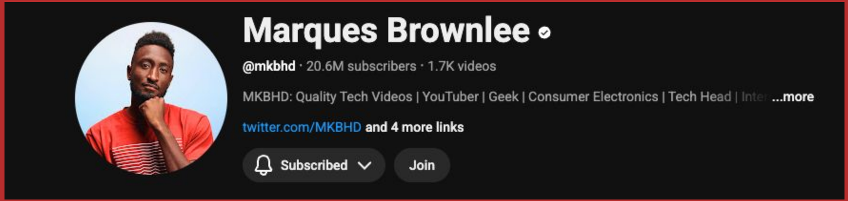
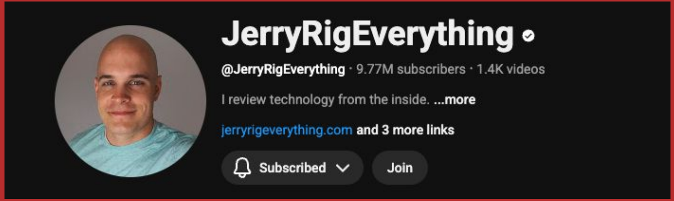
Information Warfare in Tech Markets: A Computational Social Choice Model of Influencer Seeding





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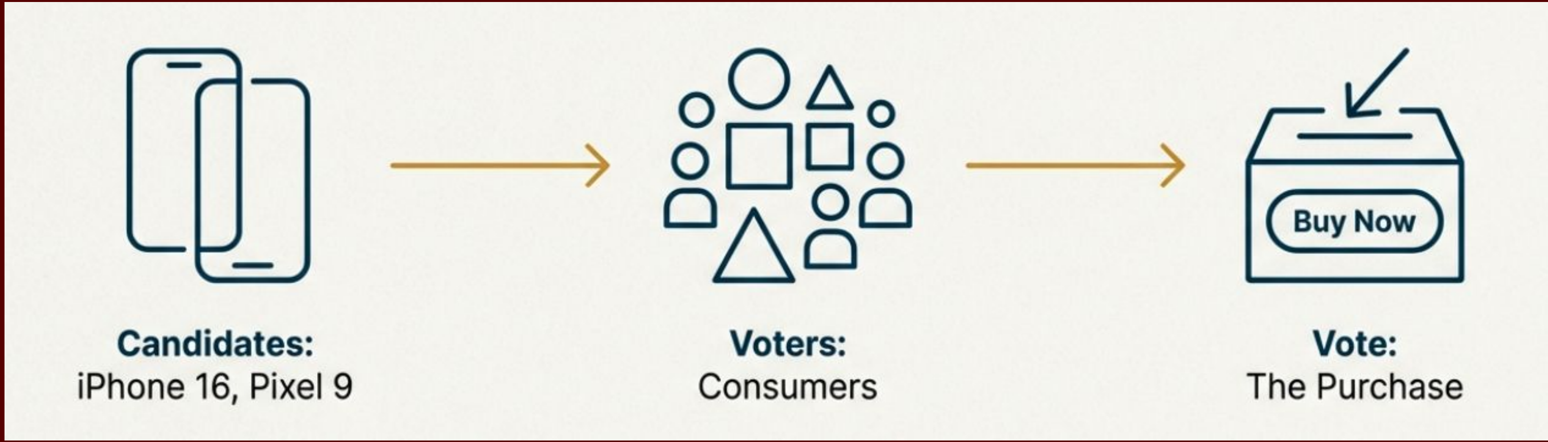
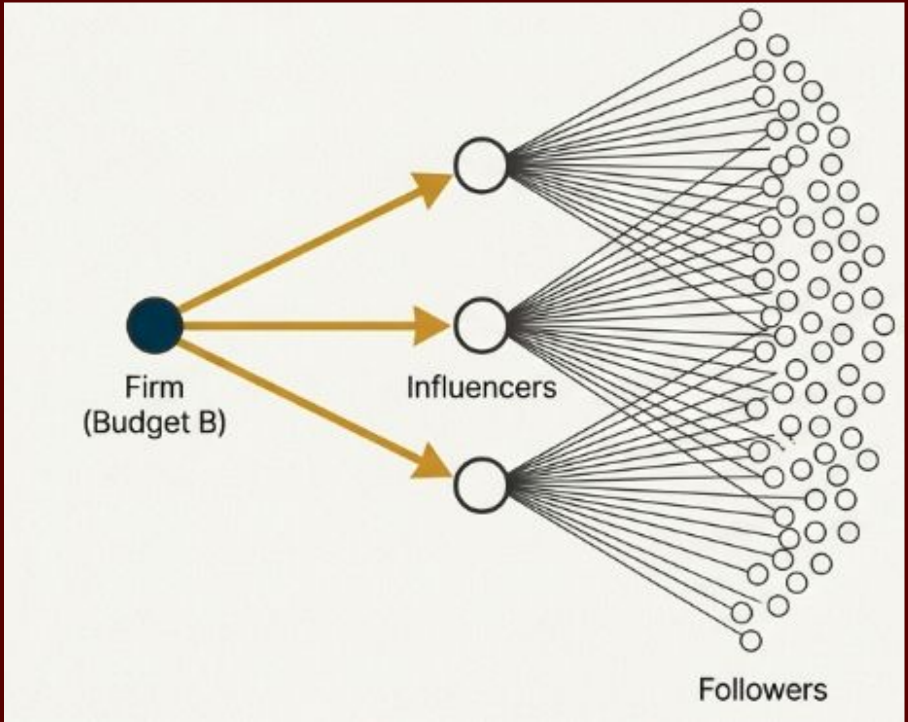
Tech market as an election



- The goal for each company is to make the most purchases (most votes)
- Primary weapon for each company is information warfare: Strategic release of leaks, rumors and influencer endorsements to alter the preference profile of the electorate before launch.
- Weapon of choice for this model: Influencer seeding

Bribery ❌ shift bribery ✅



The goal isn't to change one mind (like normal bribery) but to exploit the influencer's **social network**, which delivers the influence to thousands of followers.

