HCAIM@BME

Human Centered AI Masters
at the Budapest University of Technology and Economics

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humancentered-ai.eu

hcaim human centred artificial intelligence masters

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Motivations for Human Centered Regulation

Machines in the service of society

- It has been understood for centuries now that the wealth of societies is connected to their level of **technological sophistication**
  - human (or animal) efficiency can be surpassed by machines
- Industrial revolutions: the rise of the **machine maker** scientist/engineer
- 21st century: the rise of the machine maker with **humanities** skills

Rijn en Zon, Utrecht
(FREEPIK)

Internal pressures on Machine Makers
What is Human-Centered Design of machines?

What is not human-centered design?

Source: Elias Beck. *'Child Labor in the Industrial Revolution'*. History Crunch. December 30, 2021. https://www.historycrunch.com/child-labor-in-the-industrial-revolution.html#/

What is not human-centered design?

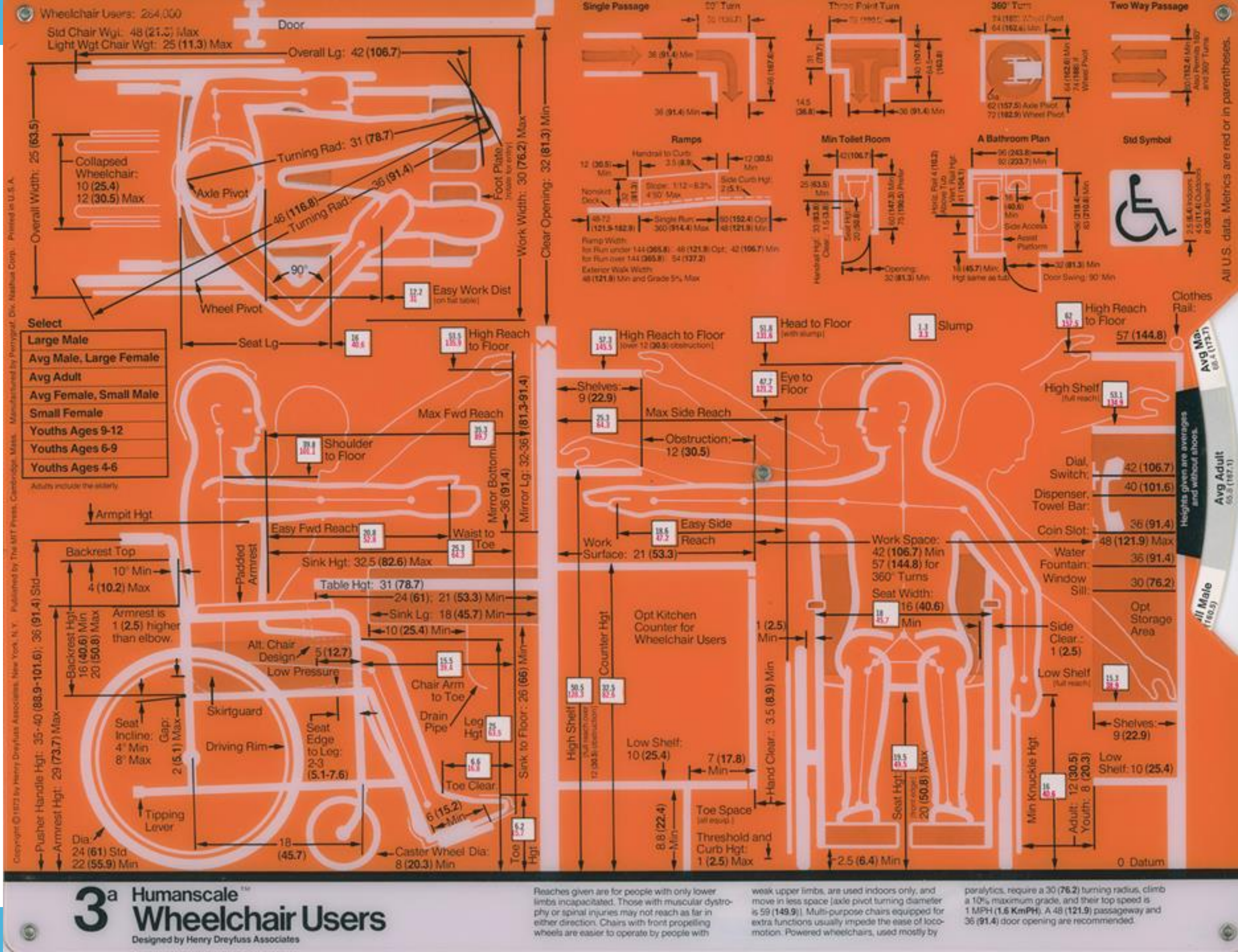
Gilbreth **chronocyclograph** of motions necessary to move and file sixteen boxes full of glass, n.d. From: Mike Mandel, *Making Good Time: Scientific Management, the Gilbreths, Photography and Motion, Futurism* (Santa Cruz, CA: California Museum of Photography, University of California, Riverside, 1989), 26.

What is the engineers role on all of this?

- Self-absolving strategy 1
    - “The imperative of technology” - This is what efficiency dictates
- Self-absolving strategy 2
    - This is what the customer wants
- Self-absolving strategy 3
    - It was legal at the time and by the way I don't know anything about law

- Human-Centered Design: **rejection of all the above**
    - **humanities toolkit**
        - **argumentation**
        - **critical thinking**

