

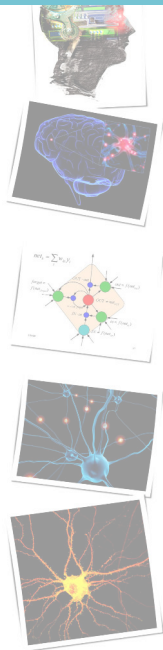
# AI and Society

## In search for an alternative modernity

Spyros Samothrakis  
ssamot@essex.ac.uk

Deputy Director of IADS and Senior Lecturer CSEE  
University of Essex

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# INTRODUCTION

- ▶ A 60 minute presentation
- ▶ Followed by brainstorming/discussions
- ▶ I've cited everything as thoroughly as I could, if you think something has not been cited adequately please let me know
- ▶ I will focus mostly on production and consumption
- ▶ Feel free to e-mail any comments you might have!
  - ▶ My current understanding has greatly improved through discussions

## THE LIVING AS INSTRUMENTS

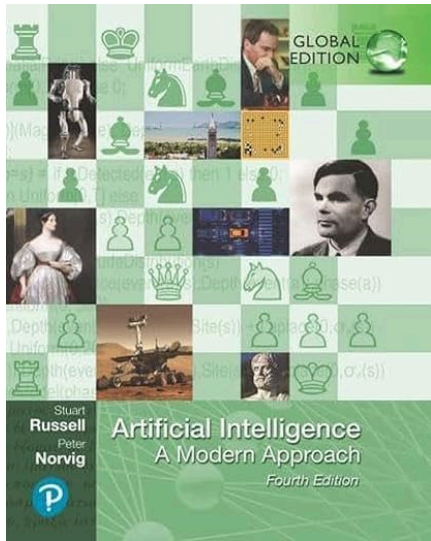
...“now of instruments some of them are alive, others inanimate; thus with respect to the pilot of the ship, the tiller is without life, the sailor is alive; for a servant is as an instrument in many arts. Thus property is as an instrument to living; an estate is a multitude of instruments; so a slave is an animated instrument, but every one that can minister of himself is more valuable than any other instrument; for if every instrument, at command, or from a preconception of its master's will, could accomplish its work (as the story goes of the statues of Daedalus; or what the poet tells us of the tripods of Vulcan, “that they moved of their own accord into the assembly of the gods”), the shuttle would then weave, and the lyre play of itself; nor would the architect want servants, or the master slaves”

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Aristotle's Politics, Book I, Chapter 4,  
<https://www.gutenberg.org/cache/epub/6762/pg6762-images.html>

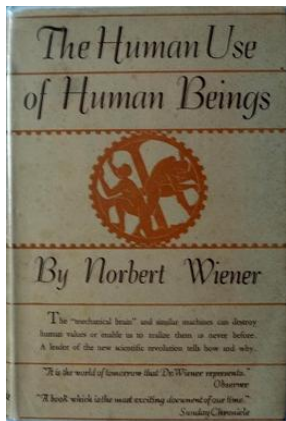
# ARTIFICIAL INTELLIGENCE (AI)

- ▶ Historically, a field of science named after a workshop (“Dartmouth Summer Research Project on Artificial Intelligence”, 1956)
- ▶ Overall goal has been somewhat vague, but broadly replicate human intelligence within a machine
- ▶ Subsumed and/or complemented fields like logic, complex systems, cybernetics, robotics, machine learning, *natural language processing*



# GOAL I: HEDONISM WITHOUT SIN

- ▶ Freedom from want
  - ▶ Material abundance
  - ▶ Cheap and good housing, cheap and high quality food, cheap clothes
- ▶ Freedom from labour
  - ▶ Hobbies 9.01-17.00, resting 17.01-21.00, social venues 21.01-01.00, followed by sleep
- ▶ Freedom from sin, no living instruments!
  - ▶ “Sin, young man, is when you treat people like things. Including yourself.”, *Terry Pratchett, Carpe Jugulum*

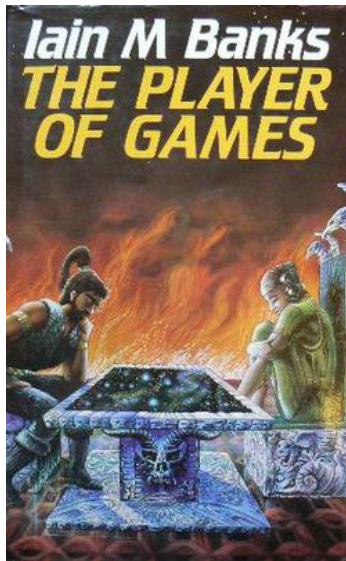


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Wiener, Norbert. "The Human Use of Human Beings: Cybernetics and Society." (1950).

