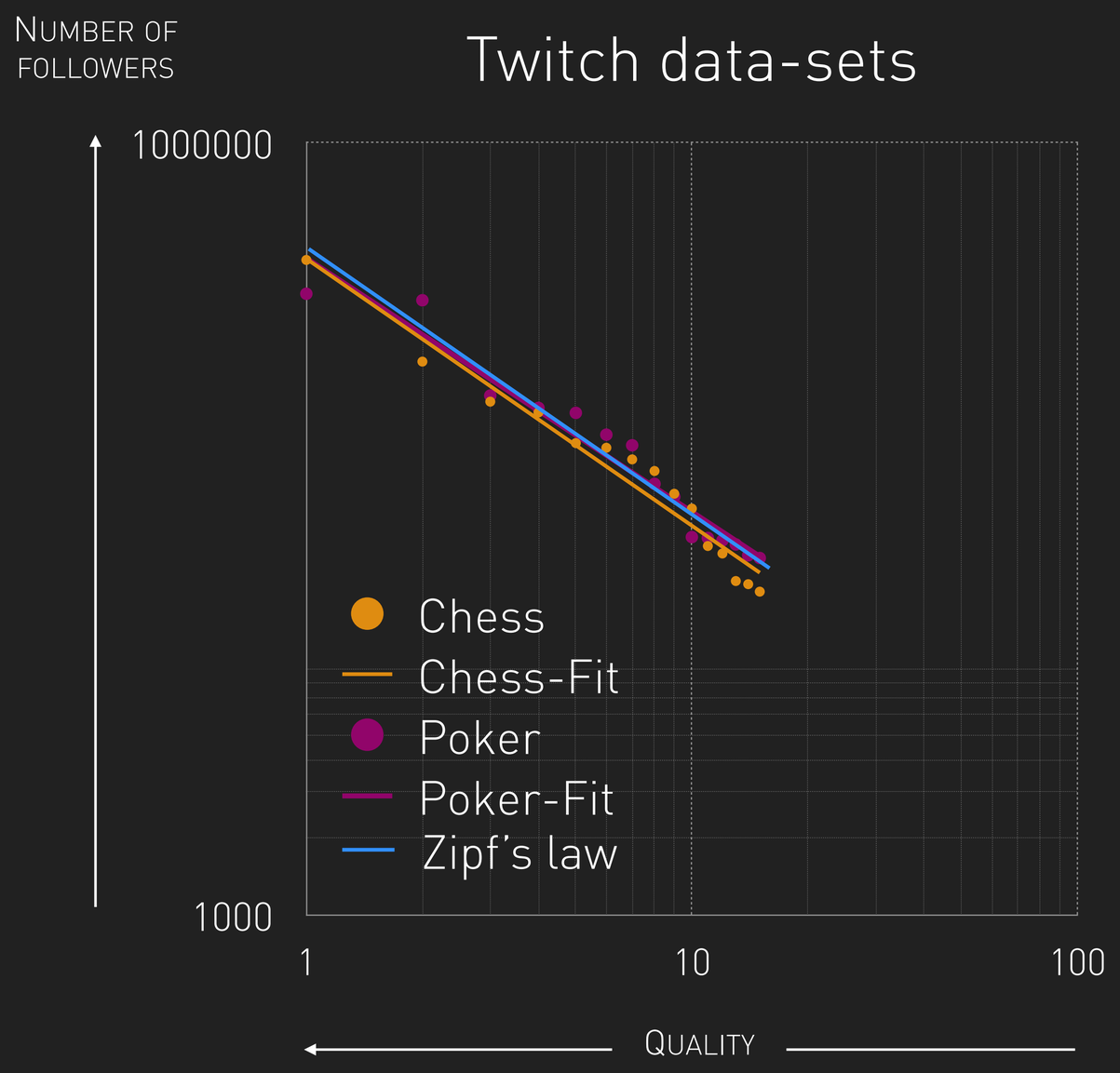
- 2 TIMES AS MANY INHABITANTS AS THE 2ND
- 3 TIMES AS MANY INHABITANTS AS THE 3RD
- 4 TIMES AS MANY INHABITANTS AS THE 4TH
- ...

Zipf's Law:

First discovered in the frequency of words we use, it is found in many natural systems including:

- Cities Size;
- Firms Size;
- Neural Activity;
- Aminoacid Sequences;
- ...

Twitch data-sets



Zipf's Law:

