Understanding the Limits of Competitive Processes

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ABSTRACT

Today, our economics and politics laud competitive processes. They tell us that if each person or organization maximizes their own interests (and everybody "competes"), the result will be globally best. That assumption, while true in some circumstances, has its limits. This paper explores what these limits are. We show how the increased availability of computation can help move society to a more cooperative, and more beneficial, stance.

Game theory gives us a perspective for understanding the tradeoffs between competition and cooperation. But the social and economic consequences of this tradeoff aren't always obvious. They involve shifting from a local perspective to a more global perspective. Computation can help, because it allows us to "jump out of our skin" enough to see general principles. We can

- **Simulate** the consequences of various cooperation vs. competition tradeoffs, and mathematically analyze them;
- Use online **decision support** systems to discuss tradeoffs, get the perspective of others, and collaborate on solutions;
- Develop **cooperative alternatives** to formerly competitive processes;
- **Educate** people about the underlying principles and their real-world consequences.

INTRODUCTION

Contemporary western society idolizes competition. A common meme is that "competition brings out the best". Our capitalist economy is based on competition between products and competition between companies. Our political system of representative democracy is based on competition between political parties and competition between candidates.

While there is a lot of truth to the advantages of competition, there are limits. The worst thing about competition is that it "competes against" cooperation – and cooperation can lead to win-win outcomes. A more nuanced view of competition, understanding its limits, can lead to wide-ranging improvements in political and economic systems.

The game theory concept of the *Iterated Prisoners' Dilemma* (IPD) provides us a framework for understanding the limits of competitive processes. We start by talking about a related economic hypothesis we call the Fundamental Theorem of Capitalism (FToC), and explore its consequences. We then discuss how modern computation and communications technologies can change the balance between competition and cooperation, for the better.

	He cooperates	He doesn't cooperate
I cooperate	*Reward:* We both get **$3** ! :-)	*Sucker's payoff:* I get **$0** He gets **$5**
I don't cooperate	*Temptation:* I get **$5**, He gets **$0**	*Punishment:* We both get **$1** :-(

Figure 1. The Prisoners' Dilemma. Two players are given a choice whether to cooperate or not. I notice that I am better off *not* cooperating regardless of whether the other player cooperates or not ($5>$3, $1>$0). But he does the same thing, the result is we both get $1. Whereas if we both cooperated, we could have gotten $3 each!

THE "FUNDAMENTAL THEOREM OF CAPITALISM"

Laissez-faire capitalism and contemporary neoliberalism are based on an assumption -- that if each person or organization does what is narrowly in their best economic interests, the result will be globally optimal. Let's call this the Fundamental Theorem of Capitalism (FToC). We now

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know that, if a certain inequality holds, the FToC can be false.

Modern game theory, especially the Iterated Prisoners' Dilemma (IPD) [Axelrod 1984], teaches us that, if each agent does what is locally optimal for themselves, the result can be *worse* for everyone than if everyone cooperated! (In the IPD, competition (or failure to cooperate) is technically referred to as *defection*).

Figure 1 shows a single instance of a cooperation-vs-competition game. The far more interesting case is when the game is iterated, and players must choose a long-term strategy. The situation we're talking about occurs whenever

Temptation > Reward > Punishment > Sucker's payoff

This is a mathematical result. It is not a political position and it is not debatable. (Though what the inequalities actually amount to in a given real situation is certainly open for debate). It constitutes a fundamental limitation on what competitive processes such as markets can achieve. Today's capitalist markets and adversarial political structures such as elections or court cases simply operate as if no such limits exist.

We maintain that blind adherence to the FToC is emblematic of unsustainable social, economic, and ecological practices, such as war, pollution, racial and other discrimination, destructive commercial competition, income inequality, and a host of other societal ills. We list a few.

• **Commercial competition:** It is often thought that competition "causes the best products to win". Sometimes it does. But this kind of *economic Darwinism* [Sandel 12] also causes duplication of effort, misleading and false advertising, exploitation of consumers, etc. Nobody knows whether the purported advantages of competition outweigh these disadvantages, because this tradeoff is never taken into consideration.

Economic Darwinism (and any form of *Social Darwinism*) is based on an antiquated view of evolutionary theory. Modern evolutionary theory says evolution selects, not just for (the circular criteria) "survival of the fittest", but for positive-sum games [Wright 01].