## GOAL II: DIVINE GUIDANCE

- ▶ Summoning a supra-intelligent being
  - ▶ Creates a wonderful reality, fixes all our problems
    - ▶ All alchemical dreams are fulfilled (incl immortality)
  - ▶ Strongly apocalyptic/religious vibes
    - ▶ An omniscient, omnipresent and benevolent disembodied entity (A(G)I)
- ▶ *The Culture Series by Ian Banks captures this trope*



# EXAMPLE VISION (NHS 2019)

## Salma in 2019, aged 48:



Salma, a senior paramedic, is a team leader in a large city. She is frequently frustrated by the lack of patient information accessible at the scene of an emergency. Furthermore, she would like to be able to provide A&E departments with better real-time information on the patients she is treating, in advance of their arrival at A&E department, in order to streamline the handover and treatment process.

Salma is determined to increase her knowledge and skillset to deploy health technologies at work. She has researched how digital health tools could improve healthcare, but has yet to see significant change or investment in technology that improves her working life. Salma participated in the comprehensive NHS consultation process aiming to capture workforce opinions on their competencies and challenges in adoption of technology.

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Preparing the Healthcare Workforce to Deliver the Digital Future, Topol, Eric and others, <https://topol.hee.nhs.uk/>

# EXAMPLE VISION (NHS 2029)

## Salma in 2029, aged 58:

Salma has seen her work transformed by the impact of digital technologies. She is transported in an autonomous ambulance that drives the most efficient route to an emergency, improving response times. On receiving the patient details, Salma gains immediate access to the integrated electronic patient record that is projected onto a digital display, providing information on medical history, allergies and pharmacogenomics profile.

Salma's smartwatch and smartphone, enabled with mobile vital signs and an ECG reader, and AI-augmented ultrasound scanner, facilitate real-time monitoring and diagnostics. All the data captured are immediately transmitted to the hospital-based team who, with the help of machine learning algorithms providing decision support, can advise, plan and prepare any additional treatment prior to the patient's arrival.

Salma receives regular education and training updates on innovation in clinical practice hosted within clinical skills hubs, which model how technology and health data can best be used to improve patient care.



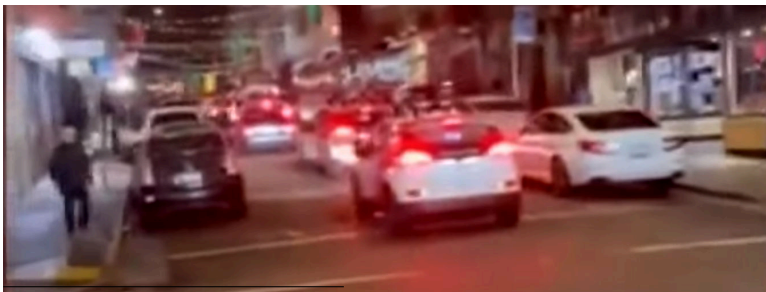
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Preparing the Healthcare Workforce to Deliver the Digital Future, Topol, Eric and others, <https://topol.hee.nhs.uk/>



# AUTONOMOUS AMBULANCES AND TRACTORS?!

- ▶ Self-driving cars have been promised continuously since 2010
  - ▶ ...some executives are now abandoning them altogether
- ▶ Optimistic view is that they will be ready in 2035



Stalled self-driving taxis clog streets of San Francisco (July 2023)

<https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/autonomous-drivings-future-convenient-and-connected>

<https://techcrunch.com/2023/10/24/dmv-immediately-suspends-cruises-robotaxi-permit-in-california/>

# ADVICE?!

“Except that was not the reality. One of IBM’s high-profile partnerships with MD Anderson Cancer Center in Texas fell apart. A doctor involved said that there wasn’t enough data for the program to make good recommendations, and that Watson had trouble with the complexity of patient files. The partnership was later audited and shelved. What went wrong?”

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How IBM’s Watson Went From the Future of Health Care to Sold Off for Parts <https://slate.com/technology/2022/01/ibm-watson-health-failure-artificial-intelligence.html>

# NOT JUST CARS...

- ▶ Manufacturing
  - ▶ Adidas closed down their lights-out factories
- ▶ Agriculture
  - ▶ Agricultural work is still done by hand
- ▶ Clothing
  - ▶ Stitched together in the global south by humans
- ▶ Healthcare
  - ▶ No robotic radiographers
- ▶ Warehouses
  - ▶ Amazon is still using humans to pack and deliver

## **Living instruments still in use, but far away**

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Adidas is closing hi-tech sneaker factories in Germany and the US ,  
<https://edition.cnn.com/2019/11/12/business/adidas-speedfactory-plants-closing/index.html>

# SUCCESS AS “PRACTICAL STATISTICS”

- ▶ Manufacturing
  - ▶ Automated ordering of new parts
- ▶ Agriculture
  - ▶ When to harvest crops
- ▶ Clothing
  - ▶ Designing shoes
- ▶ Healthcare
  - ▶ Analysing health records
- ▶ Warehouses
  - ▶ Coordinating workers, helping with sorting items

