- Henry Kautz

00:00:03Hi I'm Henry Kautz. I'm the division director for information and intelligence systems that the National Science Foundation, and I'm very delighted to introduce the first speaker in our Distinguished Lecture Series for this year.

- 00:00:17Professor Moshe Vardi is the university professor and George Distinguished Service Professor in computer science.
- 00:00:25Engineering and also director of the ken Kennedy Institute for information technology, all at Rice University. He is a leading researcher in theory and artificial intelligence, the author of over 600 papers and two books.
- 00:00:43And the whole seven honorary doctorates I only have one doctor that I actually had to work for. So I'm going to have to find the secret getting all of these honorary doctorates he also is the senior editor of the Communications of the ACM
- 00:01:00And meeting senior editor meeting he has finally taken off the yoke.
- 00:01:05A little while ago after doing a really Herculean job of turning the communications from kind of a ho hum professional magazine into a really exciting and important.
- 00:01:19Journal. So with that, I'll turn it over to Marcia
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Moshe Y. Vardi

00:01:26Thank you. Thank you. And

- 00:01:29Thank you all for joining us to this a picture today.
- 00:01:35I think it is a public tool for were living through the most significant event of our lifetime.
- 00:01:43And I grew up in the Middle East. I've been to several walls. I don't think we went to anything like this since essentially world war two in terms of impact and significance.
- 00:01:54And whenever you go to something like this, they will be there before and after and we need to think about what did we learn what's, how should we change this society.
- 00:02:05And they in the lens that I want to focus on today is efficiency versus is resilience
- 00:02:14I was asked to give a quick self introduction. So here it is, in a nutshell, I grew up in a kibbutz in Israel. You can see it's a it's a very bucolic. It was a great place to go up.
- 00:02:28In HD and I was given a 10 volumes called the young technologist.
- 00:02:34And I devoured them and it put me. It changed my path from from the umbilical parts. I'm coming for me a familiar but 10 generations of our byes and I'm the black sheep, and I wouldn't become a scientist instead
- 00:02:49I was a real nailed until about 15 years ago when he asked me to lead the study called the software offshoring study
- 00:02:58It was the first time that that took a stimulus. Look at it also kind of societal angle of computing and then no good deed goes unpunished and I became editor in chief of CCM
- 00:03:09And in particular, in the beginning of the decade, I start thinking very hard and spending a lot of my time she's thinking about computing in society, which I think is a community. We have not done enough
- 00:03:23And that's a whole other talk, of course.
- 00:03:26So there is no doubt that we're living through a crisis, but it's really not just one crisis, but it's a it's a conflation of several crises on top of each other.

- 00:03:37First, it's a public health crisis, you know, we look at this dashboard. Every day you know this is a dashboard for a few months ago by now we have we have 200,000 deaths and there's no sign that is going to to stop anytime soon.
- 00:03:54Of course, this is cause a deep economic crisis, this picture of fine horrifying. You may think it's the parking lot at Disneyland, but it is people waiting in the cars for a food bank.
- 00:04:07So people can get that just don't have food at home, they have to go to the food bank to eat in a waiting hours at the food bank, the line to get access to food. So this is the economic crisis.
- 00:04:21Or the prices are way down. Now, for most of you may have seen this is sound like good news, but when I'm in Texas.
- 00:04:28All passes down means huge economic kid but for all of us. If all prices are down, then the matter is in seems to do anything about about about energy and I'll come back to energy at the very end. So we won't get an energy, we can have to cheap oil.
- 00:04:44And of course it's also no secret that we are living through a social crisis, we had deep in equities in our society for a long time and they have
- 00:04:54Somehow there's a heightened sensitivity and less tolerant to them and is society, we are dealing with with this, how do we how do we address this in equities deep in equity the systemic inequities.
- 00:05:06And also it's no secret wherever is your political agent allegiance it. This is the going to be the most turbulent elections, at least in our in my lifetime that I think we have in this country. So we have like five k's cases combined into one into one crisis and
- 00:05:26One thing we discovered
- 00:05:29There was a magic phrase I want to go back to a phrase that we don't hear much, but that was I think there was a phrase that we're hearing this is for March and ever. We don't talk about flattening the killed
- 00:05:38And I went back to one of the blogs are talking about flatten the curve and all epidemic in some sense, go up and then they go down and they go down at some point because after some amount of
- 00:05:49Cases number of cases and death. When you do reach what we call now held immunity and the and the argument was made that we need to flatten the curve, we need to slow down and we can have too many people sick at the same time. And why is that
- 00:06:08Because we have limited capacity and the hospitals new with it. Oh, here are to conform April 22
- 00:06:16medicines are wearing garbage bags is the bottom corner virus. It's like something out of twilight zone. So we suddenly learn about new acronyms pp does not protective equipment and we just didn't just do not have enough people is in this country.
- 00:06:33And it will see people is, is not the only thing that we did not have
- 00:06:38But this sudden we discovered suddenly this deep systemic shortages and that inspired William gallstone who is from the booking booking Institute to write an op ed in order to journal in March.
- 00:06:54And he all the title was efficiency is not the only economic future.
- 00:06:59And your what of the relentless pursuit of efficiency which has dominated American business thinking for decades has made the global economic system or vulnerable to shocks.

- 00:07:13And your efficiency comes to the optimal adaptation to an existing environment when resilience require the capacity to adapt to disruptive change in the environment zillions dictionary definition, the ability to recover readily from illness depression adversity, or the lake.
- 00:07:32And I find I was just really truly inspired by this column, I do not always inspired with everything at once you're doing well. But this I find quite inspiring.
- 00:07:40And kind of eye opening and I really would like to guess what I'd like to spend the rest of the hour, thinking about this tension between resilience and efficiency and I will look both in computer science and economics.
- 00:07:58Now a girlfriend was not the only one he just put it very nice in terms of efficiency versus resilience. But Tom Friedman, the forefront of globalization, the high priest of globalization, what in May of this year, greed and globalization set a set us up for disaster.
- 00:08:17Over the past 20 years we've been steadily removing man made and natural buffers redundancy regulation and norms that provide the resilience and protection when big system with the ecological geopolitical or financial gets to race.
- 00:08:32We have been really lend recklessly removing these bubbles out of an obsession. We showed them efficiency growth or without thinking at all. So essentially the same point that the trade off between efficiency and resilience
- 00:08:52And for some reason, now my screen is stuck. Okay.
- 00:08:58It turns out that this point, once I start doing your research. It's not new. This is, this has been known for quite a while. The earliest reference I've that I found. But I'm always finding new things. And if you have new insight to give me after the talk, feel free to reach out to me.
- 00:09:15An article from 1975 on the efficiency of being efficient.
- 00:09:21And again makes this point, I'll just read the one sentence that highlighted and other festival decision making is the not honest with each poems are defined
- 00:09:31In equally now Orlando alternative sort of solution. So if you focus on efficiency, then you're going to ignore. Many other consequences and many other facet of the problem and you're only to come with a very narrow and of course of possible solutions.
- 00:09:48So let's take an example. So I remember when just in time manufacturing was really hot. What is judging time on effectively.
- 00:09:57So I remember it from, I think, from the 80s or 90s became hot and the observation was that keeping an inventory
- 00:10:05Is very expensive. Why, well first you pay for power to sit, sit in a warehouse and do nothing. So this is money is a non productive money.
- 00:10:14And you need a warehouse and you need to maintain the warehouse. All of this is expensive, very inefficient. So the idea of just in time manufacturing was let's have the parts arrive, just in time when they are needed.
- 00:10:28And and some companies, they actually was when he was a PC maker became famous not so much for technical innovation, but for
- 00:10:40Manufacturing efficiency and being the lowest, lowest cost margin manufacturer of personal computers. Now, of course, just in time manufacturing assume best case logistics it assume that the system, everything works smoothly and the parts that I just in time when they are needed.
- 00:10:59But this result in a very brittle system, there is no resilience for for disruptions.

