Process Mining & Hybrid Intelligence

(Celonis CxO Club Tokyo 26-7-2024)

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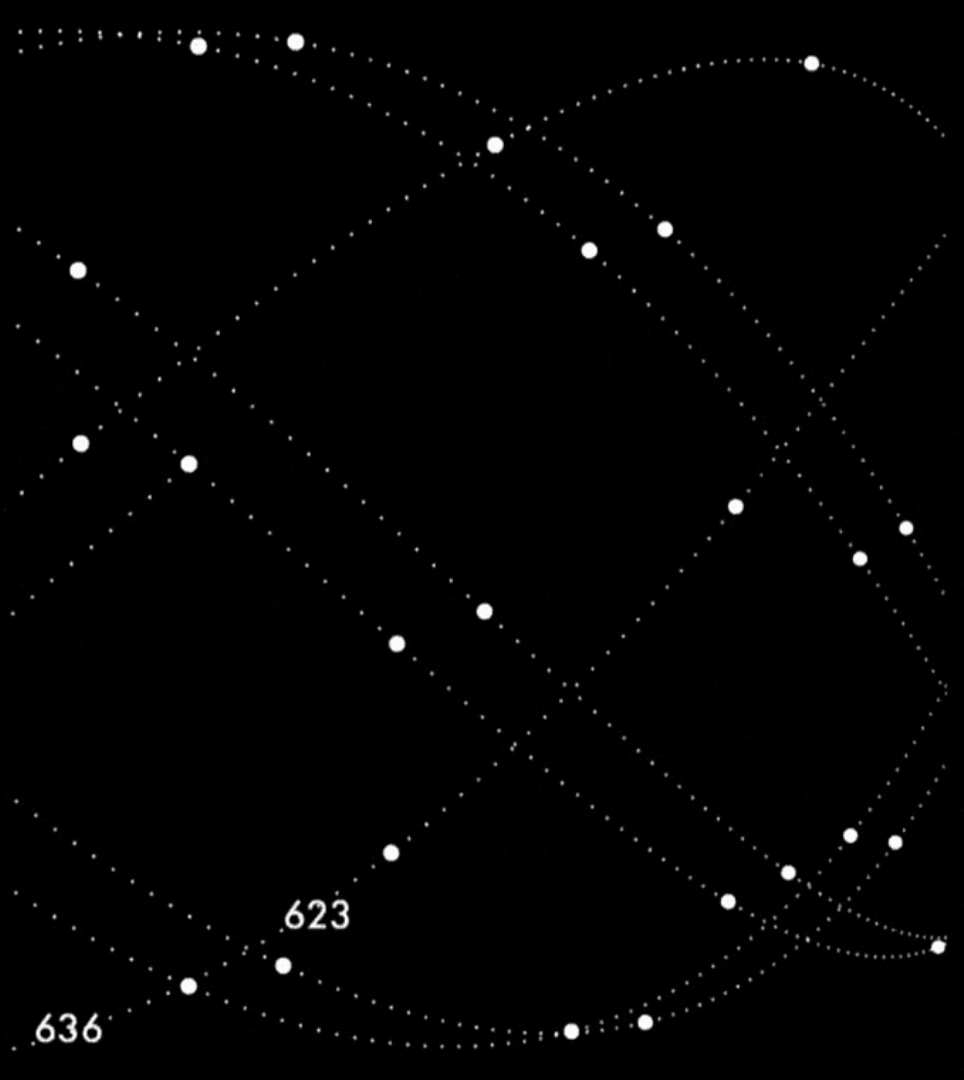
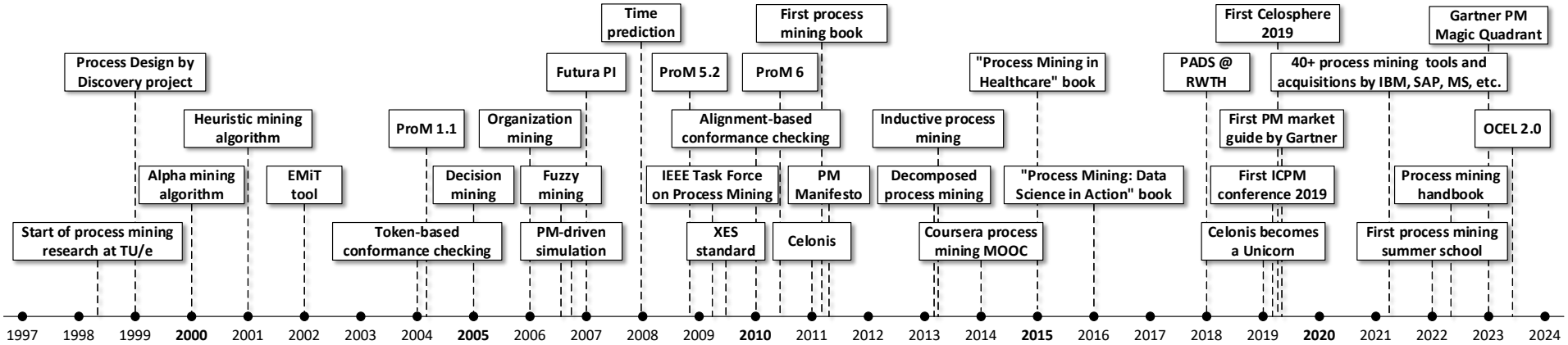
chief scientist at Celonis