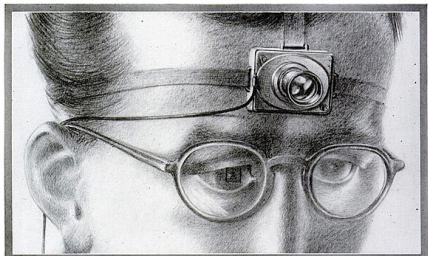


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T-test history blog post  
AI-Generated Fashion Is Next Wave of DIY Design ,  
<https://spectrum.ieee.org/dall-e-fashion-design>

# SUCCESS IN SEARCH AND NORMAL COMPUTING

- ▶ Quite a bit of what has been historically called AI is now part of normal computing
- ▶ Web searches have improved
  - ▶ ... but advertising is getting on the way
- ▶ We can process data far more efficiently and accurately
- ▶ Excellent online services, automation inside the computer



A SCIENTIST OF THE FUTURE RECORDS EXPERIMENTS WITH A 1931 CAMERA FITTED WITH UNIVERSAL-FOCUS LENS. THE SMALL SQUARE IN THE FOREGLASS AT THE LEFT SHOWS THE OBJECT

## AS WE MAY THINK

A TOP U.S. SCIENTIST FORESEES A POSSIBLE FUTURE WORLD  
IN WHICH MAN-MADE MACHINES WILL START TO THINK

*(Data) Postwar ambitions and dreams have been largely realised*

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Bush, Vannevar. "As we may think." *The atlantic monthly* 176.1 (1945): 101-108.

# ROBOTS ARE HARD – MORAVEC'S PARADOX

*“Encoded in the large, highly evolved sensory and motor portions of the human brain is a billion years of experience about the nature of the world and how to survive in it. The deliberate process we call reasoning is, I believe, the thinnest veneer of human thought, effective only because it is supported by this much older and much powerful, though usually unconscious, sensor motor knowledge. We are all prodigious **Olympians in perceptual and motor areas**, so good that we make the difficult look easy. **Abstract thought, though, is a new trick**, perhaps less than 100 thousand years old. We have not yet mastered it. It is not all that intrinsically difficult; it just seems so when we do it”*

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Moravec, Hans. Mind children: The future of robot and human intelligence. Harvard University Press, 1988.

# UBER

*Uber sold their self-driving cars division, but algorithms predict arrival times, help with bookings etc, i.e. technological success in the “virtual”, failure in the “real” .*

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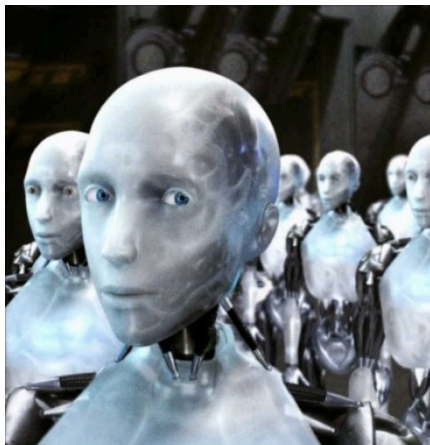
After Once Touting Self-Driving Cars, Uber Sells Unit To Refocus On Core Businesses,

<https://www.npr.org/2020/12/07/944004278/after-once-touting-self-driving-cars-uber-sells-unit-to-refocus-on-core-business>

Uber self-driving car test driver pleads guilty to endangerment in pedestrian death case, <https://edition.cnn.com/2023/07/29/business/uber-self-driving-car-death-guilty/index.html>

# HOW FAR AWAY FROM TOTAL HUMAN REPLACEMENT?

“The bar is high: AGI as defined by the contest - something like AI that can perform nearly all valuable tasks at human cost or less - which we will call transformative AGI is a much higher bar than merely massive progress in AI, or even the unambiguous attainment of expensive superhuman AGI or cheap but uneven AGI.”



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Allyn-Feuer, Ari, and Ted Sanders. "Transformative AGI by 2043 is  $< 1$ ,  
<https://arxiv.org/pdf/2306.02519.pdf>



## SO WHY THE SUDDEN HYPE?

- ▶ Large Language Models (LLMs) with chat interfaces (i.e. chatGPT), that are really good for some tasks, e.g. supporting programmers, authors
- ▶ Text to image/videos (image from twitter)



- ▶ *Had you told me 10 years ago that the future of AI would be (bad) media production, I would have not believed you*

# THE GOOD LIFE IN THE 50S

**Had you gone 70 years back, focusing so intensely on media production would have been unthinkable**

*"Europeans will understand the basic dignity of separate bathrooms, hot and cold running water, an abundance of sunlight and electric light, air, space, and green surroundings. And they'll understand, as some of our own intellectuals do not, the freedom offered by washing machines and dishwashers, vacuum cleaners, automobiles, and refrigerators"*

