Mechanism Design for Social Good

Rediet Abebe
Cornell University


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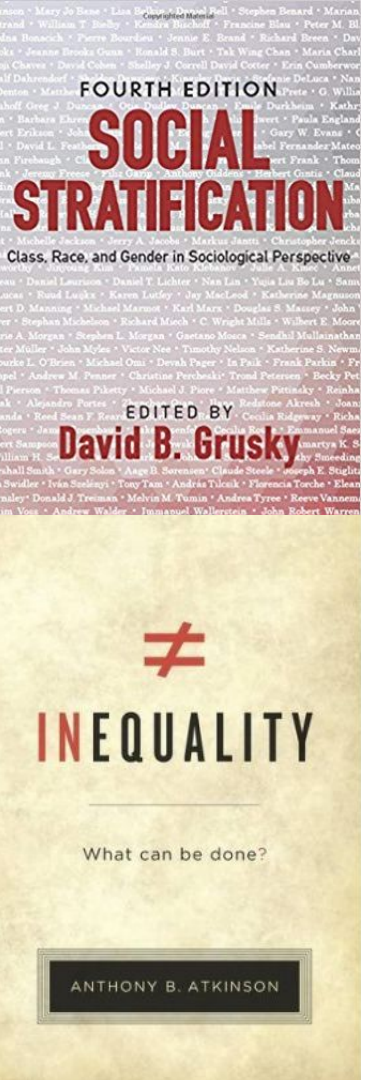


Table 1. Types of Assets and Examples of Advantaged and Disadvantaged Groups

Assets		Examples	
Asset group	*Examples of types*	*Advantaged*	*Disadvantaged*
1. Economic	Wealth	Billionaire	Bankrupt worker
	Income	Professional	Laborer
	Ownership	Capitalist	Worker (i.e., employed)
2. Power	Political power	Prime minister	Disenfranchised person
	Workplace authority	Manager	Subordinate worker
	Household authority	Head of household	Child
3. Cultural	Knowledge	Intelligentsia	Uneducated persons
	Digital culture	Silicon Valley residents	Residents of other places
	"Good" manners	Aristocracy	Commoners
4. Social	Social clubs	Country club member	Nonmember
	Workplace associations	Union member	Nonmember
	Informal networks	Washington A-list	Social unknown
5. Honorific	Occupational	Judge	Garbage collector
	Religious	Saint	Excommunicate
	Merit-based	Nobel Prize winner	Nonwinner
6. Civil	Right to work	Citizen	Illegal immigrant
	Due process	Citizen	Suspected terrorist
	Franchise	Citizen	Felon
7. Human	On-the-job training	Experienced worker	Inexperienced worker
	General schooling	College graduate	High school dropout
	Vocational training	Law school graduate	Unskilled worker
8. Physical	Mortality	Person with long life	A "premature" death
	Physical disease	Healthy person	Person with AIDS, asthma
	Mental health	Healthy person	Depressed, alienated

“official **‘income only’ measurements** of poverty… painted a picture that was too optimistic and didn’t capture the **magnitude of disadvantage**, nor the true struggles New Yorkers face in trying to make ends meet.”

POVERTY TRACKER

Photo by Sally Ryan
sallyryanphoto.com

Evicted
Matthew Desmond

How can we incorporate **income shocks**? Can these give us insights into how we should allocate resources?

Related Work

- Optimal income taxation (Mirrlees, 1971)
- Public economics work on consumption dynamics and agent-level response to subsidies (Golosov et al., ’03; Diamond & Mirrlees ’78; Cremer & Ghavari ’95)
- Emerging style of work using computational and optimization-based methods to inform assistance programs (Findeisen and Sachs, ’16; Kube et al., ’18)
- Investigation and ethics of allocating scarce societal resources (Calabresi and Bobbitt, ’74; Elster, ’92; Eubanks, ’18)