First Japanese Process Mining Conference (26-9-2019)

- It is great to see how the field is progressing and how the community is growing.
- Given the process and quality mindset in Japan, I see wonderful opportunities!

In my keynote, I will talk about the history of process mining



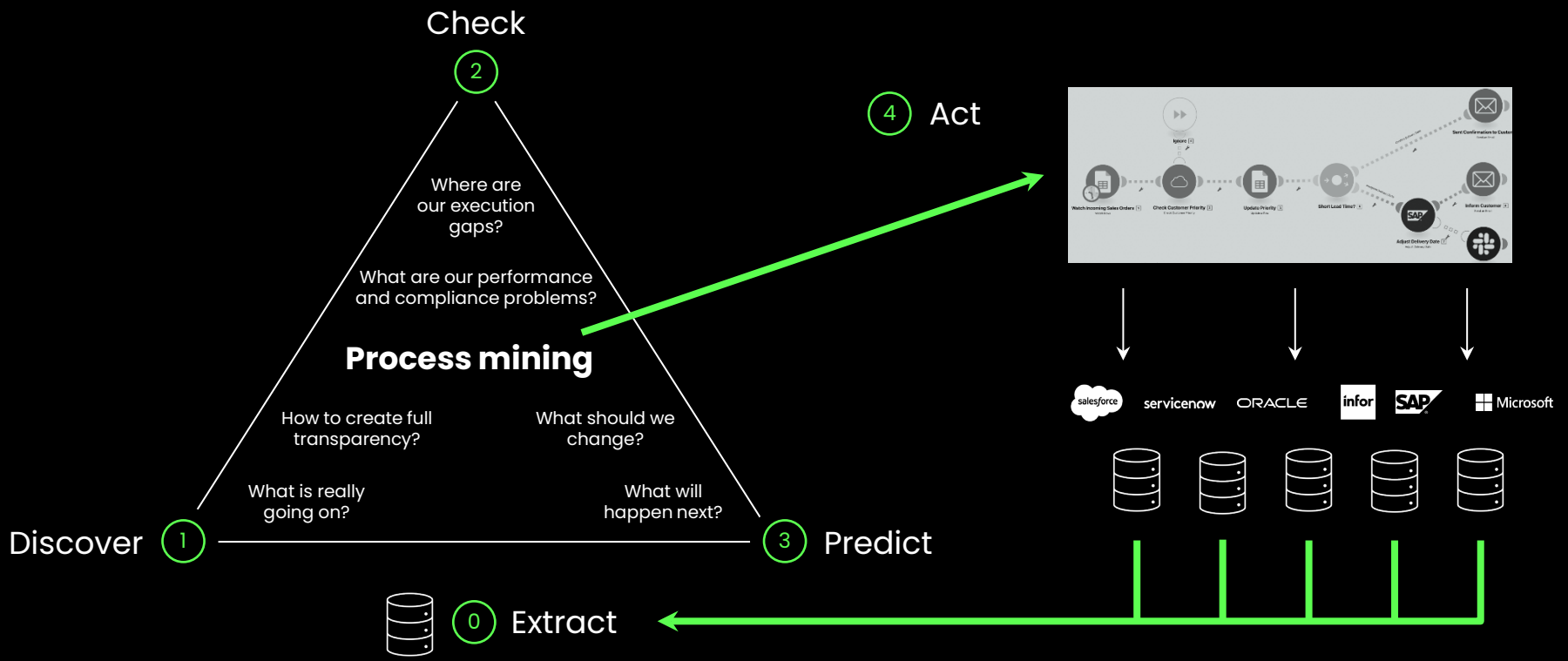
Started in the late 1990-ties as a response to disappointments related to workflow management and process modeling

Initial focus on process discovery. Despite amazing progress still not a solved problem

Around 2008, we already supported conformance checking, learning simulation models, and generating ML problems