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Haddow, Robert H. "Pavilions of plenty: exhibiting American culture abroad in the 1950s." (1997)., p44

# MAYBE THE PROMISE HAS NOT BEEN FULFILLED?

House prices as a multiple of average earnings

Schroders



Note: All data is based on calendar year averages apart from most recent, which is as at 30 November 2022.  
Source: Bank of England, Land Registry, Office for National Statistics, and Schroders. 607178

What 175 years of data tell us about house price affordability in the UK,  
<https://www.schroders.com/en-gb/uk/individual/insights/what-174-years-of-data-tell-us-about-house-price-affordability-in-the-uk/>

# JUST HOW BAD IS IT?

- ▶ Cheap toys/simulations
- ▶ Expensive necessities

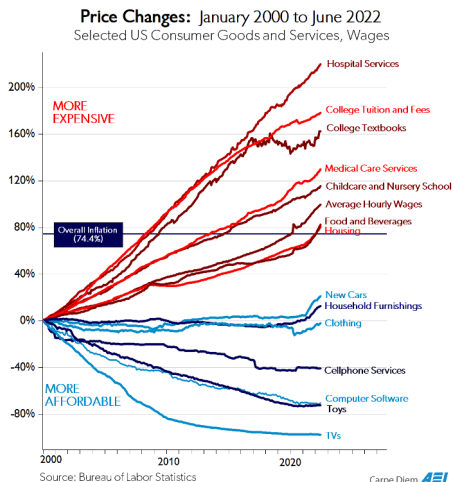


Chart of the Day . . . or Century?,  
<https://www.aei.org/carpe-diem/chart-of-the-day-or-century-8/>

# HISTORICAL ALTERNATIVES. . .

*“Planning was socialism’s supposed advantage. But East Germany’s first planners had no idea how a planned economy should function in practice. Until **1954**, no standard text on a planned economy existed, not even in the Soviet Union. Planners could, of course, study the Soviet Union in action, but many wondered whether a model based. . .”*

**Alternatives competed, but ultimately failed to bring forth the “good life”**

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Kotkin, Stephen. *Uncivil society: 1989 and the implosion of the communist establishment*. Vol. 32. Modern Library, 2010.

# END RESULT

**Table 14.11** *East German opinion on better and worse under capitalism and socialism, Spring 1994 (per cent)*

Category	Better now	Better in the GDR
* Commodity supply	98	1
Choice of papers	96	1
Travel	95	2
Possibility of independence	93	2
Expression of one's opinion	68	6
TV programmes	59	14
Leisure supply	52	26
Possibility of further education	46	23
Food prices	35	43
Health service	32	39
Free to choose education and occupation	30	36
Security of pensions	29	43
Future prospects	24	57
Occupational opportunities	23	60
School education	22	36
Supply of interesting jobs	20	63
Child-raising	8	49
Traffic safety	7	83
Safety in event of crime	3	93
Sense of community	3	87
* Rent	2	94

Source: Institut für Demoskopie Allensbach, *Frankfurter Allgemeine Zeitung*, 14.4.94, p. 5.

Therborn, Goran. "European modernity and beyond: the trajectory of European societies, 1945-2000." *European Modernity and Beyond* (1995): 1-416.

# EXISTING ECONOMICS ARE MARKET ECONOMICS

- ▶ Non-market economies are retreating (!)
- ▶ We have an impasse
  - ▶ Non-market solutions are de-legitimised, often quite literally: it is illegal for states to actively intervene in the market
- ▶ Proposing new solutions and actively implementing them is almost impossible
  - ▶ There is no indication that this is likely to change
- ▶ Socialist economies are moving towards the market, as the only way to achieve “the good life”

*Our current state of affairs favours things to stay as they are*

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Cuba is considering letting Cuban Americans own private businesses on the island, <https://www.miamiherald.com/news/nation-world/world/americas/cuba/article279649829.html>

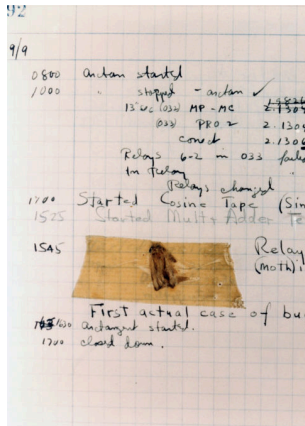
# WHAT NOW?