• **War:** If each nation computes the consequences of being attacked versus the cost of military preparation, it opts for military preparation. But that preparation itself increases the likelihood of a war (a military-industrial complex advocating war, exaggeration of threats, etc.), causing both sides to lose. Sustainable peace would free resources for both sides.

Most wars are only *pretend wars* against the so-called "enemy" – the real competition is taking place between the military and the citizens, on both sides.

The Forever War is the name of a 1974 science fiction novel and a 2015 reality. For the first time we know of, the US military-industrial complex is being paid to blow up the very stuff it has made (US-made weapons given to the Iraqi government, now in the hands of radical Islamists). If US weapons makers, who have 75% of the global arms market, are supplying both sides in an endless war, it's hard to saturate the market!

• **Pollution**: A polluter gets benefit from the activity causing the pollution, such as industrial production, while everyone else bears the cost. But if everyone pollutes, global warming or other ecological disruption causes everyone to lose, including the polluter. These kinds of situations are what economists call *externalities*.

• **Adversarial political processes:** Witness the gridlock in today's US Congress. Republicans and Democrats can't agree on anything any more than the Yankees and the Red Sox can agree on who should win a baseball game. Politicians see their main job as to win zero-sum elections rather than to collaborate on solving the country's problems.

Politicians mislead, lie, evade, or sell themselves to special interests. But if these practices become a social norm in political discourse, the poor voter who has to make a decision is faced with a game of "liar's poker", and has no basis for making a rational decision.

• **Racism**: Even phenomena like racism can be modeled with the IPD. [Axelrod & Hammond 03] reported an IPD simulation where a majority group cooperated with each other and defected with the minority group. A stable pattern emerged where the minority were indeed disadvantaged, but ironically, so was the majority! Similarly, any kind of nationalism, tribalism, sexism, homophobia, or religious discrimination, is a loss for everybody.

• **Poverty:** If we did a thorough analysis of the true costs of poverty, we would come to the conclusion that, in fact, poverty is too expensive. The apparent cheap labor costs don't take into account all the true costs.

Poverty comes with slums. We have yet to figure out how to separate them. Slums come, unavoidably, with crime, gangs and drugs. This requires the expenses of locks, police, insurance, etc. as well as the direct losses from crime. Poor countries and areas of large income disparity are more likely to be participants in wars, adding military expenses to the cost of poverty.

Perhaps worst of all, there is the opportunity cost of poverty. If a poor kid grows up in poverty, society has lost his or her potential productivity. All in all, it's almost certain that the total cost of poverty far exceeds what it would take to provide a decent living for that person. That's why many economic thinkers have proposed a Guaranteed Minimum Income, starting with Thomas Paine's Citizen's Dividend. Even on the right, libertarian economists like Friedrich Hayek and Milton Friedman [Friedman 62] are on board with this idea.

Above, we have been emphasizing the negative consequences of competition. To be fair, we should note that there's a flip side, where cooperation fails and competition succeeds. Again, it just depends on what the numbers are in the Prisoners' Dilemma matrix. Libertarians are quick to point out things like Hardin's *Tragedy of the Commons*, [Hardin 68] which is actually a corollary of the IPD. They use this to explain, for example, the failure of 20th century Communism, a positive case for the FToC.

It is liberating to realize that all these problems are instances of a common pattern. So much of today's political and economic discourse accuses the opposition of malicious intent or moral failings. Actually, it's nobody's fault. It's just that we're stuck in a pattern that we haven't been able to see. Once we do see it, we can shift the conversation from non-issues like, "Is cooperation or competition better?" in general, to trying to understand the tradeoffs, and managing them in a positive and sustainable way.

SCARCITY AND ABUNDANCE

Wright [Wright 01] makes the case, on evolutionary grounds, that the tradeoff between cooperation and competition is determined by the availability of resources. Competition is best if resources are scarce, cooperation if resources are abundant.

[Mullainathan and Shafir 13] explore the psychological consequences of scarcity. Scarcity causes *focus* -- concentration on the most important, immediate threats and opportunities. But it also causes blindness, ignoring peripheral conditions that may become important. It trades long-term for short term, promotes inefficiency, reduces the ability to make rational choices and makes it more difficult to empathize with others.

