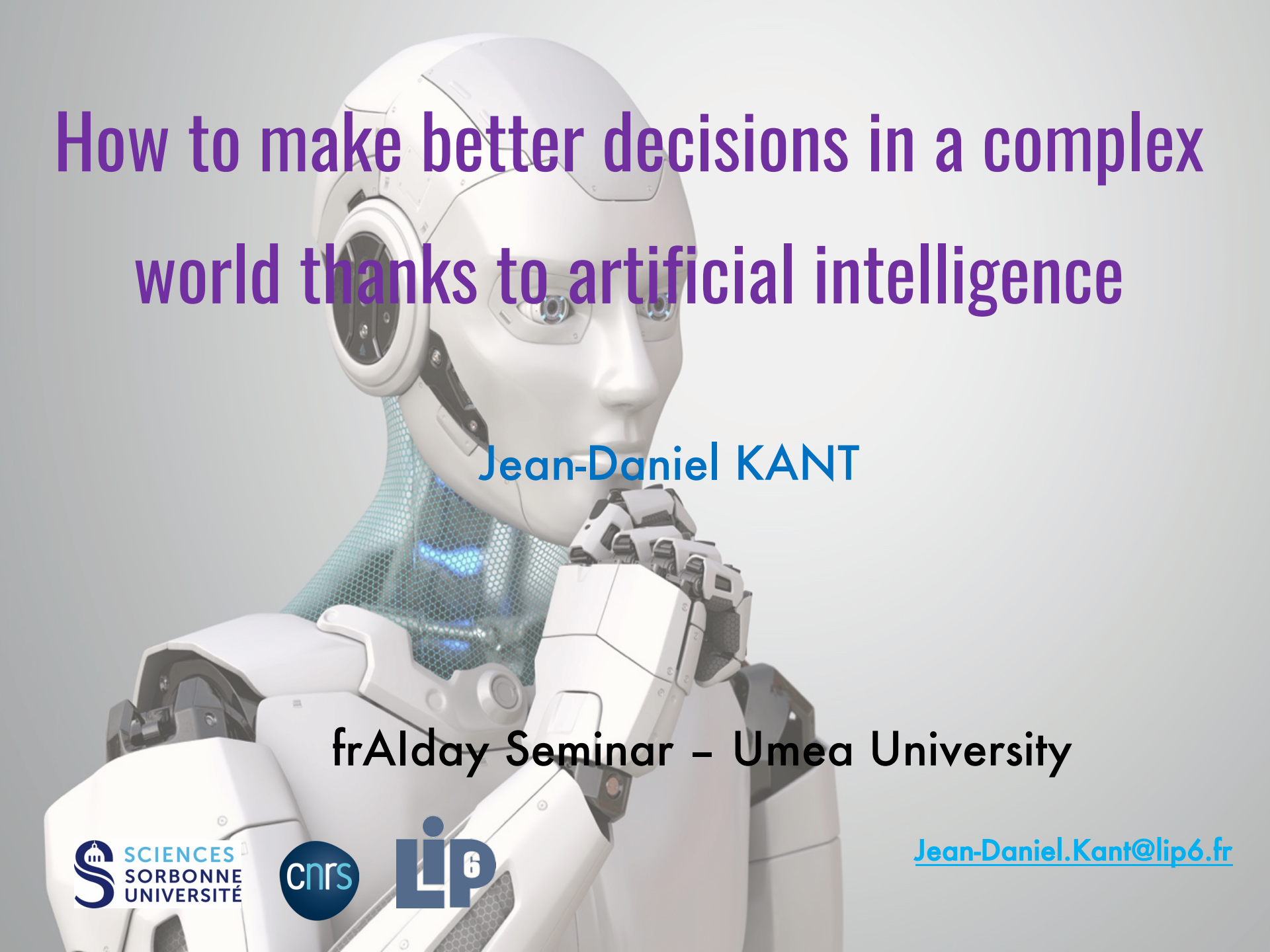


How to make better decisions in a complex world thanks to artificial intelligence

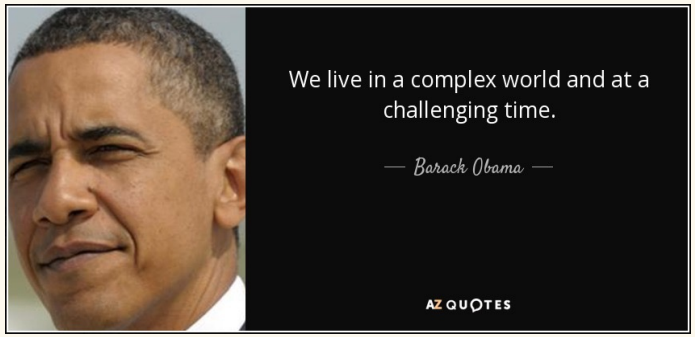
Jean-Daniel KANT

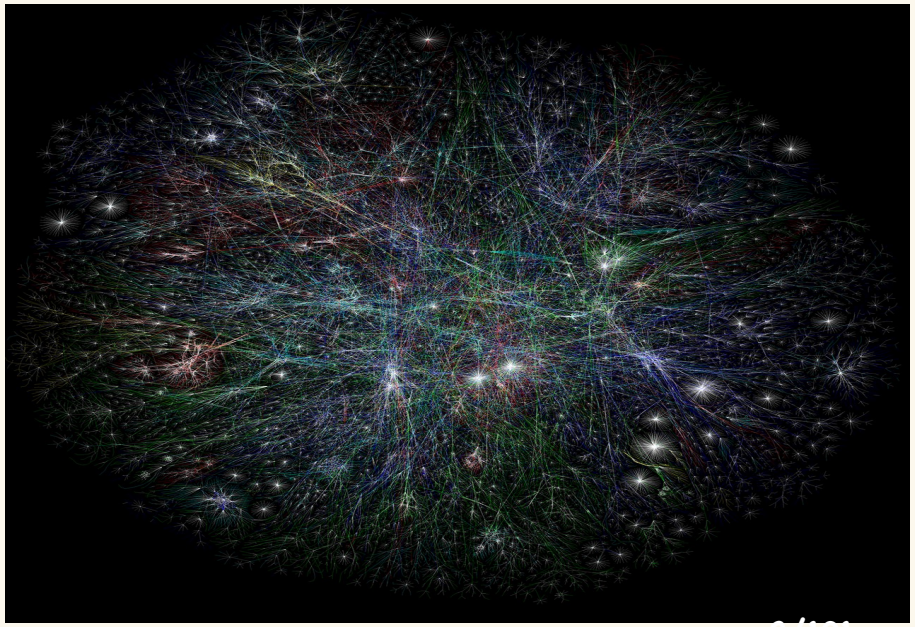
frAIday Seminar – Umea University

SCIENCES SORBONNE UNIVERSITÉ
cnrs
LIP6

Jean-Daniel.Kant@lip6.fr

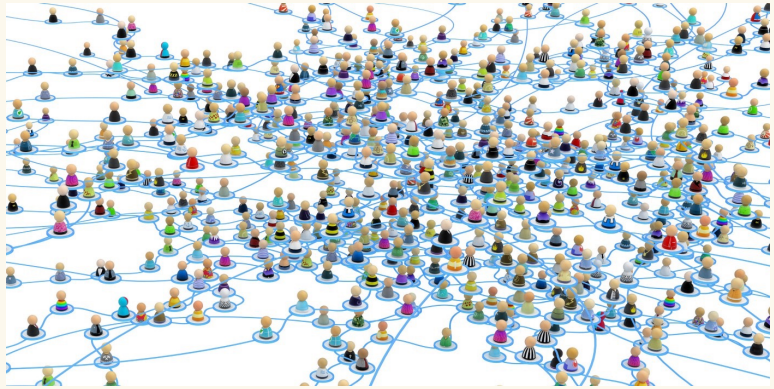
We live in a Complex World...





