Graphs in Machine Learning

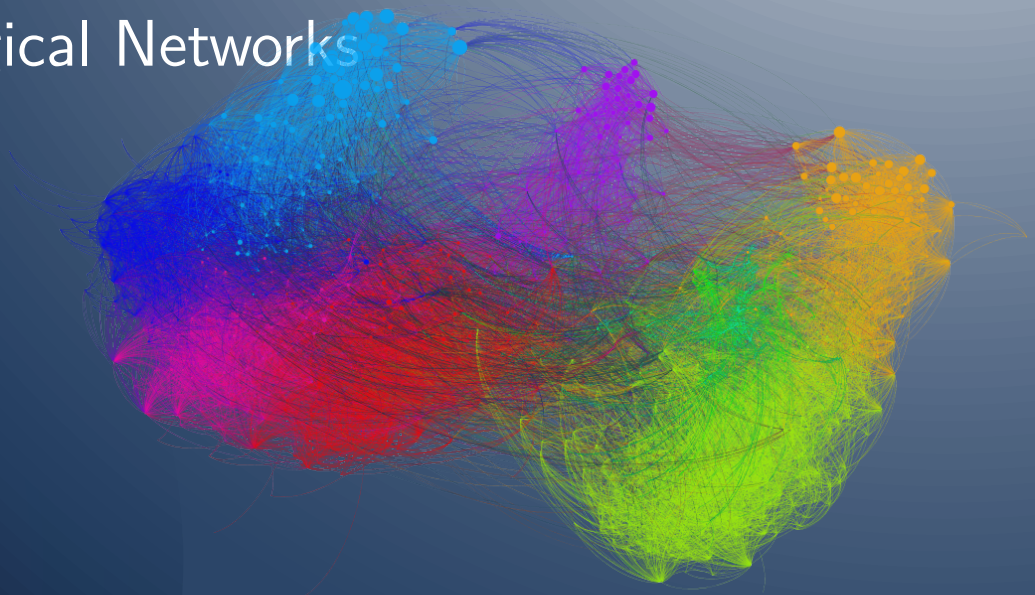
Natural Graphs

Social, Information, and Biological Networks

Michal Valko

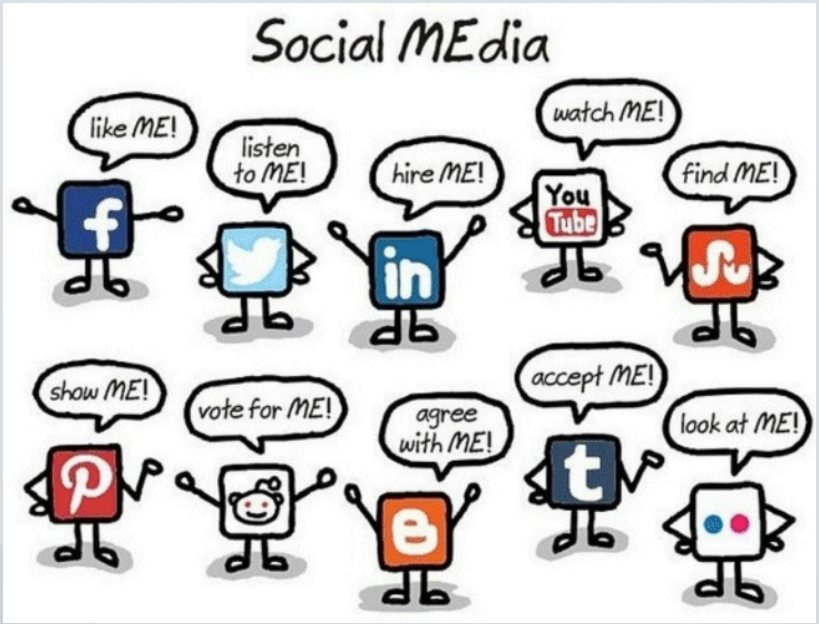
Inria & ENS Paris-Saclay, MVA

Partially based on material by: Andreas Krause, Branislav Kveton, Michael Kearns



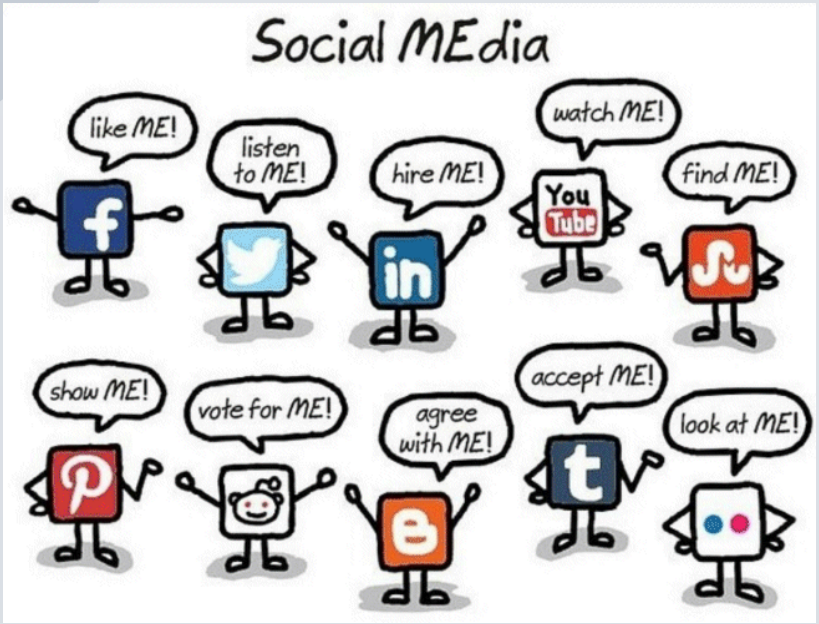
Natural graphs from social networks