Beginnings of HCD



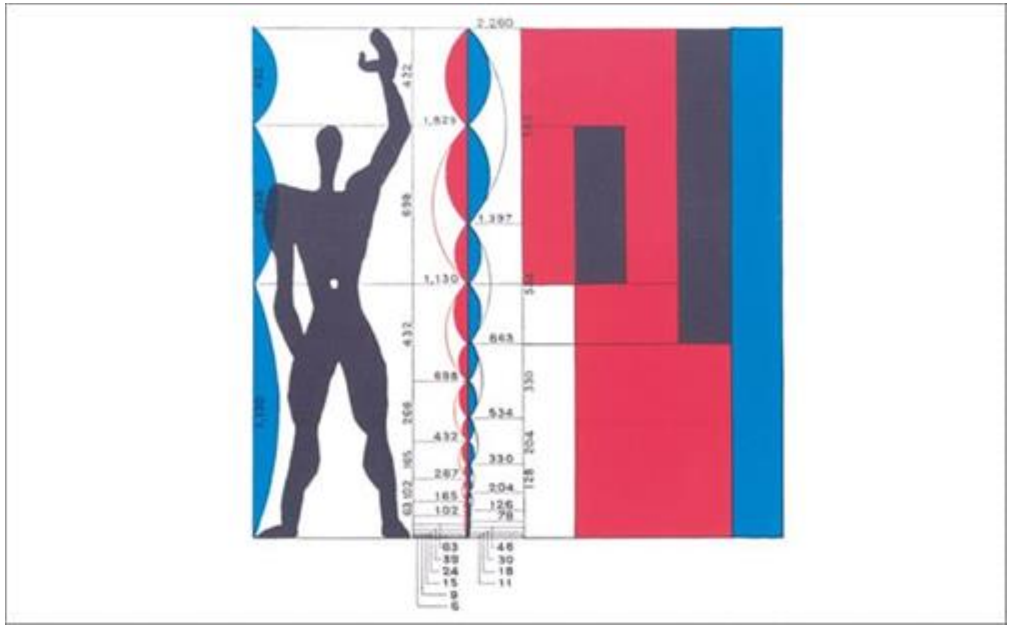
Wheelchair Users: 264,000
Std Chair Wgt: 48 (21.8) Max
Light Wgt Chair Wgt: 25 (11.3) Max
Door
Overall Lg: 42 (106.7)
Overall Width: 25 (63.5)
Collapsed Wheelchair: 10 (25.4) 12 (30.5) Max
Turning Rad: 31 (78.7)
Axle Pivot
36 (91.4)
46 (116.8) Turning Rad:
90°
Wheel Pivot
Seat Lg
Easy Work Dist
High Reach to Floor
Foot Plate
Work Width: 30 (76.2) Max
Clear Opening: 32 (81.3) Min
Single Passage
90° Turn
Three Point Turn
360° Turn
Two Way Passage
Ramps
Min Toilet Room
A Bathroom Plan
Std Symbol
Select
Large Male
Avg Male, Large Female
Avg Adult
Avg Female, Small Male
Small Female
Youths Ages 9-12
Youths Ages 6-9
Youths Ages 4-6
Adults include the elderly
Max Fwd Reach
Shoulder to Floor
Armpit Hgt
Easy Fwd Reach
Waist to Toe
Backrest Top
10 Min
4 (10.2) Max
Padded Armrest
Sink Hgt: 32.5 (82.6) Max
Table Hgt: 31 (78.7)
24 (61); 21 (53.3) Min
Sink Lg: 18 (45.7) Min
10 (25.4) Min
Armrest is 1 (2.5) higher than elbow.
Alt. Chair Design
5 (12.7)
Low Pressure
Chair Arm to Toe
Drain Pipe
Leg Hgt
Skirtguard
Seat Incline: 4° Min 8° Max
Gap: 2 (5.1) Max
Driving Rim
Seat Edge to Leg: 2-3 (5.1-7.6)
Toe Clear.
Tipping Lever
Dia 24 (61) Std 22 (55.9) Min
18 (45.7)
6 (15.2) Min
Caster Wheel Dia: 8 (20.3) Min
Pusher Handle Hgt: 35-40 (88.9-101.6); 36 (91.4) Std
Armrest Hgt: 29 (73.7) Max
Backrest Hgt: 16 (40.6) Min 20 (50.8) Max
Mirror Bottom: 36 (91.4)
Mirror Lg: 32-36 (81.3-91.4)
Sink to Floor: 26 (66) Min
Toe Hgt
Shelves: 9 (22.9)
Max Side Reach
Obstruction: 12 (30.5)
High Reach to Floor
Head to Floor
Eye to Floor
Slump
Easy Side Reach
Work Surface: 21 (53.3)
Opt Kitchen Counter for Wheelchair Users
High Shelf
Counter Hgt
Low Shelf: 10 (25.4)
7 (17.8) Min
Hand Clear.: 3.5 (8.9) Min
1 (2.5) Min
Toe Space
8.8 (22.4) Min
Threshold and Curb Hgt: 1 (2.5) Max
Work Space: 42 (106.7) Min 57 (144.8) for 360° Turns
Seat Width: 16 (40.6) Min
Seat Hgt: 20 (50.8) Max
2.5 (6.4) Min
High Reach to Floor
Clothes Rail: 57 (144.8)
High Shelf
Dial, Switch: 42 (106.7)
Dispenser, Towel Bar: 40 (101.6)
Coin Slot: 36 (91.4)
48 (121.9) Max
Water Fountain: 36 (91.4)
Window Sill: 30 (76.2)
Opt Storage Area
Side Clear.: 1 (2.5)
Low Shelf
Shelves: 9 (22.9)
Low Shelf: 10 (25.4)
Min Knuckle Hgt
Adult: 12 (30.5) Youth: 8 (20.3)
0 Datum
Avg Adult
Avg Male
Heights given are averages and without shoes.
All U.S. data. Metrics are red or in parentheses.
3a Humanscale Wheelchair Users
Designed by Henry Dreyfuss Associates
Reaches given are for people with only lower limbs incapacitated. Those with muscular dystrophy or spinal injuries may not reach as far in either direction. Chairs with front propelling wheels are easier to operate by people with weak upper limbs, are used indoors only, and move in less space (axle pivot turning diameter is 59 (149.9)). Multi-purpose chairs equipped for extra functions usually impede the ease of locomotion. Powered wheelchairs, used mostly by paralytics, require a 30 (76.2) turning radius, climb a 10% maximum grade, and their top speed is 1 MPH (1.6 KmPH). A 48 (121.9) passageway and 36 (91.4) door opening are recommended.

Image: Henry Dreyfuss Associates, *Humanscale* selector 3a “Wheelchair Users,” 1974. Plastic, paper, and metal. Milwaukee Art Museum Research Center.

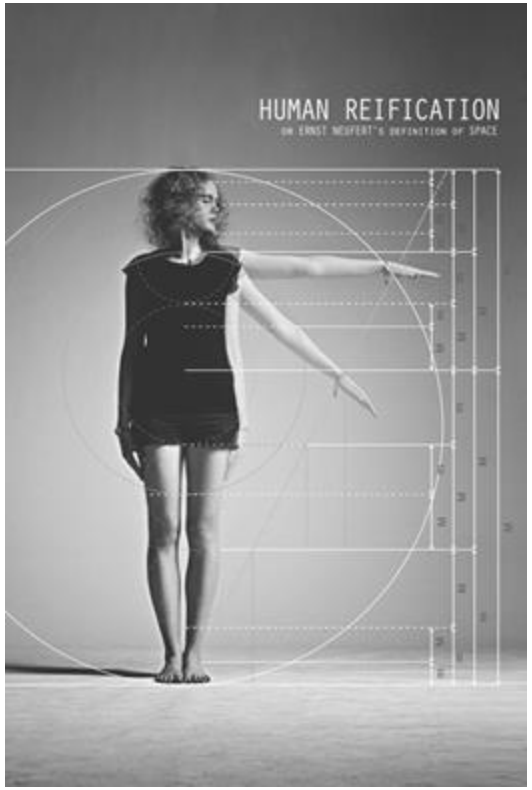
Source: Hanna Pivo, 20th-Century Tools for Measuring Time and Bodies April 19, 2019 https://blog.mam.org/2019/04/19/20th-century-tools-for-measuring-time-and-bodies/

Why do we need to deal with AI specifically?

- There already have been techno-ethical questions and **human-centered design**
  - **Ergonomy**
  - **UX design**



The Modulor by Le Corbusier 1943-54

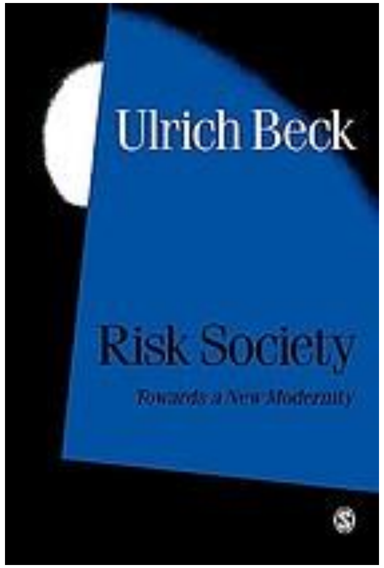


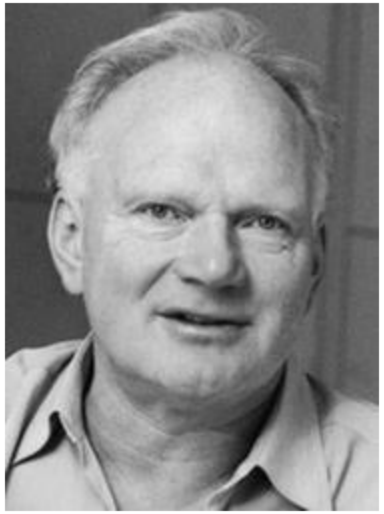
Human Reification - Paul Gisbrecht

External pressures on Machine Makers
Modernity 2.0

Ulrich Beck's analysis (1980's)

- A main feature of modern society is that it is **preoccupied with the future**, and
  - especially the negative scenarios, that is 'risks'
- Catastrophes were formerly attributed to bad luck or divine acts
  - but not in Humanity's control
- Now that our control seems greater (modern science) the **responsibility is ours**
  - this in turn undermines the institutions of modern society, e.g. trust in science





1944-
2015

Modernity 2.0

- The victories of the first modernity (taking risks) have a boomerang effect
- Taking risks not serve us anymore
- So we enter **reflexive modernity**
  - Pesticide
  - Ozone
  - Nuclear
  - Toxins
  - CFC
  - Plastics, etc.
- Plus, we anticipate even more negative consequences
  - AI, GMO