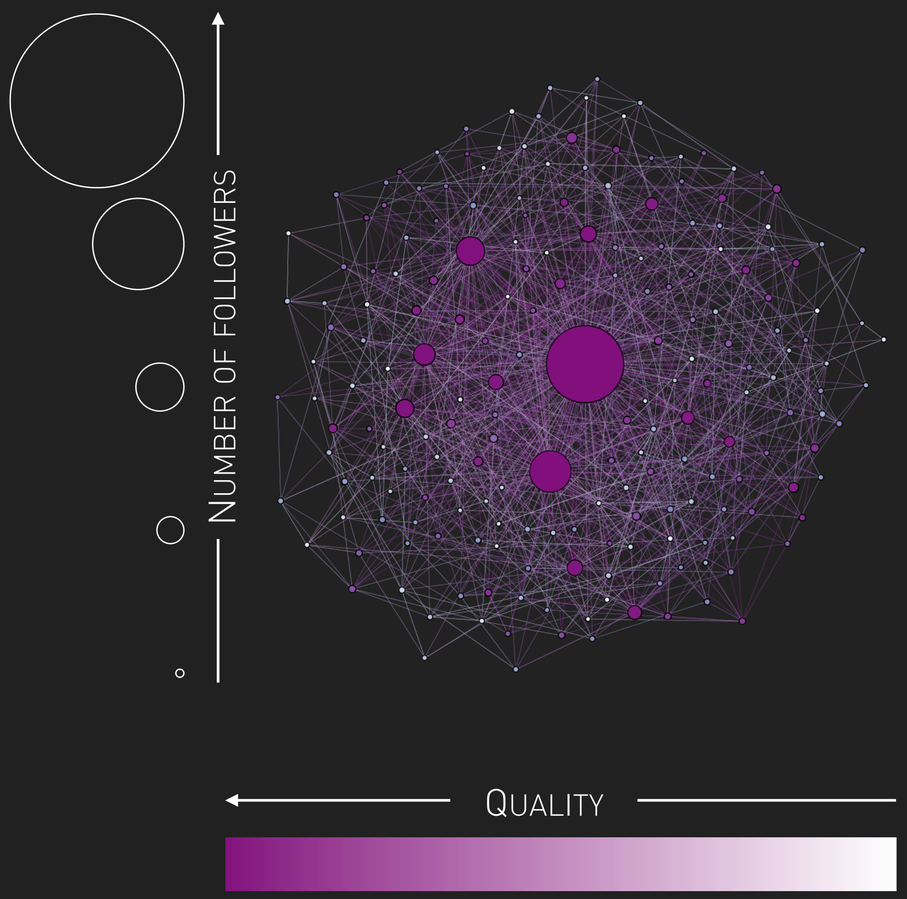
- Words Frequencies;
- Cities Size;
- Firms Size;
- Neural Activity;
- Aminoacid Sequences;
- Influencers' followers;