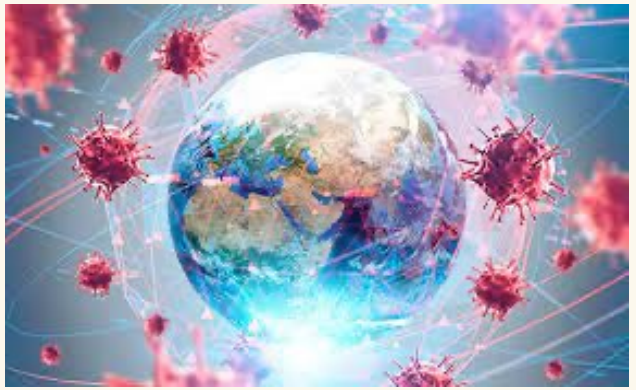
Complex system

- Composed of a large number of heterogeneous elements
- Numerous interactions between elements
  - Feedback loops
- Impossible to predict (by definition of complexity)
- A complex system must be modeled to make it intelligible (J.L. Le Moigne)
- Examples : climate, human systems, …



Worries and Crises

- Increasing crises
  - Economic, epidemic, geopolitical…
- Technological and societal crisis?
  - Will AI take our jobs?
  - Does it threaten our societies?
- Climate and environmental crisis
  - How to avoid it?
  - Or at least limit its effects ?



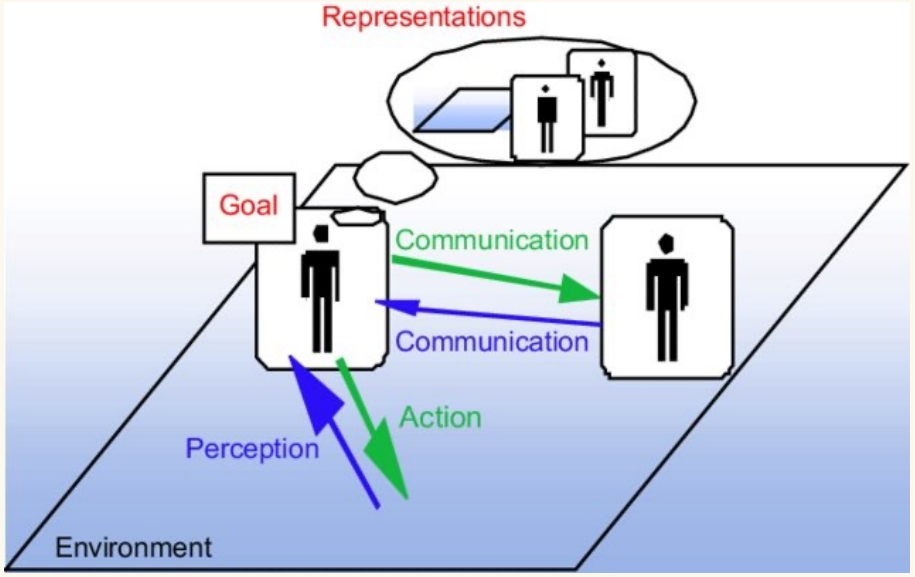
My project to give hope!

- These issues are too complex to be tackled by human brains only
- We need augmented intelligence decision tools to help us
- My goal to design such tools based on agent–based simulation
  - Evaluating in a virtual world (simulation) the policies to be carried out
  - Improve or even optimize these policies in this virtual world before applying them in the real world
  - Share the results of the simulation (decision–makers, citizens…) => collective process

Another approach to AI: agent-based simulation

Multi-Agent Systems (MAS)

- A distributed system to implement collective (artificial) intelligence
- System composed of interacting software agents
- Agents are located physically, in an environment
- They communicate and interact with each other
- Agents are autonomous and proactive
- They can have different forms of organization



- They are genuinely explainable ! (≠ machine learning)

And what is Simulation?

- We start from a phenomenon to study, to explain
- The Complex System concerned is modelled, using a MAS
- We program and run on machine (= simulation) the model (with real data if possible)
- We analyze the results
- Importance of the validation process (Kant, 1999, 2015,2019)
  - Micro–foundation of the model
  - Calibration of parameters
  - Generalization tests , emergence

Examples

WorkSim & NumJobs :

