Social Choice and Mechanism Design: Quadratic Voting

Ben Norman Game Theory Presentation

Talk Structure

- Learning Goals
- Motivation
- Intro to Quadratic Voting
- Some Properties
- Questions and Discussion

Learning Goals:

Articulate:

- why Quadratic Voting is Quadratic
  - Not linear voting
  - Not exponential voting

Applications:

- Describe and implement Quadratic Voting
- Use Quadratic Voting to efficiently make collective decisions
- Use Quadratic Voting to poll and understand others true preferences
  - Use Quadratic Voting to elicit RL agent preferences? Hmm…

Stretch Goals:

- Understanding all Politics

Preference Strength Matters

There are several decisions we might make by voting:

- Scheduling an Exam
- Building a Road
- Electing a Candidate
- Building a Lighthouse

What do these have in common?

- Preference Strength Matters
- Need Preferences / Utilities

to choose efficient social outcomes

One Approach:

Ask People for their preferences?

Problem:

- People will lie. They will overstate
  - Saw this with voting too

True Preference: $A > B >> C$, but A has no change of winning…

Stated Preference: $\mathrm{B} > A >> C$

Solution?

- VCG
  - Make Truthful Reporting a Dominant Strategy!

Example of VCG:

Let’s schedule the exam!

- disclaimer: we are not actually scheduling the exam

Two Options:

Tomorrow!

Some Reasonable Time

The class: a diverse range of reasonable bids

Kevin: 10 billion million dollars for tomorrow

Narun: 10 billion million dollars for tomorrow

Problems with VCG

- **Collusion**
  - **What we saw last slide**
  - **Only takes two to get whatever they want!**
- Payment
  - We need to charge and pay people. This is complicated!
  - Could you lie?
  - Could you default?
- Opacity
  - Are people going to understand the mechanism?
  - Are people going to trust us?
    - We charge them, we pay them, are these payments transparent?

Quadratic Voting

The Simplest Case:

- We give each person K 'voice credits'
- We have N binary propositions to vote on
- We can vote positively 'yay' or negatively 'nay' on any of these propositions multiple time
- The cost to m_i votes one way or the other, on a proposition $i \in N$, is m_i^2

Let’s Try It!

Favorite Fruit:

Durian

Dragon Fruit

Orange

Kiwi

Apple

Strawberry

Mango

Banana

Idea Behind Quadratic Voting

The cost for each vote **scales** with your preferences

We have a proposition i,

- a prior p_i of how pivotal a vote is for proposition i
- a value u_i of preferring the outcome we want of of proposition i
- a linear utility of keeping our voice tokens for later / other propositions

Then the number of votes we should cast on proposition i is $\propto \boldsymbol{p_i u_i}$

Proof of This

Imagine buying votes one by one

If we have bought v votes, the cost for an additional vote is $(v+1)^2 - v^2 = 2v + 1$ this is roughly $\propto v$

Hence,

- if $p_i v_i > c(2u_i + 1)$, we should buy another vote
- if $p_i v_i < c(2u_i + 1)$, we should not buy another vote

Thus, assuming we are rational, we should buy votes so that $c(2v + 1) \approx p_i u_i$

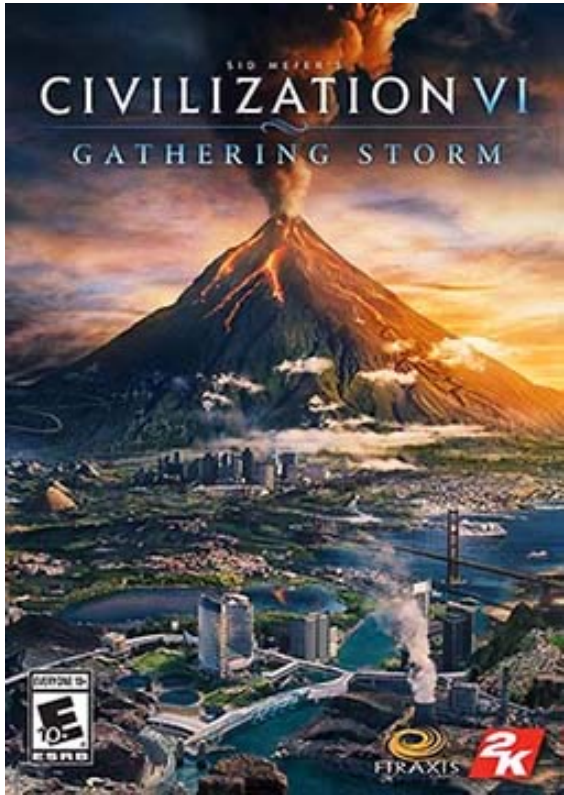
Applications

Taiwanese Government: Voting for the Presidential Hackathon

Colorado State Government to Allocate Budget

- Started in 2019
- Still using it

Voting in Civilization 6: Gathering Storm “World Council”



Benefits:

Claims:

- More resistant to collusion
- Simpler
- Asymptotically Efficient for Large numbers of Voters

Any Questions?

Aside: tyrannies of the majority and extreme

A tyranny of the Majority:

- (Weak) Majority preference causes less efficient overall outcome

A tyranny of the Extremists:

- Intense Minority Preference causes less efficient overall outcome

We want to balance the minority and majority

How we cost our votes corresponds to this.

- Rapidly increasing cost per vote ⟶ Tyranny of the Majority
  - Limits to 1p1v
- Constant cost per vote ⟶ Tyranny of the Minority
  - E.g. Lobbying by Corporations

Resources:

Weyl, Eric Glen, The Robustness of Quadratic Voting (October 23, 2016). Public Choice, Forthcoming, Available at SSRN: https://ssrn.com/abstract=2571012 or http://dx.doi.org/10.2139/ssrn.2571012

Lalley, Steven and Weyl, Eric Glen, Quadratic Voting: How Mechanism Design Can Radicalize Democracy (December 24, 2017). American Economic Association Papers and Proceedings, Vol. 1, No. 1, 2018, Available at SSRN: https://ssrn.com/abstract=2003531 or http://dx.doi.org/10.2139/ssrn.2003531

Talk: The Robustness of Quadratic Voting

Talk: Glen Weyl: Reimagining Democracy with Quadratic Funding and Quadratic Voting