Max ← Recommendation System's EXPLORATION — Min

UNIFORM RANDOM

PREFERENTIAL ATTACHMENT

EXTREME PREFERENTIAL ATTACHMENT

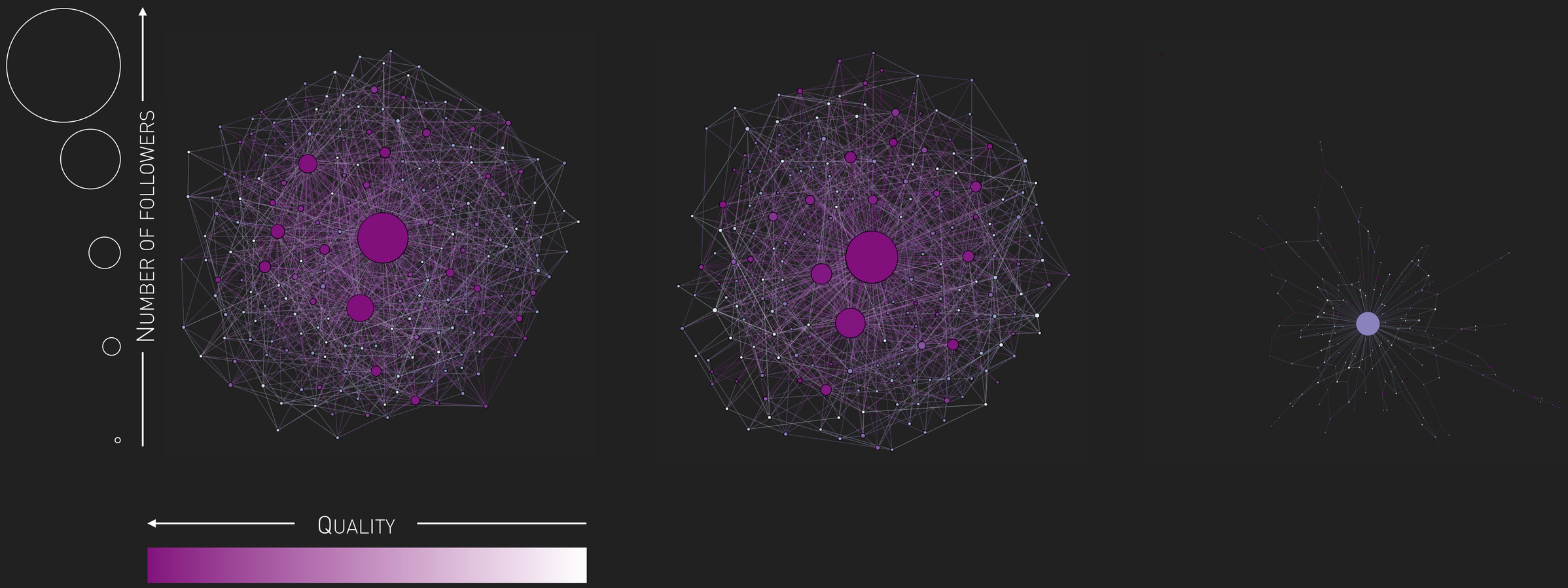


Max ← Recommendation System's EXPLORATION — Min

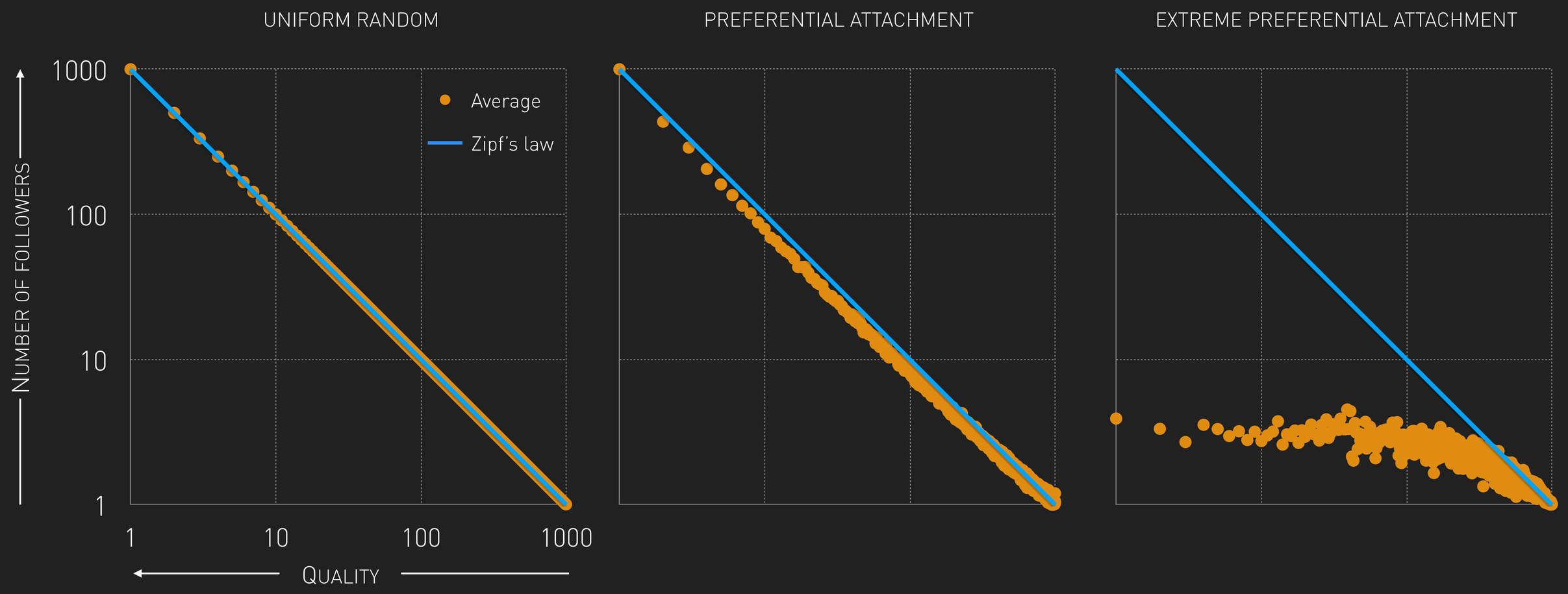
UNIFORM RANDOM

PREFERENTIAL ATTACHMENT