Exploring Labor Markets

WorkSim Project : Multi-agent model of the French Labour Market

Jean-Daniel Kant, Gérard Ballot
Nicolas De Bufala
Olivier Goudet
Zach Lewkovicz

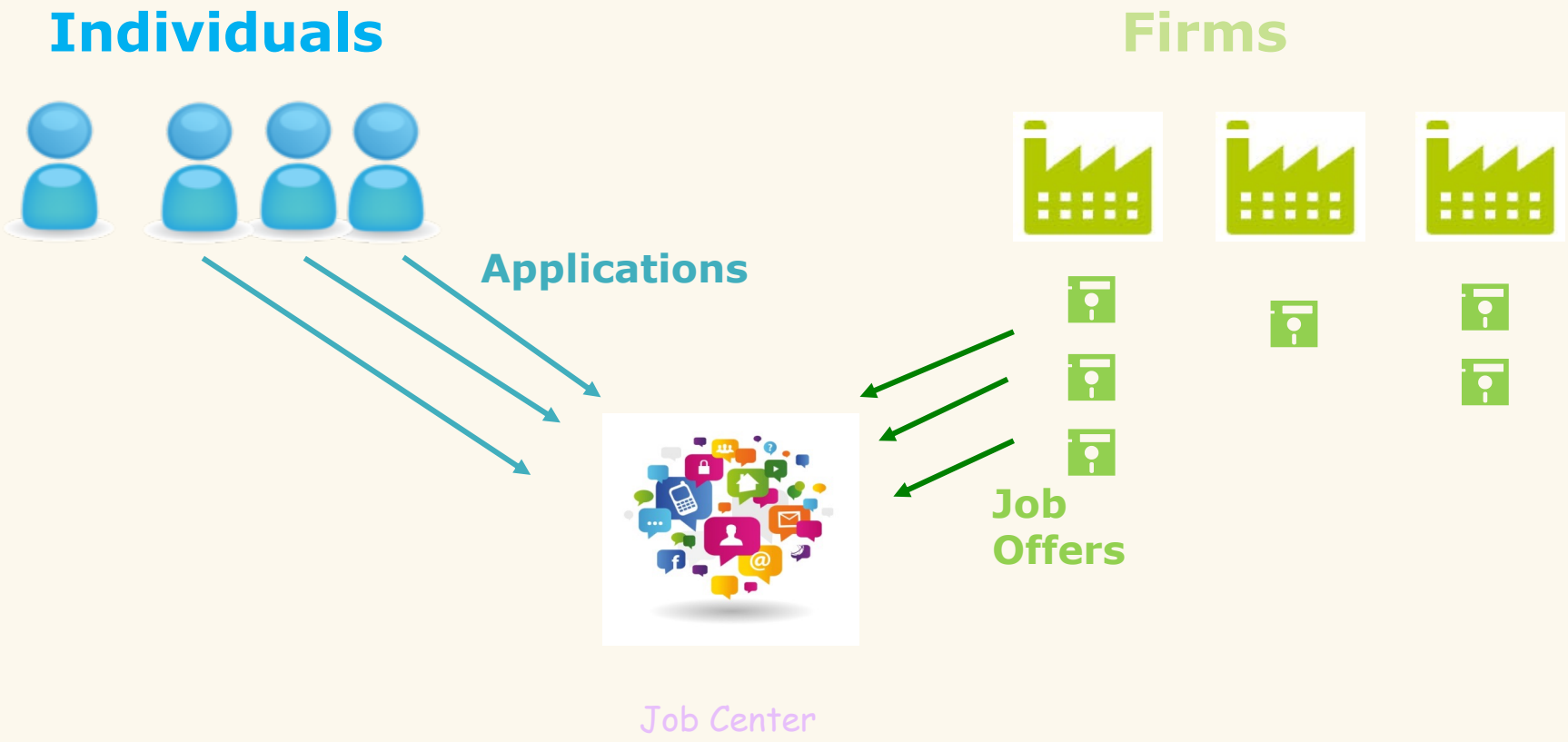
PDI MSC

WorkSim : simulateur du marché du travail (2006-2020)

http://jasss.soc.surrey.ac.uk/23/4/4.html

- Both sides of the labour market (firms and individuals)
- Heterogeneous agents, decision–making processes in limited rationality (Simon, 1955)
- Learning: accumulated experience has an impact on decisions (e.g. search, acceptance of a job)
- Detailed institutional environment:
  - Contracts, Labour Code
- Initialization and calibration on real data

WorkSim : Overview



WorkSim : Overview

Individuals

Hire

Firms

WorkSim : Overview

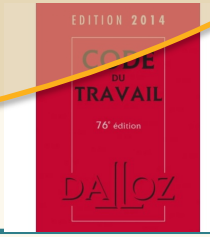
Individuals

Hire

Firms

Legal and Political Environment

Laws

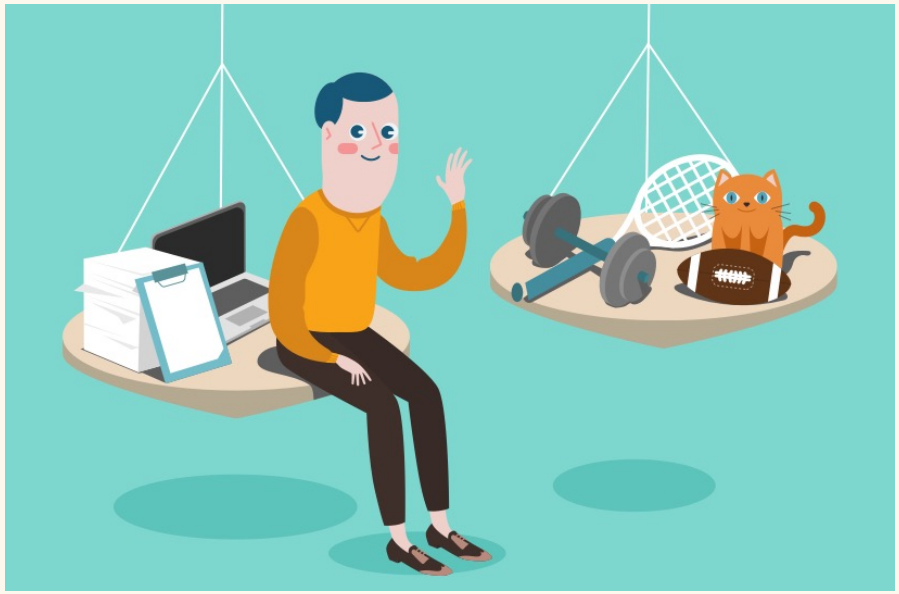


Decrees

Individuals Behavior

- An individual is in a state: inactive, unemployed, employed, student, retired
- Bounded rationality: it chooses the most satisfactory state (greatest limited use from a limited number of options)
- It evaluates its state and accessible states using a utility function that arbitrates between work and free time.

$$U=[(1- w_a - w_s).Income + w_a.Amenity + w_s.Stability]^{1-\alpha} x(Free\ Time)^{\alpha}$$



Firms Behavior

- General decision principle: cost/benefit analysis
  - Choice from a limited number of alternatives
  - [Satisficing] Choose the alternative that gives the greatest profit
- Job creation
  - anticipation (finite horizon) of demand
  - Algorithm for choosing the most appropriate contract
- Personnel management
  - Fires and promotions

Results

- Our 3–steps validation method is applied
- Generalization, emergence
  - Ex : Duality of the French Labor Market
- Many actual labor policies evaluated
  - New form of contracts, tax reductions on hirings, …
- WorkSim produced the only evaluation of El Khomri Law in France (2016)
  - Work cited by IMF and European Commission (annual reports)
  - A lot of media interest : press, radio, …

http://worksim.lip6.fr

WORKSIM : SIMULER LE MARCHÉ DU TRAVAIL

En savoir plus

MEDIAPART
SAM. 8 OCT. 2016 – ÉDITION DE LA MI-JOURNÉE

LE JOURNAL | MONDE | FRANCE | ÉCONOMIE | CULTURE | DOSSIERS | *ENGLISH* | *ESPAÑOL*

LOI SUR LE TRAVAIL: NOTRE DOSSIER — ENTRETIEN

«Espace de travail»: deux chercheurs testent virtuellement la loi El Khomri

8 JUIN 2016 | PAR MATHILDE GOANEC

Un économiste et un informaticien ont, pour la première fois, testé les effets de la loi El Khomri sur un marché du travail virtuel, qui reproduit les caractéristiques du marché de l'emploi français. Les effets sur le chômage sont quasi nuls ; l'assouplissement du licenciement économique favorise les CDI tout en les fragilisant.

69 COMMENTAIRES | A+ A-

Ils sont eux-mêmes tout étonnés de l'engouement que leurs travaux ont suscité : Gérard Ballot, économiste à l'université Assas Paris II, et Jean-Daniel Kant, chercheur en informatique spécialisé dans l'intelligence artificielle, aidé du doctorant Olivier Goudet, ont inventé un logiciel, Work Sim, qui permet de modéliser et simuler le marché du travail français. Une sorte de cousin très éloigné de la fameuse Sim City, jeu vidéo culte des années 1990 permettant de créer et modifier à loisir des villes et leurs habitants...

mediapart.fr/journal/economie/051016/rsa-contre-benevolat-le-tribunal-juge-l-initiative-illegale

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CHÔMAGE

Worksim : le logiciel qui simule les conséquences de la loi travail

Quelles seront les conséquences de la loi El Khomri sur le marché du travail ? Plutôt que de regarder dans une boule de cristal, des chercheurs ont posé cette question à leur logiciel de simulation : WorkSim.