- ▶ Double whammy
  - ▶ No mechanic slaves and no omniscient masters
  - ▶ No serious social movements that aim to reconfigure the world
- ▶ Resign and accept that all we are going to get is treats
  - ▶ I do not think the fears of Ellul or Huxley have materialised
- ▶ Maybe have a look at using AI to help with achieving post-war dreams?
  - ▶ Given current limitations, not fantasy models



# PLANNING (I)

- ▶ Wassily Leontief
  - ▶ Russian-born American economist
  - ▶ Nobel Prize in Economics in 1973
  - ▶ Initial models using Harvard mk.II (where the first computer “bug” was found!)
- ▶ Neurath, Castoriadis, Cockshot/Cottrell
- ▶ Central planning was not completely delegitimised until the mid-1970s
  - ▶ Still some talk among circular economy and green circles



Leontief, Wassily. "National economic planning: methods and problems." Challenge 19.3 (1976): 6-11..

<https://www.tandfonline.com/doi/pdf/10.1080/05775132.1976.11470215>

## PLANNING (II)

- ▶ (Was) Popular in quite a few western European countries
  - ▶ e.g. Commissariat général du plan
    - ▶ “Indicative planning”
  - ▶ British Industry until 1978?
- ▶ Still some leftovers here and there
  - ▶ Citizen initiatives (e.g. <https://www.ifixit.com/>)
  - ▶ Digital product passes

“To provide new business opportunities to economic actors through circular value retention and optimisation (for example product-as-a-service activities, improved repair, servicing, remanufacturing, and recycling) based on improved access to data”

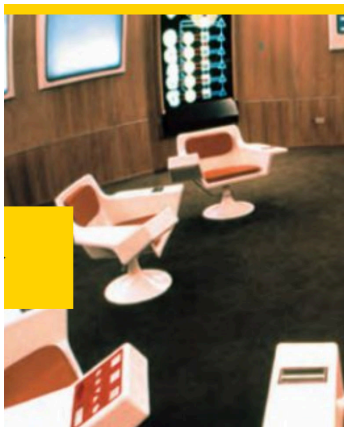
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Digital Product Passport,

[https://hadea.ec.europa.eu/calls-proposals/digital-product-passport\\_en](https://hadea.ec.europa.eu/calls-proposals/digital-product-passport_en)

# OUTSIDE OF WESTERN GOVERNMENTS

- ▶ Soviet GOSPlan
- ▶ Cybersyn in Chile
- ▶ I am not aware of any modern non-western efforts
- ▶ Inside corporations
  - ▶ Enterprise Resource Planning, corporate inventories
    - ▶ Really sophisticated real-time systems that can predict future trends, order components, guide production



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Medina, Eden. Cybernetic revolutionaries: technology and politics in Allende's Chile. Mit Press, 2011.

<https://www.tandfonline.com/doi/pdf/10.1080/05775132.1976.11470215>

# IN-NATURA PLANNING (I)

## Ingredients

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225g [softened salted butter](#), plus extra  
for the tins

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125g [golden caster sugar](#)

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100g [light brown soft sugar](#)

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1 tsp [vanilla extract](#)

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4 [large eggs](#)

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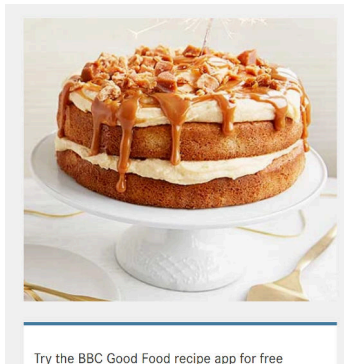
225g self raising flour

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2 tbsp [milk](#)

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[toffee](#), chocolate or caramel pieces, to



Try the BBC Good Food recipe app for free

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## Easy caramel cake

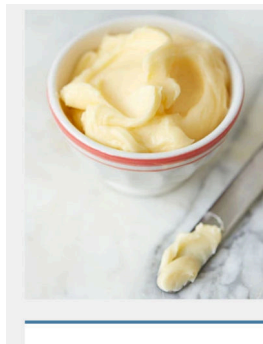
<https://www.bbcgoodfood.com/recipes/easy-caramel-cake>

## IN-NATURA PLANNING (II)

- ▶ Let us assume you would need to make 5K cakes per day
  - ▶ You would need to multiply the quantities in the recipe + labour
- ▶ You would also need to find recipes for butter, sugar, etc
  - ▶ These are generally called intermediate products
- ▶ The quantities for building a single cake are called “technical coefficients”
  - ▶ 600g of double cream + churning for 1 hour make 200g of butter
- ▶ You project demand into the future and calculate quantities needed to satisfy it

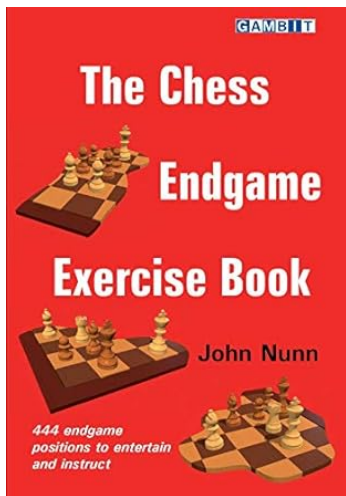
How to make homemade butter

<https://www.bbcgoodfood.com/recipes/home-churned-butter>



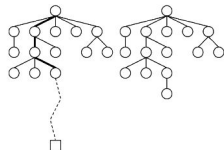
# AI PLANNING (VS ECONOMIC PLANNING)

- ▶ Choosing how to act based on deep thinking
  - ▶ You simulate future events, and find optimal actions
- ▶ End-games in Chess
  - ▶ There is an optimal route of actions to take
- ▶ Actions are production processes
  - ▶ How do we build cakes?
  - ▶ Are cakes with different material configurations more or less satisfactory? Or just different?