EXTREME PREFERENTIAL ATTACHMENT

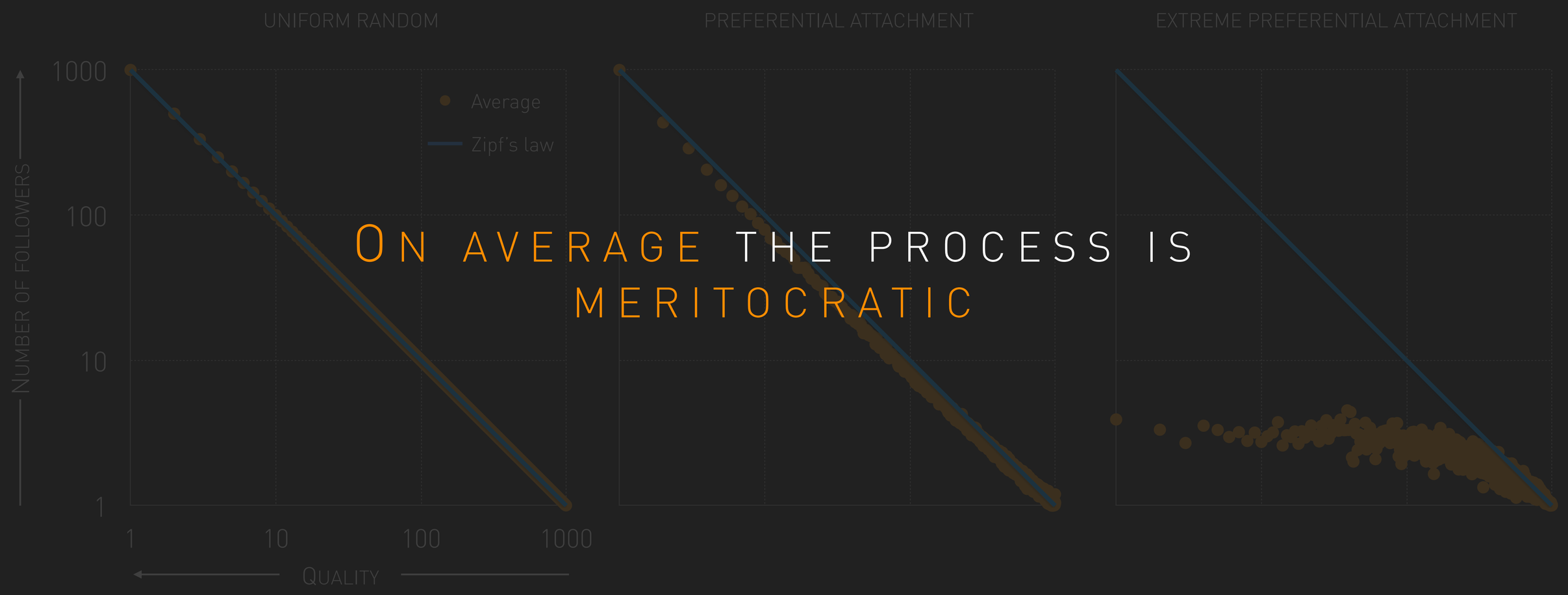


Max ← Recommendation System's EXPLORATION — Min



For all Recommendation Systems, the Expected Number of Followers increases with Quality

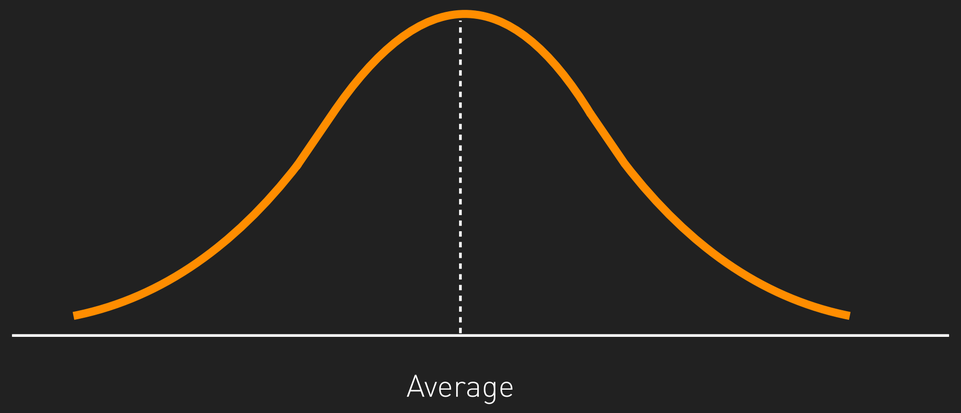
Max ← Recommendation System's EXPLORATION — Min