Adoption and awareness have increased thanks to Celonis (and we are just starting)

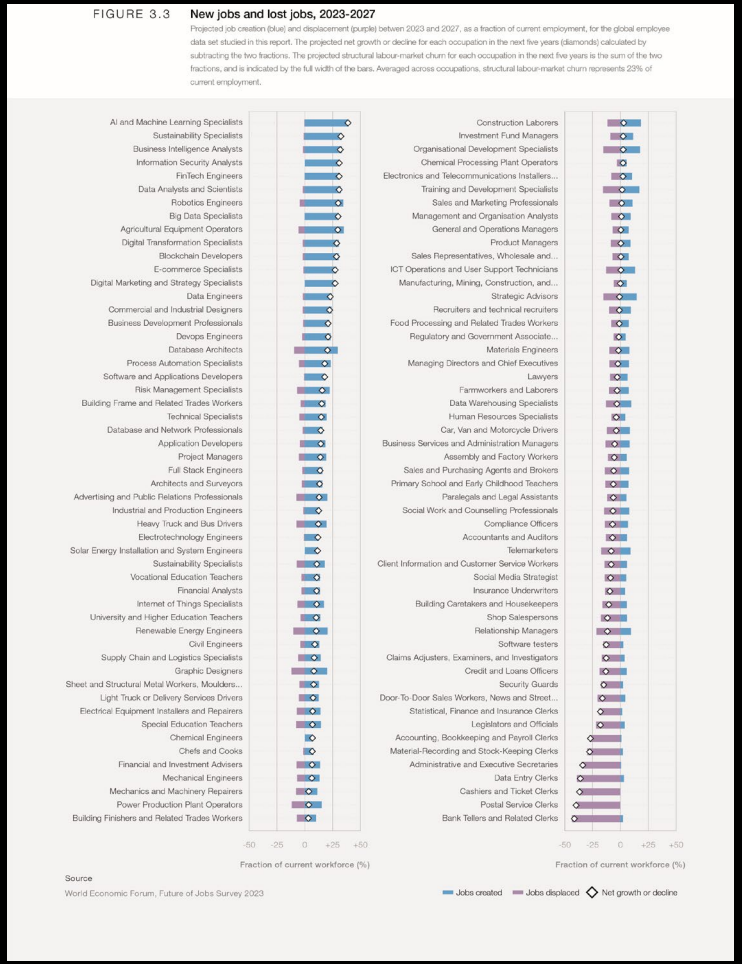
High-level view of process mining



Let’s change the topic


www.pwc.co.uk/economics
Will robots really steal our jobs?
An international analysis of the potential long term impact of automation
pwc

The Future of Jobs Report 2023 by the World Economic Forum




AI and Machine Learning Specialists
Sustainability Specialists
Business Intelligence Analysts
Information Security Analysts
FinTech Engineers
Data Analysts and Scientists
Robotics Engineers
Big Data Specialists

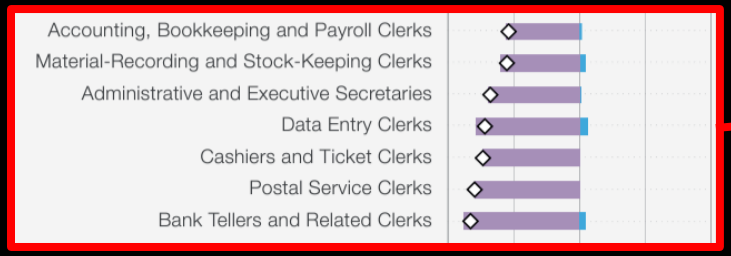

Accounting, Bookkeeping and Payroll Clerks
Material-Recording and Stock-Keeping Clerks
Administrative and Executive Secretaries
Data Entry Clerks
Cashiers and Ticket Clerks
Postal Service Clerks
Bank Tellers and Related Clerks