Par Rémy Demichelis Journaliste. Publié le 10/04/2016 à 17h31

106 549 VISITES 68 RÉACTIONS 0

Le Monde.fr ÉDITION ABONNÉS

INTERNATIONAL | POLITIQUE | SOCIÉTÉ | ÉCO | CULTURE | IDÉES | PLANÈTE | SPORT

M Idées

IDÉES | Tribunes | Enquêtes | Rencontres | Controverses | Livres | Analyses | Editoriaux | Chronique

ÉDITION ABONNÉS

« Le projet de loi El Khomri modifie profondément le marché du travail sans améliorer l'emploi global »

LE MONDE ECONOMIE | 05.04.2016 à 06h44 • Mis à jour le 05.04.2016 à 11h42

Réagir Ajouter Partager (78) Tweeter

LECTURE ZEN

Par Gérard Ballot (université Paris-II), Jean-Daniel Kant et Olivier Goudet (université Paris-VI)

Le projet de loi El Khomri a fait l'objet de multiples analyses opposées par les économistes. Tout semble avoir été dit. Mais ce projet est un ensemble complexe, et aura des effets sur un marché du travail lui-même complexe du fait de l'hétérogénéité des acteurs et des institutions. Les analyses peinent à saisir cette complexité.

Elles mettent en évidence quelques mécanismes souvent pertinents sur les bases du raisonnement économique, mais il manque un modèle qui incorpore dans un cadre unique et cohérent les multiples mécanismes à l'œuvre et aux effets souvent opposés, et permette un chiffrage qui hiérarchise ces mécanismes dans un cadre comptable contraignant.

Marianne L'AGORA

Ils ne pensent pas (forcément) comme nous

ACCUEIL | POLITIQUE | ECONOMIE | SOCIAL | SOCIÉTÉ | MÉDIAS | MONDE | CULTURE | IDÉES | SAVOIR-VIVRE

TRIBUNE

Comment la loi El Khomri change profondément le marché du travail... sans améliorer l'emploi global

Jeudi 28 Avril 2016 à 11:48

Jean-Daniel Kant, Gérard Ballot et Olivier Goudet

Jean-Daniel Kant est maître de Conférences HDR (Habilité à Diriger des Recherches) en Informatique, Université Pierre et Marie Curie (UPMC) – Sorbonne Universités. Gérard Ballot est professeur émérite, Économie, Université Paris 2 Panthéon-Assas. Olivier Goudet est ATER Informatique, Université Pierre et Marie Curie (UPMC) – Sorbonne Universités.

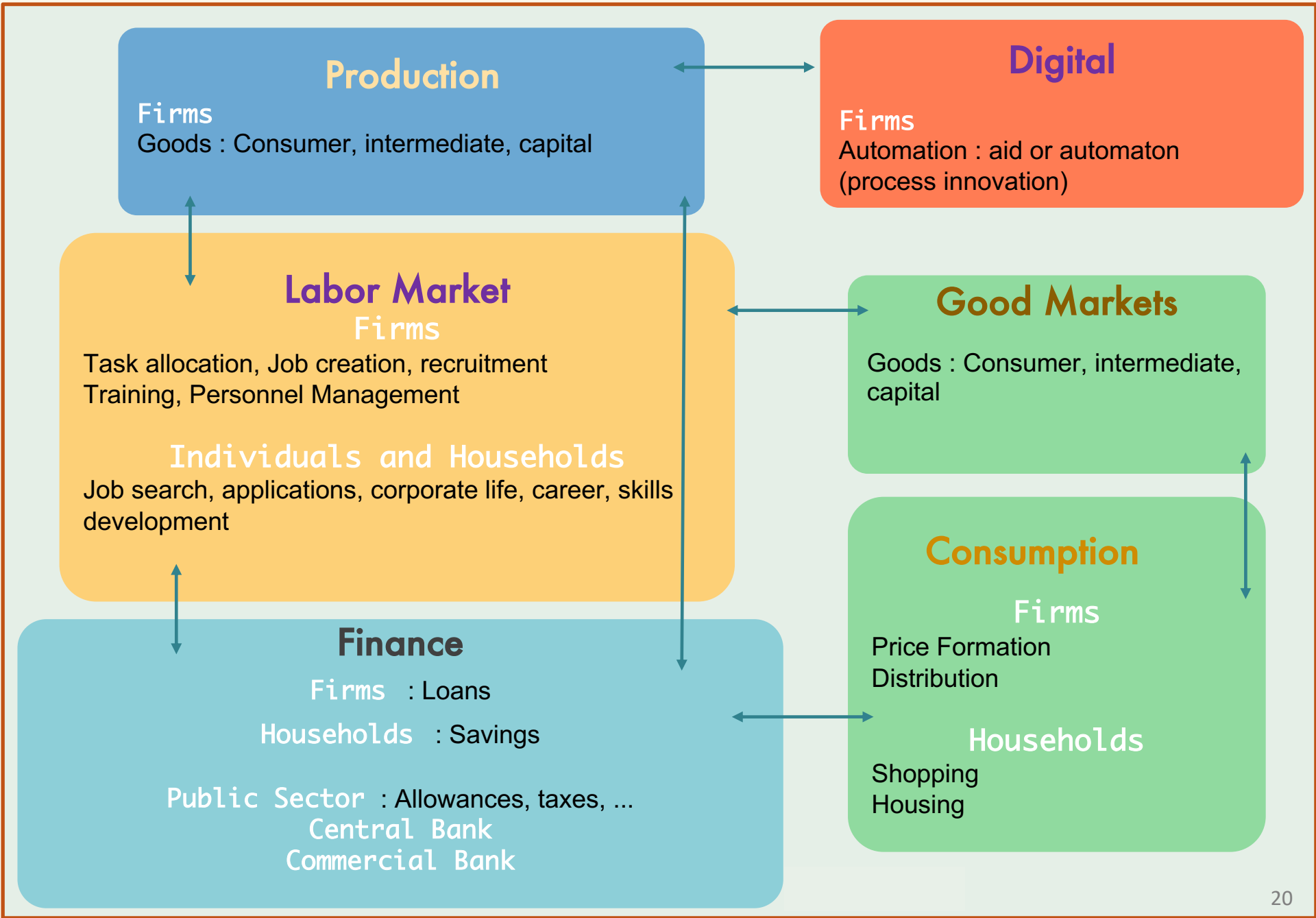
A l'aide d'une simulation informatique, trois universitaires ont tenté d'évaluer l'impact de la loi El Khomri sur le marché du travail. Il en ressort une augmentation du nombre de CDI mais surtout leur précarisation, le tout sans amélioration du taux d'emploi en France. Explications.

http://numjobs.lip6.fr/

NumJobs
An agent-based model to study labour markets and digital automation

Jean–Daniel Kant
Nicolas De Bufala
Thuan Huynh
Gérard Ballot

NumJobs overview (2018-...)



