Competition over popularity in social networks

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Eitan Altman

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The involved actors:

- **Individuals** who wish to disseminate content through a social network. **Goal: visibility, popularity**
- **Social network provider** (SNP) interested in maximizing the amount of downloads
- Has **tools** to accelerate the dissemination of popular content. Example: **Recommendation graph**

3/26/12

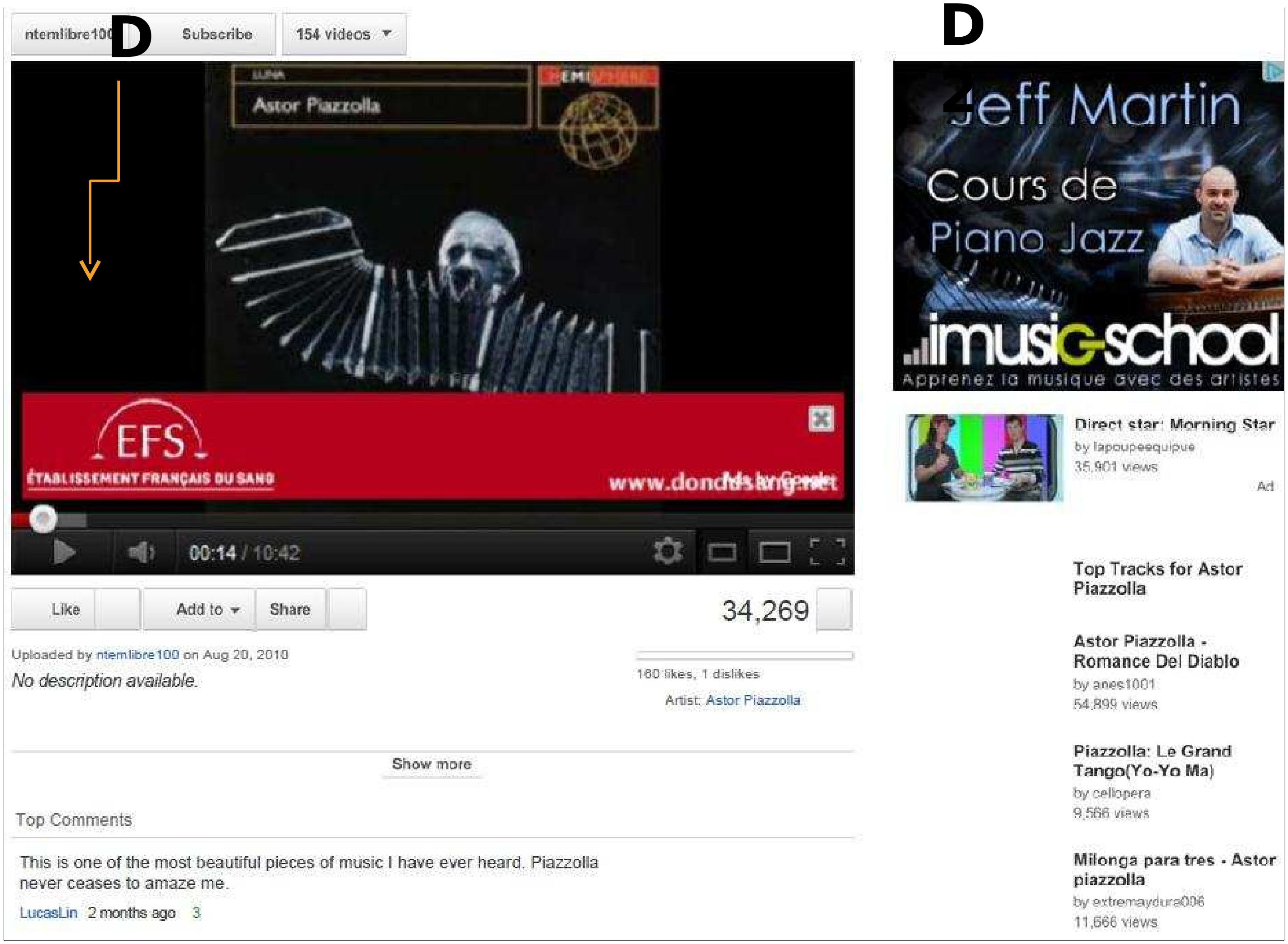
Example: YOUTUBE

3/26/12

Example: YOUTUBE

AD

AD



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Example: YOUTUBE

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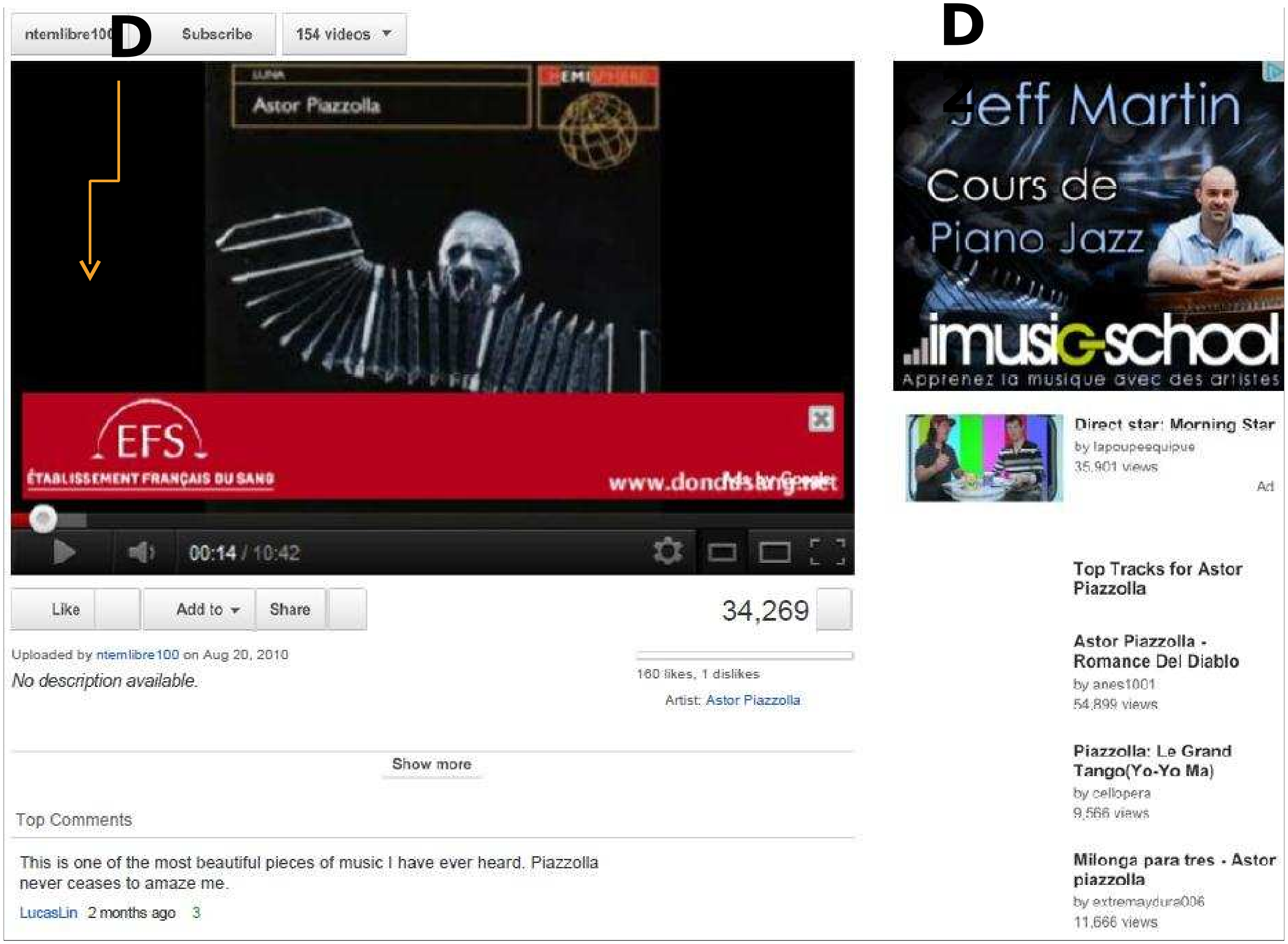
Recom graph



A list containing other ad events: Sharing and embedding

Significant discovery events

	Date	Event	Views
A	02/22/12	First view from a mobile device	107,108
B	02/22/12	First embedded on – facebook.com	75,452
C	02/22/12	First referral from YouTube search – obama singing	31,008
D	02/22/12	First embedded on – whitehouse.gov	23,221
E	02/22/12	First referral from – facebook.com	19,180
F	02/22/12	First embedded on – plus.google.com	11,465
G	02/22/12	First referral from YouTube search – barack obama singing	7,892
H	02/22/12	First referral from YouTube search – obama sings	6,601
I	02/22/12	First embedded on – failblog.org	5,824

Model

- N content creators (seeds)– players
- M potential destinations
- A destination m is interested in the first content that it will be aware of.
- Information on content n arrives at a destination after a time exponentially distributed with parameter $\lambda(n)$.
- The goal of a seed: maximize the number of destinations Xi(T) at time T (T large) that have its content (dissemination