FIGURE 3.3 New jobs and lost jobs, 2023-2027
Projected job creation (blue) and displacement (purple) between 2023 and 2027, as a fraction of current employment, for the global employee data set studied in this report. The projected net growth or decline for each occupation in the next five years (diamonds) calculated by subtracting the two fractions. The projected structural labour-market churn for each occupation in the next five years is the sum of the two fractions, and is indicated by the full width of the bars. Averaged across occupations, structural labour-market churn represents 23% of current employment.
AI and Machine Learning Specialists
Sustainability Specialists
Business Intelligence Analysts
Information Security Analysts
FinTech Engineers
Data Analysts and Scientists
Robotics Engineers
Big Data Specialists
Digital Transformation Specialists
Blockchain Developers
E-commerce Specialists
Digital Marketing and Strategy Specialists
Data Engineers
Commercial and Industrial Designers
Business Development Professionals
Devops Engineers
Database Architects
Process Automation Specialists
Software and Applications Developers
Risk Management Specialists
Building Frame and Related Trades Workers
Technical Specialists
Database and Network Professionals
Application Developers
Project Managers
Full Stack Engineers
Architects and Surveyors
Advertising and Public Relations Professionals
Industrial and Production Engineers
Heavy Truck and Bus Drivers
Electrotechnology Engineers
Solar Energy Installation and System Engineers
Sustainability Specialists
Vocational Education Teachers
Financial Analysts
Internet of Things Specialists
University and Higher Education Teachers
Renewable Energy Engineers
Civil Engineers
Supply Chain and Logistics Specialists
Graphic Designers
Sheet and Structural Metal Workers, Moulders...
Light Truck or Delivery Services Drivers
Electrical Equipment Installers and Repairers
Special Education Teachers
Chemical Engineers
Chefs and Cooks
Financial and Investment Advisers
Mechanical Engineers
Power Production Plant Operators
Building Finishers and Related Trades Workers
Construction Laborers
Investment Fund Managers
Organisational Development Specialists
Chemical Processing Plant Operators
Electronics and Telecommunications Installers...
Training and Development Specialists
Sales and Marketing Professionals
Management and Organisation Analysts
General and Operations Managers
Product Managers
Sales Representatives, Wholesale and...
ICT Operations and User Support Technicians
Manufacturing, Mining, Construction, and...
Strategic Advisors
Recruiters and technical recruiters
Food Processing and Related Trades Workers
Regulatory and Government Associate...
Materials Engineers
Managing Directors and Chief Executives
Lawyers
Farmworkers and Laborers
Data Warehousing Specialists
Human Resources Specialists
Car, Van and Motorcycle Drivers
Business Services and Administration Managers
Assembly and Factory Workers
Sales and Purchasing Agents and Brokers
Primary School and Early Childhood Teachers
Paralegals and Legal Assistants
Social Work and Counselling Professionals
Compliance Officers
Accountants and Auditors
Telemarketers
Client Information and Customer Service Workers
Social Media Strategist
Insurance Underwriters
Building Caretakers and Housekeepers
Shop Salespersons
Relationship Managers
Software testers
Claims Adjusters, Examiners, and Investigators
Credit and Loans Officers
Security Guards
Door-To-Door Sales Workers, News and Street...
Statistical, Finance and Insurance Clerks
Legislators and Officials
Accounting, Bookkeeping and Payroll Clerks
Material-Recording and Stock-Keeping Clerks
Administrative and Executive Secretaries
Data Entry Clerks
Cashiers and Ticket Clerks
Postal Service Clerks
Bank Tellers and Related Clerks
-50 -25 0 +25 +50
Fraction of current workforce (%)
-50 -25 0 +25 +50
Fraction of current workforce (%)
Source
World Economic Forum, Future of Jobs Survey 2023
Jobs created
Jobs displaced
Net growth or decline

We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run.

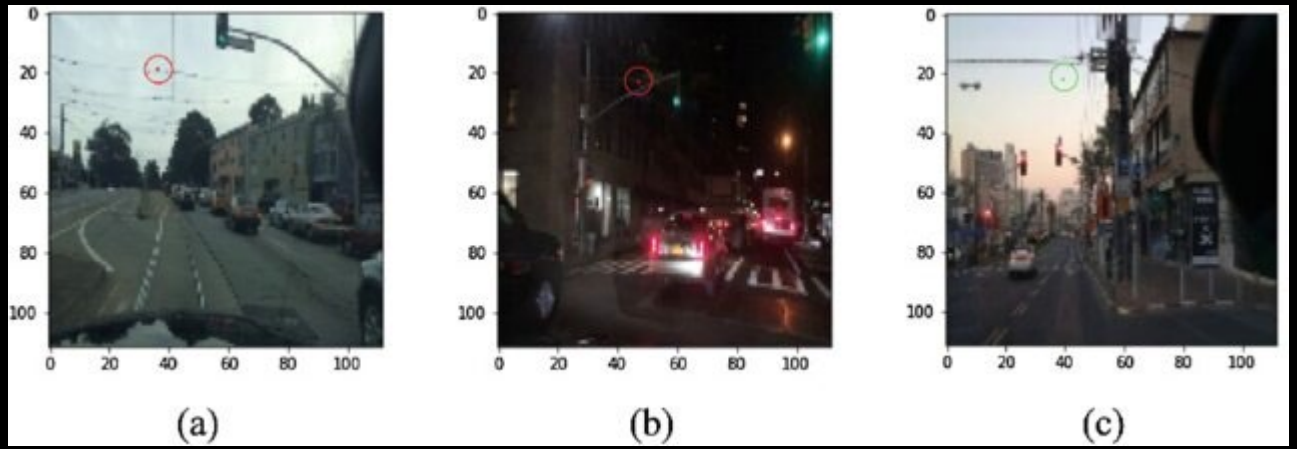
Roy Amara (former president of the Institute for the Future)


