Serie di webinar Sezione ANIMP-DIM (Digital & Innovation Management)

IA per l'Impiantistica

18/07/2024 | h. 16:00

Alfabetizzazione sull'intelligenza artificiale

AI and Generative AI

18/07/2024

a cura di:
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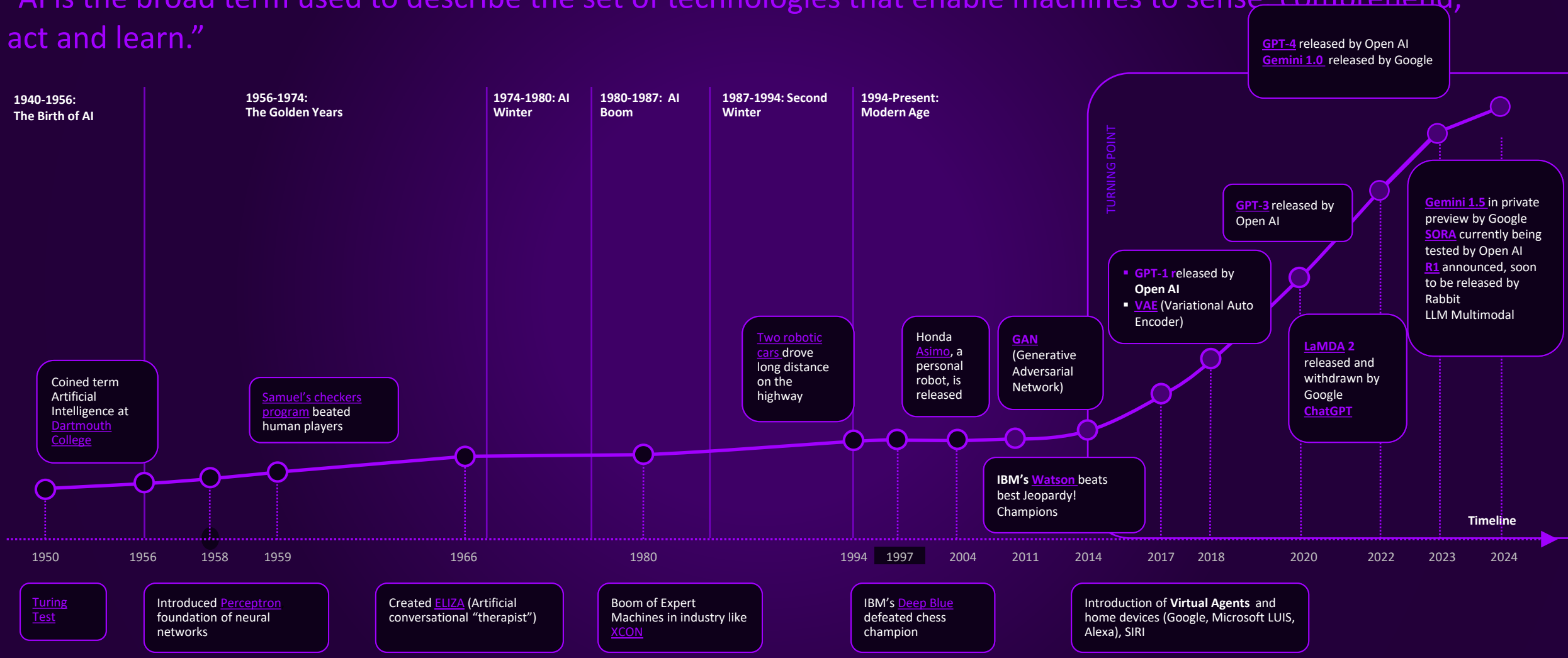
GenAI Fundamentals

GenAI momentum, history and context

The long history of AI is reaching a new golden age

"AI is the broad term used to describe the set of technologies that enable machines to sense, comprehend, act and learn."