# AI PLANNING (VS ECONOMIC PLANNING)

- ▶ **AI planning is more or less equivalent to looking for what is best process to build a cake, closer to corporate R&D**
- ▶ Modern systems re-plan every “tick”
  - ▶ Usually a fast neural network model coupled with slow tree search
- ▶ You would need a model of human preferences for an 1-1 mapping, which nobody has any idea how to construct



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Browne, Cameron B., et al. "A survey of monte carlo tree search methods." IEEE Transactions on Computational Intelligence and AI in games 4.1 (2012): 1-43.

Anthony, Thomas, Zheng Tian, and David Barber. "Thinking fast and slow with deep learning and tree search." Advances in neural information processing systems 30 (2017).

# GENERAL PROBLEMS WITH MODELLING (NATIONAL DATA)

- ▶ We do not know the coefficients!
  - ▶ There are currently no statistics, apart from very high level national input-output tables
    - ▶ Mostly useless for fine-grained control
- ▶ No notion of time!

	CPA Product	CPA_A01 Products of agriculture, hunting and related services	CPA_A02 Products of forestry, logging and related services	CPA_A03 Fish and other fishing products; aquaculture products; support services to fishing
CPA	Product			
CPA_A01	Products of agriculture, hunting and related services	4,219	1	0
CPA_A02	Products of forestry, logging and related services	86	210	0
CPA_A03	Fish and other fishing products; aquaculture products; support ser	0	0	0
CPA_B05	Coal and lignite	0	0	0
CPA_B06 & B07	Extraction Of Crude Petroleum And Natural Gas & Mining Of Meta	2	0	0
CPA_B08	Other mining and quarrying products	0	0	0
CPA_B09	Mining support services	0	0	0
CPA_C101	Preserved meat and meat products	10	1	0
CPA_C102_3	Processed and preserved fish, crustaceans, molluscs, fruit and veg	4	0	0
CPA_C104	Vegetable and animal oils and fats	0	0	0
CPA_C105	Dairy products	7	0	0
CPA_C106	Grain mill products, starches and starch products	0	0	0
CPA_C107	Bakery and farinaceous products	12	1	0
CPA_C108	Other food products	0	0	0

<https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltables/detailed>



# GENERAL PROBLEMS WITH MODELLING (OPENLCA)

**Inputs/Outputs: Chicken pasta**

**Inputs**

Flow	Category	Amount	Unit	Costs/Rev.	Uncertainty	Avoided wa.	Provider	Data qualif.	Descript.
f Olive oil, extra virgin, processed ...	Fats and oils/Vegetable ...	10.00000	g		none		P Olive oil...		
f Chicken, breast, without skin, co...	Cooked meat/Poultry	400.00000	g		none		P Chicken...		
f Tomato paste, double concentra...	Vegetables/Vegetables...	50.00000	g		none		P Tomato...		
f Dried pasta, gluten-free, cookes...	Pasta, rice and grains/Fl...	300.00000	g		none		P Dried pa...		
f Water (fresh water)	Resource/in water	3.00000	kg		none				
f Salt, white, for human consumpt...	Miscellaneous/Salts	2.00000	g		none		P Salt, whi...		
f Mediterranean spices		10.00000	g		none				

**Outputs**

Flow	Category	Amount	Unit	Costs/Rev.	Uncertainty	Avoided pr.	Provider	Data qualif.	Descript.
f Chicken pasta		1.00000	kg		none				
f Waste water	Emission to water/Imp...	2770.00000	g		none				

<https://www.openlca.org/>

[https://www.youtube.com/watch?v=DI\\_Pe3ZEzrY](https://www.youtube.com/watch?v=DI_Pe3ZEzrY)

Zeug, Walther, Alberto Bezama, and Daniela Thrän. "Life cycle sustainability assessment for sustainable bioeconomy, societal-ecological transformation and beyond." Progress in Life Cycle Assessment 2021. Cham: Springer International Publishing, 2023. 131-159.