“… we are probably only a month away from having autonomous driving at least for highways and for relatively simple roads. My guess for when we will have full autonomy is approximately three years.”
(Elon Musk, 2015)

“… People should stop training radiologists now. It’s just completely obvious that within 5 years, deep learning is going to do better than radiologists …. We’ve got plenty of radiologists already”

(Geoffrey Hinton, 2016)

No guarantees!



Green light classified as red after one pixel change

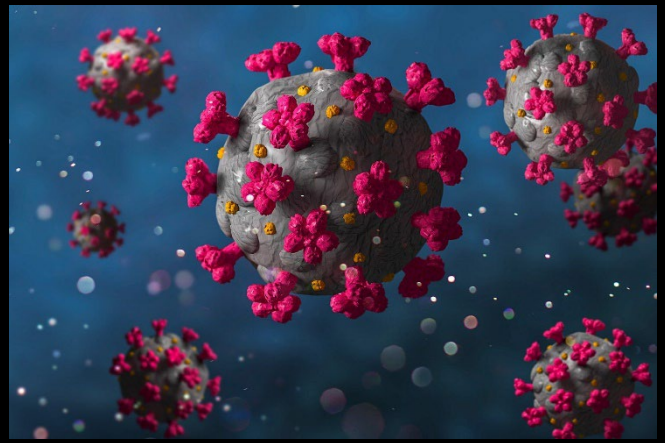
Green light classified as red after one pixel change

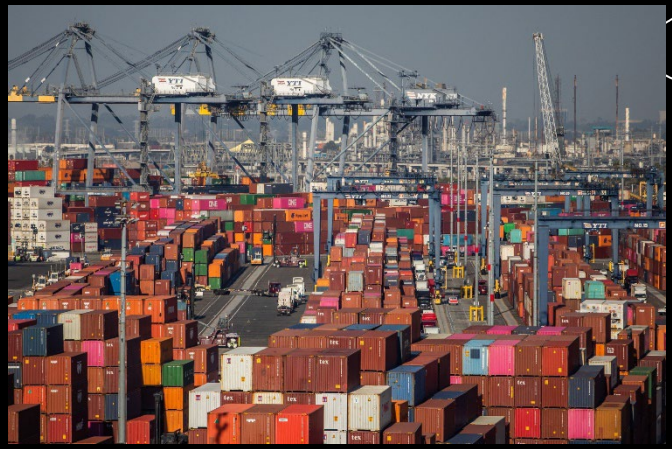
Red light classified as green after one pixel change.

Winner Nexar traffic light challenge: On average, it takes only 3 pixels to turn red into green or green into red!

Wicker, M., Huang, X., Kwiatkowska, M. (2018). Feature-Guided Black-Box Safety Testing of Deep Neural Networks. TACAS 2018. https://doi.org/10.1007/978-3-319-89960-2_22