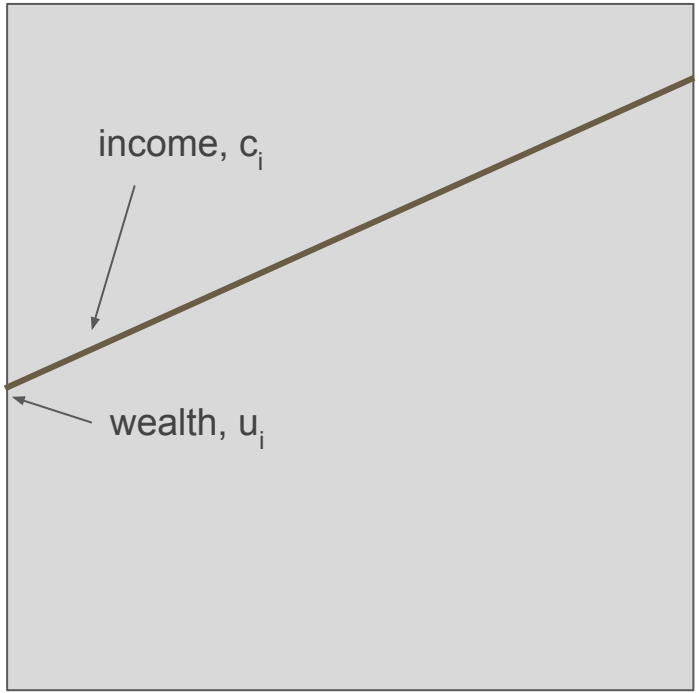
Income Shocks and Individuals' Welfare

Plan: model welfare to incorporate families' income, wealth, and income shocks

Objective: avoid undesirable live-event (e.g. eviction, loss of job, poor health)

