# Voting and Computer Science

Examples:

1. Rank aggregation.
   - e.g., combining multiple ranked lists (≈ votes) into a "consensus" list.
2. Crowdsourcing.
   - e.g., combining opinions or grades
     - e.g., in MechanicalTurk
     - e.g., peer grading in a MOOC
3. Participatory democracy.
   - e.g., budgeting decisions (which public projects get funded?)
   - technology makes voting easier, enables new types of voting (next)

# Participatory Budgeting

**Setup:** known budget $B$, possible projects + their costs.

- constraint: total cost of chosen projects is at most $B$.

**Example:** budget $B = \$1M$, costs $c_1 = \$1M$, $c_2 = \$500k$, $c_3 = \$500k$.

**k-Approval Voting:** (1) Each voter votes for at most $k$ projects.

(2) Sort projects in decreasing order of # of votes.

(3) Fund projects in this order until full budget is spent. [last project only partially funded]

**Example Con'd:** value per voter = \$4 for project #1, \$3 for #2, \$2 for #3

**Issue:** voters not forced to take project costs into consideration, risk of non-Pareto-optimal outcome.

# Knapsack Voting (URL: pbstanford.org)

(1) Each voter votes for a subset $S_i$ of projects with total cost $\leq B$.

(2) Sort projects in decreasing order of # of votes.

(3) Fund projects in this order until budget is fully spent.

Note: in example, plausible that most voters will vote for #2 + #3 rather than just #1 — results in Pareto optimal outcome!
(reason: voters forced to take into account project costs)

Note: probably too complicated for a paper ballot
(but ok with a computer interface).

# Properties of Knapsack Voting

**Assumptions**: (strong)

(1) Voter $i$ wants to fund the projects $S_i^*$ with total cost $\leq B$.

(2) Wants to maximize money spent on the projects in $S_i^*$.

[utility = $\sum_{j \in S_i^*}$ [funding to project $j$]]

**Properties**: (1) Truthful voting (i.e., vote for projects in $S_i^*$) a dominant strategy.

[intuition: dishonest vote can only divert funds from $S_i^*$ to other projects]

(2) Truthful voting $\Rightarrow$ Pareto-optimal outcome. [can't make anyone better off without making someone worse off]

[intuition: any diversion of funds from a more popular to a less popular project makes someone worse off]