Data from the past does not help in case of dramatic changes





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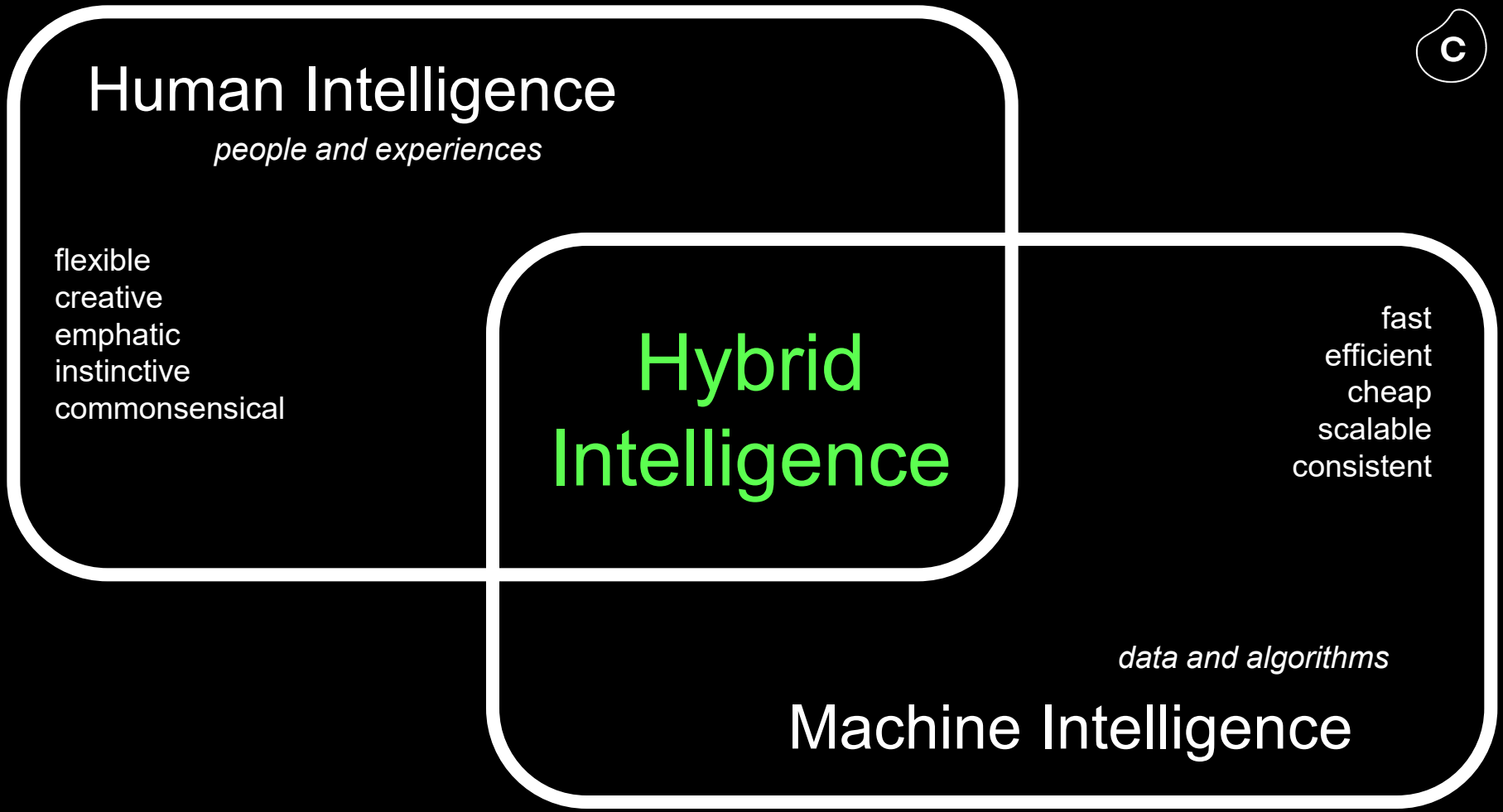

Human Intelligence
people and experiences
flexible
creative
emphatic
instinctive
commonsensical
Hybrid Intelligence
fast
efficient
cheap
scalable
consistent
data and algorithms
Machine Intelligence

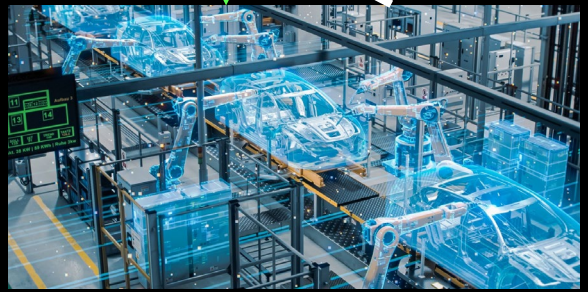
Process Mining & Hybrid Intelligence

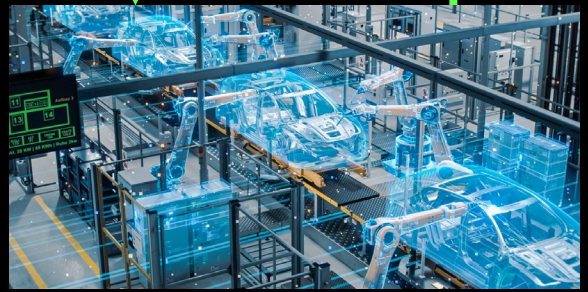
- Process mining allows for hybrid intelligence: It is still possible to look at models and things still work when circumstances change or there is little data.

- It is a key technology to support the gradual transfer of tasks from humans to machines!

