PILLARS - Pathways to Inclusive Labour Markets

Emerging digital automation technologies and the Future of Work. A Reappraisal

Maria Savona
SPRU, University of Sussex, UK;
Dpt. Economics, Luiss, IT

The hype around emerging digital automation

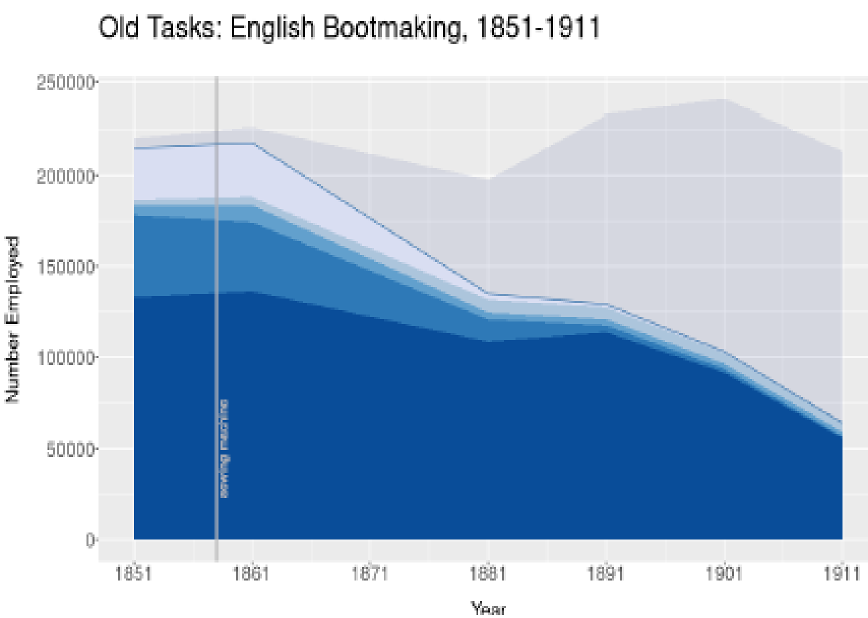
- A conscious, human-like, **Artificial General Intelligence (AGI), such as generative AI**

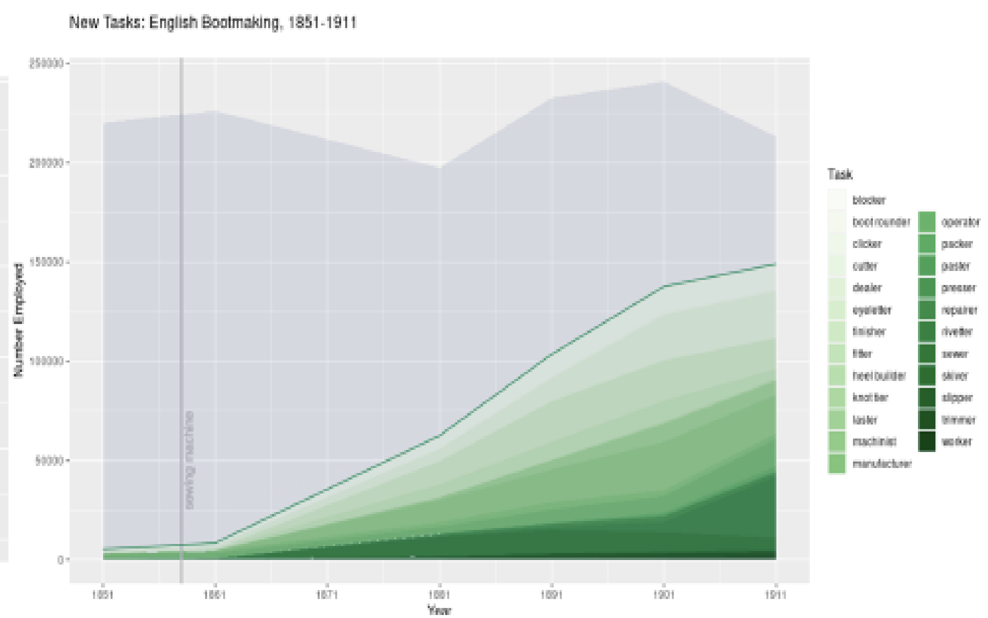
- The power of **learning by imitation**, or Machine Learning
  - The blurred boundaries between **codified and tacit knowledge** for innovation