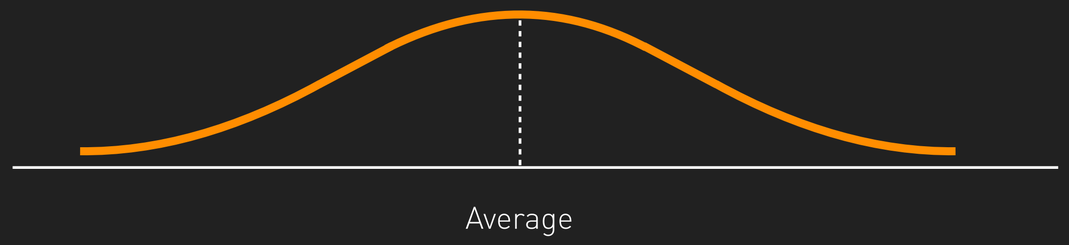


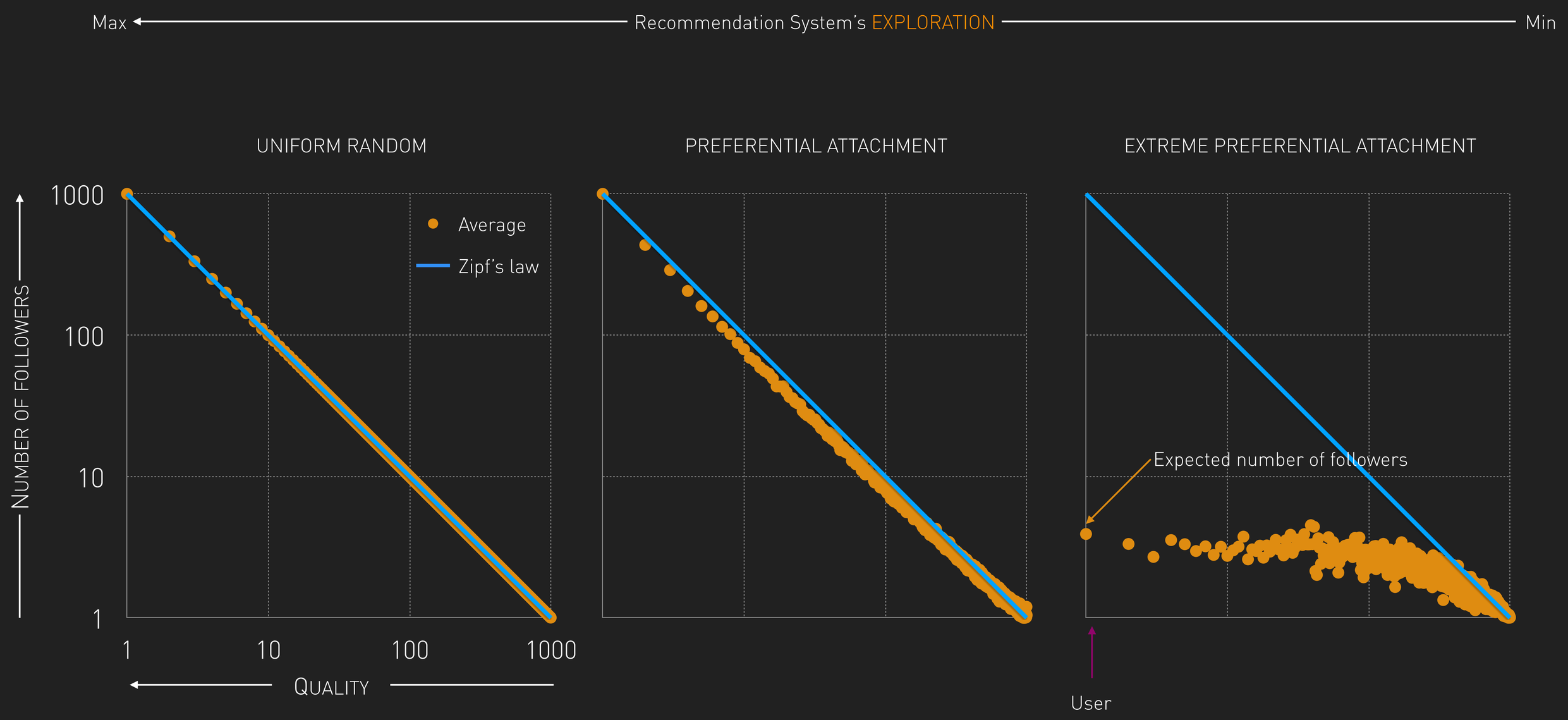
On average the process is meritocratic

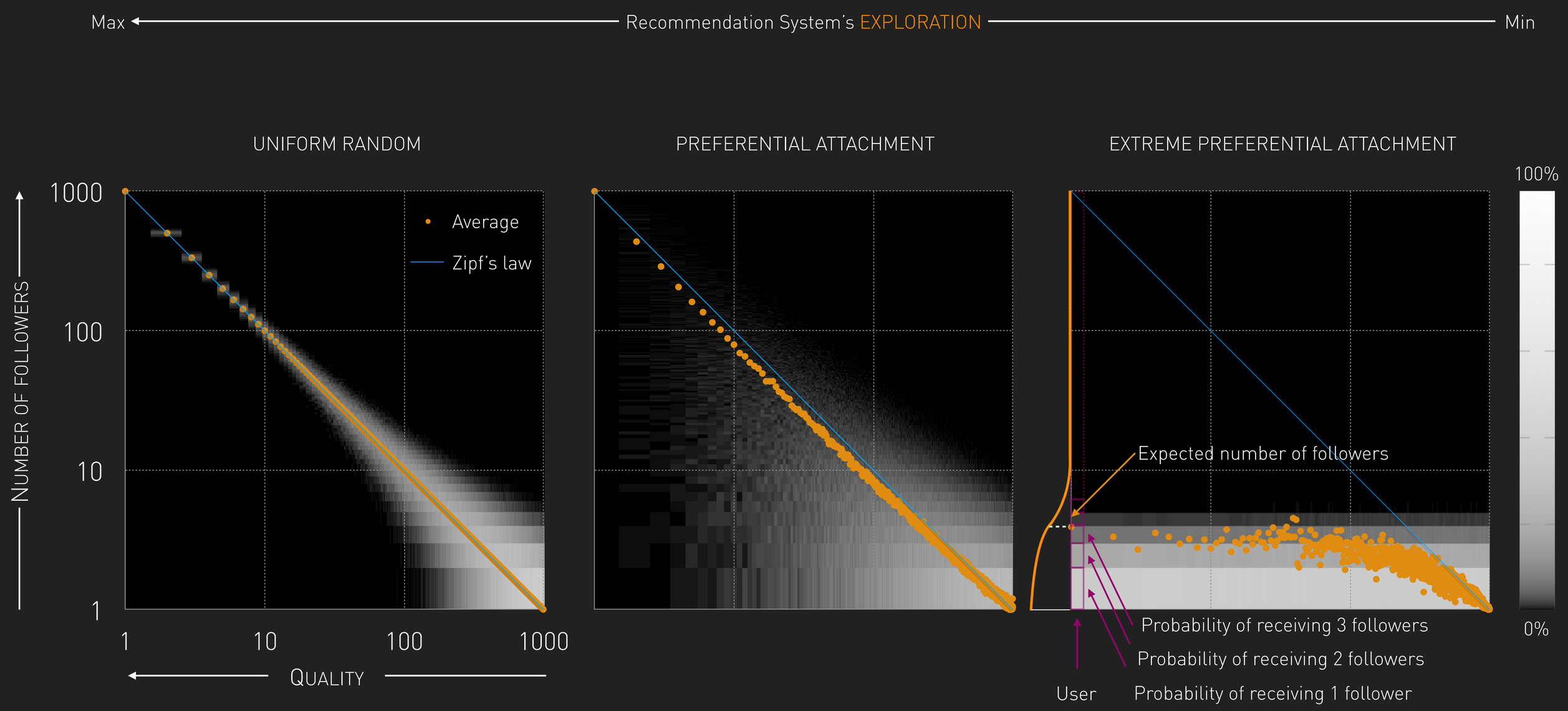
But: Let's also look at the VARIABILITY

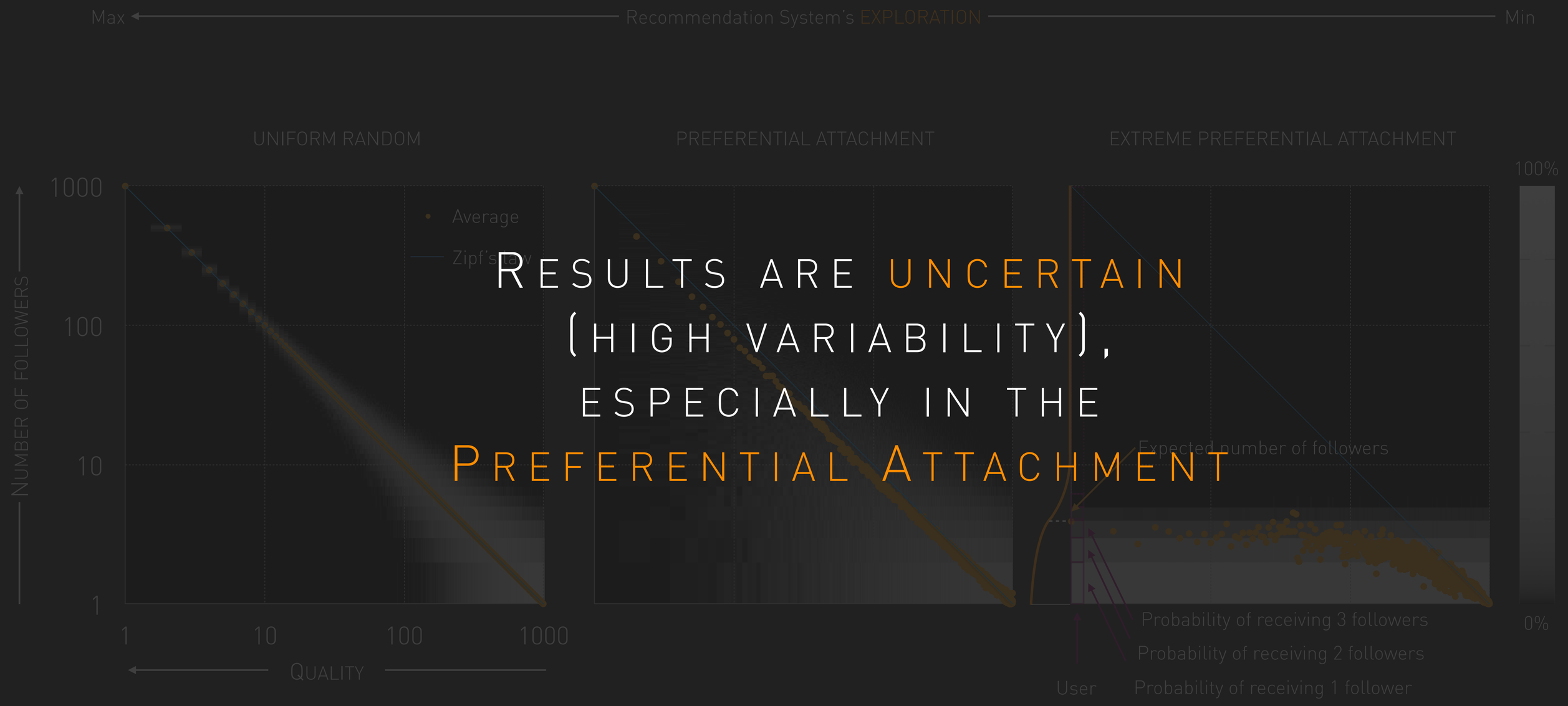
But: Let's also look at the VARIABILITY






Max
Recommendation System's EXPLORATION
Min
UNIFORM RANDOM
PREFERENTIAL ATTACHMENT
EXTREME PREFERENTIAL ATTACHMENT
NUMBER OF FOLLOWERS
1000
100
10
1
Average
Zipf's law
1
10
100
1000
QUALITY
Expected number of followers
User


Max
Recommendation System's EXPLORATION
Min
UNIFORM RANDOM
PREFERENTIAL ATTACHMENT
EXTREME PREFERENTIAL ATTACHMENT
NUMBER OF FOLLOWERS
1000
100
10
1
Average
Zipf's law
1
10
100
1000
QUALITY
100%
0%
Expected number of followers
Probability of receiving 3 followers
Probability of receiving 2 followers
Probability of receiving 1 follower
User

