

Problem A: Group Affinity and Fashion Sense

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Hipster vs. Mainstream

Which group do you belong to? **Hipster** or **Mainstream**?

- ▶ How do I adjust with the people around me?
- ▶ What changes (if any) do I make during that process? Or do I not?



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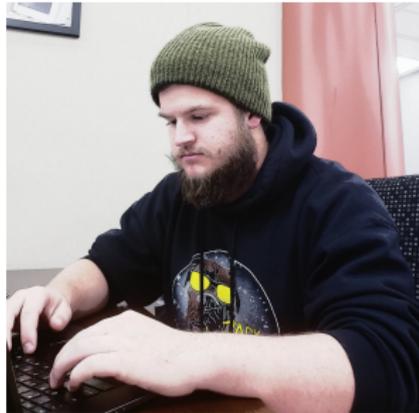


Figure: A hipster with a unique fashion sense



Assumptions

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- ▶ Constant population
- ▶ If I don't know you then you can't influence me unless you are Beyoncé
 - ▶ if $b_{ij} = 0.9$ and $b_{ji} = 0$, then i is a celebrity
- ▶ Relationships between two individuals grow and decay in the same direction on both sides (if neither of them is famous)



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Inherent Characteristics

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Inherent Characteristics

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2. **Influencing index** (ϕ): represents a person's ability to influence others; higher ϕ (range: 0 to 1)
3. **Responsiveness index** (ρ): represents a person's responsiveness to other people's influence; (range: 0 to 1)



Parameters

Interpersonal Characteristic

1. **Bond Index (b)**: represents the two way **relationship/bond** strength between two people; (range: 0 to 1)
 - ▶ b_{ij} : as perceived by j
 - ▶ b_{ji} : as perceived by i



Information Flow

Consider persons i and j :

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 - ▶ the bidirectional Bond index: b_{ij}
- ▶ h_j : j 's likeliness to become a hipster; dependent on ϕ_i , ρ_j , and b_{ij} (i from 1 to n , $i \neq j$)



Social Structure

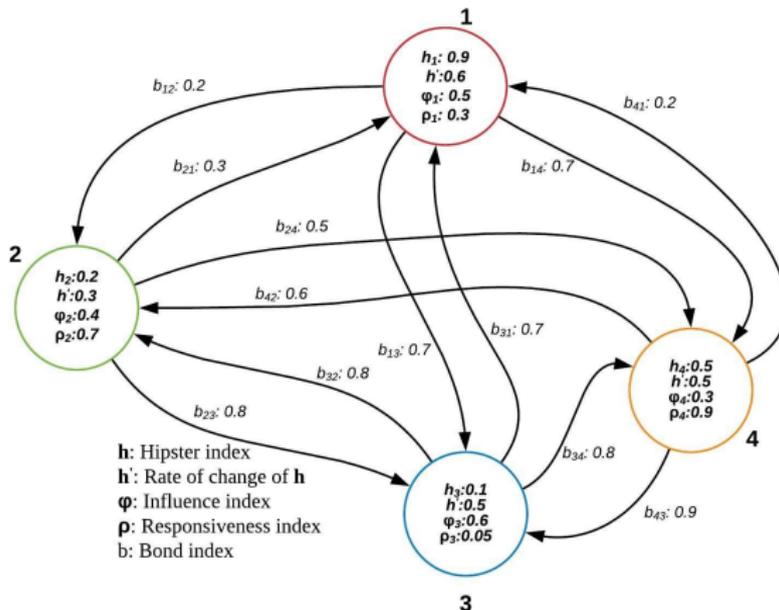


Figure: A social structure of four individuals



Data Structure

The Bond Matrix : $B(0) = \begin{bmatrix} 0.0 & 0.2 & 0.7 & 0.7 \\ 0.3 & 0.0 & 0.8 & 0.5 \\ 0.7 & 0.8 & 0.0 & 0.8 \\ 0.2 & 0.6 & 0.9 & 0.0 \end{bmatrix}$ (1)



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$$\text{The Hipster Matrix : } H(0) = \begin{bmatrix} 0.9 \\ 0.2 \\ 0.1 \\ 0.5 \end{bmatrix} \quad (2)$$



Account for Randomness

Randomness is introduced to the system at constant frequency.