- The technological anxiety (Mokyr et al, 2015) around "**this time it will be different**" in terms of **(un)employment effects**
  - Let's look at history

Technological unemployment in historical perspective. A task based approach (Vipond, 2023)

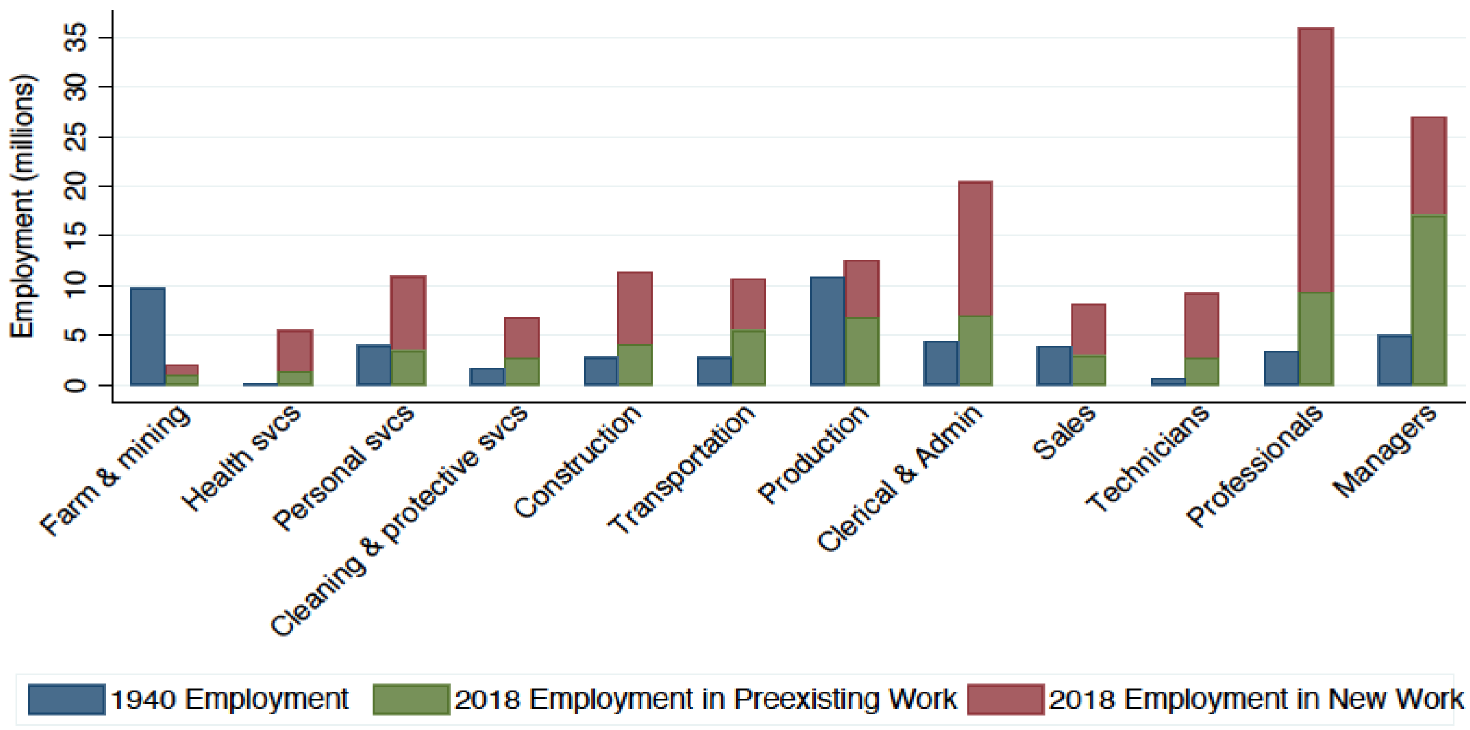
- Mechanization of the **English Bootmaking Industry** (1851-1911) from the Integrated Census Microdata project (Schürer & Higgs, 2014)
- Loss of 139,000 jobs, creation of new 125,000 jobs linked to tasks required by the introduction of the sewing machine