- people and their interactions



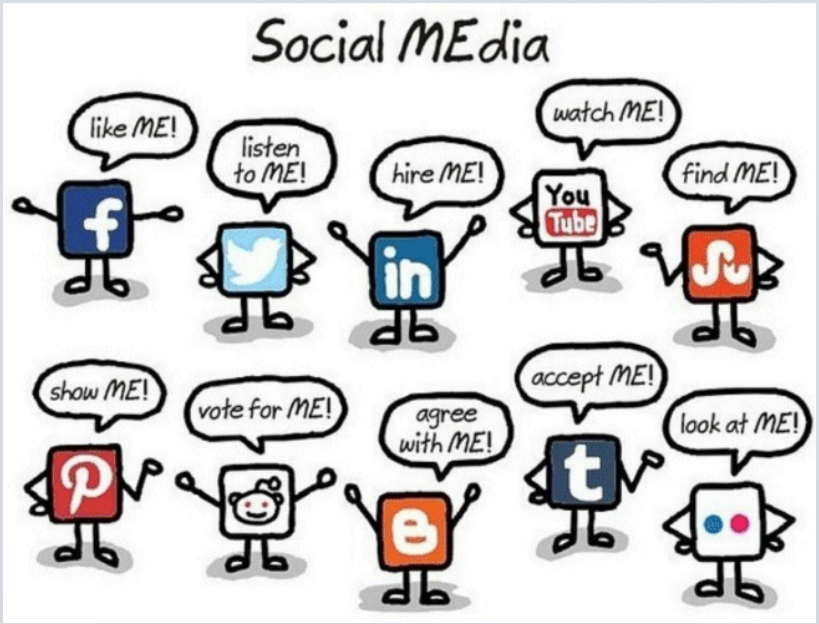
Natural graphs from social networks

- people and their interactions
- structure is rather a *phenomena*



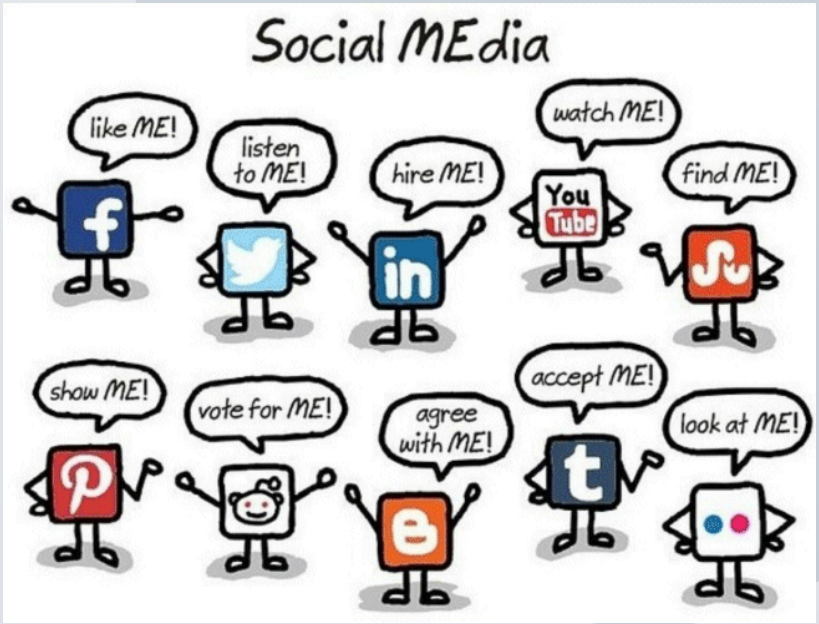
Natural graphs from social networks

- people and their interactions
- structure is rather a *phenomena*
- typical ML tasks