- ▶ **External Randomness Matrix** (R_{ex}) \leftarrow change in people's behavior/fashion senses because of *external factors*
 - ▶ \bar{r} : 0, σ : 0.2
 - ▶ $r[ij] \cdot r[ji] \geq 0$



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$$B_r(t) = B(t) + R_{ex}(t)$$

$$H_r(t) = H(t) + R_{si}(t)$$



Differential Equation Model: Social Influence

The Social Influence Force on an individual is the sum of the influences from bonded individuals in the following way.

$$C_0 \rho_i \sum_j [\phi_j b_{ji} [\underbrace{(\dot{h}_j - \dot{h}_i)}_{\text{rate of trend change}} + k \underbrace{(h_j - h_i)}_{\text{perceived trend}}]]$$

k : Scales the relative strength between the differences $\dot{h}_j - \dot{h}_i$ and $h_j - h_i$.



Differential Equation Model: Filter Bubble Drag

Filter Bubble: a situation in which an Internet user encounters only information and opinions that conform to and reinforce their own beliefs.

The Filter Bubble Drag is a simple drag force quantified by

$$-C_1 \dot{h}_i$$



Differential Equation Model: Bimodal Potential Well

A social potential energy is defined such that

1. It is **difficult** for an individual to be between a hipster and mainstream.
2. It is **impossible** for an individual to have a hipster index (h_i) outside the domain $[0,1]$.
3. The potential has symmetry about $h = 0.5$
4. The potential has no more local maxes or mins than are necessary.
5. The derivative of the potential evaluated at 0 and 1 is about 0.



Differential Equation Model: Bimodal Potential Well

Consider an infinite square potential well on $[0,1]$ and

$$U(h_i) = C_2 e^{-60(h_i - 0.5)^2}, \quad h_i \in [0, 1] \quad (3)$$

The force on the hipster index for potentials are defined by

$$F_U(h_i) = -\frac{dU}{dh}(h_i)$$

Equation (4) is derived from equation (3).

$$-\frac{dU}{dh}(h_i) \propto C_2(h_i - 0.5)e^{-60(h_i - 0.5)^2}, \quad h_i \in [0, 1] \quad (4)$$



Final System of Differential Equations

The final system of coupled differential equations is the linear combination of the social forces.

$$\ddot{h}_i = C_0 \rho_i \sum_j [\phi_j b_{ji} \underbrace{(\dot{h}_j - \dot{h}_i)}_{\text{rate of trend change}} + k \underbrace{(h_j - h_i)}_{\text{perceived trend}}] - \underbrace{C_1 \dot{h}_i}_{\text{filter bubble drag}} - \underbrace{C_2 \frac{dU}{dh}}_{\text{bimodal force}}$$



Results

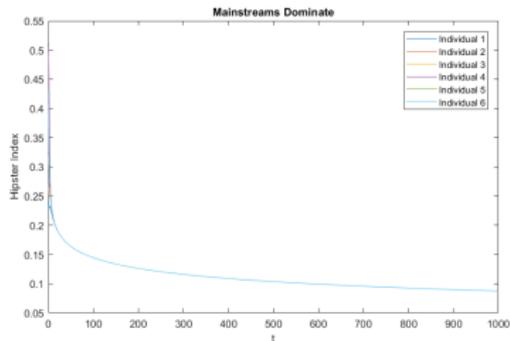
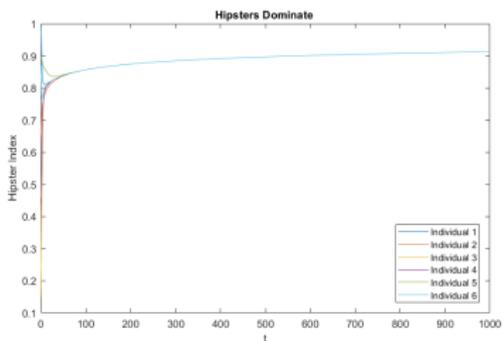


Figure: Most solutions show convergence toward a society of **one** subgroup.