Digital Model, Digital Shadow, Digital Twin

Automated in both directions





Digital Model

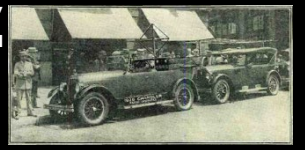
Digital Shadow

Digital Twin

Process Mining & Intelligence

Hybrid for the foreseeable future

1925: first "driverless" car by Houdina



SAE INTERNATIONAL

	Level 00	Level 01	Level 02	Level 03	Level 04	Level 05
What does the human in the driver's seat have to do?	You are driving whenever these driver support features are engaged – Even if your feet are off the pedals and you are not steering You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety			You are not driving when these automated driving features are engaged – Even it you are seated in "the driver's seat" When the feature requests, you must drive	These automated driving features will not require you to take over driving	
	These are driver support features			These are automated driving features		
What do these features do?	These features are limited to providing warnings and momentary assistance	These features provide steering OR brake/ acceleration support to the drive	These features provide steering AND brake/ acceleration support to the drive	These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met		This feature can drive the vehicle under all conditions
Example features	• Automatic emergency braking • Blind spot warning • Lane departure warning	• Lane centering OR • Adaptive cruise control	• Lane centering AND • Adaptive cruise control at the same time	Traffic jam chauffeur	• Local driverless taxi • Pedals/steering wheel may or may not be installed	Same as Level 04, but feature can drive everywhere in all conditions

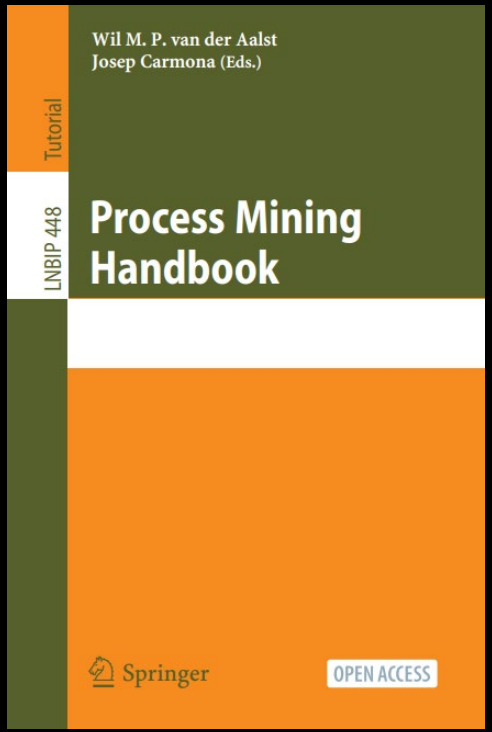
Conclusion

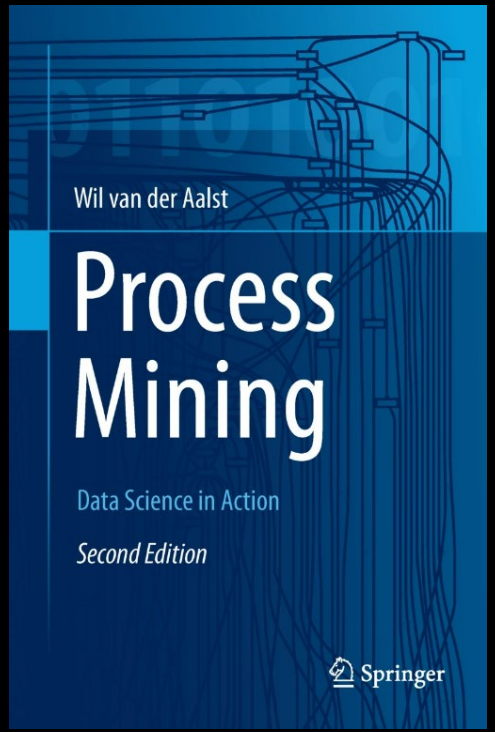
We live in a world where jobs will change dramatically. Process mining can help to cope with these changes.

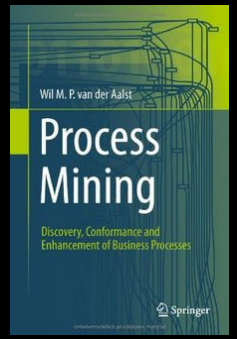
We need Hybrid Intelligence (HI). Like self-driving cars, the transition will be gradual. Process mining allows for this because models are understandable and can be combined with domain knowledge.

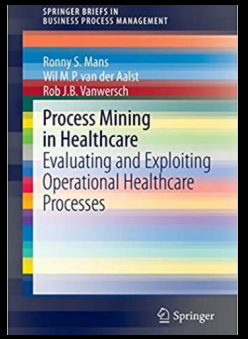
More about the history of process mining and the relation to AI/ML in my keynote.