- 00:11:06And we also it again LED. See, this is a picture from Costco FROM THE PEPPER supply section of Costco and even worse in juvenile. Why don't we, why don't why there are still not enough paper towels.
- 00:11:22And dancer is lean manufacturing and manufacturing the same as just in time manufacturing
- 00:11:27And a deck is long effort to eke out more profit by keeping inventory law left many manufacturers unprepared will covenant in stock and production is unlikely to amp up significantly anytime soon. So the quest for efficiency kemet the expense of resilience
- 00:11:56Now I want to look at other other way, kind of aspects of the of the economy that we emphasize efficiency. The expense of resilience. So even worse three where risk management is really the name of the business for many of the awards three, especially in trading.
- 00:12:14I'm
- 00:12:15Worse three essentially when almost went belly up in 2000 in 2008 and the government had to step in to save even worse than
- 00:12:23And it's not because they did not do risk management de de risk management and there was a formula called Value at Risk and you measure the you want to know that with
- 00:12:33Certain probability, maybe 99% you will not lose more than let's say 100 million dollar and you think you can absorb the loss of 100 million dollars.
- 00:12:43And people develop rich mathematical theory. This is a financial mathematician David Lee develop a formula called Gaussian couple of function. Of course, you can see that we can spend the next hour talking about this formula, which I want
- 00:12:57But it turned out later this formula dealt with Norman conditions and it led to support him efficiency for normal conditions. What did not do is is the 1% black swan event.
- 00:13:10And that 1% that happen almost bought bought him advisors down and again only other film that will that will where they
- 00:13:19did not come down is because of massive government interaction. So again, they did not really think of resilience and I'll come back to financial resistance is an example later.
- 00:13:34You know, it's interesting to think about resilience also efficiency in governance, we know the democracy is very inefficient.
- 00:13:41And yet, Winston Churchill thought about it many forms of government has been tried and will be tied in this world of scene and whoo.
- 00:13:48No one pretend to democracy. Perfect. All wise, India has been said democracy is the worst form of government, except all those other form that have been tired from time to time.
- 00:13:58So we can look now at a Congress and the paralysis. We can see the democracy is very inefficient.
- 00:14:04Generally it is more resilience and other forms of government because there is more distributed and shared decision making, of course, in the, in the face of a pandemic. This is the one case where we're finding democracy may not be very resilient. We have not dealt well with a with
- 00:14:24Partly because of our a maybe, you know, countries that can have more central a decision making and being able to deal with it more efficiently than we did and bought more resilience. So food for thoughts about governance.
- 00:14:39Remember the picture we saw have a lot of people waiting in line for food box.
- 00:14:46This could have been foreseen.

- 00:14:492016 I was studying, then I would looking at automation and label and I chemicals. These data on productivity. But courteousness year or two articles form that came up was published in May 2016
- 00:15:03One nearly half of Americans would have trouble finding $400 puppet to pay for an emergency. So if you if you Blake's book in the car and it costs about $400 to fix them.
- 00:15:1740 has almost 47% of Americans did not have $400 pill to fix a to fix a broken breaks if you raise it to book in transmission
- 00:15:30Which will be $1,000 two thirds of Americans will have trouble dealing with it.
- 00:15:35So people leaving really on the edge. And that's why we saw what happened in in a with food banks and Adam said without in Atlantic in June of this year.
- 00:15:45He didn't have to be like this, the desperation of us walking in the aftermath of the corner of I was with the particle festivals or policy decision and miss opportunities.
- 00:15:55We know that we have a society with with with the majority living on the edge, and we just accepted it in the name of efficiency.
- 00:16:05So I want to go to look at how does nature deal with this dilemma with this not dilemma. But tension between between efficiency and
- 00:16:16In resilience and in 2016 she SEM. I was doing chief and we publish an article
- 00:16:26Sexist, and I'll go with him. It was a serious article about the theory of evolution under the lens of computation.
- 00:16:32We had a bit of a challenge on what would be the purple cover illustration for such an article in a bit of humor. We put pink cover and half the people thought that most people thought it was it was funny, but some people go deeply offended. So I had to fall on my sword and apologize.
- 00:16:55But the article is a serious article and what does it look at this would buy live not in Papadimitriou
- 00:17:02And they ask the following question. If you are studying algorithms search algorithms, we know that simulated annealing, which is really based on just mutations.
- 00:17:14Is generally computationally superior to genetic algorithm that have that also have mutation, but also crossbreeding between chromosomes.
- 00:17:26People have thought that that genetic algorithm would be superior, but it turns out simulated annealing. We should just mutations are is actually better. So you can ask why his natural chosen for animals.
- 00:17:39Sexual reproduction is almost the exclusive reproduction mechanism that always kind of corner cases in exception that people jump in. Tell me about, but generally speaking animals produce sexually
- 00:17:51And but if it but you can think of the production is a search for FOR A BETTER AND BETTER ADAPTATION to nature and why. Why is it being used. Why not just mutation.
- 00:18:05And again, if you bacteria. Bacteria religious you tell me the whole society to a chromosomal transfer and let's let's not go into that, which in some sense something common they'll to sexual reproduction.
- 00:18:17But leave not in public media came up to me with a very insightful answer and the answer is that efficiency is not in this case the look at the approximating the ultimate solution.
- 00:18:29Efficiency is not the only consideration and what sexual reproduction, does it creates greater genetic diversity.

- 00:18:38And that means that it's optimized is not at the level of the individual organism, but it's optimized for the species. Species is more resilient.
- 00:18:48Because there's more diversity and when environment changes some individuals would not adapt, but others will have easier time adapting. So this pitches with getting the velocity is more resilient, even if there is a cost of efficiency.
- 00:19:05So there is a trade off between efficiency and resilience in fact boss can be thought of optimization, but deficiency. Maybe we can think of it as more focus in the short term in the resilience is in the long term.
- 00:19:19Now automatically nature we fail because it has a long time to do to do evil evolution. Right. We are over 4 billion years here on Earth alone and
- 00:19:32pitches that will not resilience. I'm not here anymore the Dinos of the T Rex was incredibly efficient hunting machine killing machine, but it was not resilient. So it is done. So what has what the species that survive have the resilience fisheries, not necessarily the efficient species.
- 00:19:52So now I want to first go back, look at computer science.
- 00:19:56So,
- 00:19:59The art of Community programming is closest we have today to the Bible of computer science. Okay. And they don't know the is the patron saint of of computer science.
- 00:20:11And he invented the area code analysis of algorithms. So what is analysis of algorithm will hear it from Wikipedia in computer science.
- 00:20:21That's why with the with the puzzle. Finally, the competition competitive algorithm. The amount of time storage or the other resources needed to execute them.
- 00:20:31So traditionally, computer science and acts of algorithm is only exclusively but efficiency and you go, you can go through the
- 00:20:40Volumes of without who do the programming and like volume for is now. I think there are six volumes. The latest one, I think isn't satisfied ability and it's all about efficiency.
- 00:20:55So let's look at sorting algorithm kind of the, one of the most classic algorithm that we teach and we study and we analyze complexity.
- 00:21:03So we talk about bubble sort, which is quadratic in the worst case, and on the other writers will
- 00:21:09Melt sort is all his, his worst cases and login. So good morning I'll go with him quick solve quadratic in the worst case, but in average case, it's also and login and considered to be one of the best sorting algorithm.
- 00:21:23In CSM in 2013 David asked. He asked Cotabato robustness of sorting, suppose that you have like a sorting gate or sorting algorithm where the competitors.
- 00:21:36Maybe on 10% they make an evil and they give you a random answer.
- 00:21:42And this is, this is kind of in the Spirit of God. Going back all the way to phenomena which I will mention again later in the future.
- 00:21:49You'll have an unreliable. You have some unreliable components. So what happened. He said, Let's run some here and some simulation 110 percent of the comparisons, the answer was on them, you flip a coin.
- 00:22:01And then he look at the outcome.
- 00:22:04And the question was how close it is to salting and that way you can measure it. For example, how many pairs are out of order.