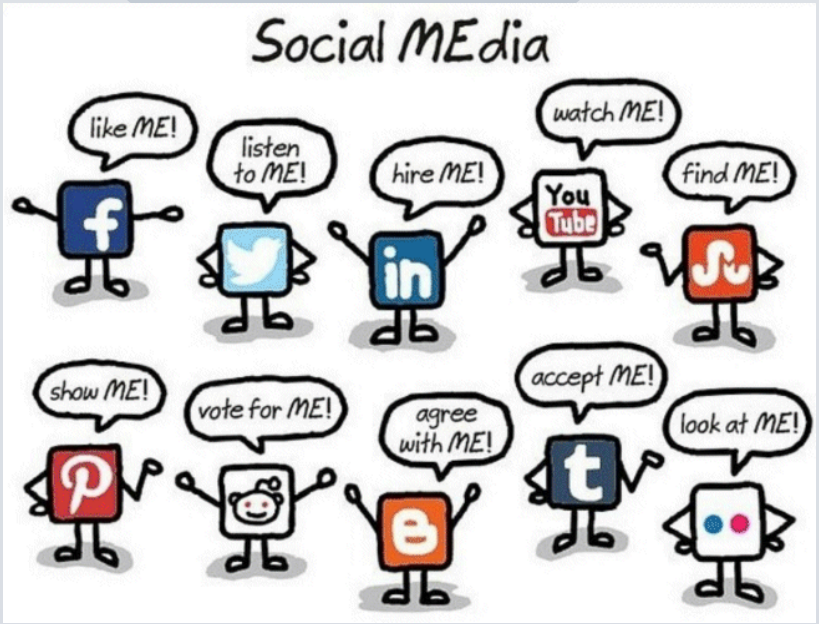
Natural graphs from social networks

- people and their interactions
- structure is rather a *phenomena*
- typical ML tasks
  - advertising



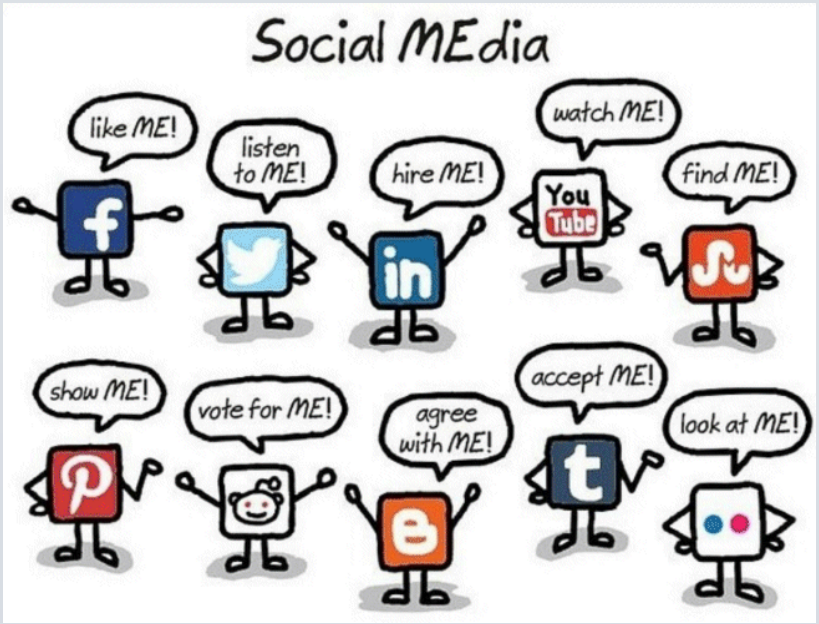
Natural graphs from social networks

- people and their interactions
- structure is rather a *phenomena*
- typical ML tasks
  - advertising
  - link prediction (PYMK)