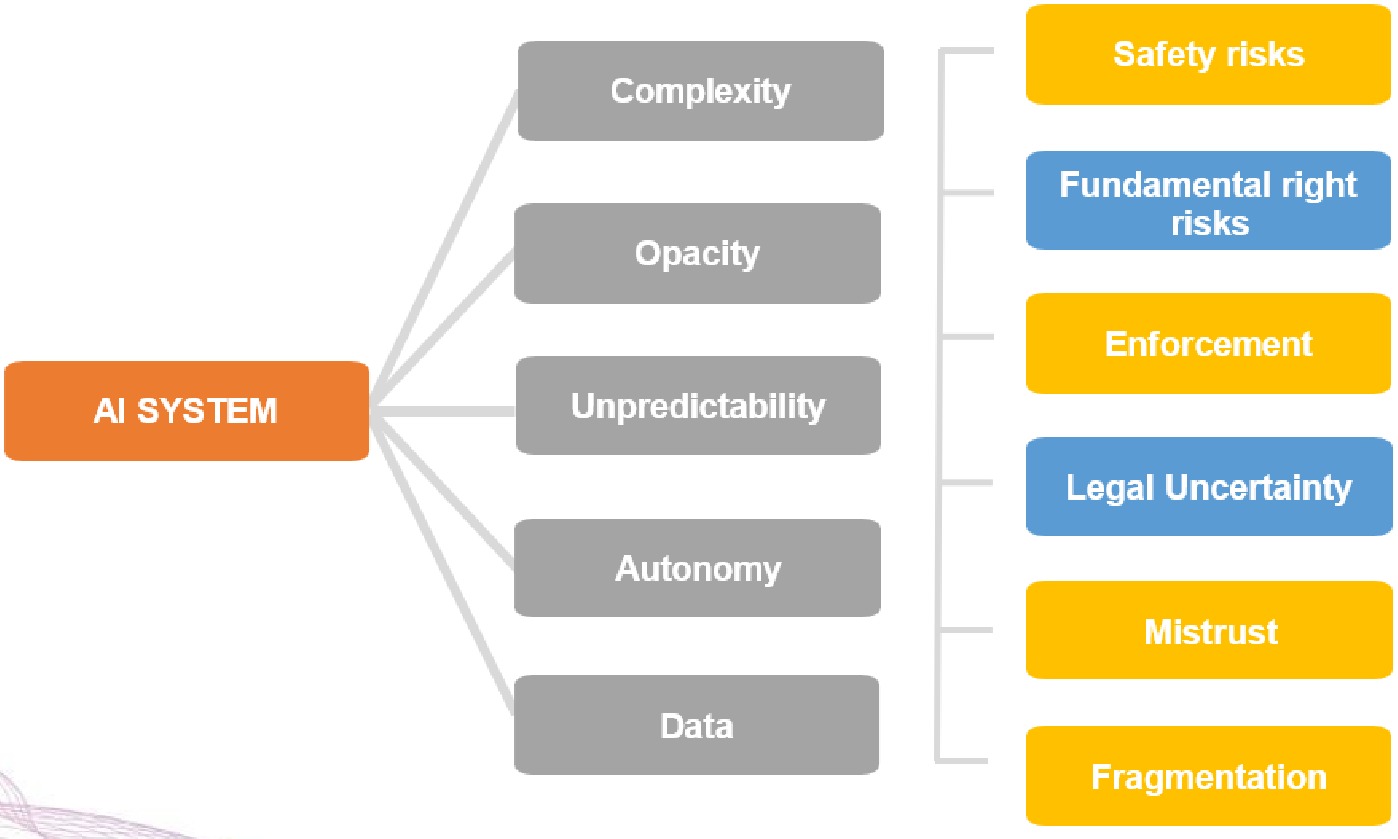
Modernity 2.0

- No clear culprits
    - many of us are implicated in these negative effects

      we need modern technology to even identify and tackle risks
- The new risks are far more evenly distributed
    - Modernity 1
        - Living next to a factory was risky, if rich you could move away
    - Modernity 2
        - Ozone, global warming
        - arguably you can only temporarily can avoid these risks with your personal wealth

AI and law

Why do we regulate AI use cas



Exploring the Boundaries of AI and Law

Are we embracing the wild west or building a digital utopia?

How can regulatory approaches for technology strike the perfect balance between fostering innovation and ensuring responsible development?

Proactive collaboration

Agile and adaptive frameworks (future proof)

Risk-based assessments

Ethical and human-centered focus

Encouraging innovation through sandboxes

Global cooperation and standards

Exploring the Boundaries of AI and Law

Why is ethics a key issue for the AI industry (ethics by design)?

How can ethical considerations be effectively incorporated into AI regulation frameworks to ensure fairness, transparency, and accountability in AI systems?

What responsibilities do organizations have to ensure fairness and non-discrimination in AI?

Ethical guidelines and principles, ethical assessments

Requirements for explainability and interpretability of AI systems

Adherence to non-discrimination principles (anti-discrimination law), discriminatory practices

Regular auditing of algorithms for biases (by who and when? by an internal and/or external auditor?)

The establishment of clear lines of responsibility and accountability for AI system outcomes

Exploring the Boundaries of AI and Law

What mechanisms and guidelines should be established to address the issue of accountability and liability in cases involving AI, particularly in complex, dynamic environments?

Clear legal frameworks that define the responsibilities and liabilities of different stakeholders in AI development, deployment, and operation

Regulatory oversight

Transparency

Continuous monitoring and auditing

Adequate insurance coverage

Exploring the Boundaries of AI and Law

Can responsibility for loss or damage caused by AI be attributed to someone? What are the potential civil law or criminal law liabilities?

Should there be specific liability frameworks for AI systems and their developers, manufacturers, or operators?

How does the use of AI technologies impact the existing intellectual property framework, and what are the implications for the protection, enforcement, and commercialization of intellectual property rights in the context of AI-driven innovations?

Exploring the Boundaries of AI and Law

How can individuals' privacy be protected when AI systems rely on vast amounts of personal data for training and operation? What measures should be in place to ensure compliance with data protection laws?

Who should be held accountable for data protection in the context of AI (data controllers, AI developers, or service providers)?

How can individuals be protected from potential adverse effects resulting from automated profiling and decision-making processes?

How can the security of data used by AI systems be ensured to prevent unauthorized access, data breaches, or misuse?

Human-centered AI engineering

What is AI? (~1950-2010)

Standard model

- Humans are intelligent to the extent that our actions can be expected to achieve our objectives
- Machines are intelligent to the extent that their actions can be expected to achieve their objectives [S.Russell, 2018: AI25]

(Bayesian) Decision theory

- Probability theory
- Utility theory
- Optimal decision
- Bayesian inference/model averaging

Universal Turing machine

- Finite operations over a finite alphabet
- Universality
- Incompleteness (truth≠provability)
- Space and time complexity classes

Turing test

- 'Can machines think?'
- Turing, Alan (October 1950), "Computing Machinery and Intelligence", Mind, LIX (236): 433–460
- Imitation game (~chat)

Problems with AI: 2010<

Technological

- Symbolic vs. Subsymbolic paradigm
- White vs. Black-box models
- Associative vs. Causal approaches
- Flat vs. Hierarchical
- Narrow vs. General intelligence

Developmental

- Understandability
- Compositionality
- Workflow
- Group work

Legal

- Safety
- Provably beneficial
- Fairness and bias
- Responsibility

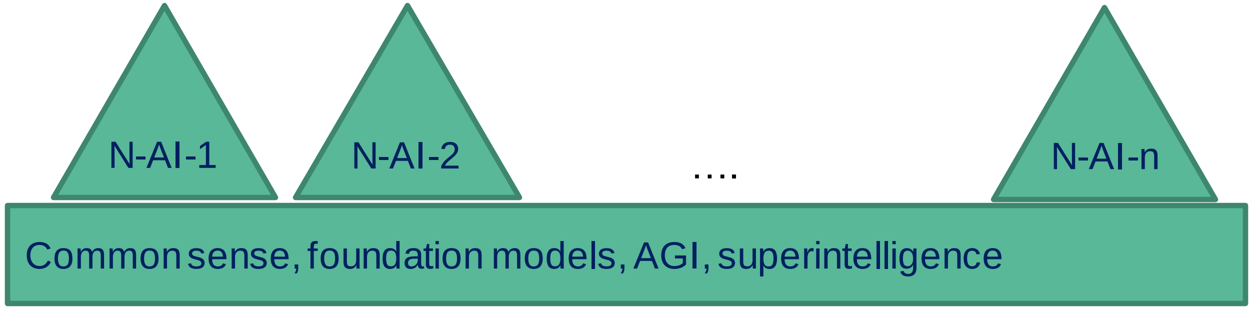
Societal

- Digital addiction
- Polarization of the society
- Fake news
- Subliminal effects
- Advertisement-driven attention economy
- Superintelligence/artificial general intelligence

Artificial general intelligence

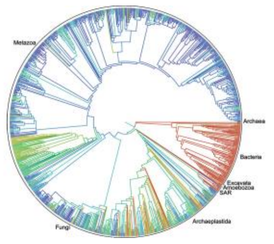
Artificial general intelligence (AGI): it can learn to accomplish any intellectual task that human beings or animals can perform.