- 00:22:11And what he discovered was a barbarous word was or bus, it produces pretty when started a list, even with Western with arrows, but missiles in QuickBooks will not robust
- 00:22:25And why was, why was quick. So Bob resort or bus because of course it does. Manual comparisons and I really needed. We need only and Logan comparisons.
- 00:22:33And Barbara. So does quadratic number of comparison. And because the aerosol random Bubble Sort will end up being much more robust so
- 00:22:43We always think of bubbles of the day example of the algorithm, not to use, but it might be the I'll go with him in the proper context because it is more robust something that typically it's not what we teach in computer science, and we should
- 00:22:58Let me go to a more modern modern example so PageRank was algorithm that landing page.
- 00:23:06Invented to to solve the result of a web search, and you may remember the days before Google where your head the search engine that did not have such. Very good.
- 00:23:21A sorting not sorting ordering ranking ranking mechanisms and you got all kinds of garbage kind of links in the new at the very top.
- 00:23:32And then a Google search engine came and it was magic. You could just write answers at the very top. And the idea was to look at the underlying graph.
- 00:23:42Look at the links and the more links, the more page link to one page, the more important it is and ultimately these general ideas because back to computing eigenvalues and taking it under marks on Markov chain, but it gives us a way to get the best result need the very, very tough.
- 00:24:03But very quickly people discovered
- 00:24:06They can change Dancer by creating by putting fake links and this became a whole industry search engine optimization
- 00:24:13How to add links to move your webpage. You want you up opening your Western you move to new the new webpage to move to the top, how to do that. So it turned out that PageRank was not resilient.
- 00:24:27And in fact, first of all, the pattern. The pattern has expired, but also
- 00:24:33If you go to Google today and ask them, what do they use, they can tell you I tried Google to publish an article themselves on selves quality and they said, we can, it's a trade secret as soon as we tell you how we we we learned the result, people will gain it
- 00:24:49So in fact, the way now to keep to keep the algorithm or bus.
- 00:24:53But keeping it secret because otherwise people. People can give me. So this is an example of an algorithm that will not be was not robust in effect on a machine learning is a whole new era of adversarial machine learning that deals specifically with this robustness issue.
- 00:25:10But I'm association. So here is, let's take a very classical concept. There is concept of pack pack learning probably approximately quite enthused about violence in 1986 but it was based
- 00:25:22On a on a concept that includes buy stock mile in 83 and I know I'll go with him that compute function approximately
- 00:25:32And what you want is to have a parameter parameter of confidence and parameter for a while and human to make sure that the EVO is is less than the relative always less than epsilon with with high confidence with confidence, at least delta maybe 99%

- 00:25:48But there's actually was an omission in scope. Miles definition, in my opinion, and omission was what happens in the event. What happened to probability one minus delta in the 1% that you allow yourself to be an arrow.
- 00:26:03And nicer is the arrow could be so large that it will tell the expectation. So in 2016 weeks my collaborator Chakraborty and meal. And I looked at this and we defined the notion of stone pack as
- 00:26:17Well, in addition, we want the expectation to be correct. The answer should be correct in expectation and you also have the probably approximately coin.
- 00:26:27And we show that you can use an algorithm that will not be only politically correct but also strongly probably a politically correct
- 00:26:35And then give you a resilience, because you have to worry about the state event. Remember the Value at Risk formula did not account for 10 events. We want to make sure that we can also filter relevance.
- 00:26:48I want to give now to look at this lens again of efficiency and resilience and bring other aspects of computing that I think should fall into this and one is is a concept that I don't think we talk enough about and this is friction
- 00:27:04In 2013 I thought about this topic and I wrote our disciplines dedicated to reducing friction latency must be eliminated bandwidth must increase ubiquity should be universal. Our goal is to reduce the friction of computing communication as much as possible.
- 00:27:20I think that's a it's an obstruction and you can find, of course, counter example. But I think it's a fair summary of how discipline. Think of friction whatever friction is I haven't defined friction
- 00:27:32But take Facebook, for example, martek ability, find the goal, the motto of Facebook was frictionless sharing and this sounds
- 00:27:40Good sharing, sharing is good and therefore fixing and selling should be good. But we now know that the utopia frictionless sharing leads to filter bubble fake news an extreme content so friction and sharing is not a good thing.
- 00:27:59Let's like another example about friction. So 2010 we had the flash crash the stock market crash 600 points in five minutes.
- 00:28:09How did it happen where we now understand it was called but algorithmic trading or high frequency trading. It was the cause of the cash.
- 00:28:16Now, it turns out that proponent of high frequency trading say this is this is good, the high frequency trading is good. It makes the market more liquid
- 00:28:26But, but people who, you know, Thomas better fee, who was one of the pioneers of high frequency trading. You said the drive for it for speed has no social value. It's all about money.
- 00:28:40And yet we have really not tied to regulate friction into trading the SEC could have said there should be a minimum, there should be a mandatory time delay for trading, but we still have high frequency trading and we have a very at risk financial system.
- 00:28:59Let's go into the social arena.
- 00:29:02An article from 2019 Jenna built right. Why is it so hard to turn a tinder that into a relationship.
- 00:29:09And should I, despite the swarms of matches. Over the years, I've never had an update turn into actual relationship. This is, I think, Dalton, but people have studied this

sociologists have studied this, and the fact that coupled with online are much more likely to squeak within one year.

- 00:29:25And it doesn't take much to understand why it's happening. I mean, Tinder requires very little investment. You just, you just swipe left or Swipe right, swipe left
- 00:29:36easy come, easy goes. So because the bus party have a sense of it was not much of investment. So therefore you invest you if you don't invest a lot you don't expect a lot so you swipe, but it doesn't go. It doesn't turn into intelligent and do a date, but not into a relationship.
- 00:29:56So imagine I go to in just down the hall. I go to our mechanical engineering department. And that's the mechanical engineer.
- 00:30:06Let's remove. I said, How about removing friction
- 00:30:10And they would say no. This is insane to remove all friction. If you think of mechanical system that some places, will we want friction someplace that we don't want friction
- 00:30:19So I'll restart the Greek philosophy about getting angry is easy, but getting angry for the right reason at the right person.
- 00:30:30At the right amount at the right time. This is how so again putting fully eliminating friction doesn't make any sense. We don't function everywhere but putting
- 00:30:40The right amount of friction in the right place in the right time. This is hard, and we have not put the sort of where to put friction properly in computing, where should we have friction for and where should we have friction less computing
- 00:30:55Let me take another aspect of I think of this whole resilience versus efficiency and I want to talk about security. So I had a discussion with a colleague of mine who is a fairly well known security researcher and
- 00:31:09We had some disagreement and he would, he would to me an email explaining this is how we do security research.
- 00:31:17This is verbatim quote from his email. First, some of the bill. I think, and it is super useful then eventually someone else comes along and find the vulnerability
- 00:31:27Then security becomes a part of an engineering process, just like we need to make sure our code does not have a bugs. It makes it crash.
- 00:31:35We also need to make sure that our code does not have bugs that can be exploited for bad purposes, then they can't for enough years and eventually secure and gets better.
- 00:31:44Security comes last. Not at the beginning. And in fact, we've seen his resume as as the whole world move to zoom and come back to that point security was something was added later security was not something that put on the first floor security we put some input on the top floor.
- 00:32:02So here we are.
- 00:32:05You know, we have a computer computer age about 75 years we can look at the touring awards as the milestone five accomplishments in computing. So we can look at the list of Turing Award, and we see, okay, how many doing awards will be given in a cyber security.
- 00:32:23As far as I can see none. We've given three doing awards in cryptography three two in the Washington tog Rafi RSA
- 00:32:31Problem in a weekly call a semicolon. The Olin cryptography, but nothing in cyber security. Why, because we still really don't have solid foundation, how to build secure information systems.
- 00:32:44And now we need to see, it's not just about compromise security. It's about vital infrastructure.