## GENERAL PROBLEMS WITH MODELLING (II)

- ▶ What exists in the world and what exists inside the computer are different
  - ▶ Simulations are almost *never* accurate enough to allow for control (“sim2real problem”)
- ▶ One needs to be able to perturb the simulation extensively in order to create general controllers
- ▶ Physics are ruthless and unfair

**Some factories are easy to control, as they are man-made artefacts, and hence the model inside in the virtual is what exists in the real**

Solving Rubik's Cube with a robot hand  
<https://openai.com/research/solving-rubiks-cube>



# CONTROL IS NOT MEASUREMENT

- ▶ Let us assume you somehow managed model the system through observations
- ▶ We would still not be able to control the system!
  - ▶ **“When a measure becomes a target, it ceases to be a good measure”** - Goodhart’s law
  - ▶ “We will measure the quality of teaching by the number of students that get high grades”
    - ▶ Trivial to game!
- ▶ “Increase the number of cakes!”

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Teney, Damien, et al. "On the value of out-of-distribution testing: An example of goodhart's law." *Advances in neural information processing systems* 33 (2020): 407-417.

# NON-LINEARITY

- ▶ Reality is not linear
  - ▶ Making two cakes does not require just  $x2$  he quantities of labour and material
- ▶ You need one bench for  $\{1, 2, 3, 4, 5\}$  cakes, two for  $\{6, 7, 8, 9, 10\}$ 
  - ▶ Think pregnancy (two women will not give birth in 4.5 months)
- ▶ It is debatable if such details are captured in the input-output model

# PREFERENCES

- ▶ Leontief (and others) propose they should be put under vote
  - ▶ Never clear to me that preferences can be articulated
    - ▶ i.e. you might like something, but you do not know why
    - ▶ You probably do not know what you want
- ▶ Trends change all the time
- ▶ Obvious conflicts of interest all over the place
- ▶ Tons of different scoring/voting mechanisms
- ▶ Where do your preferences come from?
  - ▶ What is the role of advertising in creating desire?

# FUNCTION APPROXIMATION, CATASTROPHIC FORGETTING AND PLASTICITY–STABILITY

- ▶ Function approximation
  - ▶ Models are never exact, need to be approximated
  - ▶ The type of approximation you have creates biases
- ▶ Catastrophic forgetting
  - ▶ Humans forget, machines forget catastrophically
  - ▶ You train a robot how to drive, it forgets how to cycle
- ▶ Plasticity-stability
  - ▶ How much should you forget? How much should you remember?

# ALIENATION AND FEEDBACK MECHANISMS

- ▶ Who is making these cakes?
  - ▶ *Aaaah, but we are going to have democratic procedures in place*
  - ▶ ...or any mechanism of your choice
    - ▶ Cake makers are coerced, cake eaters do the coercion!
  - ▶ It's the cake making process that's boring
- ▶ Labour is not really fun
  - ▶ Especially if you have no control over it
  - ▶ It's not fun *even* if you have control over it

# WHAT NOW?

- ▶ Commodity power
  - ▶ Build intermediate products that are used as often as possible, standardise on them
- ▶ Decentralisation of production
  - ▶ Every household controls part of their own production
    - ▶ “Strictly no pre-packaged meals”
  - ▶ Household machines that would turn intermediate products into full final products
- ▶ Equivalence of process
  - ▶ You would never have the same meal twice

## **You might be far better off with a model that optimises multi-echelon inventories (working paper...)**

Samothrakis, Spyridon. "Artificial intelligence and modern planned economies: a discussion on methods and institutions." AI & SOCIETY (2024): 1-12. <https://link.springer.com/article/10.1007/s00146-023-01826-7>



# THIS IS WHERE PLANNING WILL REVERT TO BY DEFAULT



With the warm weather in Cuba, people could do without washing machine dryers. So they found other uses. These motors powered fans, lawnmowers, shoe repair tools and key copiers. They were used to chop vegetables and shred coconut. Photo by Ernesto Oroza. [See more photos of Cuban inventions here.](#)

# CAN WE CREATE A SCIENCE OF ALTERNATIVES?

- ▶ Write these standard planning textbooks!
- ▶ Have real, working examples of successful non-market economies to draw inspiration from
- ▶ Specialised venues and journals that deal with the topic
- ▶ Learned societies, whose aim is to develop the field further

Make a science out of the hunch that something better must exist!

# CURRENT STATE OF PLANNING

- ▶ The general idea is to work through simulations
  - ▶ One imagines a fictional economy, made up by fictional quantities
  - ▶ Runs simulations/optimisation algorithms
  - ▶ Picks up favourite optimisation method/agent-based simulation/game-theoretic model
- ▶ Adds a bit of a sauce
  - ▶ Regularisation, approximation, ...
- ▶ Whatever comes out of this is a **hypothesis**, not a statement about reality!

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Zheng, Stephan, et al. "The AI Economist: Taxation policy design via two-level deep multiagent reinforcement learning." Science advances 8.18 (2022): eabk2607.