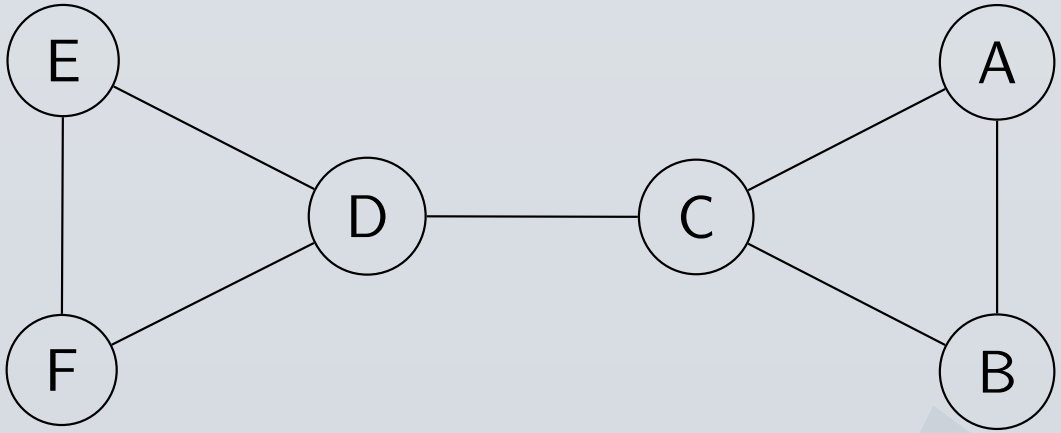


Natural graphs from social networks

- people and their interactions
- structure is rather a *phenomena*
- typical ML tasks
  - advertising
  - link prediction (PYMK)
  - find influential sources

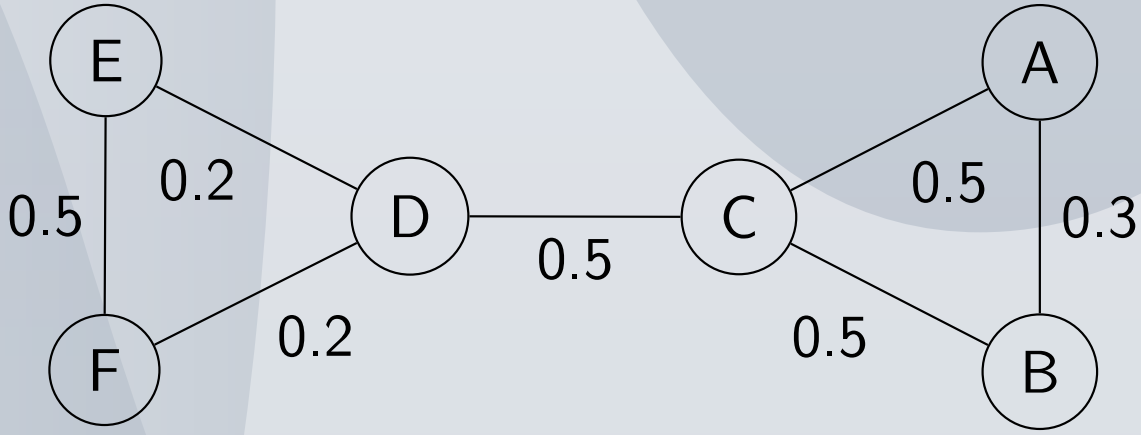


Success story #1 Product placement - problem



Maximizing the Spread of Influence through a Social Network
http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf

Success story #1 Product placement - problem

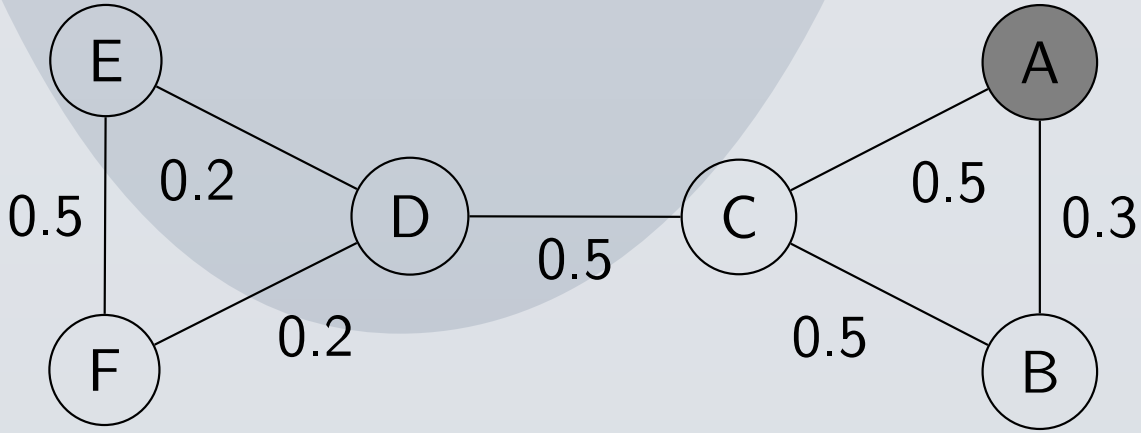


Who should get free cell phones?