- 00:32:51communication infrastructure is vital. But it's not just our communication and computing infrastructure. It's a power infrastructure. It's a financial infrastructure.
- 00:33:00So our community somehow marches along without realizing that we have given up in some aspect of resilience and we're living over in a very fragile very fragile world these days. And I'll come back to this.
- 00:33:16And poverty, I would argue, did come from a philosophy that our community tended to have not everybody, but there's a clearly a streak deep streak of cyber liberty libertarianism
- 00:33:28So if we compare cybersecurity to Car. Car and safety, you know, the
- 00:33:33Ford Model T when of the manufacturing line in 1908 400 years now, we've been trying to reduce fatalities and we've done actually a fairly good job, reducing fatalities.
- 00:33:44we institutionalize it, we have the National Transportation Safety Board All about automobile safety who's responsible for cyber security.
- 00:33:54Well, it's distributed. It's nice. Some nice some and they say some here's some there is not clear, there's no one agency to regulate cyber, cyber, cyber security and that's partly because we hate regulation. This is a in the tech community people keep telling you regulation stifles innovation.
- 00:34:13And so just don't talk to us about regulation, but when it comes to cyber security, it's unlikely that this issue will be addressed without government regulation. So we need to really how to take to take security seriously and regulation, seriously.
- 00:34:32So this was the computer science and let's go back to economic efficiency.
- 00:34:38So,
- 00:34:39It's become very clear that because we pursued efficiency so so enthusiastically that we had. We did not develop the buses and we need to deal with a pandemic and a simple example is a
- 00:34:54CDC budget cut in February of this year and President Trump defended it by saying, we can hire more doctors when we need them.
- 00:35:02Which is true we can hire more doctors when it, when we need them. But by the time by the time we need them, we have in the middle of a crisis. And so we end up by efficiency given up resilience
- 00:35:16So I went to Invesco pedia to learn a little more about economics. So what is economic efficiency. This is the inverse to period definition, it could goods and factor of production on similar to the allocated to the most valuable us and waste is minimized. This is efficiency.
- 00:35:35And free market advocate. This is, again, for me, the investor pedia free markets advocates argue it so individual self interest.
- 00:35:44And freedom of production and consumption economic efficiency is achieved in the best interest. Society is called unfulfilled. So everybody would follow their, their self interest. Everybody optimized for themselves and the result would be efficiency and optimally ophthalmology. Wow.
- 00:36:04So the film market would give us both efficiency and optimally.
- 00:36:09But I want to question does efficiency guarantee optimal
- 00:36:16So you have to go and learn a little bit about about economics.
- 00:36:21And the basic theorems in micro economic and the basic field is called the first willful theory and felt wonderful theories about efficiency. It basically said, under certain

technical assumptions. The market will converge towards a competitive fire to optimal equilibrium

- 00:36:38So this is efficiency that this that this give us opportunity. How well does an equilibrium sell the best interest of society.
- 00:36:47So this is a question that was not well studied by economist. So, computer scientists got into two studies.
- 00:36:56And this study of efficiency versus optimal. It was started by CUJO PSN Papadimitriou 1999
- 00:37:03They were inspired by by we, when we develop, like for example online. I'll go with. We want to know how well as an on an unwritten perform
- 00:37:12Is as opposed to the to the as opposed to the best offline algorithm. And so we studied this online ratio and they say, why don't we apply the same to the study of equilibrium
- 00:37:23And they say, what, what is the ratio between the worst possible Nash equilibrium and the social optimum. So in this is in games where everyone has utility. So this was our optimum is the best that society collectively can do, and this was called later, the price of anarchy.
- 00:37:41And what they're showing the price of unlucky can be arbitrarily high depending on the complexity of the system.
- 00:37:48So that means that what
- 00:37:51The belief.
- 00:37:53That the free market will give us efficiency and optimal at this is completely misguided. If you have efficiency, there's no guarantee of optimal
- 00:38:03So efficiently does not guarantee that the best interest of society as a whole lot fulfilled.
- 00:38:11But the polling goes deeper later on fuels data public me to do with with those those collection Goldberg ask how long will it take
- 00:38:19To to converse with equilibrium and the assumption is that it's a free market. So the only way we converge back to equilibrium is by a sequence of local important
- 00:38:30So one Melton realizes that she can raise the price a little bit,
- 00:38:34And one provider realize that they can make a little more of the of the of the commodity. So it's a sequence of local improvement. It's really analogous to a local sales.
- 00:38:44Local steps you gradually converge and the pool with technical have resolved the prove that that finding much creativity. Most people complete but what it means and simple awards. It may take a very, very long time of small steps to convert to an equilibrium
- 00:39:03But this means that if it takes so long, the world will change during the time because things will change price will change supply which and the mind, the mind we change.
- 00:39:14So the answer is we are never at an equilibrium. So this whole focus and it's actually known by some economies. It takes too long to convert so even so much of economy based on equilibrium theory we are never in an equilibrium. And even if we get to an equilibrium. It's not optimal.
- 00:39:31So this really takes make some of the attitude towards free market in the really fundamentalist a ideas that there's no relationship to reality.
- 00:39:43Is the the paradigm of that was a movie 1987
- 00:39:49movie called Wall Street and Michael Douglas plays this a financier Gordon Gekko, and you give us our speech. It's a famous speech. You can find it.

- 00:40:00On YouTube greed for the lack of better word is good and argument is, this is how Adam Smith invisible and works. Everybody optimizes for themselves.
- 00:40:10And as as at the end society will reach optimum. But we know that this is not the case. We're not greedy algorithm get stuck in local optima
- 00:40:18My opinion right now, when it comes to cyber security we're stuck in a in a equilibrium, equilibrium and some system integration is needed.
- 00:40:29To drive us out of this out of this local optimal local optimum in this case.
- 00:40:35Because somehow the market does not appreciate enough security you know program sale for features systems and for features.
- 00:40:44Or busyness not for buttons. If you think what happened in terms I know of one car will safety Volvo safety is a marketable feature.
- 00:40:53But from what most other car manufacturers. They just have to meet government standards, if there is safety in cars. Is it called the government stepped in and applied standards and we don't have it when it comes to cyber security where market failure.
- 00:41:08Now, interestingly,
- 00:41:12THIS IS NOW THEY IT THIS PAST WEEKEND was just the fifth anniversary of the article by by Milton Friedman.
- 00:41:21Argue that the social responsibility of the corporation is to make profits. So there was a journal head that I'm sorry, the new of time is a special, special issue and the headline was greed is good, except when it is bad.
- 00:41:34And they quoted, for example, Marc Benioff who is the CEO of Salesforce.
- 00:41:39And he all he did not. I did not agree with Friedman's n and the decade since since since I'm only expresses myopia.
- 00:41:47Just look for the obsession with maximizing profit for shareholders has bought us terrible economic racial in health inequalities.
- 00:41:54The catastrophe of climate change. It's no wonder. There's so many young people now believe the capitalism cannot deliver the equal inclusive sustainable future they want. So if capitalism is going to work is not by by your myopic myopic focus on efficiency and profits.
- 00:42:17In fact, I mean you go back to some of the basic assumptions in a in a in an economic and there is this musical culture that economics half jokingly called Homer. Homer economic who's
- 00:42:27And this is a superior rational agent who just focused on their self interest and just optimize the utility and economies. I mean, you know, this is the whole, this whole branch in in between psychology and economics to study behavioral economics. People do not behave rationally.
- 00:42:46But I think a more fundamental truth was actually stated already in the 50s by him. Simon also computer scientists and he introduced the concept of satisfying, which would you settle for good enough outcome.
- 00:43:01And this is actually how most people operate they settle for good enough outcome. It's less efficient. It's more resilient.
- 00:43:09And I was intrigued enough by there that I want to see, can I turn this into a into a research problem.
- 00:43:15And I want to tell you this is this. I'm going to zoom in a little bit into a technical
- 00:43:20About three technical slides to tell you about some work done by my PhD student where we try to take this and you're good enough.