- Vision, robotics, natural language processing (NLP)
- Self-driving cars, automation of scientific discovery,...



Domain-specific General Problem Solvers (GPS, 1957)

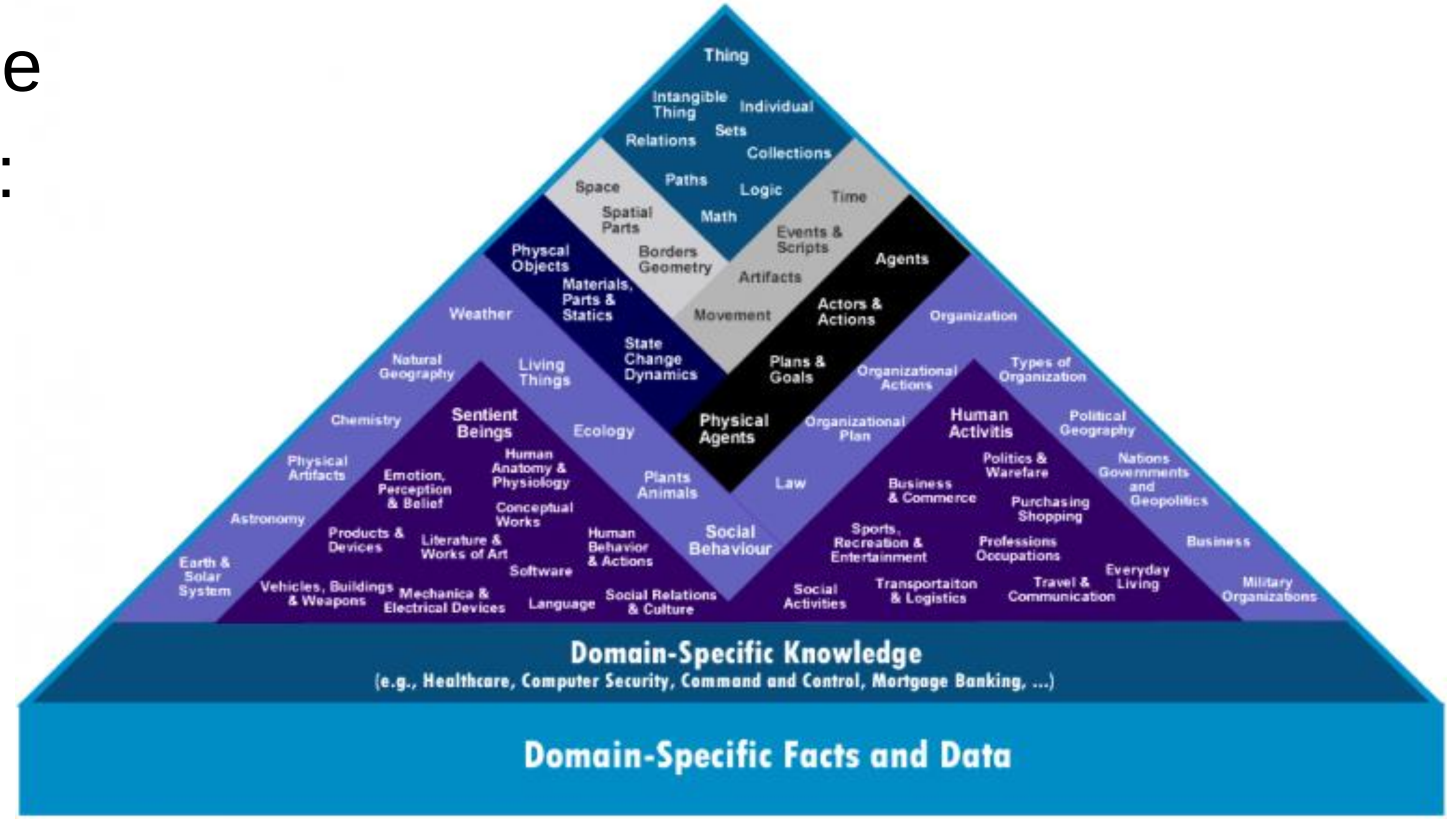
Knowledge bases: Encyclopedists (~1750), WorldBrain (1936), Naive physics manifesto(1979), CYC(1984-), Wikimedia(2003), GitHub(2007)
AGI systems: IBM Watson(2011), WolframAlpha(2009), AlphaZero(2017), chatGPT(2018-),...



Current biomass (C): ×10^{11} tonnes
#DNA base pairs: 10^{37}
#species: ~10^{7} (extinct: x10^{9})
#animals: ~10^{19}
#cells in human body: ~10^{14}
#neurons in brain: ~10^{11}
#synapsis per neuron: ~10^{4}

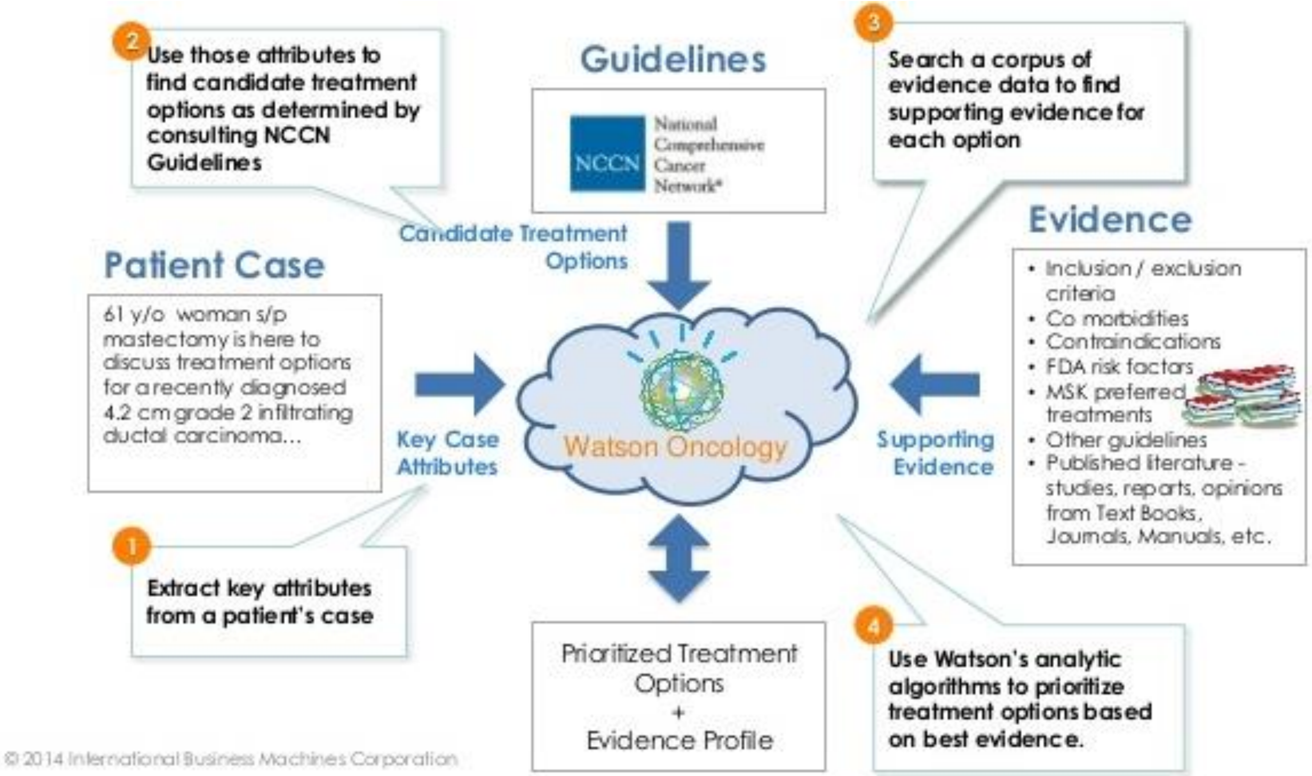
The Cyc project (1984-2016)

- Goal: common sense
- Estimations in 1984:
  - 250 000 rules
  - 350 man-year
- Language: CycL
- Access: OpenCyc
- State (~2020)
  - 239,000 concept
  - 2,093,000 facts



Lenat, Douglas. "Creating a 30-million-rule system: Mcc and cycorp." *IEEE Annals of the History of Computing* 44.1 (2022): 44-56.