Techniques: formulate optimization problem & analyze computational tractability

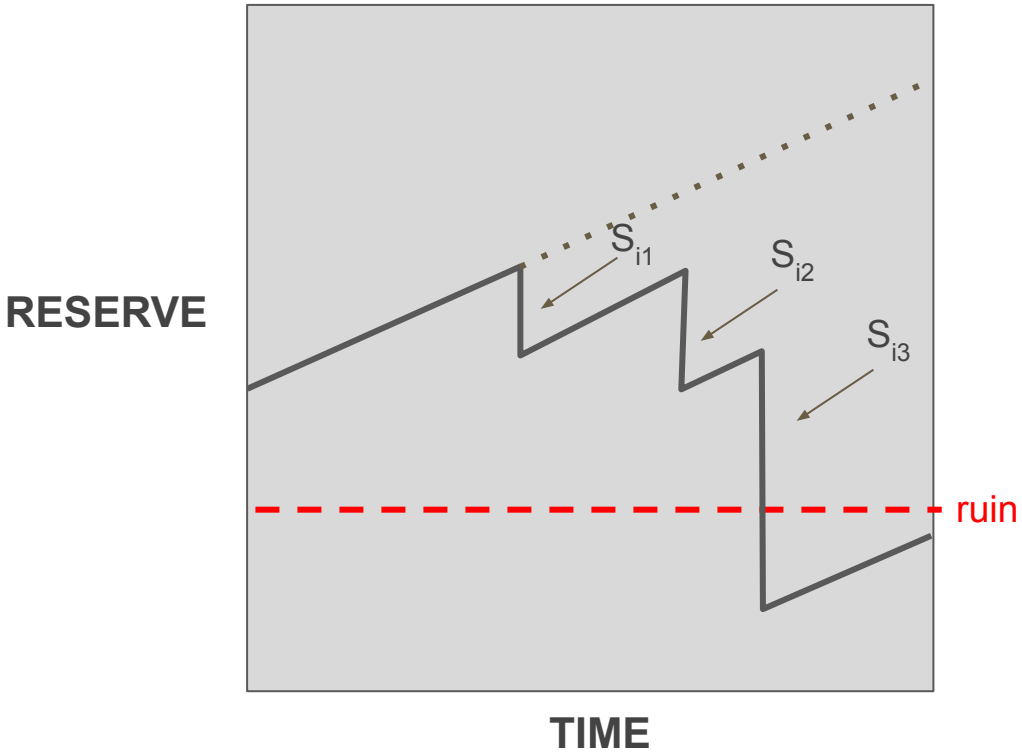
Modeling an Agent's Reserve



Reserve: no shocks

$$R_i(t) = u_i + c_i t$$

Modeling an Agent's Reserve



Reserve: with shocks

$$R_i(t) = u_i + c_i t - \sum_{j:T_{ij} \le t} S_{ij}$$

- Shocks: $S_{i1}, S_{i2}, \ldots$ arriving at $T_{i1}, T_{i2}, \ldots$
- Poisson arrival, rate β_i
- Shocks drawn from F_i

The Optimization Problem

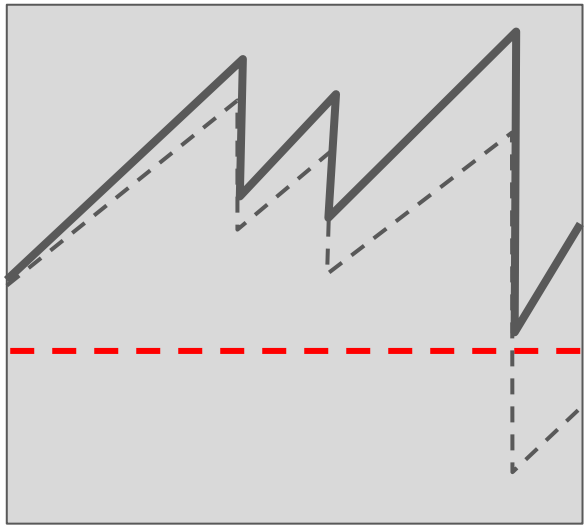
Object of Interest: ruin probability

$$\psi_i = \psi(c_i, u_i, \beta_i, F_i)$$

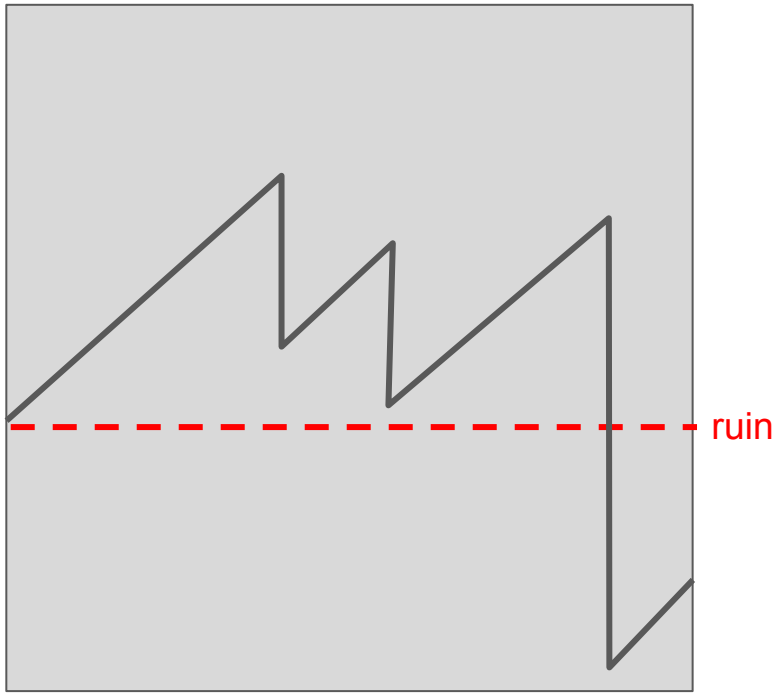
Income Subsidy: supplement agent's income with x_i subject to budget constraint B