- 00:43:27In turn into a research problem. So my students Superman bunzl was she just became a CI fellow. Thank you. NSF
- 00:43:36And she walked on discounted some games. So you have two players who are making moves on it on a on a golf game and in every state, you get the reward and the stream of the stream of rewards is is aggregated by a discounted some
- 00:43:52And there is a classical optimization problem. Find a strategy for Player zero that will maximize the world against players one strategy.
- 00:44:02And this is well known to be in Parliament time using value iteration, which is an algorithm algorithm. Of course we know a lot also know in reinforcement learning and many other application, you got you to optimize the values until, until you convert so classical result from 1996
- 00:44:19What a question we asked ourselves. Suppose, in addition to the optimization problem.
- 00:44:27We also want to have on the on the sequence of states we want to avoid the contemporary extended goals, some constraints on a sequence of states, for example, every method sent
- 00:44:36Is eventually received and these are what we call have constraints would distinguish between the heart constraint which are this temple goals and the self optimization problem.
- 00:44:46But it turns out, this was shown a few years ago that in this case there's no optimal strategy. There's no optimum.
- 00:44:54So the question is, what can we do then and we decided to look as satisfying. So look at this situation, but instead of, instead of optimum.
- 00:45:04Me sort of optimizing the reward. Now we're asking, there is a threshold and you want to do better than the special, for example, maybe this is a a
- 00:45:15Energy expenditures and you want to make sure we don't exceed a certain threshold or certainly would you want to exceed it, but this, you still want to, you still have how temple constraints.
- 00:45:26And now we're able to actually to prove that there is an algorithm for integral discount factors.
- 00:45:36Again, I want to go into detail, but by giving up opportunity. And he said, settling for good enough result we're actually able to do to do more.
- 00:45:46So I think this is a an interesting idea for many people in computer science. What about instead of doing optimization to just do do good do good enough satisfy sing and see what lens it what computational avenues. It opens to us giving up on optimally.
- 00:46:06So let's go back to covered 19. Now what did walk
- 00:46:11Well, the internet did work. We're working from home shopping from home teaching from home living for one giving size distinguish lectures from home.
- 00:46:20How do we do that well redundancy redundancy redundancy. So we've learned anything is that you can build the reliability and resilience using dundon. See, I don't know the full history of this
- 00:46:34Clearly when you when you go to Shannon Iroquois or error correcting God's use of redundancy to establish Brazilians for Norman when he talks about how to be reliable organism from unreliable sales. Again, it was about redundancy.
- 00:46:50The Fed, the Fed now knows if you want bank to be resilient. They have to have redundancy of capital. So we go back to value at risk. You cannot have just, you need to have

- 00:47:00It's beyond quantifiable. They just, they just want to make sure the new value scenarios and I want to make sure you have redundancy of capital.
- 00:47:07And in the hero part of the one who are for this for the internet is Paul Baran who needs to be a household name, but he's not. But here is a recent a description of his vision of distributed network.
- 00:47:22Bonds motivation.
- 00:47:24For creating is a revolutionary approach to communication networking. This is packet packet switching was driven by the dominant issue of the 1960s. The Cold War and the overhanging sort of nuclear annihilation.
- 00:47:37America's nuclear capability depend depend on maintaining. What is the teaching defense community called minimum essential communication.
- 00:47:46Which was the amount of connectivity needed for us to credit limit and the threat of mutually assured destruction.
- 00:47:53Which most observer believe was essential to turn the Soviet Union from attempting a preemptive strike.
- 00:47:58So many thing many people always thought of users who destruction as it is crazy strange lobby idea.
- 00:48:05But he gave us very resilient community infrastructural internet I can give this talk today. We can survive covered 19
- 00:48:13In a very form of indirection that goes back to mutually assured destruction, I find, is absolutely amazing chain of events, how we got today and where we got started in the 1960s.
- 00:48:27So I want to summarize, but resilience is a fundamental but underappreciated societal need
- 00:48:35I'm a computer scientist I spending a lot of time, the last few years learning about economics. I think both fields and probably we can apply to many other filters will need to focus more on resilience
- 00:48:46And important observation is that people and markets and societies are not very good at preparing for very low probability events. Okay, so take care insurance as an example.
- 00:48:58Everybody that has a car in the society has car insurance or almost everybody. Why is that
- 00:49:05Because we are forced I just had to renew my my car registration was. It was the state of Texas, and I had to provide proof of insurance, otherwise I will not get
- 00:49:15A target that can that can put on my car. So I'm forced to buy insurance. Now why don't rely on the market to do that because they know it's not it's not reliable so social action is required.
- 00:49:27So we need to think of many other aspects where we need resilience and you will not happen without societal action to ensure resilience. Because otherwise people will focus on people in market will focus on efficiency.
- 00:49:40And many people are saying that covered 19 he just does to himself, have a much bigger challenge coming down the down the highway for us, which is climate change.
- 00:49:49So we are all watching in whole what's happening in a in on the west coast.
- 00:49:55And if you want to see a trend, then somebody did do a trend and they put a the amount of a want white land acres Burundi millions of acres in California, Oregon, Washington. And you can see a clear linear trend.

- 00:50:10So we have a huge problem coming, coming at us. And if you want to get really, really scared that I suggest you read a book form but 5656 years ago.
- 00:50:21By all this case and in Conway called the collapse of Western civilization. It's a kind of historical science fiction science fiction. It's the history of what's happening with the collapse.
- 00:50:31That he given I think from the historian in the 23rd, 24th century and it's absolutely chilling when you read it. Of course it's a scenario. Nobody knows exactly how things will unfold. BUT IT'S NOT AN IMPOSSIBLE SCENARIO. And he's very, very scary.
- 00:50:48And I want to give in closing a shout out to one is very new book that just came out by lean sell and upsell called the innovation delusion.
- 00:50:59And they write the vast majority engineer will wind up maintained existing system, keeping them going. Thank goodness overvalued, then you
- 00:51:07The argument. America has been seduced by default chance of innovation, causing us to chase novelty and pursue disruption.
- 00:51:15When neglecting maintenance infrastructure and what's the public and private sectors, we know that we have deferred investment infrastructures of trillions of dollars. We've under invested
- 00:51:26And they blame, I would say is if part of I view myself as part of the tech community. In this case, it was a partnership somehow between the tech community and the financial community.
- 00:51:36And they said innovation culture started to come into vogue with the financialization of the global economy in the 1980s, before going into hyperdrive with the rise of the Internet. So I lived in in Palo Alto for about
- 00:51:5015 years in the early 1980s, early 80s to mid 90s and then it was really people really thought about the places as a as an engine of technical innovation.
- 00:52:01And then the.com.com happen and then Silicon Valley became the place of becoming rich instead of becoming just, you know, tech tech technical innovation something did change.
- 00:52:16And the other book that I think we should go back and read is actually not a new book. It's a book at about 25 year old book. It's a book by older Rick back German sociologists called the risk society.
- 00:52:27And you basically argues that the modern society.
- 00:52:31Is actually globally is very precarious.
- 00:52:35If you look at these two years after after the book came out to novel happen and against your noble couldn't couldn't have ended up much much worse. You know, again, we lucked out which are noble which to which are noble Fukushima.
- 00:52:49Couldn't be much, much worse. And he argued that this society. We are not ready for this loud scale threats.
- 00:52:58And there is an article by Adam tools and foreign policy asked the question, so really the export by the case is such a noble an ongoing Corn, corn, have I was a pandemic is how to navigate this world.
- 00:53:09And I think the day the buzzer for the day to be resilience resilience resilience and I think the National Science Foundation in particular.
- 00:53:19Needs to take a step back and look at their portfolio and ask how much are we investing in efficiency and how much are we investing in resilience, because ultimately our resilience is about survival efficiencies not. Thank you very much.
- 00:53:45Me I muted.

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Henry Kautz
00:53:47Hi. Thank you. Thank you, my fabulous talk. Um, we now have time for her question answering.

- 00:53:58If I'm correct. Yeah, I think I would say a Q AMP a
- 00:54:04Chat and people can type in their, their questions and I'll go go through them and then ask them to Marcia, so, um, well, the first one simple the Will the slides be available yeah the the this the seminar is being recorded and will be posted and there'll be
- 00:54:30A when

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Moshe Y. Vardi
00:54:31You and I, should I put up I'll share with you a PDF. You can post next to the presentation. Yeah.

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Henry Kautz
00:54:37Great. Okay. See, and there's just lots of people making comments and here's one from NSF, I would love to hear you view your views upon whether privacy is also stuck in a local optima much like cyber security.

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Moshe Y. Vardi
00:54:58So I think that the issue is a privacy. I think most of stalking local in local Bessemer of optimizing the actual local press email, we should call it

- 00:55:09That was stuck, but for different reasons. I think, I think, well, the common thing is some of the market, the market doesn't quite value it properly. But I think for different reason. I think that a
- 00:55:22A securities in this invisible thing. So it just hard for that said, well, that's why if you take away the requirement for car insurance, even though most people understand that they can be financially ruined.
- 00:55:34By an accident. They still will not buy insurance. And so we have to have a societal intervention, a government individual quote will have insurance, and I think that's the issue is that somehow
- 00:55:47There are features you know that this is there is a famous I forgot who said that God made me chased but not today.
- 00:55:54You know, I see an ice cream. And I know last name is not good for me. I stopped eating ice cream tomorrow. I mean, this is called also by economists hyper discounting.
- 00:56:03We can get the smaller the world now even though it costs us more in the long term, and we're very bad at making long term a
- 00:56:11Evaluation kind of really computing properly present present value privacy in some sense it's a, it's a, the same, but not the same. So you can argue that people give away their data.