IBM Watson (2011)



2 Use those attributes to find candidate treatment options as determined by consulting NCCN Guidelines

Guidelines

3 Search a corpus of evidence data to find supporting evidence for each option

Candidate Treatment Options

Evidence

- Inclusion / exclusion criteria
- Co morbidities
- Contraindications
- FDA risk factors
- MSK preferred treatments
- Other guidelines
- Published literature - studies, reports, opinions from Text Books, Journals, Manuals, etc.

Patient Case

61 y/o woman s/p mastectomy is here to discuss treatment options for a recently diagnosed 4.2 cm grade 2 infiltrating ductal carcinoma...

Key Case Attributes

Watson Oncology

Supporting Evidence

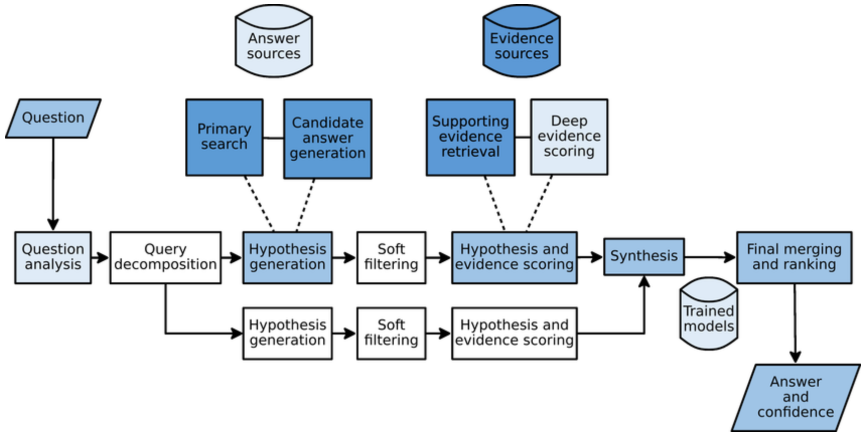
1 Extract key attributes from a patient's case

Prioritized Treatment Options + Evidence Profile

4 Use Watson's analytic algorithms to prioritize treatment options based on best evidence.

© 2014 International Business Machines Corporation

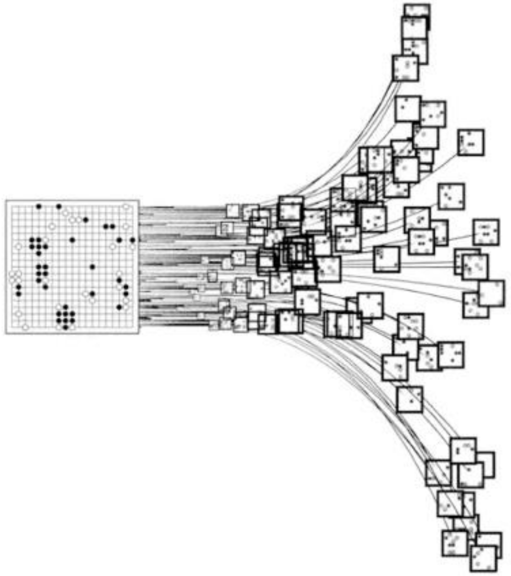
- Natural language processing
- Inference
- Game theory



Strickland, E. (2019). IBM Watson, heal thyself: How IBM overpromised and underdelivered on AI health care. *IEEE Spectrum*, *56*(04), 24-31.

AlphaGo (2017)

- Google DeepMind
- Monte Carlo tree search
- 2016: 9 dan
- 2017: wins against human champion



Silver, David, et al. "Mastering the game of Go with deep neural networks and tree search." *nature* 529.7587 (2016): 484-489.
Silver, David, et al. "Mastering the game of go without human knowledge." nature 550.7676 (2017): 354-359.

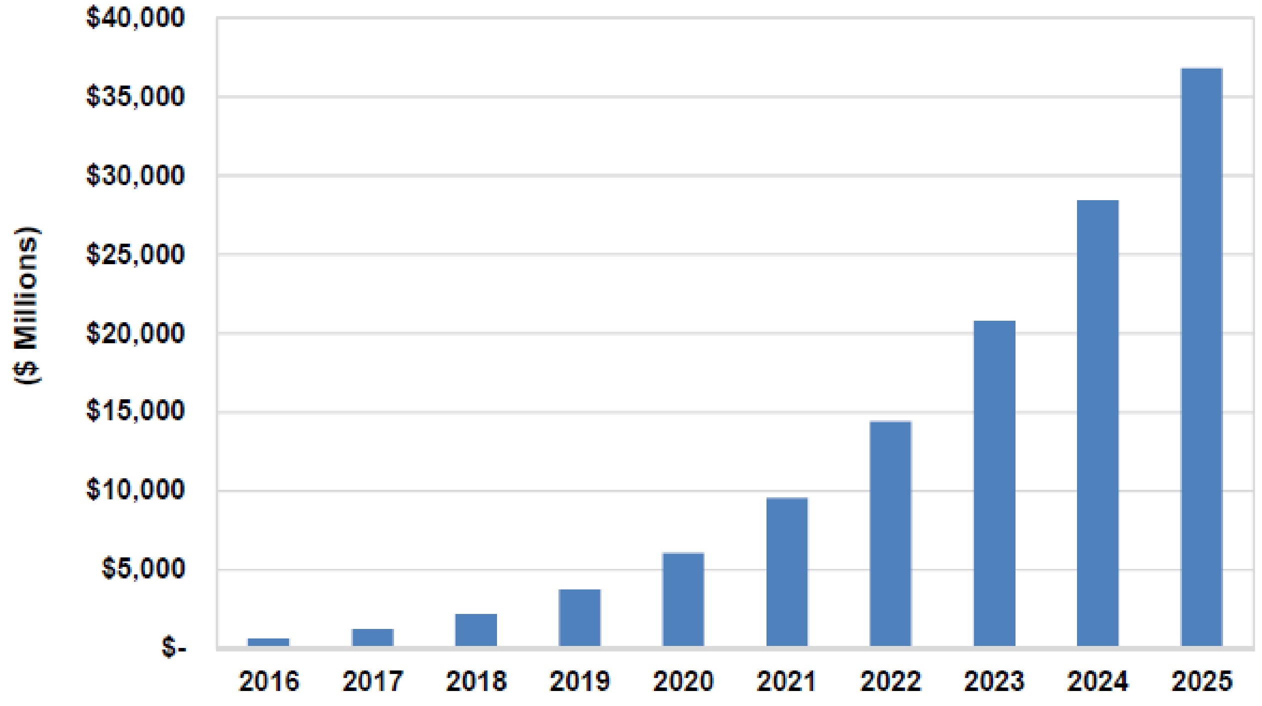
Generative pre-trained transformers

- Vaswani, Ashish, et al. "Attention is all you need." Advances in neural information processing systems 30 (2017).
- Radford, Alec, et al. "Improving language understanding by generative pre-training." (2018).
- Subramanian, Sandeep, et al. "**Learning general purpose distributed sentence representations via large scale multi-task learning**." arXiv preprint arXiv:1804.00079 (2018).
- Brown, Tom, et al. "**Language models are few-shot learners.**" Advances in neural information processing systems 33 (2020): 1877-1901.
- Ouyang, Long, et al. "**Training language models to follow instructions with human feedback**." Advances in Neural Information Processing Systems 35 (2022): 27730-27744.
- Bubeck, Sébastien, et al. "**Sparks of artificial general intelligence: Early experiments with gpt-4.**" arXiv preprint arXiv:2303.12712 (2023).
- Luo, Renqian, et al. "BioGPT: generative pre-trained transformer for biomedical text generation and mining." Briefings in Bioinformatics 23.6 (2022): bbac409.