Shift Bribery over Social Networks

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Inputs for the shift bribery model (Hota et al., 2025)

C: A set of m candidates {c1,...,cm}.
V: A set of n voters {v1,...,vn}.
P: The preference profile, where each voter vi has a linear ranking >i over C.
p∈C: The preferred candidate (the one we want to win).

New stuff:

- **G= (V,E):** A directed, weighted social graph.
- **w(u,v):** The weight of the edge from voter u to voter v, representing influence strength.
- **p∈C:** The preferred candidate (the one we want to win).
- **s= (s1,...,sn): The Shift Vector** si ∈N0: Number Of Positions Candidate Is Shifted Forward (left) for voter vi via direct bribery.
- **Π:** A family of cost functions
- **B:** The bribery budget

Effective Shift Formula. For each voter v_i, the effective shift s_i' is:

$$s_i' = s_i + \sum_{j \in N_{in}(i)} \lfloor s_j \cdot w(j,i) \rfloor$$

But wait…this is the tech world…so i introduce: Seeding-Shift-Bribery

$$I = (C, V, G, p, C_{rival}, B, \Pi, \rho)$$

Destructive influence (C_{rival})

Example: Iphone pays the influencer to spread a rumor like “pixel 10 overheats easily”

Model implementation:

We allow signed shifts:

- $S_i > 0$: promote our product
- $S_i < 0$: attack the rival

Negative shift: shifts/pushes rival down in follower rankings

Fanboy resistance (ρ)

Example: finding it easier to use apple products vs google OR just a fan of a company

Each voter “v” has a resistance threshold ρ_v.

Influence only has an effect if | incoming influence from influencer| > ρ_v

p = iPhone 16

$c_{(\text{riva}□)}$ = Pixel 9

$$I_i = s_i + \sum_{j \in \text{Parents}(i)} \lfloor s_j \cdot w(j,i) \rfloor .$$

The influence that reaches each follower is:

For B: Ib = 3 . 0.9 = 2
For C: Ic = 3 . 0.5 = 1
For D: 1d = 3 . 0.2 = 0

Edges = Trust weights

B

ρB=1

w(A,B) = 0.9

Node A

MKBHD

Strong positive shift: sA=+3

w(A,C) = 0.5

C: Apple fanboy

ρC=3

w(A,D) = 0.2

D

ρD=3

D: Android loyalist

ΔB(p)=max(0,2−1)=1
iPhone 16 moves up by 1 position in B's ranking.

IC =1, ρC=3
$\Delta C(p)$=max(0,1−3)=0
Already loves apple does not change anything

ID=0, ρD=3
ΔD(p)=0
Completely ignores the review

What the problem asks:

1) We pick a signed shift vector (positive = promote p, negative = attack rival).

2) We must stay within budget: Total cost of all shifts ≤ B.

3) Influence then spreads through the network (followers receive scaled influence based on trust weights).

4) Each voter applies resistance (weak influence is ignored; strong influence changes rankings).

5) Influence produces:

- Δ(p) → how much *p* moves up
- Δ(rival) → how much the rival moves down

6) Rankings are updated, and we check:

The Core Question:

“Does there exist *any* shift strategy that stays within budget and makes our product *p* win under Plurality?”

Sometimes some candidate moves one shift up the preference profile but does not come to the first: concept of better off/worse off

Seeding-Shift-Bribery Model Is **NP-Complete**

It is in NP: all steps run in polynomial times, it is easy to verify

If we turn off our models new features, our model reduces to the shift bribery over social graphs model which is already NP- complete. (Hota et al.)

It also includes the classical Shift-Bribery hardness results (Faliszewski et al.)

Since Seeding-Shift-Bribery strictly generalizes both NP-hard models, it cannot be easier.

In complexity terms: “**if a problem A is NP-hard and can be obtained as a special case of a more general problem B, then B cannot be easier, solving B would immediately solve A.**”

Future work:

- What if loyalty changes over time?
- Can we design a good enough <u>heuristic algorithm</u> for firms to use?
- *fav: modelling this problem as a "possible winner" problem as sometimes you have information about some phones but not all of them.

[1] Hota, A., Dey, P., Bandopadhyay, S., & Thiagu, S. (2025). Shift Bribery over Social Networks.
[2] P.Faliszewski, P.Manurangsi, and K.Sornat. Approximation and Hardness of Shift-Bribery. Artificial Intelligence
[3] Makulilo, A.(2024).Negative Campaigning and Vote Choice: Rationale, Trends, and Future Research. International Political Science Abstracts, 747-762.

Complicated? i know right.

Questions? (pls be nice)