$V = \{$**A**lice,**B**ob,**C**harlie,**D**orothy,**E**ric,**F**iona$\}$

Maximizing the Spread of Influence through a Social Network
`http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf`

Success story #1 Product placement - problem

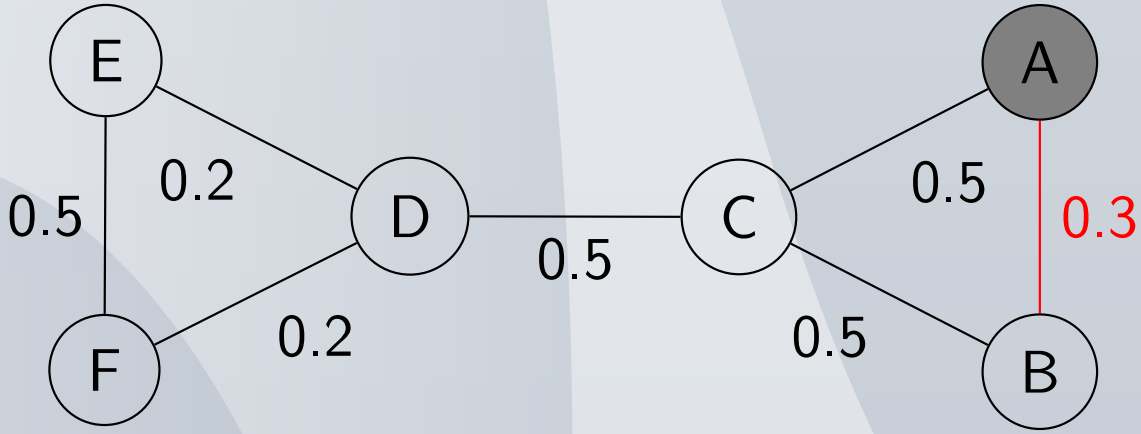


Who should get free cell phones?

$V = \{$**A**lice,**B**ob,**C**harlie,**D**orothy,**E**ric,**F**iona$\}$

Maximizing the Spread of Influence through a Social Network
`http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf`

Success story #1 Product placement - problem

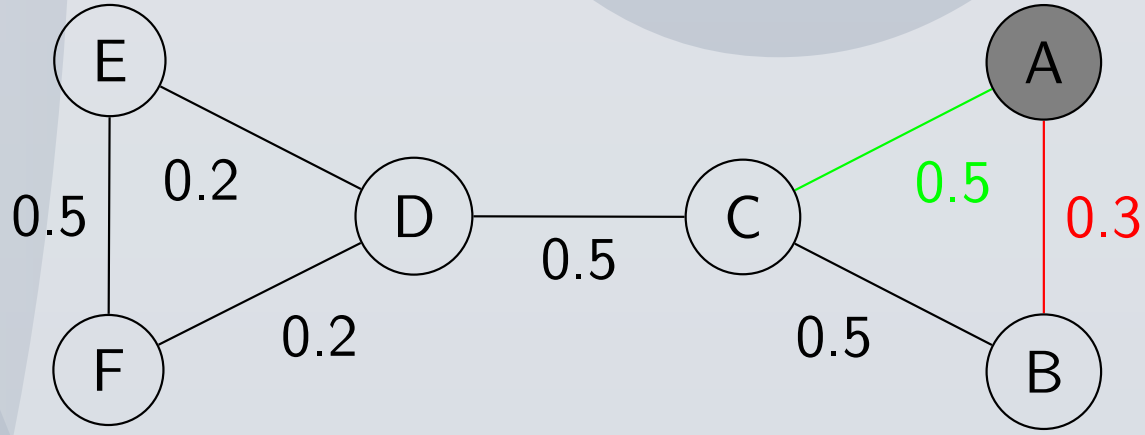


Who should get free cell phones?