Financial resources

1-10 bn$ monthly investment in AGI (2023)!

Chart 1.1 Artificial Intelligence Revenue, World Markets: 2016-2025

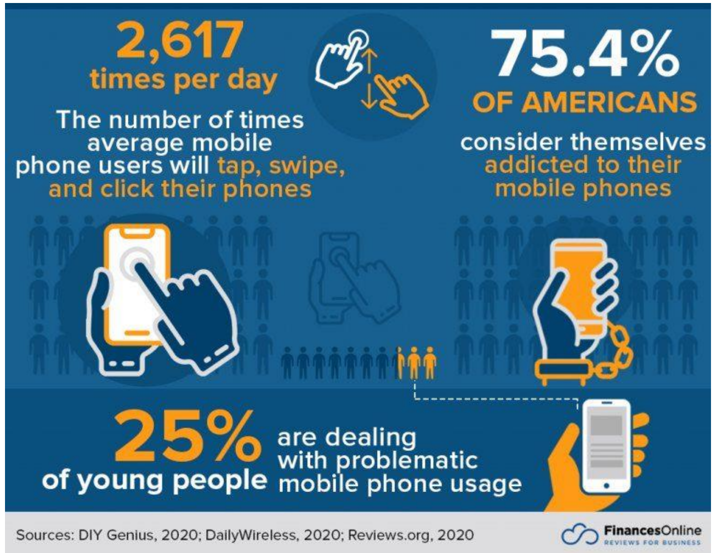


(Source: Tractica)

Digital addiction

No need for AGI to ruin humanity/democracy/mental health; basic AI is enough: addiction, bias, fairness, privacy, polarization, fake news,...

Reinforcement learning in action:
training brains in the attention economy



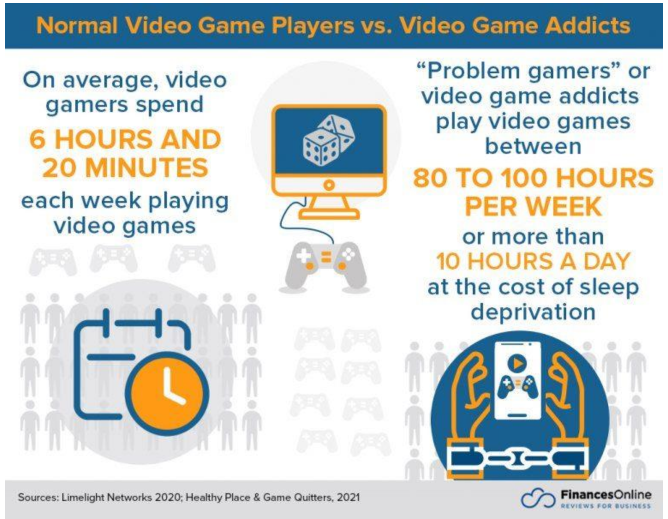
2,617 times per day

The number of times average mobile phone users will tap, swipe, and click their phones

75.4% OF AMERICANS consider themselves addicted to their mobile phones

25% of young people are dealing with problematic mobile phone usage

Sources: DIY Genius, 2020; DailyWireless, 2020; Reviews.org, 2020

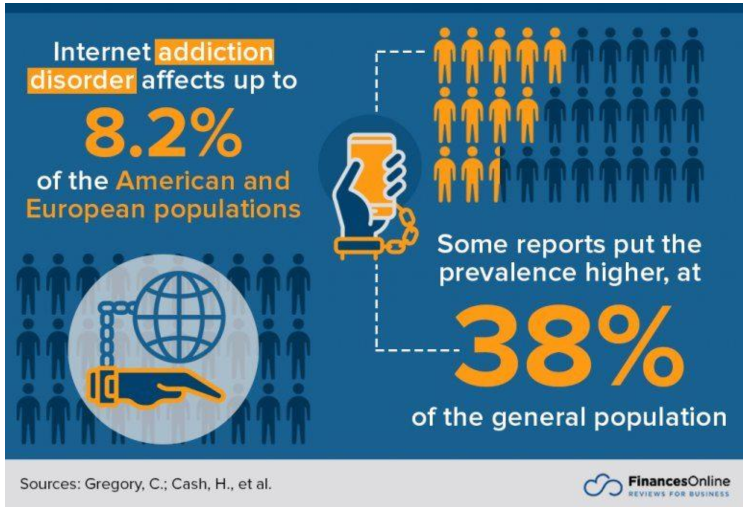


Normal Video Game Players vs. Video Game Addicts

On average, video gamers spend 6 HOURS AND 20 MINUTES each week playing video games

"Problem gamers" or video game addicts play video games between 80 TO 100 HOURS PER WEEK or more than 10 HOURS A DAY at the cost of sleep deprivation

Sources: Limelight Networks 2020; Healthy Place & Game Quitters, 2021



Internet addiction disorder affects up to 8.2% of the American and European populations

Some reports put the prevalence higher, at 38% of the general population

Sources: Gregory, C.; Cash, H., et al.

https://financesonline.com/technology-addiction-statistics/

Problems with electricity (~1900)

Technological

- Generation
- Transformation
- Transfer
- Storage
- Usage

Developmental

- Maintainance
- Institutional

Legal

- Safety
- Responsibility
- Universal access (at minimum level)

Societal

- Health
- Electric shock
- Electromagnetic effects
- Urban environment
- Economy

Problems with drugs (~1900)

Technological

- Discovery
- Synthesis
- Formulation
- Storage
- Usage

Developmental

- Mechanism of action
- Target proteins/pathways
- Distillation/extraction
- Synthesis

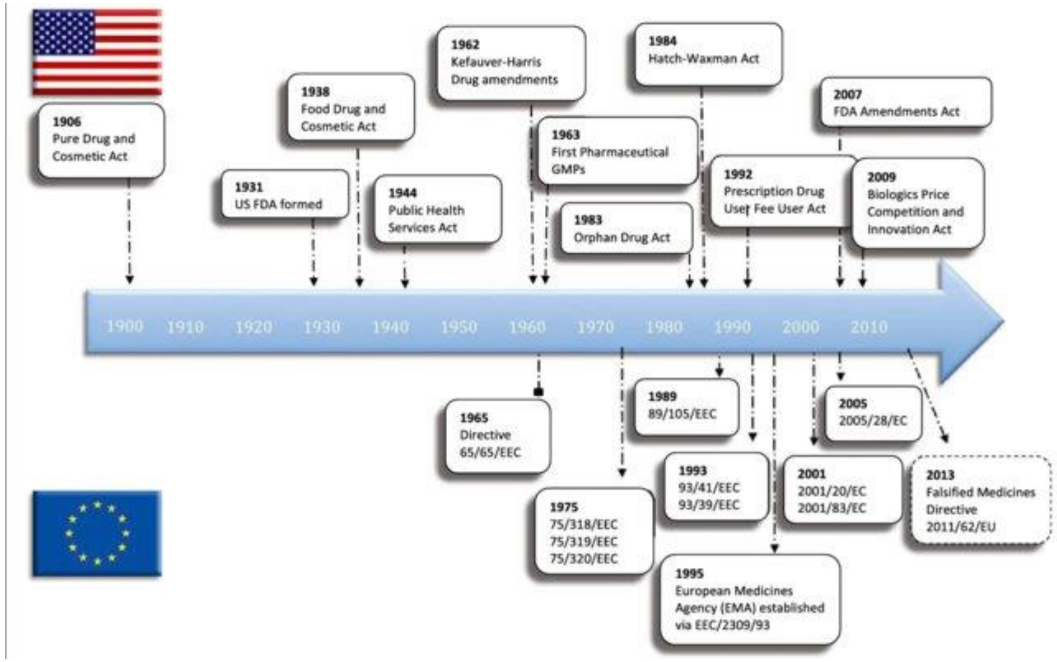
Legal

- Safety
- Responsibility
- Provably beneficial
- Pricing
- Universal access (at minimum level)