- 00:56:25But to give away the data, partly because it is it is opaque. How much data they given how it's given. So the tech company knows all about us. We don't know anything about them.
- 00:56:36And who gets this data. I mean, there's a whole network of data broker who sell who buy and sell data and we know nothing about it.
- 00:56:44And also, I call it the, the, there is a famous saying Greek our dog is called a the central power of sin. He paradox. If you have a heap of sin and you take one game at a time.
- 00:56:57Well, if you take a box and you take one grain, you are left with a hip have sent everybody would say, but we all on the same if you take enough grain that he will disappear.
- 00:57:07So this is called this the fellow of induction.
- 00:57:11You can argue, but there are various. There are various sent he paradox. If I put one grain of sand on the floor.
- 00:57:19You just one good enough, saying, if I put, if I take it another good enough. And it's another grain of sand, but clearly when there's any if you put enough of them. It's a boxing will give our data away one grain at a time and we have no idea what is the cumulative picture look like
- 00:57:36And and and right now it's a bit it's it's given data collecting data from us is the big business model for some of our largest tech companies in particular this definitely go for a folder for Google and Facebook Apple actually managed to make a business model out of privacy. Okay.
- 00:57:58It's possible to do that. What happened on your iPhone says on your iPhone. I think, again, we do require some kind of a government regulation.
- 00:58:07To deal with the privacy issue he ties, you know, in particular social media ties to to speech and freedom of speech and hate speech, it's a it's a very, very thorny issue. I don't know that we'll have to, we'll have to
- 00:58:23slog through these to figure something out. When it comes to privacy.
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Henry Kautz
00:58:27Okay, let me add some questions. So two related questions. So one is, is there's kind of attention in your talk between ophthalmology and robustness. So when you talk about
- 00:58:44Algorithms that that get stuck in local minima. It seems that that actually might be a good thing if that's a robust local minima and then sort of related that
- 00:58:56Have you or others are thinking about, well, I just need to change my objective function and then I can do optimization and optimize for robustness and this is dislike in machine learning, you add regularization to your objective function to increase the robustness of your solution.
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Moshe Y. Vardi
00:59:18So I think this is a
- 00:59:22Actually closer to what I would call another call multi criteria optimization
- 00:59:28So, so the answer is, you know, it's part of why I get upset, you know, the US News and World Report.
- 00:59:34Just came up with the new banking and everybody goes, dog. Of course, all the institution that did well, such as ice University got a dog about this ranking.

- 00:59:44But the reality is that there's no way to linear rock institution that are very, very different and we take different country areas and we put magical magical way to aggregate them and poof, we're in order and every everybody seduced by disorder.
- 00:59:58But it's really the multi dimensional problem at best. You can talk about the optimal kale.
- 01:00:04And decision making should be highly individualized. What is more important to you when you come to to
- 01:00:11University, are you, do you care more about the social like you come up with academics. Do you care more about the day we have lots of trees. That is how important please do to have lots of trees.
- 01:00:21And answer is it's this all life is about trade offs and the thought that you can reduce all trade off to to waiting
- 01:00:31Many years ago when I was at IBM
- 01:00:34We had to decide when I've been willing to IBM and do crisis. And one of the people who reported to me. He wanted me to help him to decide how to allocate his time between doing science and doing technology.
- 01:00:47So we said, let's, let's do this. Let's just put it into ultimately one optimization problem.
- 01:00:53And what we got was, we, we did answer an answer. What is you do either only Sansa only technology.
- 01:01:00And we was tested it and it said this is nonsensical answer. What's wrong, and the answer was, we framed it ultimately isn't as an optimization problem.
- 01:01:10In the for the optimal is going to be an extremely point and the reality is that life was more complicated life is not linear. This is my biggest bit of wisdom I can share life is not linear.
- 01:01:22And optimization is difficult. And yeah, you can wait. You can try to combine sing, but it's not clear to me. There is a principal way.
- 01:01:31To combine efficient. This was resilient. You need to think of the context and the context is sometimes not just what the individual person once once, but what society what society does. So for individual person, it might be the doing car insurance is not efficient.
- 01:01:49And the father shouldn't do it. And in small, small probability that have an accident.
- 01:01:55And they'll have a huge claim, but they don't have enough money to pay for the claim declare bankruptcy and and that's the way they deal with it. So it might be for each individual
- 01:02:04Efficient answer. Do not buy car insurance and I have not done the analysis. I'm just hypothesizing
- 01:02:09But this society. We said no, this is, this is actually very big world and people don't have car insurance. So we come up with a societal answer to this. We're facing kind of power of the same issue is with climate change where we need global cooperation.
- 01:02:24So people now think of globalization is a dirty word. But they are, we cannot deal with climate change without some global cooperation and for each country, my, you know, this is a classical Prisoner's Dilemma. Which country might be efficient to defect.
- 01:02:39But globally. We understand everybody defects. We all school
- 01:02:43So I don't think it's a simple. Let's just find a way to put the way to convert into one optimization problem, I think, I think it's more complicated than that.
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Henry Kautz
01:02:51Thank you. Another question from the Q AMP a screen.

- 01:02:57Would like your thoughts on countering this information to block sites and sources that produce false material and even promote dangerous ideologies, or should we allow them to flow but regulate, but how

Moshe Y. Vardi
01:03:11So the problem for us is, you know, you think, what has changed. So imagine that day.

- 01:03:19The 20 years ago.
- 01:03:22I wanted to publish some kind of a KKK Paul KKK op ed in the newspaper.
- 01:03:30And I submitted for to New York Times and they don't even reply to my email. I tried the washington post was juggling know me and I keep trying.
- 01:03:40And eventually, maybe I find some some small newspaper in some small town, maybe in the South, not going to pick on anyone. And they published my op ed.
- 01:03:52So it was published. I had, I had freedom of I'm free to write this article.
- 01:03:59But the the ECHO is going to be very small. It's would just be in a small town.
- 01:04:04Now imagine that we are taking all the newspapers of the world, all the newspaper of the world when connecting one newspaper
- 01:04:16And now this one newspaper decide what to publish and what not to publish
- 01:04:22And on one side. What's gets published in newspapers in this newspaper can be read by everyone in the world. Everybody it translated to all the languages, somehow, everybody can read
- 01:04:34On the other hand, if it's not public. I mean this newspaper has tremendous amount of power to decide what's good publishing. What doesn't get published. This is the situation we are now with, especially with Facebook.
- 01:04:46So on one hand, Facebook, give a megaphone to all kind of bad information. And this was this information and hateful information.
- 01:04:56On the other hand, who is going to decide what should we publish and what what what's not to publish, especially when it comes to political speech.
- 01:05:05So I this is to me right now. One of the biggest challenges is, is a, you know, that is section to sell t that says that Facebook is a platform, and for that are not
- 01:05:15Reliable for what is being published on them myself parties. It's actually a question about if they're really platform because there are go in and actually much more the algorithm decides what people can see so they're not a passive platform.
- 01:05:29But whether we we give them if we take away the protection from them suddenly they are responsible. Do we expect Facebook to make all publishing decisions.
- 01:05:39I think this is this is right now. This is a social dilemma. Call it now that the social dilemma of social of social media and we as a society have to figure out what is the answer in one people are you dancers antitrust policy is that we have
- 01:05:55One large Facebook and when you send why because this is because of medical floor network, the network law favorable such a one essentially a one Facebook.
- 01:06:08We need to sit down and seek very hard. I think how to deal with this challenge.