Results

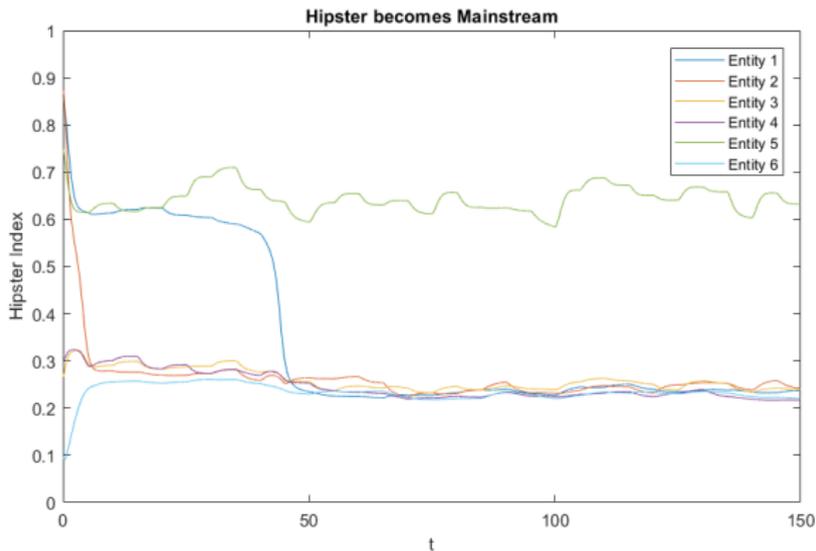


Figure: A hipster changes to being mainstream after about 45 units of time



Results

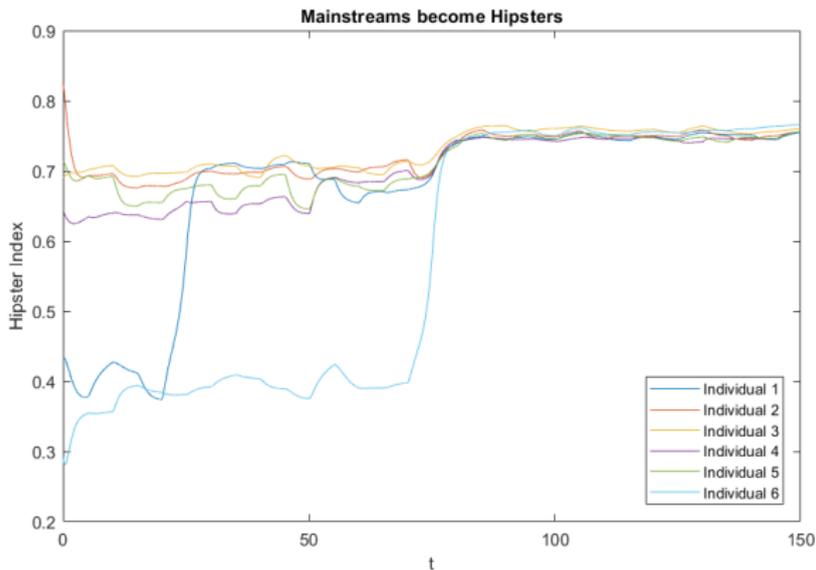


Figure: Two mainstreams become hipsters at different times.



Results

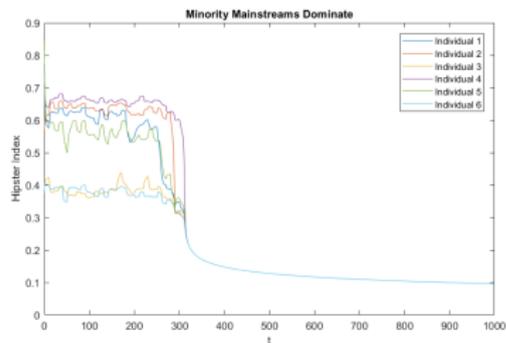
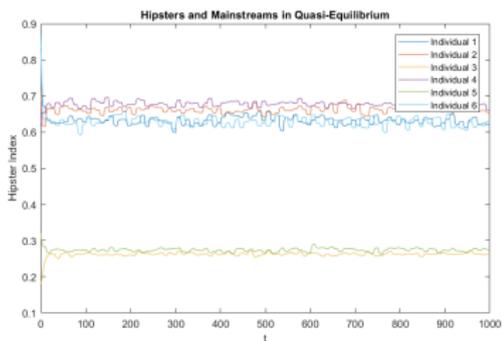


Figure: It is difficult to indicate when random effects will force convergence of the subgroups



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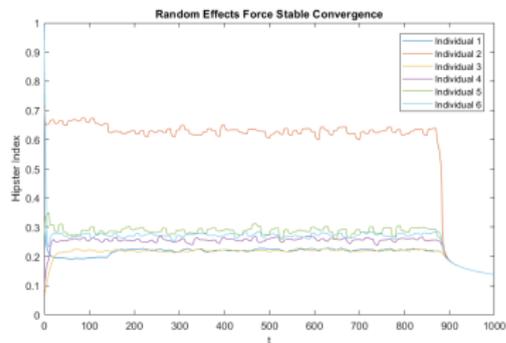
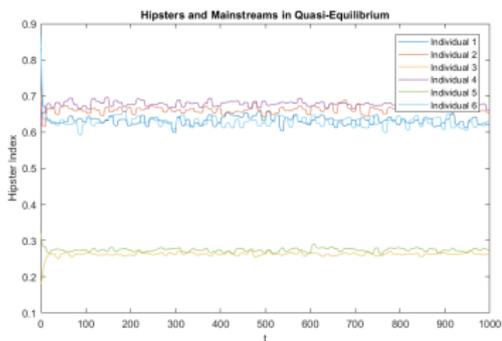