A long journey from the General Intelligence disappointment to the current great excitement

General Intelligence

“Actual” thinking

General purpose intelligence that can be applied to any problem

DISILLUSION

VS

Narrow Purpose

“Simulated” thinking

Artificial Intelligence systems focus on managing a single or limited task

GREAT EXCITEMENT

Artificial Intelligence Cognitive Domains

Advanced Analytics

- Predictive & Prescriptive Model
- Forecasting model also based on Time Series
- Predictive Maintenance
- Early Warning Definition
- Warranty/ Parts Lifecycle Analytics

Computer Vision

- Advanced OCR/ICR
- Video Analytics
- Digital Signage & Authenticaton

Natural Language Processing

- Virtual Assistant
- Chatbot
- Expert System
- Text Analysis

Generative AI has a strong impact on all Cognitive Dimensions

Generative AI allows machines to create new content based on the data it has been trained on

Generative AI

Language

Language generation

- Virtual agents & search engines
- Documents Generation & Summarization
- Virtual voices & identities

Vision

Image generation

- Images & Video Generation
- 3D environments and digital twin
- Quality enhancement

Reasoning

Synthetic Data

- Synthetic Data
- Data & Signal enhancement
- Code Generation & Migration

* Not Exhaustive

The momentum for Generative AI (GAI) is strong

10+ B$

Microsoft invested in **Open AI** in 2023 (plus at least 3 Billion in 2022)

>450

start-ups are now working on **Generative A.I.**

4 B$

Just invested by Amazon in Anthropic (2023, September)

10%

of all **data** could be **A.I. generated by 2025** – Satya Nadella, CEO of Microsoft

Generative AI Tech Landscape Overview*

* As of April 2024, Not exhaustive

Hyper-Scalers

Proprietary PaaS Strategy

OpenAI Public

OpenAI Services available on public cloud provided by OpenAI, under subscription or not (e.g. https://chat.openai.com/)

Not regulated for Corporate
US localized

NOT APPLICABLE FOR A CORPORATE

OpenAI Private

OpenAI Services available on the private cloud provided by OpenAI, under subscription.

Regulated under OpenAI T&C
US localized

HARD TO APPLY FOR A CORPORATE

OpenAI @ Azure

OpenAI and MSFT Services in general availability on Microsoft Azure private cloud subscription.

Regulated under MSFT std T&C
EU localized

APPLICABLE TO A CORPORATE

Google GenAI

Google Generative AI (GEMINI) provided on Google Cloud Platform (GCP) private subscription,

Regulated under GCP std T&C
EU localized

APPLICABLE TO A CORPORATE

AWS GenAI

3rd Parties (e.g. Anthropic, AI21), open source (LLaMA, MIXTRAL) or proprietary models (Titan) supported on AWS Bedrock in private subscriotion.

Regulated under AWS std T&C
EU localized

APPLICABLE TO A CORPORATE

On Prem

3rd Parties and Open-Source foundational models, suitable for being operated on a proprietary infrastructure + proprietary foundation model (Omniverse).