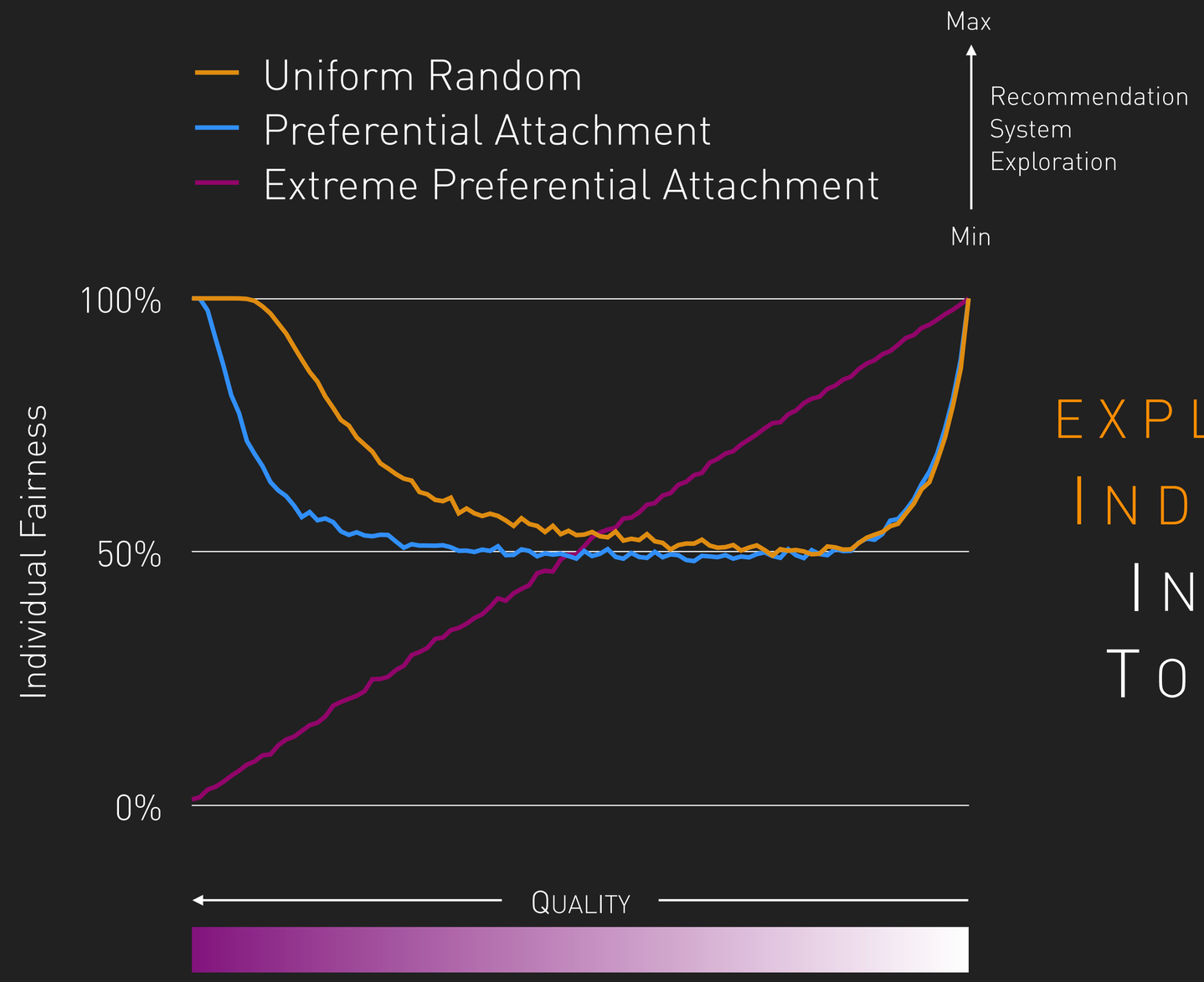


Results are uncertain (high variability), especially in the Preferential Attachment

Since the variability is large, is the process always Meritocratic?

Individual Fairness:

What is the probability that the Nth Quality-ranked individual is in the top-N Most followed ones?