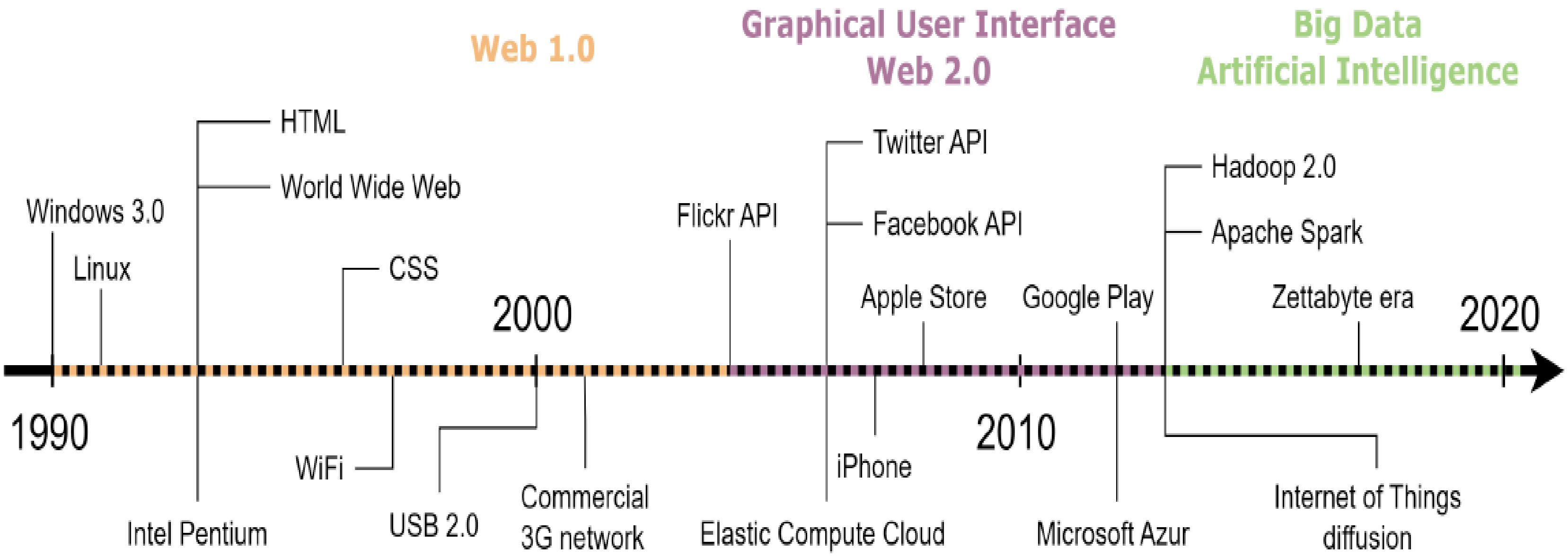


New frontiers: the origins and content of new work, 1940-2018 (Autor et al, 2022)

Employment counts by broad occupation (1940 and 2018), by titles present in 1940 and titles added subsequently