Some results (2022)

- 10–year duration (2016 → 2026), average over 24 simulations
- Digital production: 50% FR / 50% foreign
- Overall: negative impact on employment: –1.2 million

	No Digital	Digital	Difference (points)
Unemployment rate	10,1%	12,8%	**+2.7**
Employment rate	68,0%	64,5%	**-3,5**
Participation rate	75,6%	74,0%	**-1,6**

$$Unemp.\,\text{rate} = \frac{\#\text{unemployed}}{\#\ active} \qquad Emp.rate = \frac{\#employed}{Population15-64ans} \qquad Part.rate = \frac{\#active}{Population15-64ans}$$

What if Digital was 100% French?

- All digital goods are manufactured in France
- Overall: positive impact on employment: + 666 000 jobs

	No Digital	Digital	Différence (points)
Unemployment rate	10,1%	7,2%	**-2,9**
Employment rate	68,0%	70%	**+2**
Participation rate	75,6%	75,4%	**n.s.**

Many analyses are possible

Top 10 most aided tasks

Task Name	Task Frequency	AS : Aid	Context
Check the conformity of data or documents	9,89%	80,25%	OP
Write technical documentation	5,67%	77,20%	MT
Manage the production process	4,36%	65,64%	OP
Implement commercial and promotional actions	7,90%	63,71%	EC
Carry out tests, studies and experiments	3,15%	63,33%	CC
Administer an information system	4,24%	61,92%	MT
Develop and implement operating procedures	5,86%	61,84%	MT
Adjust, program and start up a machine	11,45%	61,37%	MT
To master the technical environment	39,96%	59,01%	MT
Analyze, exploit, structure data	14,84%	58,62%	CC

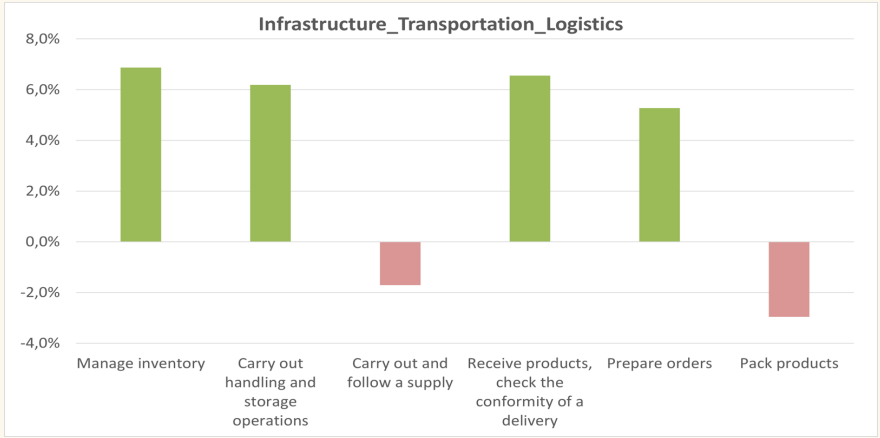
Top 10 most « AI » aided tasks

Task	Automation Strength : AI Aid	Context
Carry out breeding operations	40,0%	MT
Repair a machine or equipment	38,3%	MT
Master the scientific environment	37,1%	CC
Carry out maintenance and technical support operations	34,7%	MT
Manage an activity	34,3%	OP
Manage safety and risks	33,3%	MT
Carry out cultivation operations	33,1%	MT
Manage the production process	32,1%	OP
Carry out tests, studies, experiments	29,1%	CC
Carry out a technical diagnosis, solve a technical problem	28,7%	MT

Top 10 most automated tasks

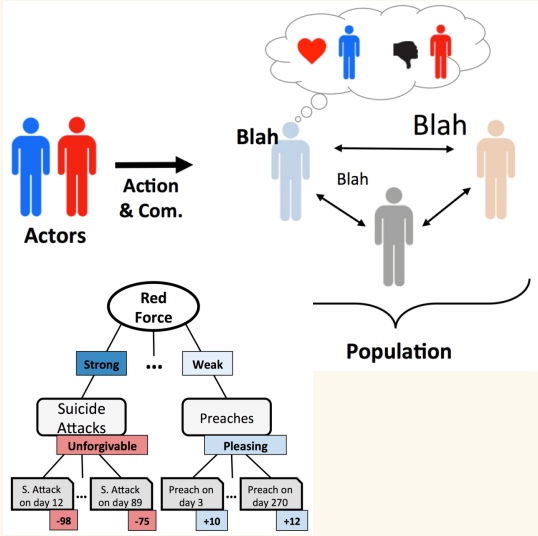
Task Name	Automation Strength : Automaton	Context
Estimate the value of a good, a product	16,7%	OP
Detect defects, propose corrective actions	14,0%	MT
Repair a machine, an equipment	13,0%	MT
Carry out a technical diagnosis, solve a technical problem	12,1%	MT
Carry out a medical diagnosis, design and implement care protocols	11,7%	HR
Collect data or information	11,2%	CC
Manufacture, shape products	11,1%	MT
Carry out a maintenance or technical support operation	10,6%	MT
Carry out preparation operations	10,6%	MT
Handle a handling or construction machine	10,1%	MT

Impact on skills



Other projects (Social Simulation)

- **Polias** : **Attiude and opinion dynamics** (with K.L Brousmiche & Airbus Defence & Space)
- **HappyWork** **Satisfaction at work** (with K. Chapuis & Technologia)
- **Coban** : **Innovation Diffusion** (with S. Thiriot & Orange Labs)
- **G–Impact** : Diet Adoption (with M.Franceschetti & C. Herpson)



Terra Neon

Decision support software to reduce human impacts on the Earth System

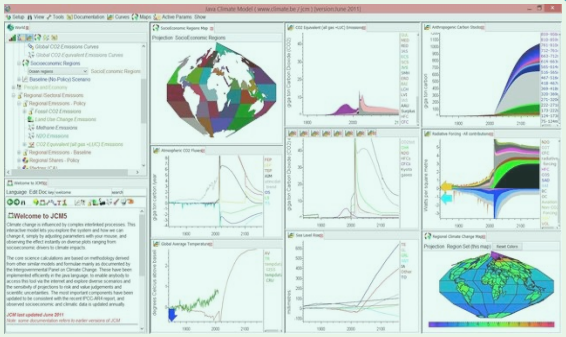
J.-D. Kant , C. Herpson, M. Franceschetti

TerraNeon's vision

TerraSim

Scientific Model

- Modeling the Earth System
- Climate and biodiversity
- Economy and Social
- Rules, laws, policies