$V = \{$**A**lice,**B**ob,**C**harlie,**D**orothy,**E**ric,**F**iona$\}$

Maximizing the Spread of Influence through a Social Network
`http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf`

Success story #1 Product placement - problem

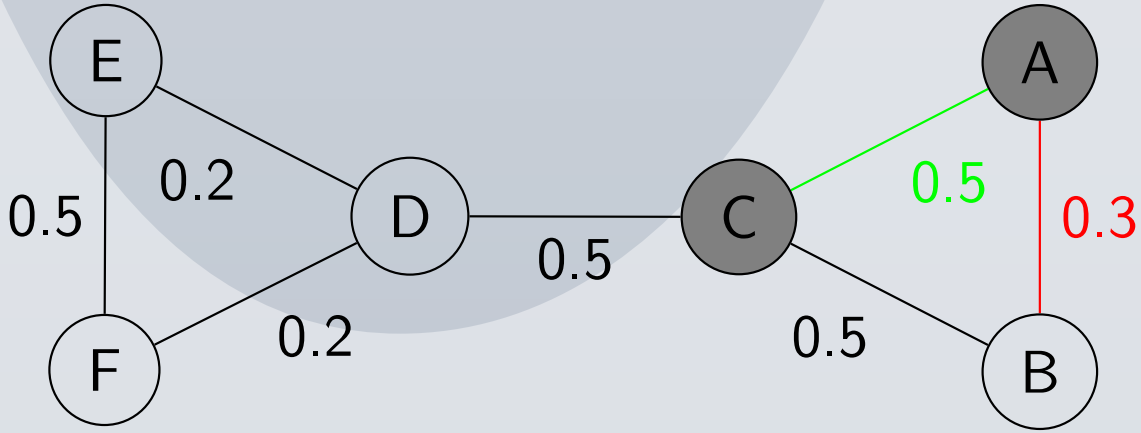


Who should get free cell phones?

$V = \{$**A**lice,**B**ob,**C**harlie,**D**orothy,**E**ric,**F**iona$\}$

Maximizing the Spread of Influence through a Social Network
`http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf`

Success story #1 Product placement - problem

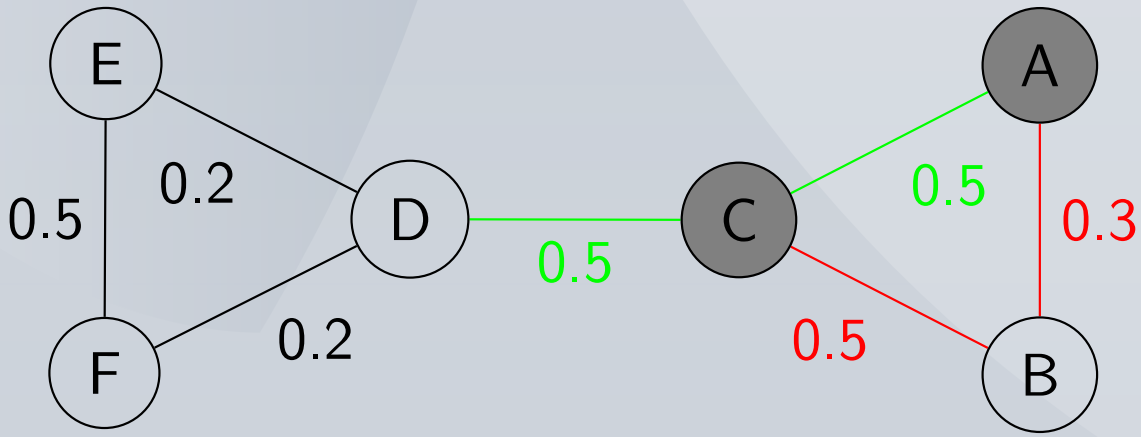


Who should get free cell phones?

$V = \{$**A**lice,**B**ob,**C**harlie,**D**orothy,**E**ric,**F**iona$\}$

Maximizing the Spread of Influence through a Social Network
`http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf`

Success story #1 Product placement - problem

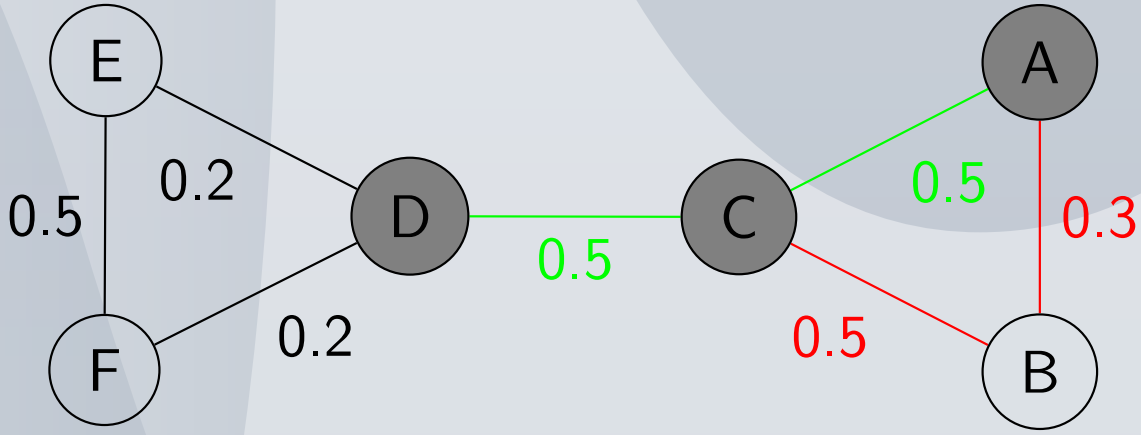


Who should get free cell phones?