Exploration improves Individual Fairness, In particular for Top-Quality Nodes

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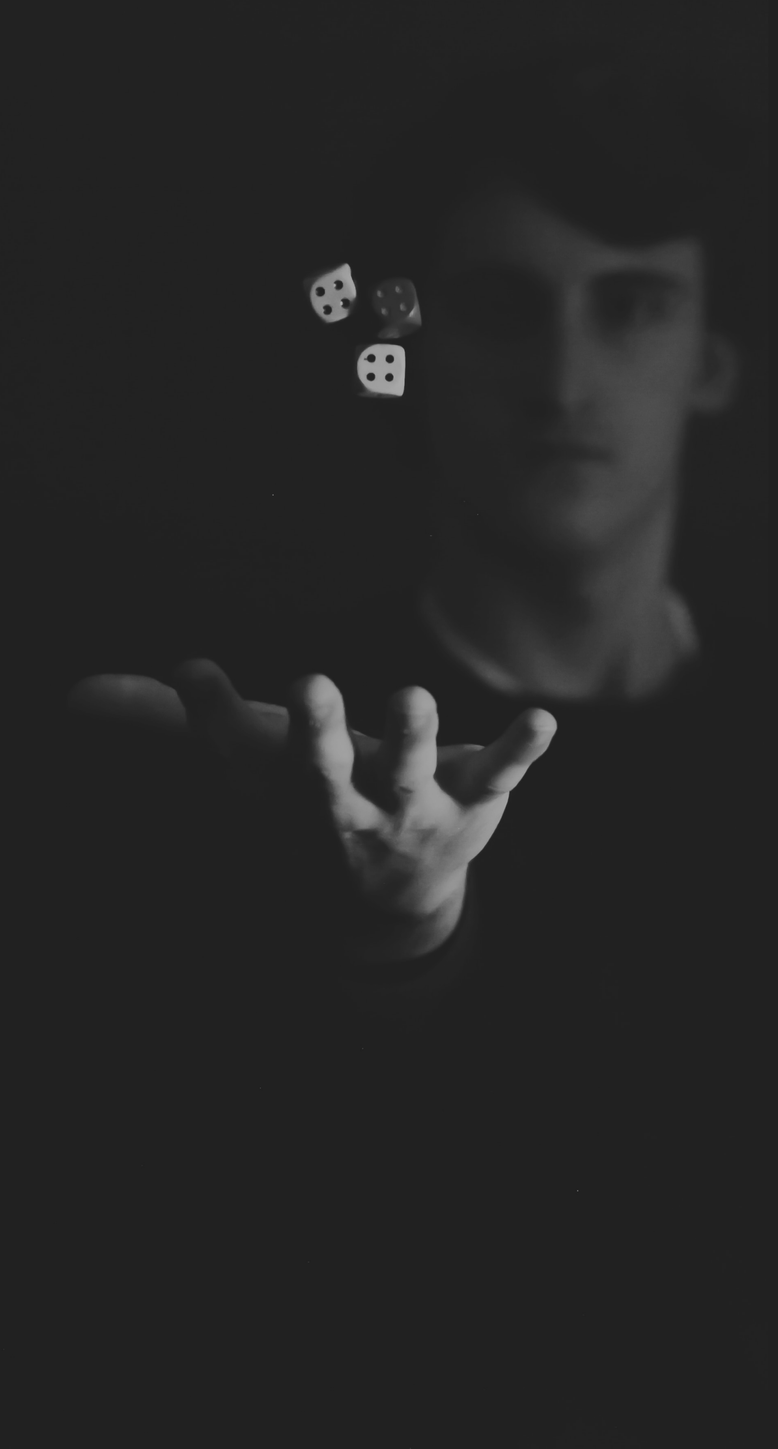
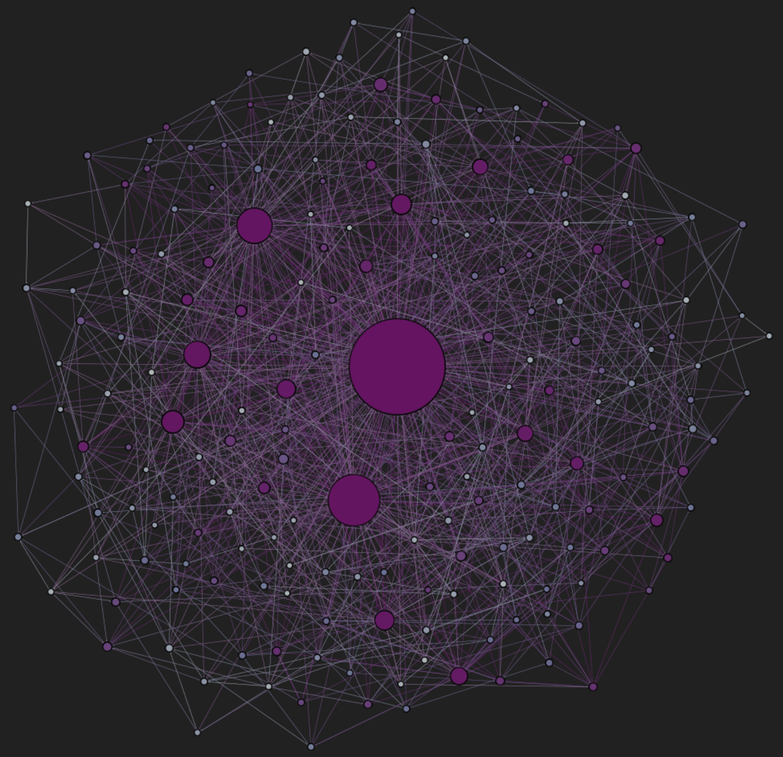


- Highlighted the importance of the UGC-Quality
- Split the network formation process into “visibility” and “decision”



- Studied the correlation between Quality and number of followers
- Understood the impact of Recommender Systems on individual fairness

Exploration

Fairness and meritocracy

UNIFORM RANDOM

PREFERENTIAL ATTACHMENT

EXTREME PREFERENTIAL ATTACHMENT

Research Questions:

- How do social media influencers emerge?

  Social media influencers emerge as a result of the interplay between the Recommendation Systems that promote content creators differently and the Users' Strategic Interactions that aims at maximising the quality of the UGC they receive.

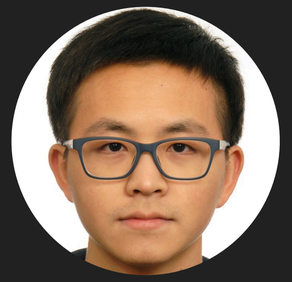
- What is the effect of the Recommendation Systems?

  Recommendation Systems have an impact on Individual Fairness, which is particularly negatively affected in case of low levels of exploration.

Acknowledgments

Prof. Dr. Florian Dörfler
ETH Zürich

Prof. Dr. Wenjun Mei
Beijing University (prev. ETH Zürich)



Cheng Li
Former ETH Master student

Prof. Dr. Anikó Hannák
University of Zürich

Stefania Ionescu
Ph.D. at University of Zürich

ETH zürich

NCCR Automation

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References

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