Min-sum: minimize expected # of ruin

$$\min_{x_1+\cdots+x_n=B} \sum_{i=1}^{n} \psi(c_i + x_i, u_i, \beta_i, F_i)$$



The Case with No Initial Wealth



Suppose we have shock-size distribution F_i given by only its mean μ_i

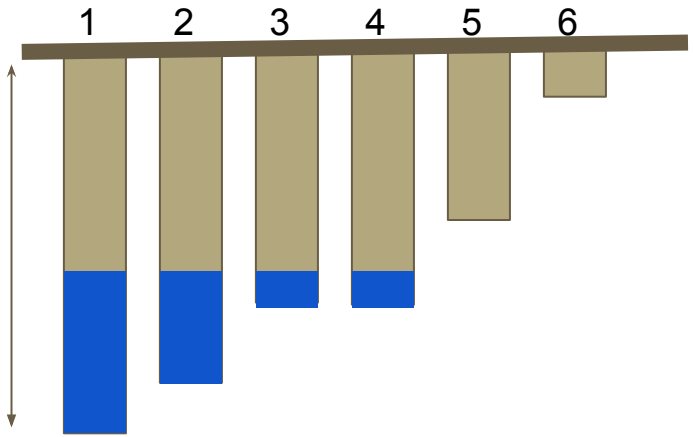
Assume positive drift, $c_i - \beta_i \mu_i > 0$

Ruin probability has a simple expression

$$\psi(c_i, 0, \beta_i, \mu_i) = \frac{\beta_i \mu_i}{c_i}$$

An Optimal Solution for Income Subsidy

$$-\frac{\beta_i \mu_i}{(c_i + x_i)^2}$$



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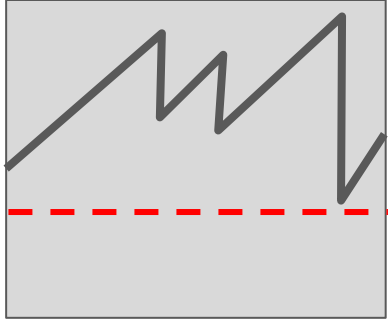
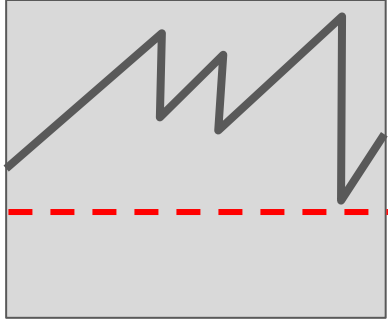


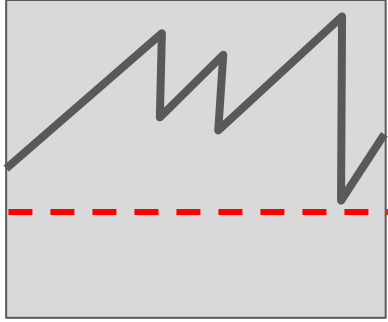
How different can our priority orderings between…

(1) income vs. our ordering?



How different can our priority orderings between…

(1) income vs. our ordering? **Maximally**



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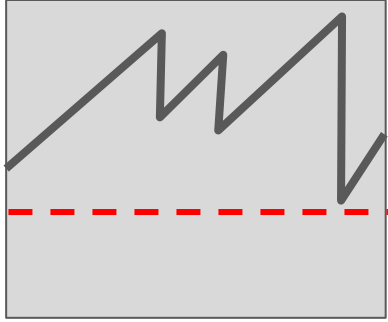

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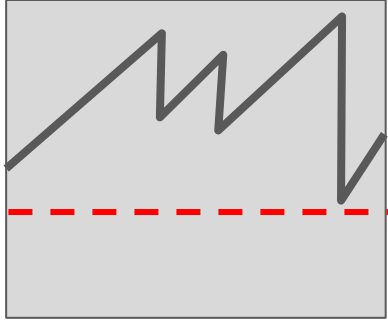

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(1) income vs. our ordering? **Maximally**

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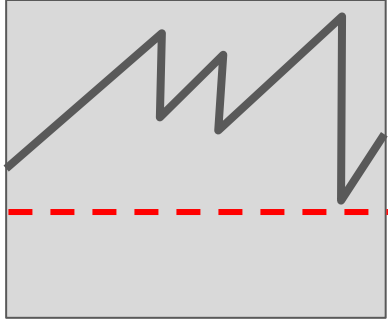
(3) income vs. wealth subsidy?