- Player n can accelerate its information process by a constant **a** at a cost c(**a**)
- Uniformization: let
- $J^i(v, \mathbf{x}, \mathbf{a})$ = total utility for player i if at time 0 the system is at state x, player j takes action aj and the utility to go for player i from the next transition onwords is v(y) if the state after the next transition is y.

$$P_{\mathbf{xaz}} = \begin{cases} (M - |\mathbf{x}|)\frac{a_i \lambda_i}{\lambda} & for\ \mathbf{z} = \mathbf{x} + e_i, \mathbf{x} \in \mathbf{X} \setminus \mathcal{M} \\ 1 - (M - |\mathbf{x}|)\frac{\sum_i a_i \lambda_i}{\lambda} & for\ \mathbf{z} = \mathbf{x}, \mathbf{x} \in \mathbf{X} \end{cases}$$

Define

$$\delta_j(v, \mathbf{x}) = v(\mathbf{x} + e_j) - v(\mathbf{x}).$$

Define for each player i, $\mathbf{x} \in \mathbf{X} \setminus \mathcal{M}$, $\mathbf{a} \in \mathbf{A}$ and $v \in R^{\mathbf{X}}$:

$$J^i(v, \mathbf{x}, \mathbf{a}) = -c_i(a_i) + \frac{(M - |\mathbf{x}|)}{\lambda} \sum_{j=1}^{N} a_j \lambda_j (\zeta_i(x_i) 1\{j = i\} + \delta_j(v, \mathbf{x}))$$

$$0 = \max_{u \in \Delta(\mathbf{A}_i)} J^i(v_i, \mathbf{x}, \mathbf{u})$$

- We solve the DP

- **For linear dissemination utility, we can reduce the state space to the number of destinations that have some content. 1-dimensional!**

- **Solution: formulate explicit M matrix games, the equilibrium at matrix m is the equilibrium of the original game at state m**

The case of no information

Let $\overline{x}_i(t) := E[X_i(t)]$ and $\overline{x}(t) := \sum_{i=1}^{N} \overline{x}_i(t)$. Then

$$\dot{\overline{x}}_i(t) = \lambda_i w_i^2 (M - \overline{x}(t))$$

This is a differential game with a compact state space.

Results

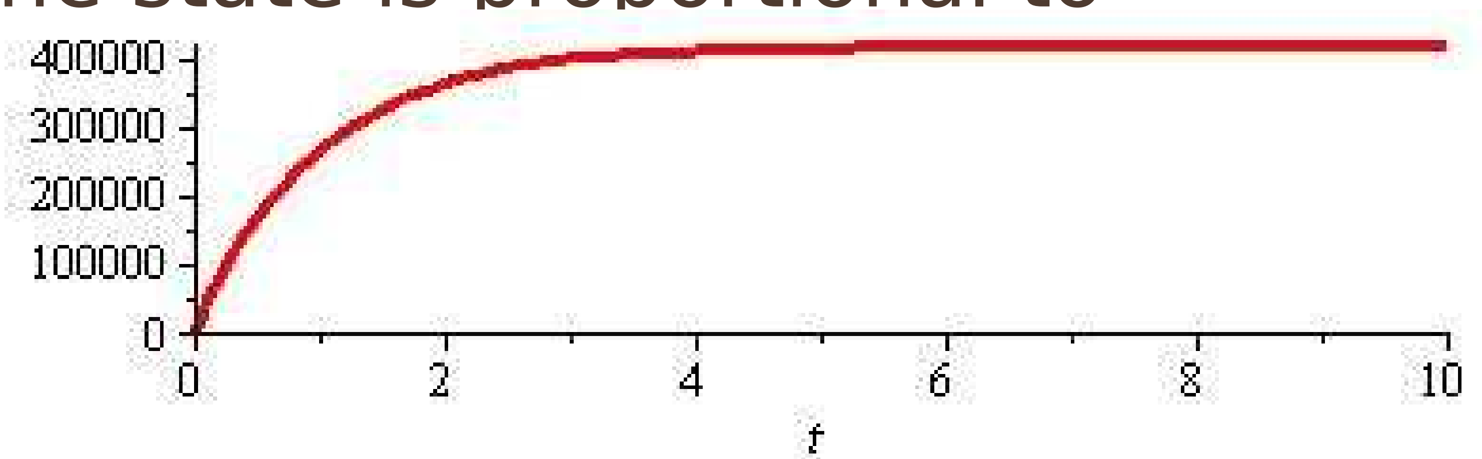
Again state space collapse to dimension 1

- Equilibrium at state m obtained as equilibrium of m-th matrix game. Now m is a real number

- For linear acceleration cost – same threshold policies

Results

- Static case (policies constant in time): explicit expressions for the state evolution and the utility.
- The state is proportional to

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Good fit!