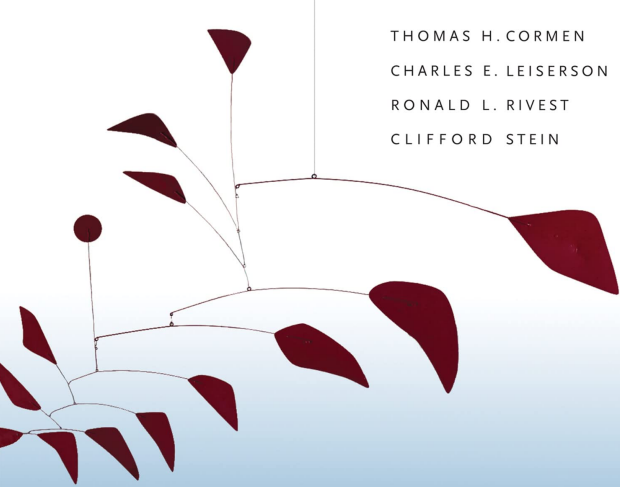


# Algorithms for Democracy

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CLIFFORD STEIN

INTRODUCTION TO

# ALGORITHMS

THIRD EDITION



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“An *algorithm* is a well-defined *computational* procedure that takes a set of values as *input* and produces another set of values as *output*.”

INTRODUCTION TO

# ALGORITHMS

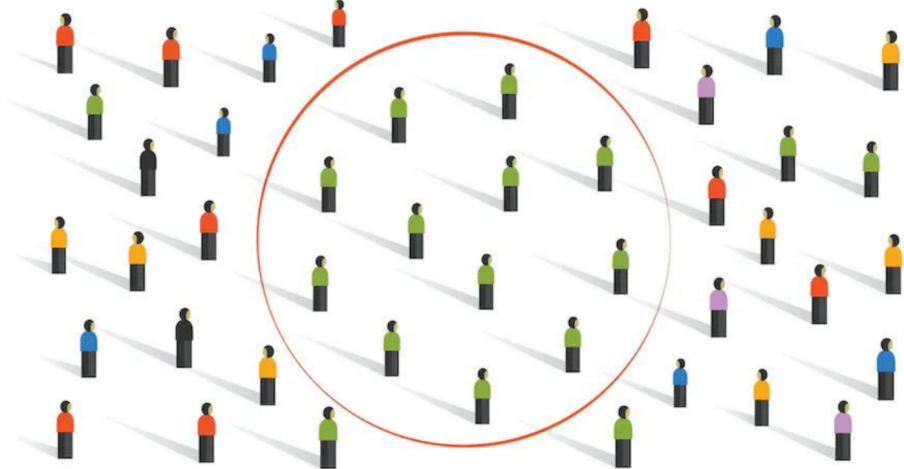
THIRD EDITION

# **Algorithms for Democracy**

## Twitter algorithm could threaten Turkish democracy

BY DAILY SABAH | ISTANBUL | MAR 17, 2023 - 2:28 PM GMT+3 |





# Algo populism: The algorithmic threat to democracy

22nd March 2023 by Editor BizNews

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# Don't trust that algorithm

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In her new book, "Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy," Cathy O'Neil, Ph.D. '99 argues that the algorithms dictating so many aspects of modern life are encoded with opinions and biases disguised as empirical fact, inflicting harm right under our noses.

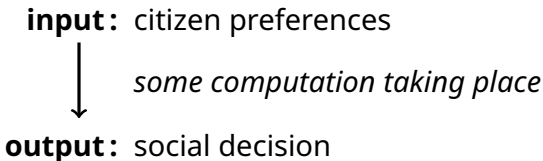


# Algorithms **for** Democracy



# Social Algorithms

Every time we, as members of the society we live in, take a *social decision* affecting us all, we execute an *algorithm*:



We can (and should!) study such *social algorithms* just as we study ordinary algorithms. *Is it efficient? Is it correct? ...*

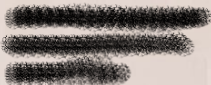
# Three Examples



Gemeente  
Amsterdam

PostNL  
Port Betaald  
Port Payé  
Pays-Bas

Retouradres Postbus 2003, 1000 CA Amsterdam



Datum

25 oktober 2021

Ons kenmerk

BB 071

**Buurtbudget Nieuw-West: € 864.000,-**  
Waar moet het geld heen?

**Maak snel open!**



000 #Y228U6C#41#0S01#

# Participatory Budgeting

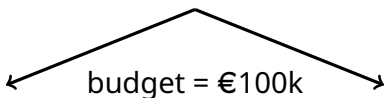
Each project has a *cost*. Citizens *approve* projects they like.  
Need to *select* the best projects, subject to the *budget limit*.

*How? That is: what algorithm should we use?*

# Analysis

Most widely used algorithm (known as *GreedyApproval*):

*Iterate through projects by number of approvals, accepting every project that still fits the budget.*



Does *GA* maximise utility?

400	fountain	€60k
350	trees	€50k
250	benches	€50k
17	statue	€40k

Thus: No!

(problem is NP-hard)

Is *GA* a fair algorithm?

600	playground	€50k
500	daycare	€50k
400	skatepark	€50k

Thus: No!

better use *EqualShares*  
(agents with virtual currency)



# Spectrum Auctions

Government wants to *auction off* the rights to use specific bands of radio frequencies to telecom companies—which are only interested in certain *combinations* of frequencies.

*How? That is: what **algorithm** should we use?*

# Analysis

First idea for an algorithm:

*Try to **allocate** frequencies to companies in a way that maximises the **sum of the prices** of accepted bids.*

Why is this problematic?

- **Combinatorial explosion**: when there are  $n$  companies and  $m$  frequencies, we need to check  $n^m$  allocations!

Idea: use sophisticated **optimisation** techniques

- **Incentive to lie**: companies will try to get a better deal by under-reporting their true valuations of frequencies!

Idea: use (generalised) **second-price auction**





## Voortgezet onderwijs



### School zoeken

De schoolwijzer helpt bij het zoeken en kiezen van een school.

### Aanmelden

De stappen die u moet doorlopen om uw kind aan te melden voor de brugklas.

### Nieuwkomers

Informatie voor nieuwkomers met leerplichtige kinderen.

### Vragen

Ga voor vragen over de overstap naar het voortgezet onderwijs naar [www.schoolkeuze020.nl](http://www.schoolkeuze020.nl).

# School Choice

Each pupil gets to *rank* some of their most preferred schools.  
Need to *match* pupils to schools, while respecting *capacities*.

*How? That is: what *algorithm* should we use?*

# Analysis

First idea for an algorithm (used in Adam until 2014):

*Each **unallocated pupil** applies to **favourite school** with capacity. If necessary, select by **priority/lottery**. Repeat.*

Looks great:

*Algorithm is **optimal** in this sense: no other algorithm could ever assign more pupils to their favourite school.*

But in fact it isn't:

- *Top-ranking a very popular school is quite **risky**.*
- *So many pupils will **lie** about their true ranking.*
- *So above "optimality" is **meaningless!***

The famous **deferred-acceptance algorithm** is a better choice.

# Take-Home Message

Many decisions of societal significance are taken by running *social algorithms*. We can and should study these algorithms using the great toolbox of computer science!

This research area is known as *computational social choice*.

Examples discussed today:

- Participatory budgeting (*buurtbudgetten*)
- Spectrum auctions (*veiling frequenties voor 5G*)
- School choice (*centrale loting en matching*)



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