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The General Case

General distribution of shock sizes

Agents' reserve can have negative drift: ruin probability = 1

Function ϕ is no longer convex; can show optimization is NP-hard

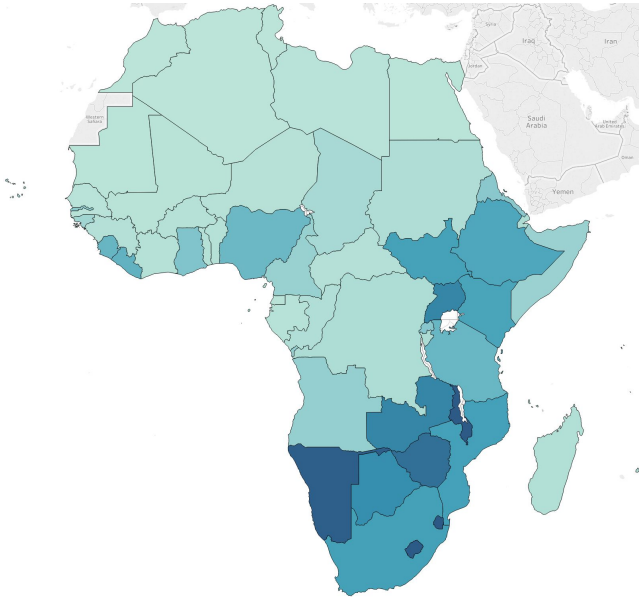
Theorem: we can give a fully-polynomial time approximation scheme (FPTAS) to optimize for the min-sum objective.

Data Inequalities

(U.S. Trans Survey, 2015)

(Fountain and Bearman, 2012)

(Abebe et al., 2019)

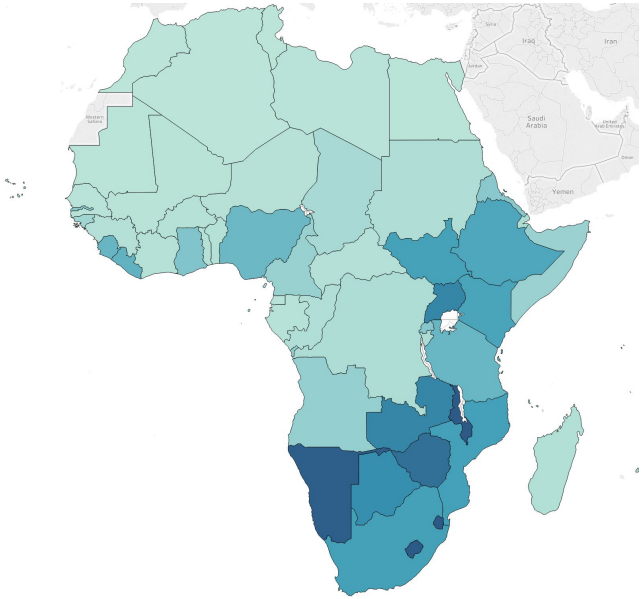


Using Search Queries to Understand Health Information Needs in Africa

R. Abebe, S. Hill, J. W. Vaughan, P. Small, and H. Andrew Schwartz. (ICWSM, 2019)

(0.85%) Drugs: drug, treatment, patients, abuse, therapy, drugs, resistance, antiretroviral, substance

(2.28%) Symptoms: pain, sign, lymph, swollen, nodes, sore, symptom, symptoms, throat, infection



(0.66%) Breastfeeding: positive, baby, mother, breastfeeding, breast, mothers, child, born, feeding, babies

(0.46%) Stigma: stigma, issues, discrimination, related, ethical, legal, prevention, safety, pdf, workplace

(0.45%) Gender Inequality: spread, gender, contribute, power, relations, infections, ways, inequality, unequal, infection