Owned, localized and regulated by the Corporate

APPLICABLE TO A CORPORATE

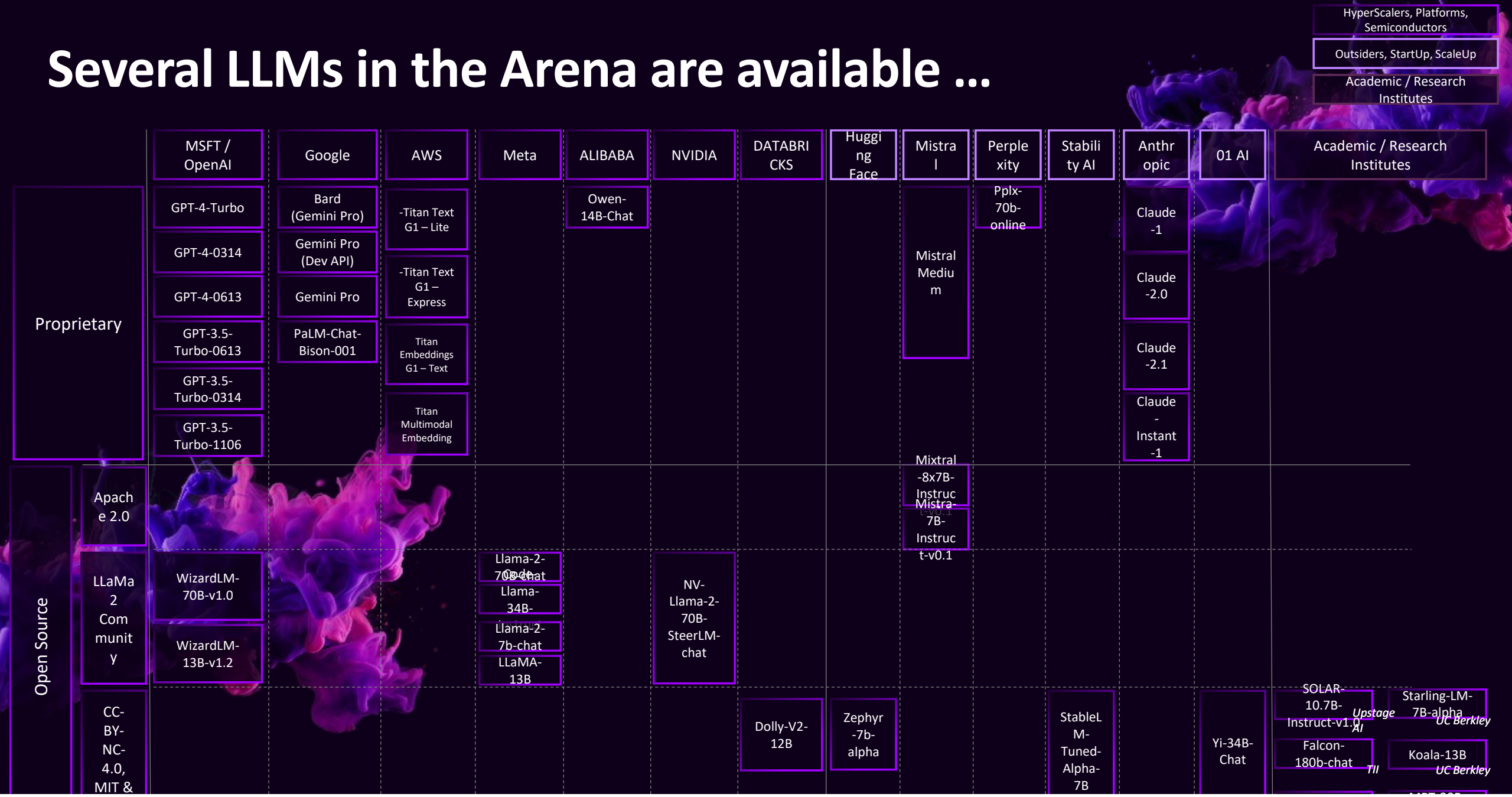
On Edge

Third Parties and Open-Source foundational models, suitable for being operated on a On-Edge devices network.

Owned, localized and regulated by the Corporate

APPLICABLE TO A CORPORATE

Several LLMs in the Arena are available …



Experiments in the Italian Market

Model	Description	Based on	License	Trained on	Founded by
MINERVA *Live*	*Minerva is the first family of LLMs pretrained from scratch in Italian developed by Sapienza NLP in collaboration with Future Artificial Intelligence Research (FAIR) and CINECA. The Minerva models are truly open (data and model) Italian-English LLM, with about half of the pretraining data composed of Italian text.*	**From scratch**	Open	**Leonardo (Cineca)**	Università La Sapienza
ZEFIRO *Live*	*Large Language Model Open Source Italian created by training Mistral-7b with an Italian corpus, focused on use cases of dialogue with the user*	Mistral-7b	Open (Apache 2.0)	8x NVIDIA DGX H100	Università di Pisa
LLAMANTINO *Live*	*Fine-tuning of LLaMA 2 pre-trained 7b and 13b models to improve the performance of Italian language dialogue use cases*	LLaMA 2-7b, LLaMA 2-13b	Llama 2 Community License	8x nodi **Leonardo (Cineca)** – 32x NVIDIA A100	Università di Bari (PNRR)
FAUNO *Live*	*Fine-tuning of a chatbot model created from LLaMA-7b, obtained with a dataset of dialogues in Italian, both in the general-purpose field and on specialized topics (e.g. Medicine, computer science)*	LLaMA-7b	Open (Apache 2.0)	1x Nvidia RTX A6000	Università La Sapienza
CAMOSCIO *Live*	*Fine-tuning to improve the Italian language performance of Alpaca, a chatbot model from Stanford University that was in turn created starting from LLaMA-7b*	LLaMA-7b	Open (Apache 2.0)	1x GeForce RTX 3090	Università La Sapienza
MODELLO ITALIA *Live*	*"Generative artificial intelligence system that represents not only our language, but one of the most sophisticated civilizations through the art, culture and excellence for which we are famous in the world" (U. Sharka, CEO iGenius)*	**From scratch**	Open	**Leonardo (Cineca)**	iGenius
FASTWEB *WIP (exp. July-Sept. 24)*	*Model developed on 31 Nvidia DGX H100 units provided with 248 GPU Nvidia H100 Tensor Core and trained on +1.5 Billion tokens from Italian source (leveraging specifically on contents provided by publishers and government sources – e.g. "Gazzetta Ufficiale")*	**From scratch** / Mistral 7B (to be confirmed)	Commercial (to be confirmed)	31x NVIDIA DGX H100	Fastweb
VELVET *WIP*	*A large language model (LLM) that will operate, first of all, with a focus on the Italian language and content and will be developed in a multilingual key, providing for the main European idioms.*	**From scratch** (to be confirmed)	Open	**Leonardo (Cineca)**	Almaviva