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Henry Kautz
01:06:13Okay. And in other words, it's really hard and you don't know
- 01:06:18None of us know yet.
- 01:06:20So here's a okay so have another NSF question somewhat live question if whoever the next president is calls you up and says, Professor have already joined my scientific advisory board, what would be your first action items fee. So imagine just joined all STP.
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Moshe Y. Vardi
01:06:40So first of all, just because the President cold calls you up, does not mean you have to say yes, it will depend with the pool will depend also which President
- 01:06:51So, um,
- 01:06:55But secondly, you know, having, having, having oil STP is is important and basically
- 01:07:03Understanding that the goal of the government cannot be just even if you're in college. Let's University. Now let's invest in quantum let's just take an investment.
- 01:07:15Kind of going back a little bit, we celebrated just last spring, the 75th anniversary or fun of vulnerabilities bush.
- 01:07:23Signs. The Endless Frontier article which was a around April April or May of 19 4045 or 75 years
- 01:07:32And I've called this article is ultimately the foundation for example of National Science Foundation and invaluable bush makes the argument.
- 01:07:40That basic science is good for society. Why because basic science will give us economic growth and would give us say HEALTH AND WILL GIVE US national security and so on and so forth. So he called for a major federal investment in basic science.
- 01:07:57And of course, he's right, but he's not completely right because investment in in a basic science. We all understand isn't today. I think when you stand, it is necessary, but it is not sufficient.
- 01:08:10That is to say, you can have innovation.
- 01:08:13But it doesn't even if it can't contribute to economic growth doesn't necessarily contribute to shared prosperity.
- 01:08:20And if you don't have a good public health system, then you can have cutting edge cancer treatment, but still cool life expectancy, because we don't do we don't do a pre and postnatal
- 01:08:33Care well in this country. So I think the scientific community needs to own it, that that investment in in r&d does not necessarily translate
- 01:08:45To societal progress. And the reason that we are all benefiting from ultimately from we're all living in the generosity of the taxpayer that creates would committee, I think.
- 01:08:56An obligation for us a moral obligation of science for the public good, doesn't mean that we only do applied science. It's still seeing basic sciences good investment.
- 01:09:05But it has to be accompanied by sort of policies that will look at the market failures. And why does in science translate always to public good.
- 01:09:15And and address, not just the science part but looking also at this day we need science policies. It makes you the science or Domingo tickets to the public good.

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Henry Kautz
01:09:27I have a question from our
- 01:09:31The director of size our field tends to tilt towards efficiency in that we look for things that we can quantify and improve upon
- 01:09:40Computer, sir. Security is an example of a field that is about low probability events you have thoughts on how we can shift our research mindset and methods to better address the important challenges in p on like this that is ones that are focused on low problem of the events.

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Moshe Y. Vardi
01:09:58So I had the conversation. Some years ago with another size ad. We talked about the situation. And I said, maybe we're not investing enough in in a
- 01:10:09In a security ourselves. And I was so look we dancer what look we can. I can actually quantify.
- 01:10:17How many dollars, it takes to generate a paper because we know how much money we're investing, we know how much a papers are getting so so maybe we get a I don't know exactly. But let's say $50,000 generate another paper.
- 01:10:32To you.
- 01:10:34We are somewhere in the in the in that neighborhood. Okay. Give, give or take. He said, okay, so suppose that I make enough investment to generate 1000 more papers in in computer security.
- 01:10:48We eat change will it move the needle on a global scale in in how in the cybersecurity of the infrastructure in the system in this country.
- 01:10:59And the answer was, and I said, You know what, that's a good question. I don't know that that will change it. So again, if we want
- 01:11:09We need to think that there has to be a whole chain. It's not enough that with more papers published, we need to look at the whole ecosystem.
- 01:11:16Why easy it and I've been somewhat faster than I was trying to get my to me what's happening in cybersecurity. My metaphor. We there is a dumb.
- 01:11:24It is leaky and we'll keep sticking fingers and every time we see another whole was taking other finger why Paulie dancer was the dam was poorly built
- 01:11:35And we need to change the way you present the boundary conditions. And the question is, and I think it would require some similar thinking. And again, the same way. I don't
- 01:11:42It's the same way to say, I don't have a good answer, but I think we need to sit down and not just think it's not just a research problem.
- 01:11:50It's what maybe the polar may have to do with a liability laws. Maybe if if companies will have a higher liability in case of in case of cyber security breaches.
- 01:12:00They will put more money into it, while they're not following best practices. Many people saying the date that this this there is body of knowledge.
- 01:12:08But companies are not following why they're not following it. What is the market failure. I think, again, we need to take a border. Look, it's not just about security results. It's about how do we translate it ultimately to to to to public good.

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Henry Kautz
01:12:24Okay. I have a question. Getting back, I guess, a more technical question of how do we actually measure resilience. So we have a system. Let's say a multi agent system and we have these adversarial

- 01:12:40Actors these non Gaussian, type, type events.
- 01:12:45So you gave, you gave an example of strong pack where you're going to say, well, you want your algorithm to still have the right expectation
- 01:13:01But sometimes it really in an adversarial situation you might not be able to prove that so what what work. What can you actually say about how do you measure give some number two how resilient resilient. The system is so

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Moshe Y. Vardi
01:13:17I think that a. In this case, I don't have a direct answer, but I have, I think, a clear indirect answer, which is, I think,

- 01:13:24A launching some kind of program for the study of resilience that that's exactly what I think size can do. Okay, so this I'm in some areas, I don't have a
- 01:13:35Very good answer, but I think we have not been we have paid for 70 years we've been attention to efficiency.
- 01:13:42in certain contexts, of course, we will teach to resilience, as I said, the design of the internet is about to Syria.
- 01:13:47People do distributed system talk a lot about fault tolerance. So in certain parts of computer science, you find a lot that's in machine learning machine learning.
- 01:13:56But I think we need to to take resilience now is something that we need to study and maybe it's a maybe there are you know efficiency we translate it mostly to a small number of answer resource usage and how close we are to optimal
- 01:14:12It's not clear that in the dizziness will have again such small number of answer, maybe it's a more complicated. This would be more answers.
- 01:14:20But I think this is a there is, I would say, is that a, let's see, down in and launch size program on resilience
- 01:14:28I mean, recently, if you think about the size for with the acronym people or something like that, which is the size program force essentially for scalability.
- 01:14:37Or so in some sense for in particular because of Moore's law or the death of Moore's law that slow down or whatever you want to call it.
- 01:14:45How do we, how do we continue to to move the scalability. A angle. So, which is again about efficiency. Let's have a program. Let's have spoken about efficiency cost Directorate.
- 01:14:56People in different fields, all the way from the theory, same way that the theory people now studying bias. For example would be by us becoming our technical technical field.
- 01:15:06Let's look at resilience algorithmic resilient systemic machine learning resilience system as Ian with the agents resilience
- 01:15:14I think this this. I said, I just give one tiny example, your research problem, but I think that we need to unleash people say creativity to study resilience

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Henry Kautz
01:15:26Okay, that that's actually a great idea. And I want to remind people that for the NSF people only at 4pm Eastern Time. Today we have an office hour
- 01:15:40With launch party and there's a separate link, you should have received for a different different zoom meeting for this drop into discuss and I know I'll be there. And I'd like to actually
- 01:15:53Go into depth with with with them about this idea about how to shape shape or program.
- 01:16:01I'm
- 01:16:02To see a few more questions.
- 01:16:08One is in your sort of wide ranging thoughts about resiliency economics. Have you also been looking at information from neuroscience about how the brain that's resilient.
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Moshe Y. Vardi
01:16:25No, I think that's a. So the brain actually is a good example. I think, I think that's a I like this suggestion. I mean, one of the. We know, for example, you know, this part of biology, the brain is resilience in a set like brain plasticity means that you lose part of the brain.
- 01:16:44And other parts. Take the all of that part. So there was a
- 01:16:50I read the case in the case of years ago about this woman that always has some she has some problem with with walking in gate and eventually as an inner 20s that finally the MRI and it turned out that she lacked one hemisphere, she only had one hemisphere of the brain.
- 01:17:08And she grew up not not hundred percent norm, but almost normal, this is, this is just mind blowing that you can just have half the brain and still have some problem but but by and large before be functional in generally, in fact, my understanding is, again, I'm not a, not a
- 01:17:30Not a biologist, or an anatomy, but my understanding is part of what's happening aging. There are a lot of the body has a lot of kind of spare capacity lot of redundancy.
- 01:17:39And as we age, we lose some of the redundancy in the fall, we lose resilience. As we age, we lose resilience, because we have lost, we are using spare parts.
- 01:17:49And as we lose redundancy will lose resilience. So all of us became a bit more fragile.
- 01:17:55As we get older. And part of it, losing redundancy. So the body does it by month by redundancy and adaptability. So these are I think the two elements but again there are people who I'm sure know much more about me bodies and me.
- 01:18:09But yes, I think, I think biology has done a lot for resilience. Even the level of the organism. And again, I think, to me, the first principle of resilience is redundancy.
- 01:18:22And there are other computer science, you know, we have a whole product. Great. Redundant Array of independent these where we have redundancy is a fundamental design principle.
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Henry Kautz

01:18:33And I guess are related to this, this notion of redundancy and also how nature does things he mentioned genetic algorithms and so generally a genetic algorithm will provide

- 01:18:47Many different solutions because typically a problem will have many different retail optimal solutions. If you get a whole slew of those were
- 01:18:57As is a sort of the greedy approach will get you one one really solution. So it's really just a confusion between efficiency and greed like that it's it's really like the idea that that
- 01:19:17It's not, it's not the need to be inefficient. Maybe it's just not to to keep a singular focus on a single dominate mating strategy.