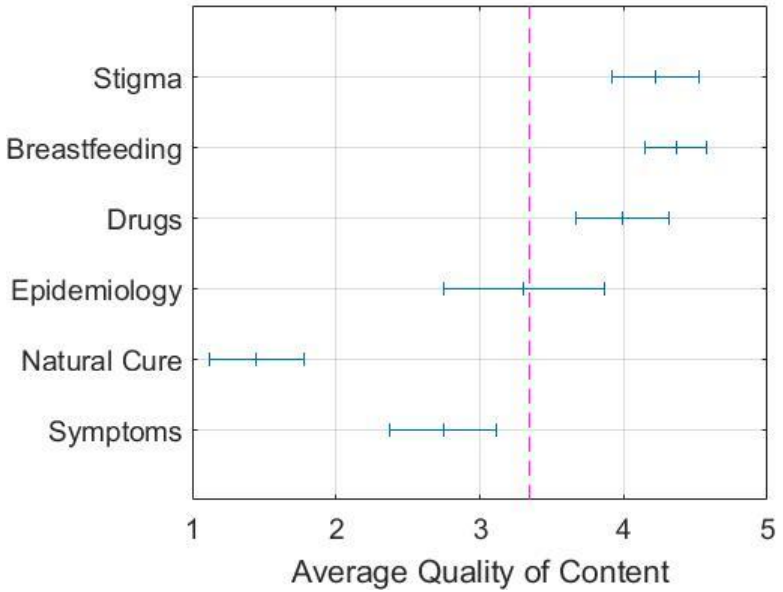
(0.74%) Natural Cures: cure, oil, black, healing, heal, healed, seed, herbs, natural, cures

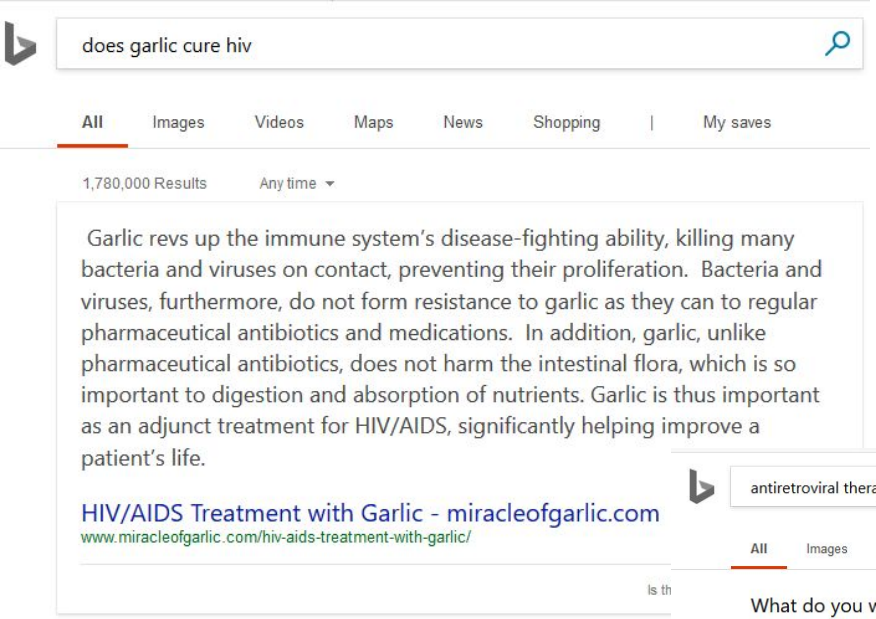
Sample Natural Cure Queries

Prophet *** *** heals aids
Blackseed oil olive leaf hiv
Prophet *** testimonies healing hiv
HIV healing prayers *** ***
Olive leaf extract cures hiv
Honey bee venom cures aids
Lemon baking soda cures aids
Nigella sativa cures hiv
Chlorine dioxide cures hiv