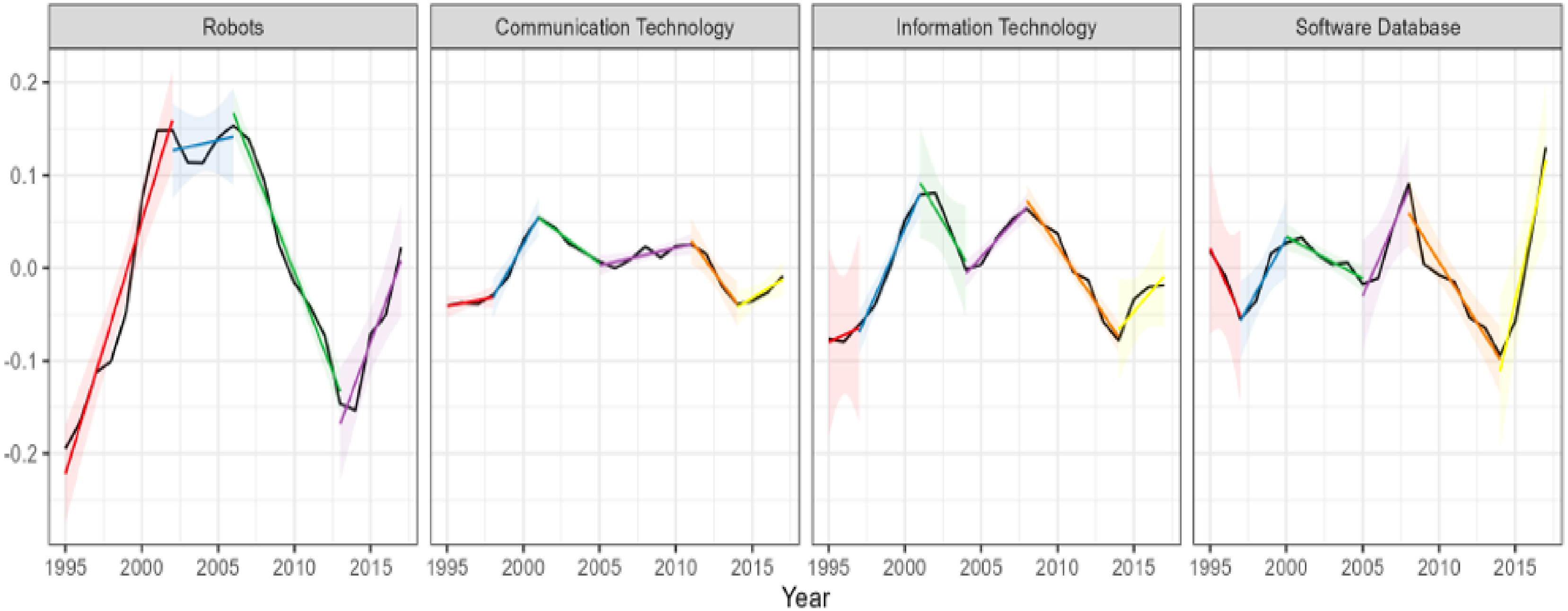
Timeline of major digital innovations over the past 30 years (Ciarli et al, 2023)



Cycles of technology investments in Europe 1995-2017 (Ciarli et al 2023)

Technological cycles in Europe between 1995 and 2017 ▸ Timeline

- ROB: Industrial robots (1995–2012), Robotics (2013–)
- CT/IT/SDB: Web 1.0 (1995–2005), GUI/Web 2.0 (2006–2012), Big Data/AI (2013–)



Key findings on cycles of investments (Ciarli et al, 2023)

- Investment cycles in technologies follow technological breakthroughs

- Short run labour market impacts smooth out in the long run
  - Employment to population: effects disappear in the long run (except for robots, net positive)
  - Wages: only short run effects

- Deceleration in investments in robots (ICTs and SDB) bring a positive (negative) effect on employment

- Phase of technology adoption seems to matter more than regional differences in productivity and specialization

Plus ça change, plus c’est la même chose?

- Mechanization (19th), electrification (20th), digitization (20th & 21st)
- The disappearance of manufacturing? Digitization, **human-machine interface** and the replacement of **services**
    - The emergence of **cyber-physical systems** in the realm of production (broadly intended)

So:

*We assess the **potential** for the EDT, and whether this time it will be different, begins with a careful assessment of the **emergence of new capabilities in the cyber-physical systems for labour saving devices,** that are the current subjects of **research, development and initial deployment**.”* (Savona et al., 2022)