## LINKS TO ARTIFICIAL LIFE

*A-life may already have achieved this goal, according to the evolutionary biologist John Maynard Smith of the University of Sussex. Smith, who pioneered the use of mathematics in biology, took an early interest in work at the Santa Fe Institute and has twice spent a week visiting there. But he has concluded that artificial life is “basically a fact-free science.” During his last visit, he recalls, “the only time a fact was mentioned was when I mentioned it, and that was considered to be in rather bad taste.”*

- ▶ The above approach is a leftover from the days of complexity theory
- ▶ *Debates without experimental data are of a theological bent*
- ▶ *Debates without data at all are pulp fiction*

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From Complexity to Perplexity Can science achieve a unified theory of complex systems? Even at the Santa Fe Institute, some researchers have their doubts, <https://www2.econ.iastate.edu/tesfatsi/hogan.complexperplex.htm>

# DATA ON CONSUMPTION

- ▶ We need a vector of commodities that we consider a societal minimum
  - ▶ Housing, electricity, food consumption
- ▶ On a really granular level (i.e. per product and product type)!
  - ▶ This should include services (i.e. when production and consumption happens more or less at the same time)
  - ▶ Time

What do people consume? How often do consumer products need replacement? What are the timelines of consumption? How is consumption spread around the world? What other forces impact it, beyond availability? What are the externalities of consumption? What kind of white goods should we be developing?

# DATA ON PRODUCTION

- ▶ Supply chains and supply chain optimisation
- ▶ Understand the forces of production close-up
- ▶ Again, data per production unit!

Who makes commodities? What are the production methods used? Where are commodities produced? What are the routes that bring them to our door? Where is labour needed? What kind of labour is needed? Where are we seeing advances in automation and heavy productivity gains (in terms of natural quantities)? How deep are the supply chains? What are the externalities of production?

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Hubbs, Christian D., et al. "Or-gym: A reinforcement learning library for operations research problems." arXiv preprint arXiv:2008.06319 (2020).

# HOW TO COLLECT SUCH DATA?

- ▶ Webscrape popular websites
- ▶ Data journalism / ship logs?
- ▶ Surveys and consumer reports
- ▶ Talk to the industry directly, talk to specialised academics
- ▶ Visit production sites

**You need a serious amount of funding to do this, which means grants**

# BENCHMARKS

- ▶ Even if completely in the virtual, different methods we come up need to be comparable with one another on a quantitative level
- ▶ Think the progress of computer chess, the drosophila of AI
  - ▶ Poker, Go, Starcraft, custom games, etc
- ▶ A set of benchmarks, with known flaws, but with clear goals
- ▶ Can focus community on groups of challenges that are meant to capture progress
- ▶ What would be the equivalent for (economic) planning?
  - ▶ How do we make sure it is not too abstract (e.g. includes time and changing preferences), but also not too granular?
  - ▶ Simulations? Real world data?
  - ▶ OpenLCA benchmarks?

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Perez-Liebana, Diego, et al. "The 2014 general video game playing competition." IEEE Transactions on Computational Intelligence and AI in Games 8.3 (2015): 229-243.



# WE NEED EXPERIMENTS!

- ▶ The above are still observational data!
- ▶ Why is this important?
  - ▶ What is the effect of smoking on life expectancy?
    - ▶ Force some people to smoke
    - ▶ Force another group of people not to smoke

You would need to collect some experimental-like data (otherwise, I can come up with (latent) confounders and reason against your conclusions forever)

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Pearl, Judea, and Dana Mackenzie. The book of why: the new science of cause and effect. Basic books, 2018.

# BUT DO WE? MAYBE WE NEED A NEW KIND OF SCIENCE OVERALL?

- ▶ Physics was successful because we could isolate system components and experiment ruthlessly in controlled conditions
  - ▶ Societies are nothing like this
  - ▶ In open systems, new types enter the fray all the time
  - ▶ It's like playing chess and a new kind of piece joins the game, and nobody knows how it moves and how it got there
- ▶ We can do exceptionally well in games and factories because the model *is* the system
- ▶ *Knightian uncertainty, not chaos or complexity is the issue!*

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Loasby, Brian J. "Closed models and open systems." *Journal of Economic Methodology* 10.3 (2003): 285-306.

Li, Tien-Yien, and James A. Yorke. "Period three implies chaos." *The theory of chaotic attractors* (2004): 77-84.

# CONCLUDING

- ▶ No general instruments (now or in the near future)
- ▶ Consumption and production need to be re-integrated at the household level
- ▶ We need machinery that can help us have creative lives at home
  - ▶ Not (just) of the hobby kind
  - ▶ Cook, build, weave, garden, construct, assemble
  - ▶ We should not plan for finished goods, but for ingredients and instruments
- ▶ **Knighthian uncertainty** (vs aleatoric and epistemic uncertainty)
- ▶ **Multi-echelon inventory / supply chains might be the right model to optimise...**

# QUESTIONS?

▶ Questions?