If we cooperate, it will be easier to create resources. It is easier to cooperate if we have sufficient resources. Thus, there is a chicken-and-egg relationship between cooperation and abundance. Smarter people are more cooperative [Jones 08]. There's also a chicken-and-egg relationship between competition and scarcity. Scarcity causes people to fight over scarce resources, and fighting makes it harder to be productive. How do we avoid the vicious cycle and get on the virtuous cycle?

By extrapolating current trends in material resource consumption, people have warned that crucial resources like water or minerals will become increasingly contentious in the 21st century. If competitive patterns continue to dominate economic activity, we may indeed face an increasing scarcity of material resources. Cooperation can circumvent the inefficiencies of competition, leading to sustainable use of material resources.

Intangible resources are much less subject to limitations. Moore's Law gives us ever-growing computational capacity, assuming society can maintain this law. Information and education are distributable at near-zero cost. So how do we turn an abundance of computational and human resources into physical resources, encouraging a more cooperative society?

THE MAKER MOVEMENT

In the 1970's, the key transformer of western civilization were personal computer hobbyists. They changed computers from expensive corporate tools, to information utilities for the rest of us. Today, a potentially larger trend, the *Maker Movement*, is poised to make an even grater difference.

We predict that today's large industrial manufacturing corporations, which are forces for centralization and regimentation of society, will gradually get disintermediated by 3D printers. Printers will locally produce most physical objects people need.

Today's 3D printers only produce small plastic objects, and are slow and expensive. But progress is rapid in getting them to print a range of other materials, including metal, glass, carbon fiber, and biomaterials.

Even food can be produced (mitcityfarm.media.mit.edu). Aeroponic agriculture uses much less space and energy to grow plants, as little as 2% of the water as conventional agriculture, no pesticides, and less fertilizer. Aquaponics can raise fish, and microalgae can be grown both for food and "bioplastic", which can be formed into filament for the raw material input to a 3D printer. Parts for these food systems can themselves be printed on a 3D printer.

Larger 3D printers could print parts for housing and transportation vehicles. Pick-and-place machines and construction robots could help with assembly. Design will be re-oriented towards things that can be made from simple, abundant, recyclable materials (e.g. carbon fiber replacing metals).

That means you make exactly what you want without the need for most of its current costs: design, transportation, warehousing, retail, financial transaction costs, marketing, profit and corruption. Typical goods are sold for many times their manufacturing costs, so any economy of scale is often dissipated by these inefficiencies.

In the long run, individuals or small groups may be able to make so much of their own basic needs that there will be no need for formal employment. Many decry increasing *technological unemployment*. But it's not workers that are obsolete – it's the idea of a "job".

We, of course, expect some resistance from vested interests, but the Internet is at least an existence proof that movements like this cannot be stopped. Hackers share designs and collaborate on sites like Thingaverse. so distribution is quick, efficient and free. Already, machines to recycle plastic soda bottles (and previously printed parts)

into printable filament are available at low cost. The goal of the RepRap project [Jones et al 11] is to make a printer that can print all of its own parts. This cradle to cradle recycling bodes well for sustainability. The bottom line: abundant computer resources help reduce the scarcity of physical resources and thus foster cooperation over competition.

DOES COMPETITION MOTIVATE?

Another half-true cultural myth is that "competition motivates people". Certainly, in some situations such as competitive games, that's true. But what kind of motivation does competition provide?

Competition doesn't motivate all people equally. It works best with people who have "competitive personalities", which have their good and bad sides: drive and determination, yes, but also aggression and hostility. Competitive personalities tend to be more associated with men rather than women. Blanket assertions that people will be motivated by competition tend to disenfranchise those who don't fit the competitive personality profile.

There's nothing wrong with competition as entertainment, when games are good clean fun between consenting adults. But in *gamification*, which artificially introduces competition in education and the workplace, people may feel obligated to participate. Those who don't have competitive personalities will actually be *demotivated*. They sense, not incorrectly, that situations that necessarily have few winners and many losers can be a sucker bet.

Psychologists distinguish between *intrinsic* and *extrinsic* motivation [Kohn 92]. Intrinsic motivation for an activity means that you want to do the activity for its own sake. You listen to music because you enjoy hearing it. Extrinsic motivation is provided by incentives that are external to the activity itself: rewards, prizes, grades, and rankings. Competition can only provide extrinsic motivation.

Numerous studies have shown that while extrinsic motivation can be effective in the short term, it tends to decrease intrinsic motivation in the long term. Kohn [Kohn 93] describes an experiment where young children were given a dollar for each crayon drawing they produced. Initially they produced more drawings than a control group that was not rewarded. But then, much later, simply left in a room with crayons and paper, and offered no reward, they were far less motivated to draw than the control group!