Simulator

- Indicators, graphics,...
- Analyses, evaluations

ImmerSim

Immersive Simulation

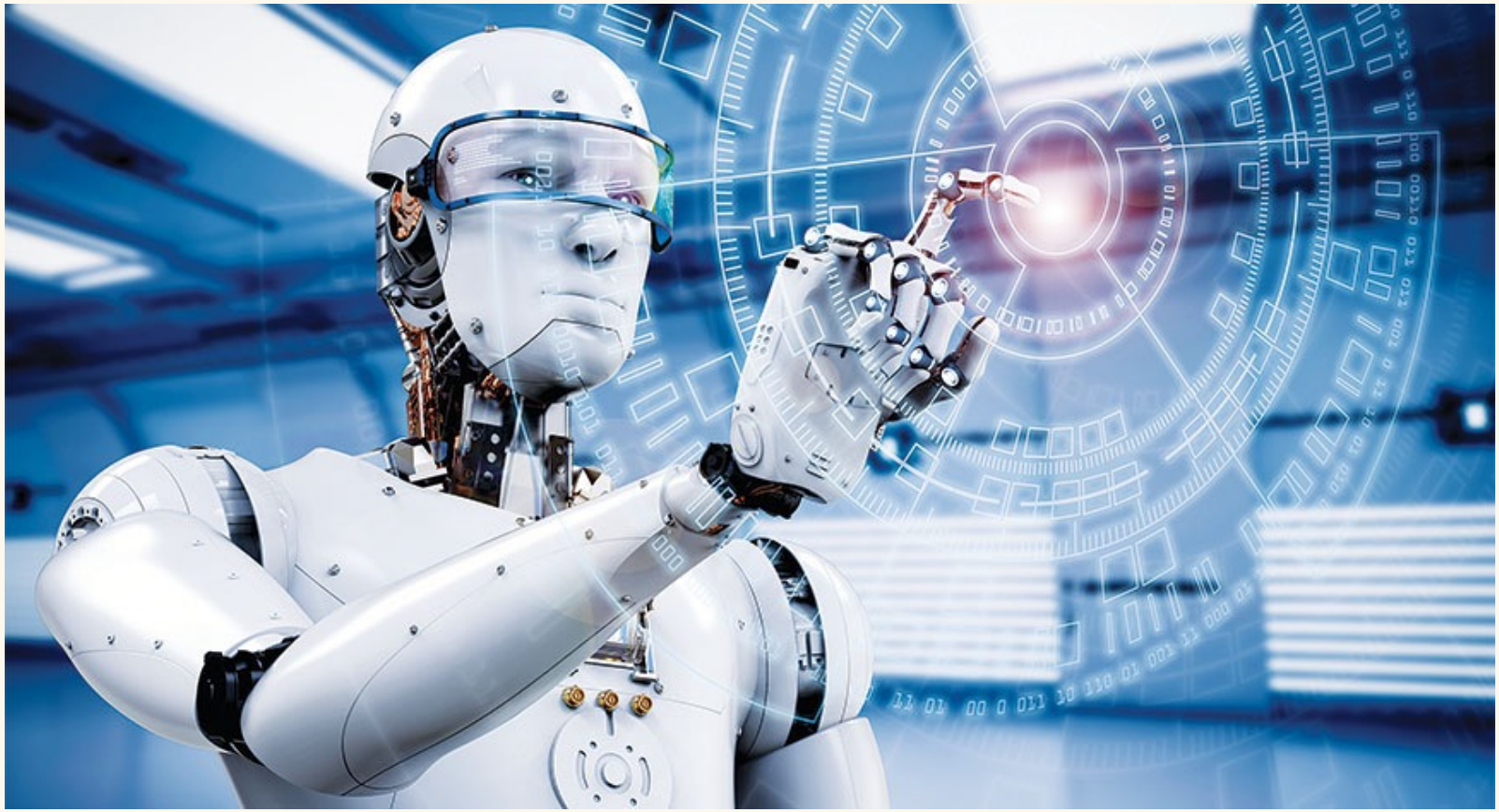
- "Living" in immersion society,
- Projecting into the future

CollecSim

Participatory Simulation

- Collective deliberation
- Achievable consensus-building

To Conclude...



What vision for AI?

- Strong tech–savvy vision
  - The human fails and must therefore be replaced by more efficient machines (AIs)
  - Problem when these machines become highly autonomous
    => singularity, super intelligence

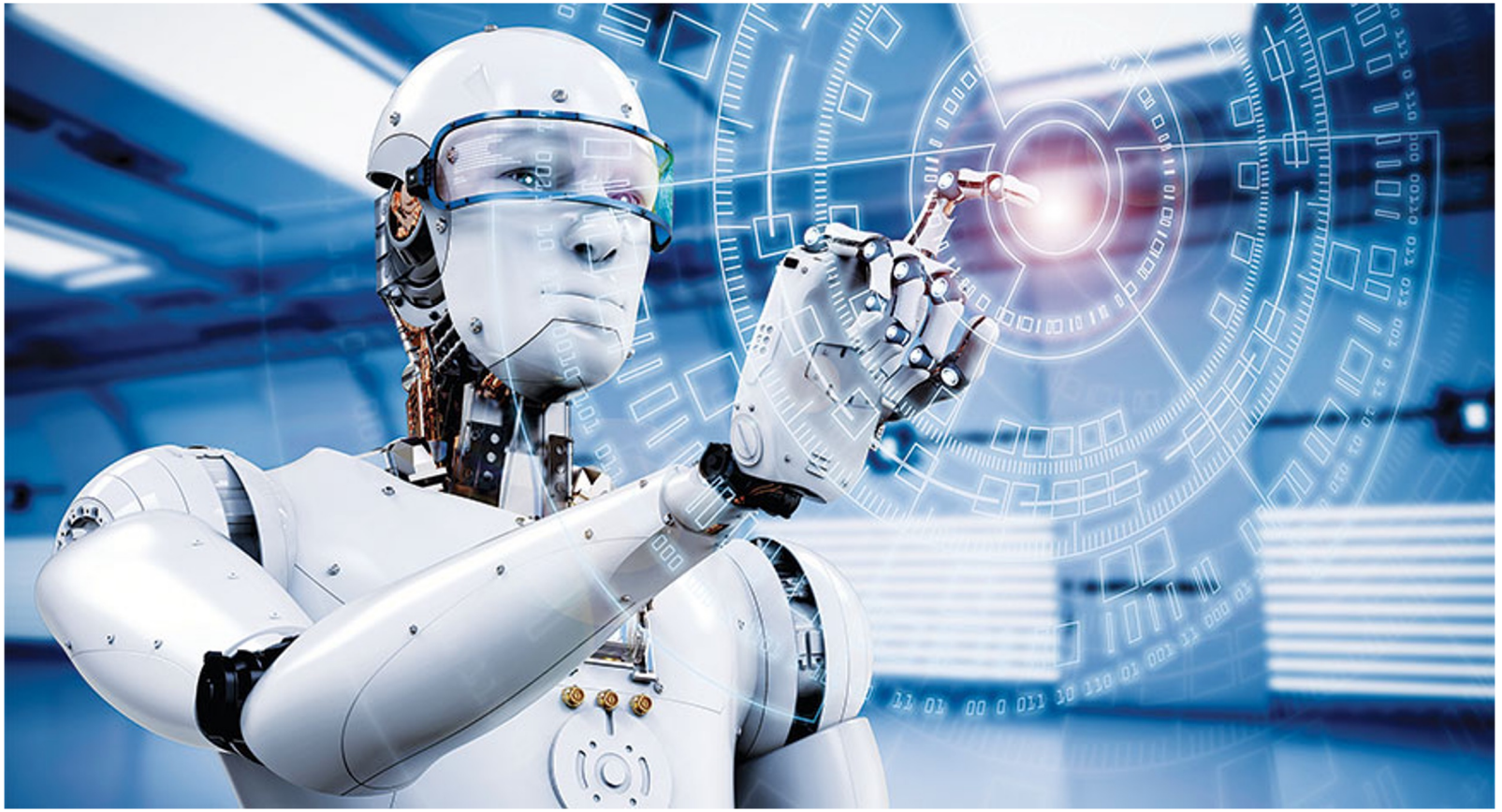
- Techno–moderate vision
  - Why replacing humans with machines ?
    We are already enough (too) many,
    there is unemployment...
    It implies to redefine what work is
  - Do not delegate our intelligence to machines (e.g. chatGPT)
  - Other problems (climate, environment) risk to be aggravated by a massive use of AI, which is resource–intensive
  - **GO FOR Augmented intelligence !!** 🙂