Moshe Y. Vardi

01:19:30So, you know, it will be, you know, for example, I remember when

- 01:19:36That after a because of the Y2K there was a need to replace
- 01:19:43A control boxes in the power of the raid.
- 01:19:48And before that, there was a gazillion different control boxes because it just organically different companies put different control boxes and one other thing that happened is that became the the control plane kind of the pocket became much more of a mono culture.
- 01:20:05And because of that, it became much less resilient become much more vulnerable because it means you only need to know how to attack very small number of have a type of control unit.
- 01:20:15So again, when we, when you focus on on the best you end up. This is the remember when the inefficiency of being efficient you narrow the set of solutions.
- 01:20:28And many darn cases where we need to have just answer would be to have diversity of solution. In fact, one of the when we talk about a the argument why we need in society to promote diversity.
- 01:20:42That really two arguments to decide. One is the diversity is, I would say one argument is, is a social justice argument why diversity is it's just a social justice, to be fair to more people.
- 01:20:54There's almost always the other side the business argument for diversity, which is more diversity creates more perspectives and more perspective leads to better decision making.
- 01:21:05And, you know, many we need to think about it again. Do we want system that are just monolithic one particle many different implementation or different optimization criteria I am trying to you to not come up with answers, but to open the door to ask you more questions.

Henry Kautz

01:21:24Okay. I'd like to inject

- 01:21:26I hope you. I hope you saw are going strong. We have about five more minutes.

Moshe Y. Vardi

01:21:31This is

Henry Kautz
01:21:32A really exciting conversation like to inject I would have my own questions again. So during this pandemic decided to

- 01:21:41Do some programming and just learn some some modern programming. So I learned
- 01:21:50A Java, JavaScript programming and created some, you know, some demos and things and and then was greatly
- 01:22:02Like learning discovering TypeScript which attempts to put some structure on top of JavaScript. But what it was struck me as his boy.
- 01:22:11JavaScript like Python is essentially a zero security language. You cannot write secure code because at runtime.
- 01:22:21Any little any function, you'll call can go in and start mucking around with sort of other with other objects and functions.
- 01:22:30And I just don't see how you could have any secure guarantees about a programmer to either
- 01:22:36A language and yet they've really taken off because there's very low friction and and then they're trying to bolt on security with things like TypeScript, but it's just after the fact and and really not as effective.
- 01:22:54As it has a programming language community kind of let us down in the sense that, you know, there's all this
- 01:23:01All these programming languages, which you can, it's easier to write correct programs, but they they they not caught on. Because to the extent that the Python and TypeScript have caught on. Because there. There's just a little bit more friction there.
- 01:23:20So do we need to rethink programming languages to get both that
- 01:23:25The, the frictionless mere frictionless, but also get something that that you can actually prove your code is right.

Moshe Y. Vardi
01:23:34So, you know, remember this, this email, quote, it's really a verbatim quote for me. Even the type was our verbatim from that email from from from this nameless colleague

- 01:23:48That security is always kind of an afterthought. And I remember hearing an interview, many years ago was an architect to design high rise building
- 01:23:58And he said the following metaphor. He said, imagine that you have 100 story tower.
- 01:24:03You already designed it, and then they asked you to add one more floor. They wanted to be handled in one
- 01:24:11So you think, OK, I've already had this design 400 stories. All I do is add one more the top
- 01:24:17He said this is the wrong way to think about it left to sing that the one that you add is at the very bottom. So you have to like 100 stories and lift them and stick one Florida bottom
- 01:24:29So that's really, but if you built a system. And I would say now late and security. It's too late.
- 01:24:37And I think it. I wouldn't blame just the PL people I think as a community, we have just not taken security seriously enough. We didn't start with with first do no harm.
- 01:24:50They should be, I think that we should have some kind of First do no harm. First first suspects security and privacy. Now let's talk about what feature, you would you want to add in

- 01:24:59We didn't do it. We assume you can add them all. Look, these are designed this design flaws. I think the internet is one of the biggest thing since sliced bread. But we basically say, we'll put security at the application level doesn't work. We know that now.
- 01:25:15I mean, you look at a Intel discover the data security flaws and it's Michael architectural is it's a you know people discover now with all these say all the security a all these attacks side channel attacks that are very, very, very cold because they have focused on efficiency.
- 01:25:34And so we need to start thinking from, how do we build secure systems.
- 01:25:40And we need to put security say we need to say security and privacy fails, let's let's build nothing unless you don't do told me how you're going to from day one. We think about security and privacy.
- 01:25:51Then you start adding other features because and the same thing if you just want to make the programming easy and security will come by higher level put on top of it. It's not going to work.
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Henry Kautz
01:26:02And said, I wish we had a lot more time because I think that's exactly right. And, but how the question is how do we, I guess.
- 01:26:13make that happen because we as academics, we can
- 01:26:17We can proclaim that and we can tell our students to do it. But of course, there's this big commercial world out there. And so there might need to be some some sticks, as well as carrots involved.
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Moshe Y. Vardi
01:26:31Look part of of the cyber libertarian a attitude. Look at every, every, every competing product that that you use, and look at the license and look at the disclaimer of liability in the license.
- 01:26:46And you will never drive a car, we will have the same disclaimer of liability when it comes to cars. It's called it's it's it's a disc profile Poldark
- 01:26:56And it used to be the presumption was buyer beware caveat emptor but we
- 01:27:02Throw out a sequence of cases and legislation in one step at a time. We understand that we are live today, such as 252 technologically sophisticated society.
- 01:27:11You cannot tell people check your uncle your backers check make sure that it is safe. Know you buy a new car at least use cameras and different model, but this is a new car they respond this the strict liability of the manufacturer
- 01:27:25But when it comes to computing technology, somehow we covered an exception. No, no, no, we are not responsible. Why is that why should we be held.
- 01:27:34To a higher standard than people who make we make a vacuum cleaner. They are more they have more liability.
- 01:27:41Then that people who make today product it on on this world. Okay. And so I think the stick would be. Let's start with liability laws. Why should we have an exception. Why are we so privileged to have this exception that no no other industry has

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Henry Kautz
01:27:57That that's that's a great comment, we've run out of time. This is then fabulous I you have many comments on the Q AMP. A that just saying, great job. I want to read one

- 01:28:11That really calls out something special about your talk. It says you have to be a boss to do a whole size Distinguished Lecture in Comic Sans font ordered by vintage Tetris.
- 01:28:25So, so instead we we appreciate that and, you know, especially those of us who really like Comic Sans. And have you know we've been bullied over the years that it's a terrible font, but it actually it's a really nice readable.

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Moshe Y. Vardi
01:28:41Comic Comic Sans. I get the people who love it. The people who hate it. To me it looks personable.

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Henry Kautz
01:28:48Exactly. Okay. So I'll see you again at four o'clock, and thank you. If you enjoyed this webinar, please stay tuned for our webinar series.

- 01:29:03next webinar will be Krysta Svore from Microsoft, who will be talking to us about quantum she leaves a quantum computing group where they're actually building quantum computers at Microsoft.
- 01:29:20And then we'll have a whole series of monthly speakers all online for your viewing pleasure in the coming months. Take care everyone stay so

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Moshe Y. Vardi
01:29:30Just do me a favor. If somebody can copy the chat and send me the chat.

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Henry Kautz
01:29:35Will do.

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Moshe Y. Vardi
01:29:36Okay, see you see what this afternoon.