SIMULATION

We are also faced with another kind of limit. Each person has only limited time, limited knowledge, and limited ability to perform inference. One reason why the FToC and its ilk are so seductive is that they only require that each

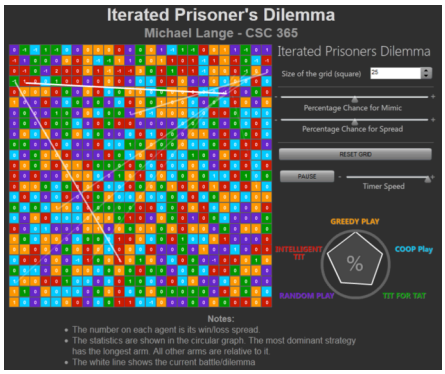

Figure 2. An interactive simulation of various strategies for the Iterated Prisoners' Dilemma.

individual agent consider its own perspective, not that of others, which makes it a computationally less challenging task. Locality in general is a good thing, unless it causes you to miss an important nonlocal property.

We would not even have the understanding of the IPD we do today, were it not for simulation. The mathematics of the Prisoners' Dilemma was first discovered in 1950, by Merrill Flood and Melvin Dresher. But it wasn't until Axelrod's 1984 book, reporting simulation of agents following a variety of strategies, that the implications became widely understood.

In Axelrod's simulations, the most successful strategy was called *Tit-for-Tat*, which started out by cooperating, and then reciprocated the opponent's behavior. In general, successful strategies were *nice* (never first to defect), *provokable* (avoided being taken advantage of), and *forgiving* (willing to try cooperation after defection). We should note that the theoretical problem of an optimal strategy for the IPD in general has not yet been fully solved. But simulations are a powerful tool for uncovering the principles of cooperation-competition tradeoffs. It is better to center a debate around the fidelity, assumptions, and outcomes of simulations, than around preconceived ideological notions.

DECISION SUPPORT

Computation can also help us in bridging the gap between abstract mathematical understanding and real-world political and economic discourse. Every day, people have to make decisions about whether to cooperate or to compete, or whether to support cooperation or competition in their organizations. We believe interactive decision-support systems can be a vital tool in coping with this complexity.

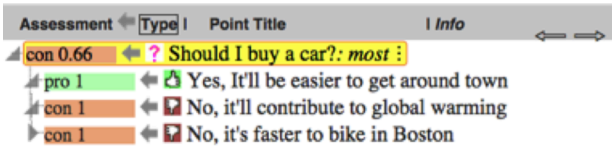

Figure 3. The Justify decision support system. Here, an argument weighing the pros and cons of buying a car.

The primary decision procedure today in most organizations is the so-called "meeting", a relatively unstructured real-time discourse. Usually, the decision procedure is either the democratic *emote and vote*, or, if there's a designated authority, *plea and decree*. Neither provides the best opportunity for creatively solving problems and achieving consensus [Susskind and Cruikshank 06].

Justify [Fry and Lieberman 13] is a decision support system that records a discussion as a hierarchy of *points*, each expressing a single question, fact, or opinion. Each point has a *type* that expresses its role in the discussion, such as *pro* or *con*. It provides semi-automatic summarization at every level, and an interactive development environment (IDE) for a variety of decision procedures. It can help people who join mid-discussion to catch up, and decouple decisions from the pressure of real-time response, personalities and emotions.

One of our research goals for Justify is to provide explicit support for discussion and negotiation patterns that are more likely to lead to productive, "win-win" cooperation. Adversarial discussions where each side tries to win at the expense of the other are doomed to get decided only by "might makes right".

The Harvard Project on Negotiation (www.pon.harvard.edu) and Consensus Building Institute (www.cbuilding.org) translate the lessons of game theory for a general audience in books like "Getting to Yes" [Fisher, Ury, Patton 91]. Other threads of work come to similar conclusions from the alternative perspectives of counterculture politics [Butler and Rothstein 87] and psychotherapy [Rosenberg 03]. We are investigating whether the kinds of communication patterns recommended in these books can be given explicit computational support in Justify.