Jean-Daniel.Kant@lip6.fr - https://lip6.fr/jean-daniel.kant

Selected papers

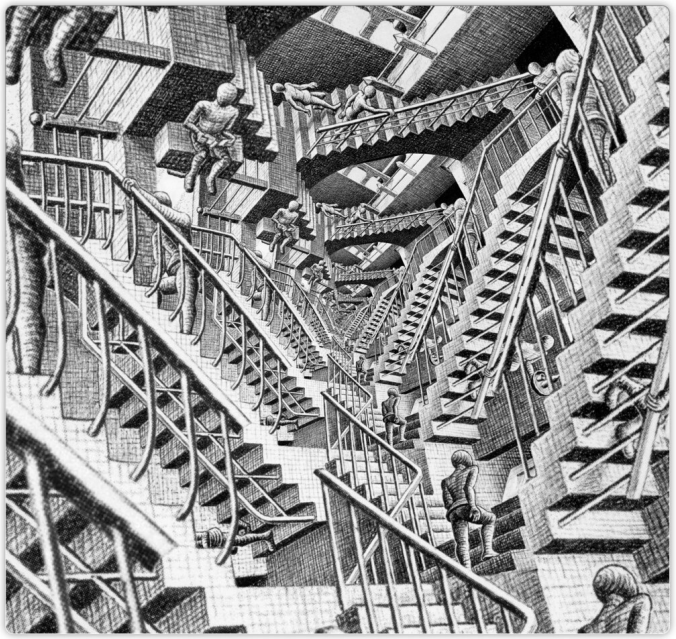
- Jean–Daniel Kant. An agent–based simulation approach to evaluate and design policies. *20th International Workshop on Multi–Agent–Based Simulation (MABS 2019)*, May 2019, Montreal, Canada.
- J.–D. Kant, G. Ballot, and O. Goudet. WorkSim, an Agent–Based Model to Study Labor Markets. *Journal of Artificial Societies and Social Simulation*, 23(4), 2020.
- O. Goudet, J.–D. Kant, and G. Ballot. WorkSim: A Calibrated Agent–Based Model of the Labor Market Accounting for Workers' Stocks and Gross Flows. *Computational Economics*, 50(1):21–68, July 2016.
- J.–D. Kant, G. Ballot, and O. Goudet. WorkSim, an Agent–Based Model to Study Labor Markets. Journal of Artificial Societies and Social Simulation, 23(4), 2020. https://www.jasss.org/23/4/4.html
- K.–L. Brousmiche, J.–D. Kant, N. Sabouret, and F. Prenot–Guinard. From Beliefs to Attitudes: Polias, a Model of Attitude Dynamics Based on Cognitive Modeling and Field Data. *Journal of Artificial Societies and Social Simulation*, 19(4):2, October 2016. https://jasss.soc.surrey.ac.uk/19/4/2.html
- S. Thiriot and J.–D. Kant. Using associative networks to represent adopters' beliefs in a multi–agent model of innovation diffusion. *Advances in Complex Systems*, 11(2):261–272, 2008
- M. Franceschetti, C. Herpson, J.–D. Kant. How beliefs on food and climate change impact the dietary adoption ? An agent–based approach. Social Simulation Conference 2022.

APPENDICES



Complexity is not a bad thing!

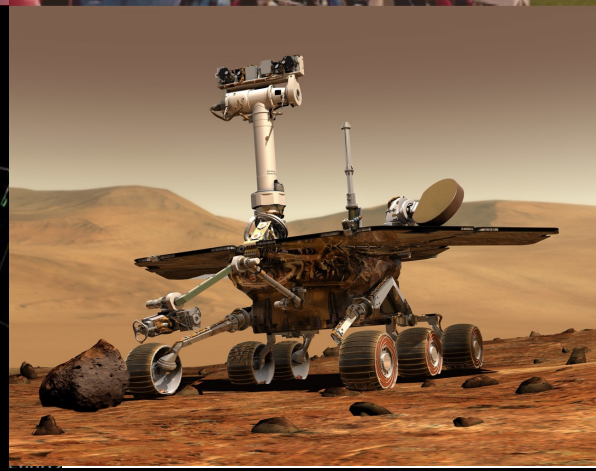
- It teaches us the nuance
  - Neither white nor black…
- … and modesty
- It forces us to be more ambitious
  - No simple answer to a complex problem
- A systemic AND long–term approach is needed
  - Difficult for human cognition
- Multi–agent simulation is an ideal approach to help us meet all these challenges!