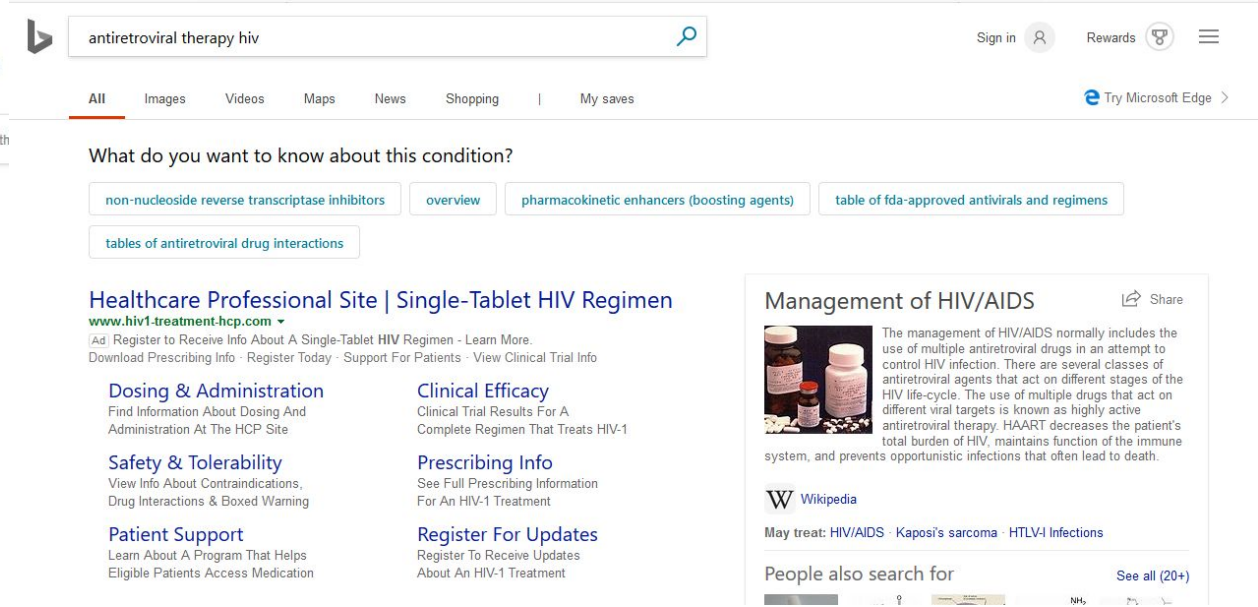
Variance in Quality of Content

- Evaluate the quality of content of webpages returned to users
- Web-pages returned for natural cures often contain issues related to **relevance, accuracy,** and **objectiveness** in health





Natural Cures & Remedies



Antiretroviral Drugs

topic of queries

high-authority sites

search engine bias

Active Groups

ACD Working Group for Human Embryonic Stem Cell (hESC) Review

HeLa Genome Data Access Working Group

ACD Diversity Working Group Subcommittee on Peer Review

ACD Working Group on Diversity

Next Generation Researchers Initiative Working Group

ACD Working Group on Diversity, Diversity Program Consortium Subcommittee

ACD Working Group on Artificial Intelligence

Background

Artificial Intelligence (AI), machine learning (ML), and deep learning (DL) are being integrated into many areas of biomedical and clinical research. Most NIH institutes and centers have some investments in AI, ML or DL; for example, to develop these technologies, use them to assist in research processes, or apply them to assist with clinical diagnostics and decisions, among other applications. Overall at NIH, these technologies are cross-cutting, with individual investments and specific applications to diseases or disciplines varying from institute to institute. But there is no overarching strategic plan, and there is concern that NIH is underinvesting in an area that has enormous promise for biomedical research. As AI/ML/DL are more heavily integrated into biomedical and clinical research and medicine, NIH is committed to generating cross-agency efforts in these areas.

How can we use algorithmic and computational insights to **improve access to opportunity** for historically underserved and marginalized communities?

MD4SG

Mechanism Design for Social Good

R. Abebe, Kira Goldner (UW), Irene Lo (Stanford)

MD4SG Research Group (Summer, 2016)

Global Perspectives on Inequality

Bias, Discrimination, and Fairness

Online Labor Markets

Healthcare

Housing

Developing Nations

MD4SG

MD4SG '19

3rd Workshop on Mechanism Design for Social Good

June 28, 2019 at Phoenix, AZ, USA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