Conventional negotiation assumes that each party should want to get as much as possible for themselves – "More is better". This is another case, like the FToC, where natural limits to the process are not being recognized [Schwartz et al 02]. Most true "utility curves" are not completely linear nor infinite. More commonly, there's a certain level, below which a proposal is unacceptable, the minimum needed to *satisfice* the goal. Beyond that, there's a linear range, then it plateaus. Holding out beyond the plateau only serves to make agreement more difficult.

In salary, for example, surveys show that life satisfaction plateaus at a relatively modest level of income – around $50-75K/year [Kahneman and Deaton 10]. Conversely, some employers support the idea of a living wage, despite having market power to force employees with few alternatives to accept lower salaries.

The problem with maximizing goals is that it sounds good when you hear it from the football coach, but if all agents do it, it forces a zero-sum game, risking mutual defection as in the IPD. One possible role for a computer agent (as for a human mediator) is to elicit the utility curves from each party independently. Then the mediating agent could compute the "trading zone" where all parties have their needs satisficed, and the surplus value is fairly shared.

Susskind [Susskind 14] and others advocate multi-attribute negotiations, where win-win outcomes can arise from differences between how the parties value the different attributes. The combinatorics of attribute bundles increase the potential complexity of negotiations, which again, cries out for computer support.

COOPERATIVE ENTERPRISE

How do we repeat the untapped benefits of cooperation, especially when the dominant economy assumes a competitive stance? The danger is that small numbers of cooperators can be defeated by defection from a larger group of competitors, a danger that is borne out by observation of IPD simulations.

One long-standing answer is the formation of *cooperatives*. I (Lieberman) have my bank account and my mortgage in a cooperative bank (credit union), buy my food from a food co-op, shop at a cooperative university bookstore, have lived in housing cooperatives for decades, have bought car insurance from a cooperative, and have my bike fixed at a cooperative repair. Cooperatives can be started on a small scale, grown incrementally, and don't require violent revolutions or mass protest movements. The Internet itself is perhaps the best and most impactful example of a cooperative. It took over from for-profit, competing information services (anyone remember Compuserve and The Source?).

As the cost of communication falls, this decreases coordination cost, making cooperation more attractive. In the pre-internet, pre-cell phone economy, intermediaries supplied coordination as a service for profit. This is not bad in itself, but intermediaries have a tremendous temptation to use their oligopoly position to extract exorbitant profits.

Game theory models this through what is called the *Ultimatum Game* [Guth et al 82]. The so-called "New Economy" enabled by the Internet refers to the disruption caused by replacing for-profit intermediaries with distributed computing. We can cut out the very expensive middlemen, called *disintermediation*.

Examples abound. Travel agents were disintermediated by airline reservation sites. Amazon disintermediated bookstores. YouTube disintermediated television. AirBnB

disintermediated hotels. Zipcar, Uber, and bike share disintermediated transportation. We've already talked about 3D printers disintermediating manufacturing.

Society would do well to encourage the formation of cooperatives and low-overhead private intermediaries. We should be on the alert for defensive actions by traditional companies, which will try, via regulation, cartels, and bribery, to derail new institutions. We should understand the principles that cause them to succeed or fail, relative to traditional capitalist profit-maximizing enterprises. We should develop new technologies for automatic matching of supply and demand, and do-it-yourself products and services.

EDUCATION

Last but not least, our most powerful tool in encouraging a more cooperative society, is simply, *education*. Fortunately, that too, is being facilitated and made more accessible by technological progress.

We recommend that the fundamentals of game theory, including the Prisoner's Dilemma, be taught to everybody. The math is easily understandable to high-school students.

It can be fun to teach, starting with role-playing games, where students have to make the choice of whether or not to cooperate in a face-to-face situation. They can also play with computer simulations of strategies. Online courses can make this subject accessible to anyone connected to the global Internet.

CONCLUSION

Our present economic and political institutions were developed at the time of the Industrial Revolution, where material resources were relatively scarce, communication and coordination were relatively difficult, and little was known about the mathematical structure of competitive and cooperative situations. Now we are in the Information Age, where information resources are abundant, communication and computation are inexpensive, and we have a much better theoretical understanding of game theory. It's time to rethink economics and politics.

Society needs both competitive and cooperative processes. But we are now in an age of transition, where the balance between competition and cooperation is changing. We no longer have to settle for the limits of a society that always prioritizes competition over cooperation. We believe that, in no small part as a result of advances in science and technology, the balance is shifting radically in favor of cooperation. If we all win, each of us wins.

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