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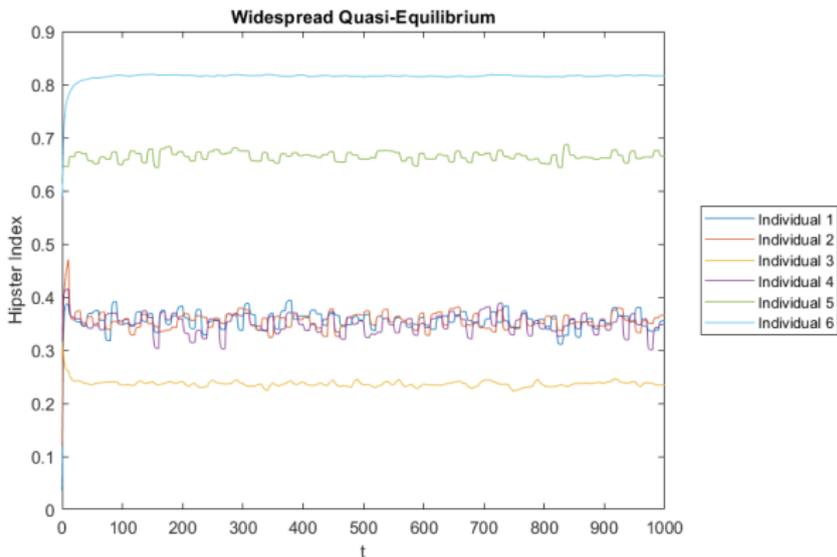


Figure: Some solutions seem counter-intuitive, with quasi-stability in sparse subgroups.



Additional Issue 1

Question: How can a company increase the sale of an item?
Change the item? Or its advertising?

→ **Celebrity Endorsement!**

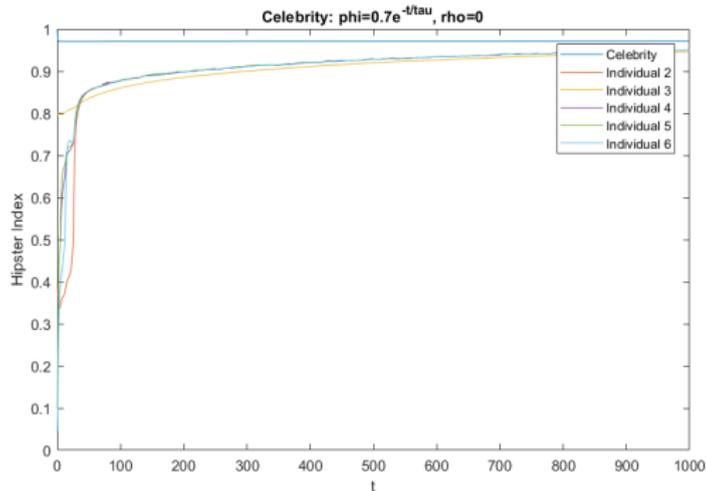


Figure: Effect of celebrity endorsement



Additional Issue 2

Question: What if there are two aspects instead of just one? Say, clothing and hairstyle!

→ **Style indices (an index for each aspect of appearance)**

Hipster index (attitude) \Rightarrow Style indices (aspects of appearance)



Additional Issue 3

Question: Dependency on initial conditions?

→ **Same set of initial conditions can result in different results (due to the effect of randomness)**

→ **Convergent initial condition (all people are hipsters/mainstreams) is likely to result in convergent final condition. But there is a finite chance that self-induced randomness will kick in to split the group into two subgroups.**



Conclusion

- ▶ Four parameters: three inherent characters and an interpersonal character,
- ▶ Social Structure: Information flow through Interconnected Graph with nodes and edges
- ▶ Randomness: Abrupt changes in people's behavior
- ▶ Our model predicts that random influences will force convergence over infinite time.



Future Works

- ▶ Account for time delay in information flow,
- ▶ Generate more efficient (continuous) way to generate randomness,
- ▶ Account for population change.



References

-  Dunbar, R. I. M. (1992). "Neocortex size as a constraint on group size in primates". *Journal of Human Evolution*. 22 (6): 469–493. doi:10.1016/0047-2484(92)90081-J.
-  "Are we stuck in filter bubbles? Here are five potential paths out". Nieman Lab.
-  [https://phys.libretexts.org/Courses/University of California Davis/Modern Physics/One-Dimensional Potentials Infinite Square Well](https://phys.libretexts.org/Courses/University_of_California_Davis/Modern_Physics/One-Dimensional_Potentials_Infinite_Square_Well).



Thank You!

?

- ▶ What was the unit of time?
- ▶ Initial values for Hipster index (array)?