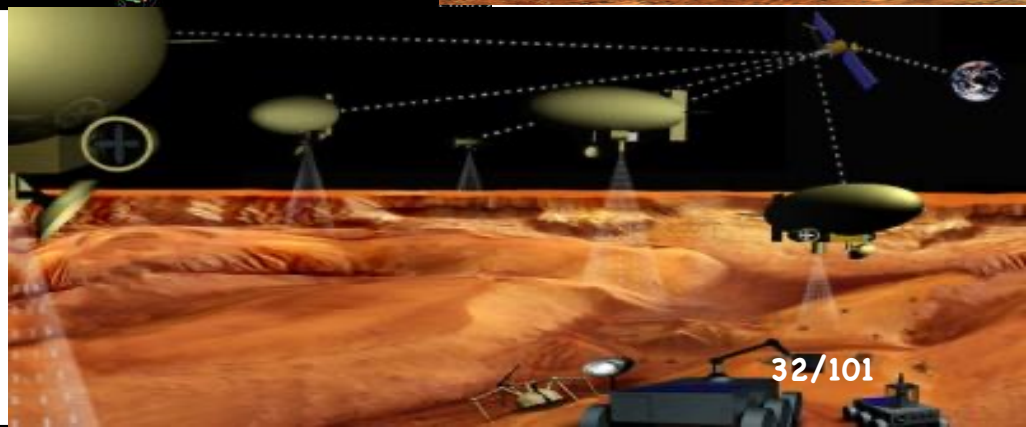


Infinite Relativity

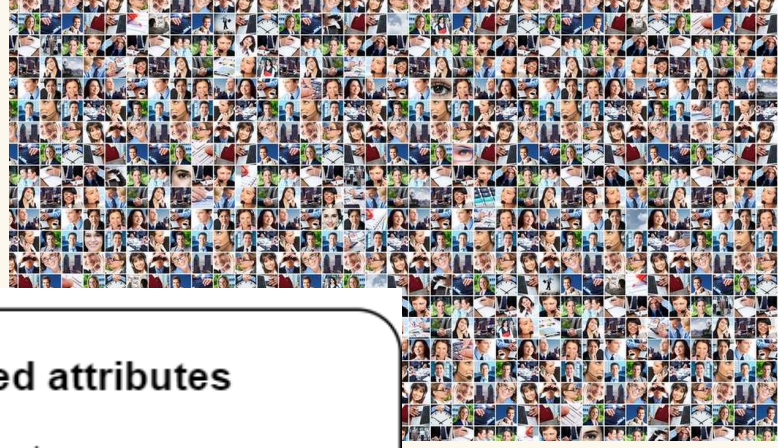
M.C. Escher

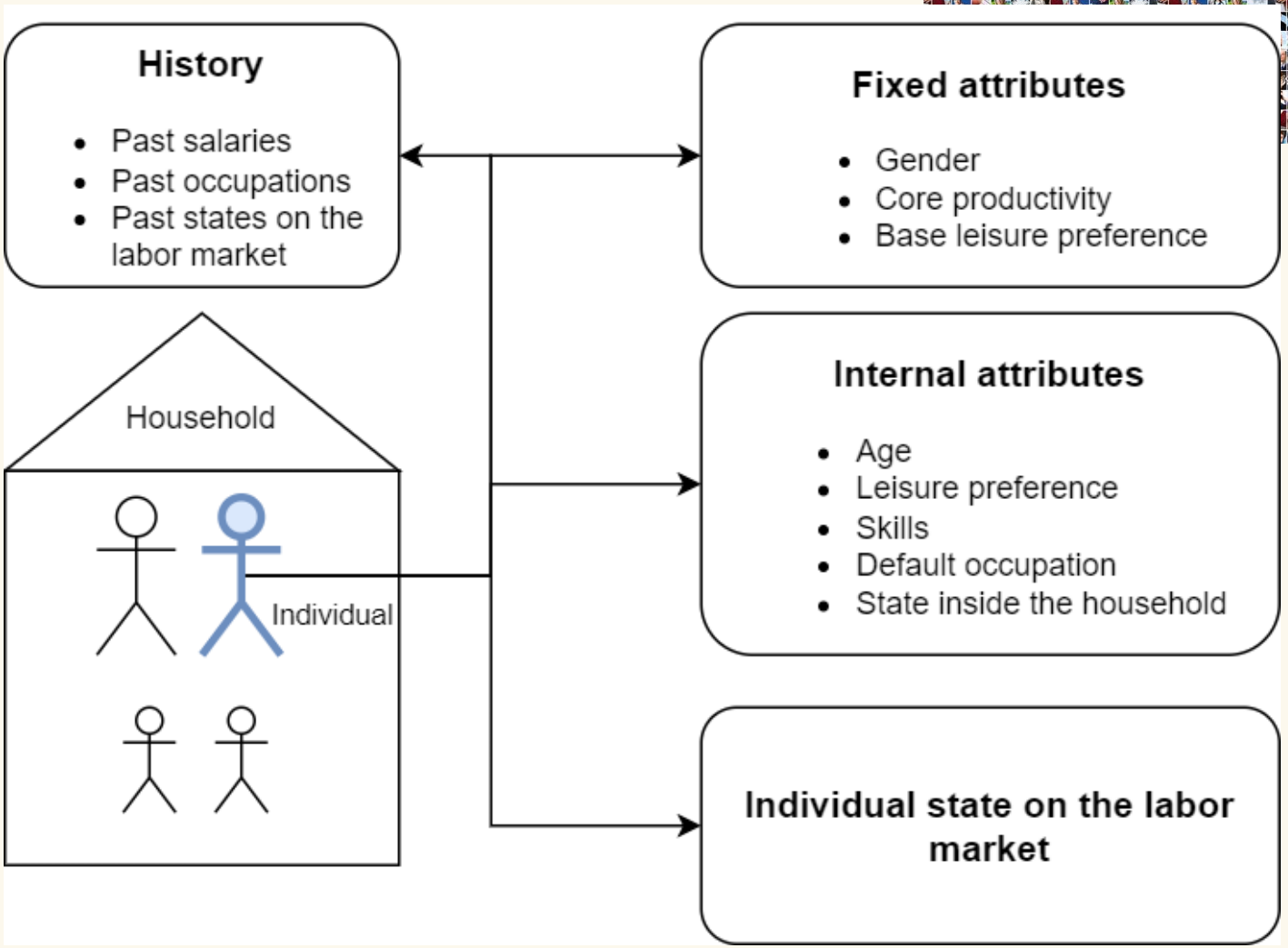
Applications



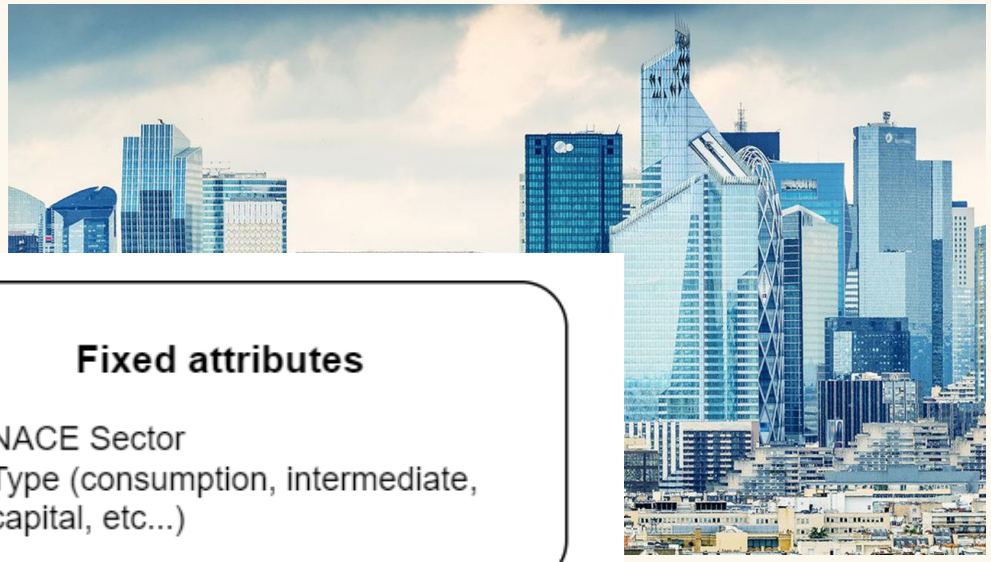


Individuals





Firms



History

- Past employees and contracts
- Hiring experiences
- Sales and revenue
- End of previous contracts
- etc...

Fixed attributes

- NACE Sector
- Type (consumption, intermediate, capital, etc...)

Internal attributes

- Employees (and occupations)
- Capital goods (all types)
- Produced goods
- Revenue
- Spendings
- Consumption (intermediate goods)
- Task list and Leontieff coefficients