$V = \{$**A**lice,**B**ob,**C**harlie,**D**orothy,**E**ric,**F**iona$\}$

Maximizing the Spread of Influence through a Social Network
`http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf`

Success story #1 Product placement - problem

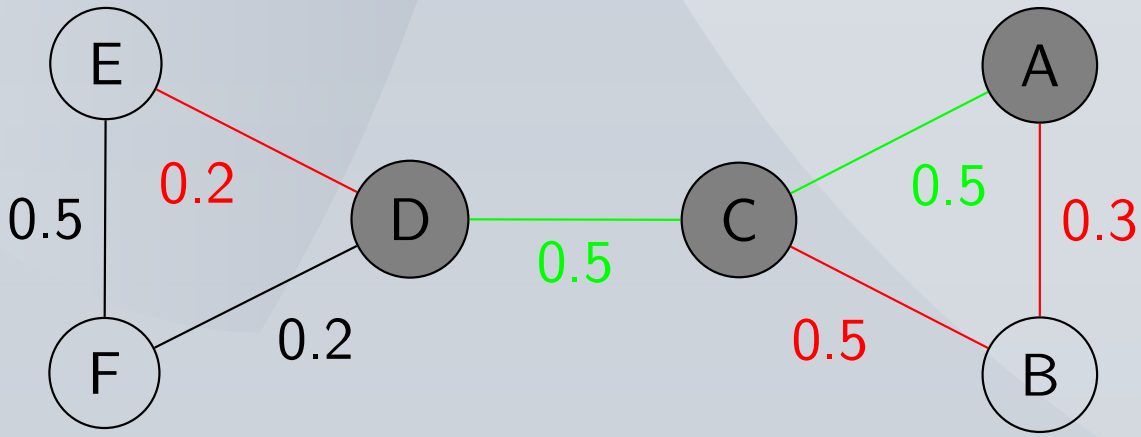


Who should get free cell phones?

$V = \{$**A**lice,**B**ob,**C**harlie,**D**orothy,**E**ric,**F**iona$\}$

Maximizing the Spread of Influence through a Social Network
`http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf`

Success story #1 Product placement - problem

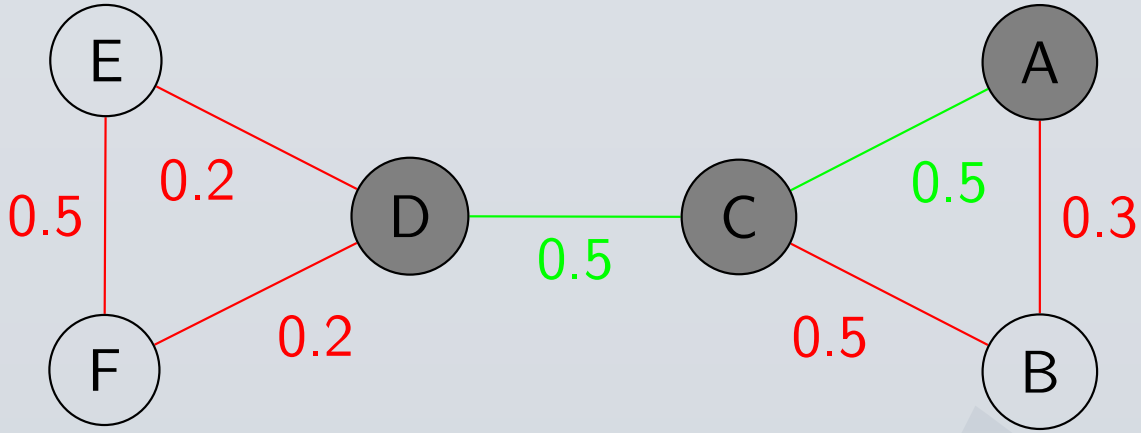


Who should get free cell phones?