Societal

- Disease burden
- Side-effects
- Addiction
- Miracle cures

Regulation for drug discovery


1906
Pure Drug and Cosmetic Act
1931
US FDA formed
1938
Food Drug and Cosmetic Act
1944
Public Health Services Act
1962
Kefauver-Harris Drug amendments
1963
First Pharmaceutical GMPs
1983
Orphan Drug Act
1984
Hatch-Waxman Act
1992
Prescription Drug User Fee User Act
2007
FDA Amendments Act
2009
Biologics Price Competition and Innovation Act
1900
1910
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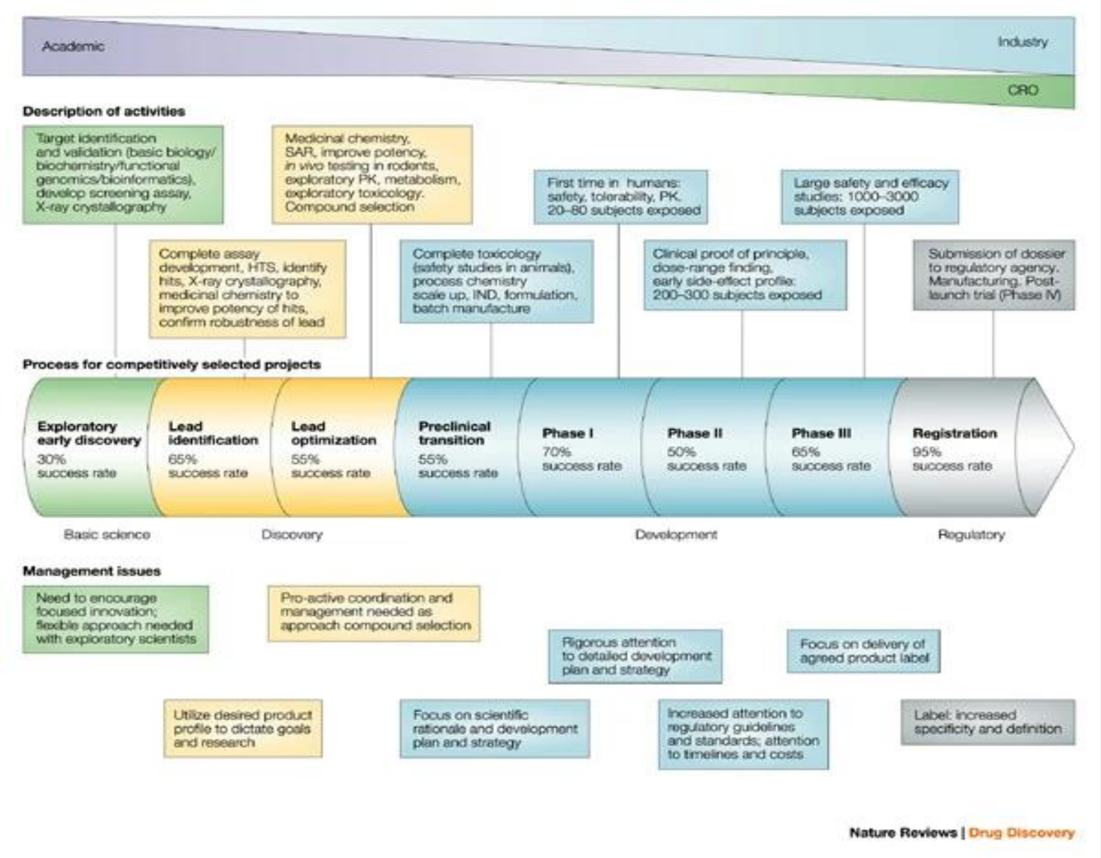
Directive 65/65/EEC
1975
75/318/EEC
75/319/EEC
75/320/EEC
1989
89/105/EEC
1993
93/41/EEC
93/39/EEC
1995
European Medicines Agency (EMA) established via EEC/2309/93
2001
2001/20/EC
2001/83/EC
2005
2005/28/EC
2013
Falsified Medicines Directive 2011/62/EU

Dunne, Suzanne, et al. "A review of the differences and similarities between generic drugs and their originator counterparts, including economic benefits associated with usage of generic medicines, using Ireland as a case study." *BMC Pharmacology and Toxicology* 14 (2013): 1-19.


Academic
Industry
CRO
Description of activities
Target identification and validation (basic biology/ biochemistry/functional genomics/bioinformatics), develop screening assay, X-ray crystallography
Medicinal chemistry, SAR, improve potency, in vivo testing in rodents, exploratory PK, metabolism, exploratory toxicology. Compound selection
First time in humans: safety, tolerability, PK, 20–80 subjects exposed
Large safety and efficacy studies: 1000–3000 subjects exposed
Complete assay development, HTS, identify hits, X-ray crystallography, medicinal chemistry to improve potency of hits, confirm robustness of lead
Complete toxicology (safety studies in animals), process chemistry scale up, IND, formulation, batch manufacture
Clinical proof of principle, dose-range finding, early side-effect profile: 200–300 subjects exposed
Submission of dossier to regulatory agency. Manufacturing. Post-launch trial (Phase IV)
Process for competitively selected projects
Exploratory early discovery
30% success rate
Lead identification
65% success rate
Lead optimization
55% success rate
Preclinical transition
55% success rate
Phase I
70% success rate
Phase II
50% success rate
Phase III
65% success rate
Registration
95% success rate
Basic science
Discovery
Development
Regulatory
Management issues
Need to encourage focused innovation; flexible approach needed with exploratory scientists
Pro-active coordination and management needed as approach compound selection
Rigorous attention to detailed development plan and strategy
Focus on delivery of agreed product label
Utilize desired product profile to dictate goals and research
Focus on scientific rationale and development plan and strategy
Increased attention to regulatory guidelines and standards; attention to timelines and costs
Label: increased specificity and definition
Nature Reviews | Drug Discovery

Nwaka, Solomon, and Robert G. Ridley. "Virtual drug discovery and development for neglected diseases through public–private partnerships." *Nature Reviews Drug Discovery* 2.11 (2003): 919-928.

HCAI interpretations

Human-computer interaction

- Man-machine interfaces
- Man-machine hybrids
- Linguistic interfaces
- Sensorimotoric/brain-computer interfaces
- Augmented reality

Human-compatible AI

- Intelligence explosion
- Artificial general intelligence (AGI)
- Superintelligence
- Existential risk
- Value alignment
- Provably beneficial AI

Human-centered AI (HCAIM)

- **Human rights (mental health,..)**
- **Democratic society (fake news,...)**
- **Trustworthy/Explainable AI**
- **Human-computer cooperation**
- **Collaborative workflows**
- **Auditing/approval (AI safety)**

Intelligence everywhere

- Smart wearable electronics
- Smart homes/cities
- Autonomous vehicles

Novel elements in HCAI

hcaim human centred artificial intelligence masters

Theory

- Federated learning, privacy-preserving learning
- Probabilistic programming, causal inference
- Machine teaching, collaborative inverse reinforcement learning, reinforcement learning with human feedback
- Multitask learning, transfer learning, foundation models, artificial general intelligence