FoW forecast requires to go granular

- What is the value of going granular?
  - The logic Substitution/Compensation becomes too simple: more of a **"task redesigning"** within a single occupation (Arntz et al., 2017)
  - Can EDT potentially **substitute**, **complement**, and/or **reconfigure** specific **technical tasks** within occupations within sectors, that are executed by humans?
  - Can we infer trends and dynamics on future of work from EDT characterized by **complex interdependency** and the **pervasive presence of artificial intelligence** (AI)?
  - **Granularity** is essential to pick up exposure, adoption, task replacement/complementarity, and a trove of other dimensions (knowledge codification, innovation, interactions with people, symbols)

Examples of relevant EDT (I)

A	**Robots (Articulated, Cylindrical, Cartesian, Dual Arm, SCARA)**
1	Machine vision and real-time monitoring
2	Co-bots
3	Swarm robotics
4	Service robotics
5	Semi-autonomous (e.g. bricklaying)
6	Automated platforms/vehicles
7	Tunnel boring and mining robots
8	Drones
9	Robotic vehicles (including Space vehicles and rovers, autonomous vehicles, submersible robots)
10	Exoskeletons
B	**Physical Data Acquisition Technologies**
1	Scanners
2	Sensors
3	Remote Sensing
4	GPS
5	CCTV
6	Scientific and engineering instruments
7	Healthcare instruments (including personal health instrumentation)
8	Data scraping

Examples of relevant EDT (II)

C	**Software-based Data management**
1	Database systems
2	Relational databases (including API)
3	Cryptography, security, and blockchain mining)
4	Big data analytics
D	**Computing**
1	Automated storage and retrieval systems (including cloud storage)
2	Computer architectures (including edge computing, cloud computing, HPC, grid computing)
E	**AI (not directly as a cloud service) & Intelligent Information System**
1	Simulation
2	Machine learning (predictive systems)/ Deep Learning
3	NLP
4	Machine vision (image recognition)
5	Expert systems
6	Speech recognition and production
7	Text recognition and production (including machine translation)
F	**Additive manufacturing (using any material e.g. powder metallurgy and bioplastic filament)**
1	Prototyping (including tools production, production at scale)
2	3D printing
3	CAD/CAM (prototype and/or production)

Examples of relevant EDT (III)