$V = \{$**A**lice,**B**ob,**C**harlie,**D**orothy,**E**ric,**F**iona$\}$

Maximizing the Spread of Influence through a Social Network
`http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf`

Success story #1 Product placement - problem



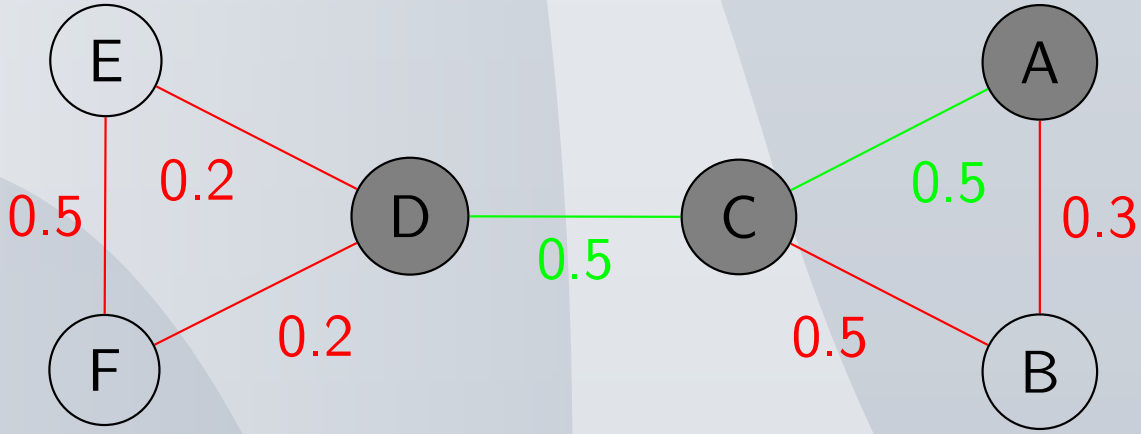
Who should get free cell phones?

$V = \{$**A**lice,**B**ob,**C**harlie,**D**orothy,**E**ric,**F**iona$\}$

$F(S) =$ Expected number of people influenced when targeting $S \subseteq V$ under some propagation model - e.g., cascades

Maximizing the Spread of Influence through a Social Network
`http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf`

Success story #1 Product placement - problem



Who should get free cell phones?

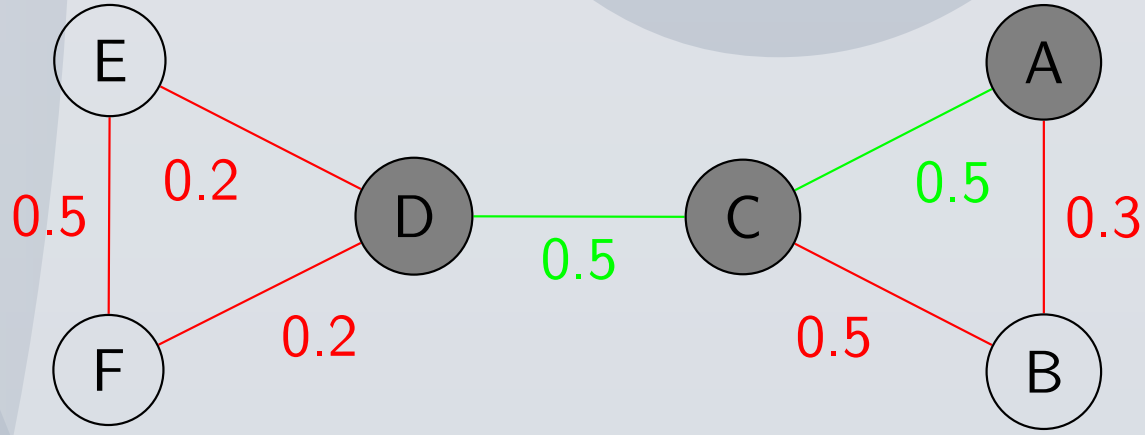
$V = \{$**A**lice,**B**ob,**C**harlie,**D**orothy,**E**ric,**F**iona$\}$

$F(S) =$ Expected number of people influenced when targeting $S \subseteq V$ under some propagation model - e.g., cascades

How would you choose the target customers?

Maximizing the Spread of Influence through a Social Network
`http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf`

Success story #1 Product placement - problem



Who should get free cell phones?

$V = \{$**A**lice,**B**ob,**C**harlie,**D**orothy,**E**ric,**F**iona$\}$

$F(S) =$ Expected number of people influenced when targeting $S \subseteq V$ under some propagation model - e.g., cascades

How would you choose the target customers?

highest degree, close to the center, . . .

Maximizing the Spread of Influence through a Social Network
http://www.cs.cornell.edu/home/kleinber/kdd03-inf.pdf

Michal Valko

michal.valko@inria.fr

Inria & ENS Paris-Saclay, MVA

https://misovalko.github.io/mva-ml-graphs.html