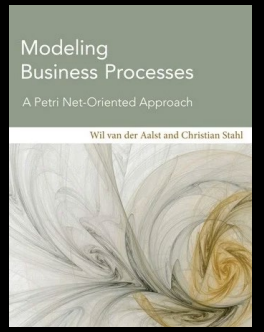
Learn More: Here are some books (not intended to be complete)

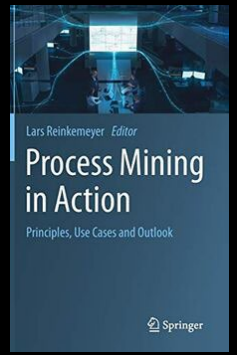


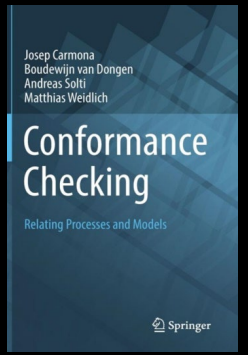


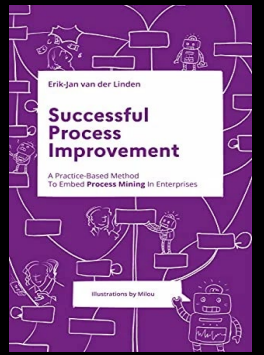




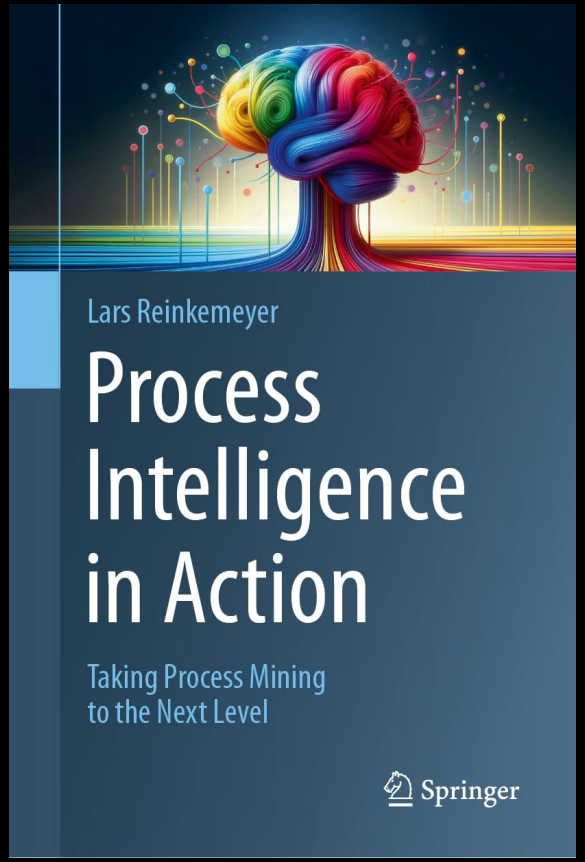


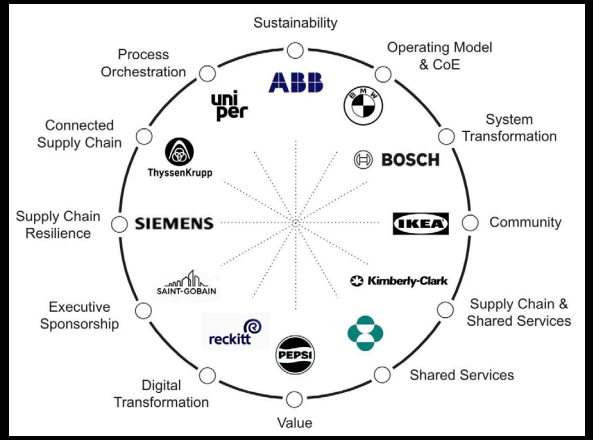




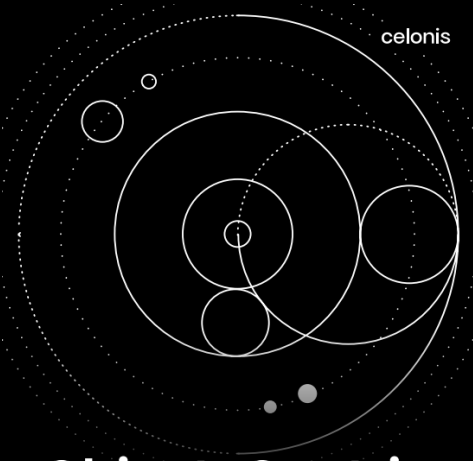


More on PM applications and object-centric process mining






mathematics
MDPI
Article
Object-Centric Process Mining: Unraveling the Fabric of Real Processes
Wil M. P. van der Aalst



Object-Centric Process Mining

The next frontier in business performance

Prof. dr. ir. Wil van der Aalst
Chief Scientist, Celonis