Practice

- Automated programming
- Collaborative workflow systems
- Testing/Auditing

Ethics

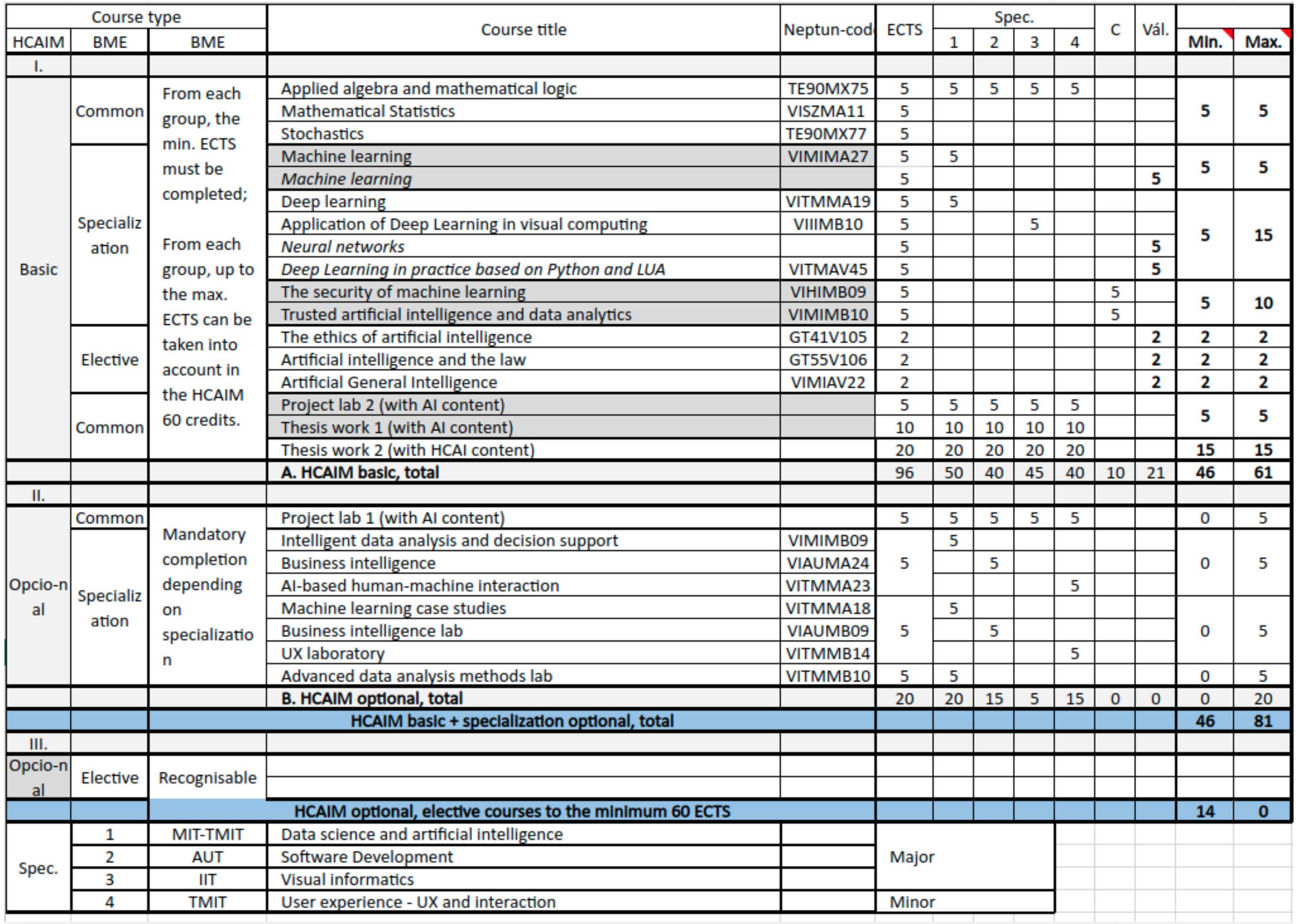
- Rights for digital assistants/twins

Society

- The EU AI Act

HCAIM @ BME (2022<)

The 60-credit EU-level HCAIM program is embedded into a 120-credit, 2-years M.Sc. program.



Course type			Course title	Neptun-cod	ECTS	Spec.				C	Vál.		
HCAIM	BME	BME				1	2	3	4			Min.	Max.
I.													
Basic	Common	From each group, the min. ECTS must be completed; From each group, up to the max. ECTS can be taken into account in the HCAIM 60 credits.	Applied algebra and mathematical logic	TE90MX75	5	5	5	5	5			5	5
			Mathematical Statistics	VISZMA11	5								
			Stochastics	TE90MX77	5								
	Specialization		Machine learning	VIMIMA27	5	5						5	5
			Machine learning		5						**5**		
			Deep learning	VITMMA19	5	5						5	15
			Application of Deep Learning in visual computing	VIIIMB10	5			5					
			Neural networks		5						**5**		
			Deep Learning in practice based on Python and LUA	VITMAV45	5						**5**		
			The security of machine learning	VIHIMB09	5					5		5	10
			Trusted artificial intelligence and data analytics	VIMIMB10	5					5			
	Elective		The ethics of artificial intelligence	GT41V105	2						**2**	**2**	**2**
			Artificial intelligence and the law	GT55V106	2						**2**	**2**	**2**
			Artificial General Intelligence	VIMIAV22	2						**2**	**2**	**2**
	Common		Project lab 2 (with AI content)		5	5	5	5	5			5	5
			Thesis work 1 (with AI content)		10	10	10	10	10				
			Thesis work 2 (with HCAI content)		20	20	20	20	20			**15**	**15**
			A. HCAIM basic, total		96	50	40	45	40	10	21	**46**	**61**
II.													
Opcio-nal	Common	Mandatory completion depending on specialization	Project lab 1 (with AI content)		5	5	5	5	5			0	5
	Specialization		Intelligent data analysis and decision support	VIMIMB09	5	5						0	5
			Business intelligence	VIAUMA24			5						
			AI-based human-machine interaction	VITMMA23					5				
			Machine learning case studies	VITMMA18	5	5						0	5
			Business intelligence lab	VIAUMB09			5						
			UX laboratory	VITMMB14					5				
			Advanced data analysis methods lab	VITMMB10	5	5						0	5
			B. HCAIM optional, total		20	20	15	5	15	0	0	0	20
		HCAIM basic + specialization optional, total										**46**	**81**
III.													
Opcio-nal	Elective	Recognisable											
		HCAIM optional, elective courses to the minimum 60 ECTS										**14**	**0**
Spec.	1	MIT-TMIT	Data science and artificial intelligence		Major								
	2	AUT	Software Development										
	3	IIT	Visual informatics										
	4	TMIT	User experience - UX and interaction		Minor								

HCAIM @ BME

hcaim human centred artificial intelligence masters

Participants

- Graduation at 2022.: 3 students
- Graduation at 2023 spring: 5 students
- Participants in 2023 spring: 19+11+2 students in their 1st/2nd/r3rd semester

Diploma Supplement

HCAIM certificate: **The student completed the requisite learning outcomes of the Human-Centred Artificial Intelligence Master's (HCAIM) programme, defined by the INEA/CEF/ICT/A2020/2267304 EU project.**

HCAIM@BME: Related programs

hcaim human centred artificial intelligence masters

Data science and AI M.Sc. specialization

Spring semester (mandatory)

- Machine learning 5 ECTS
- Intelligent data analysis and decision support 5 ECTS
- Advanced data analysis methods lab 5 ECTS

Fall semester (mandatory)

- Deep learning 5 ECTS
- Machine learning case studies 5 ECTS

Common (C) Elective

- Privacy and Security in machine learning 5 ECTS
- Trustworthy AI and data analytics 5 ECTS
- ...

Elective

- AI ethics 2 ECTS
- AI Law 2 ECTS
- Engineering Ethics 2 ECTS
- Artificial General Intelligence 2 ECTS
- ...

HCAIM@BME: Related programs

human centred artificial intelligence masters

Human-centred intelligent data analysis

A new Specialization in the EIT Digital Data Science Master School Programme

Fall semester (mandatory)

- AI Ethics 2 ECTS
- AI Law 2 ECTS
- Intelligent data analysis 5 ECTS
- Privacy and Security in machine learning 5 ECTS
- I&E Study 6 ECTS
- Thesis I 10 ECTS

Spring semester (mandatory)

- Trustworthy AI and data analytics 5 ECTS
- Thesis II 20 ECTS

Elective

- Engineering Ethics 2 ECTS
- Artificial General Intelligence 2 ECTS
- ...

eit Digital

Thanks!

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Budapest University of Technology and Economics

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