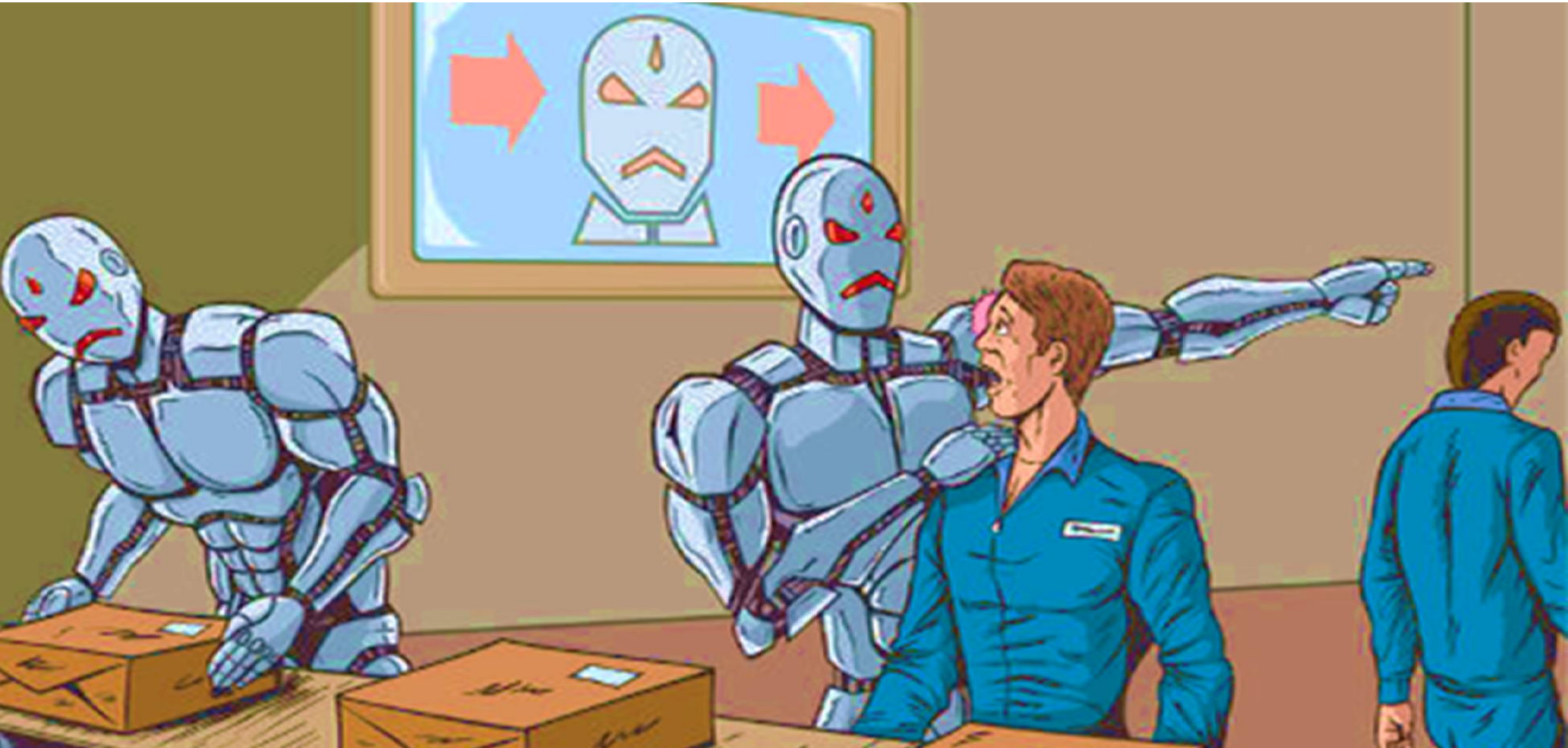
G	**Networking**
1	IoT (including Radio-frequency identification (RFID) systems)
2	Wireless communication (including 5G)
H	**User interface**
1	Conventional input devices (e.g. keyboard, mice, pens, webcams)
2	Display devices (conventional)
3	Augmented reality (including holograms)
4	Haptics and Tele-haptics (including all tele-operations of physical machinery by human operator requiring feedback)
5	Virtual Reality (including 3D Visualisation)
6	Touchscreens/kiosks for customer interface
7	Sound technologies (e.g. noise cancellation)
8	Neuroscanning
9	Gamification
I	**Other**
1	Machine Tools
2	Factory control system

Key results of a quali-quanti analysis of technical papers

- Automation technologies, including within the same family, are fundamentally different in their design and the tasks they can execute
- The number of sectors that attract the development of most automation technologies is still relatively limited, but expanding.
- Automation related to robotisation is likely to become more and more substitutive of tasks performed by humans
- The use of codified or tacit knowledge is fairly associated with routinisation, whereby the most routinised tasks performed by these technologies seem to make use of codified more than tacit knowledge.
    - data intensive technologies interact more with symbols, rather than with things or people as robotisation-based automation.

Imaginaries of EDT – Gloomy?

- The future of work depends on **technologies' evolution**, their idiosyncrasies, their **stage of development and adoption**, the specific **sectors** that are mostly exposed to each of them, the specific **tasks** they complement or replace, their convergence towards complex technology systems integrating both **software** and **hardware** components, the shapes of **human-machine interactions**



Policy challenges

- Monitoring the evolution of technologies and the **overall level of (un)employment** at certain critical timing (i.e. Generative AI), not only new emerging tasks, but the transition between old and new
- The evolution of technological breakthrough is shaped by cycles of technology investments and policy support to firms in EDTs
- Facilitating citizens and workers' voices involvement in decisions to support critical technologies (e.g. platform workers) in case effects on **working conditions** worsen
- Much of ETDs is largely data intensive, and an inclusive **governance of data** is a major policy challenge, if we consider issues of individual data, digital trade and the narrowing of AI research
- The regulation of the boundaries between **human and artificial intellectual property rights** is also a major policy challenge, from the perspective of antitrust and value redistribution

THANK YOU FOR YOUR ATTENTION!

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