GROUP RECOMMENDATIONS:

AXIOMS, IMPOSSIBILITIES, AND RANDOM WALKS

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MAKING A CHOICE…

Plenty of item classes where there is a wide variation in quality, but no easy way to estimate it…
How do we make a decision?

RECOMMENDATIONS
SOURCES OF RECOMMENDATIONS

Professional reviewers (newspapers, online, etc.)

Signals (not applicable in all cases)

Friends and family opinions

Computer recommendation systems
COLLABORATIVE FILTERING

Using the large datasets collected on users, find a user with similar tastes, and recommend according to it.
In real life family and friends are prime source of opinion and influence, so the social graph should be taken into consideration when making recommendations.

"Trust-based recommendation systems: an axiomatic approach", Andersen et al.
MIND THE GRAPH - SHOULD I READ THAT BOOK?

Opinionated members of the social graph have differing recommendations, which undecided people take into account…

“Trust-based recommendation systems: an axiomatic approach “, Andersen et al.
How do we decide on where to go to dinner?

GROUP RECOMMENDATIONS
GROUP RECOMMENDATIONS

A single, joint, recommendation made to a group of people, intending to do an activity together:

- Restaurants
- Vacation destination
- Movies
- Book club
- Computer (& Xbox) games
MIND THE GRAPH - LET’S GO TO DINNER: IS THAT RESTAURANT ANY GOOD?

Opinionated members of the social graph have differing recommendations…
MIND THE GRAPH - LET’S GO TO DINNER: IS THAT RESTAURANT ANY GOOD?

A recommendation gives the group “+”, “-”, or 0.

\[ R:2^n \rightarrow \{+, -, 0\} \]
AXIOMATIC APPROACH

Defining the properties of the system we desire, and build a system using them, instead of accepting the problems and limitations of the system we have thought of.
BASIC AXIOMS
Axiom I: Anonymity

Isomorphic graphs have isomorphic recommendations.
AXIOM II: POSITIVE RESPONSE

If recommended “+”, adding a “+” node doesn’t change the recommendation. Adding a “+” and “-“ connected to the same node doesn’t change recommendation.

R( + ) = R( + + )
AXIOM III: IIS (INDEPENDENCE OF IRRELEVANT STUFF)

Adding unconnected nodes does not affect the recommendation.
GROUP POWER AXIOMS
STAR GROUPS

Groups which are internally homogenous, with opposite outside influence.
AXIOM IV: $\alpha$-CENTRIPETAL

Opinionated nodes in the recommended group have a larger influence on the recommendation than those outside it.

$R(\alpha) = +$ for any $\alpha > 1$

$\alpha |(+)| \geq |(-)|$

for any $\alpha > 1$
AXIOM V: $\left(\beta, r\right)$-CENTRIFUGAL

The opinionated nodes in the recommended group do not always determine the recommendation, depending on the ratio of undecided to decided voters ($r$).

$R(\cdot) = -$ for $r > 1$ and $\beta < 1.5$

for $r > 1$ and $\beta < 1.5$
AXIOM VI: INTERNAL CONSISTENCY

If all unanimous disjoint divisions of a group have the same (none 0) recommendation - that should be the group’s recommendation.
What recommendation system supports all these axioms?

NONE!
Axioms 1-6 are not compatible: No recommendation system can ensure all 6.
INFLUENCE STRUCTURE AXIOMS
AXIOM VII: TRUST PROPAGATION

Trusting an undecided node outside the recommended group is like trusting the nodes it trusts.

\[ R(\text{-}) = R(\text{-}) \]
AXIOM VIII: SCALE INVARIANCE

Multiplying all edges from a node does not influence the recommendation.
AXIOM IX: PROPORTIONAL INCLUSIVENESS

An opinionated node outside the recommended group, connected to an undecided node inside it, has an influence with relation to its significance on the undecided, and the nonvoter’s in the group.

$$R(+) = R(-)$$
What recommendation system supports these axioms?

RANDOM WALK

Well, a group variant of it…
Theorem II

Axioms 1-3 and 7-9 are satisfied by a single recommendation system — group random walk.
GROUP RANDOM WALK

\[ R(\begin{pmatrix} \text{sgn}(-1) \\ \text{sgn}(-1 + 1) \end{pmatrix}) = - \]
FUTURE WORK

Expand the use of the social graph in group recommendation settings.

Axiomatizing other recommendation systems.

Finding further desirable features of group recommendation systems.
Some recommendations don’t work out very well...

The End

Thanks for listening