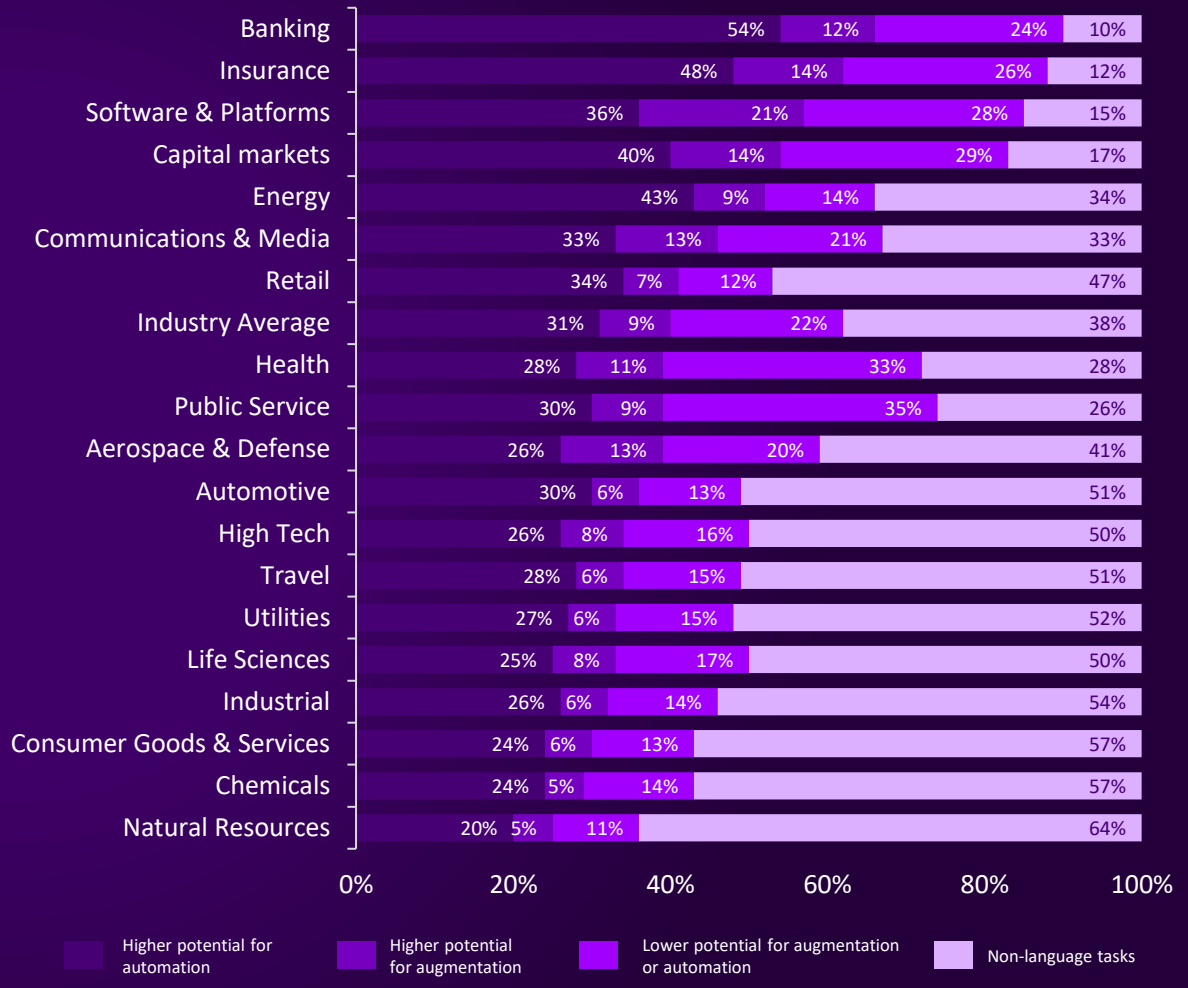
Generative AI will transform work across industries…

4 in 10

want to make a large investment in Generative A.I.

40%

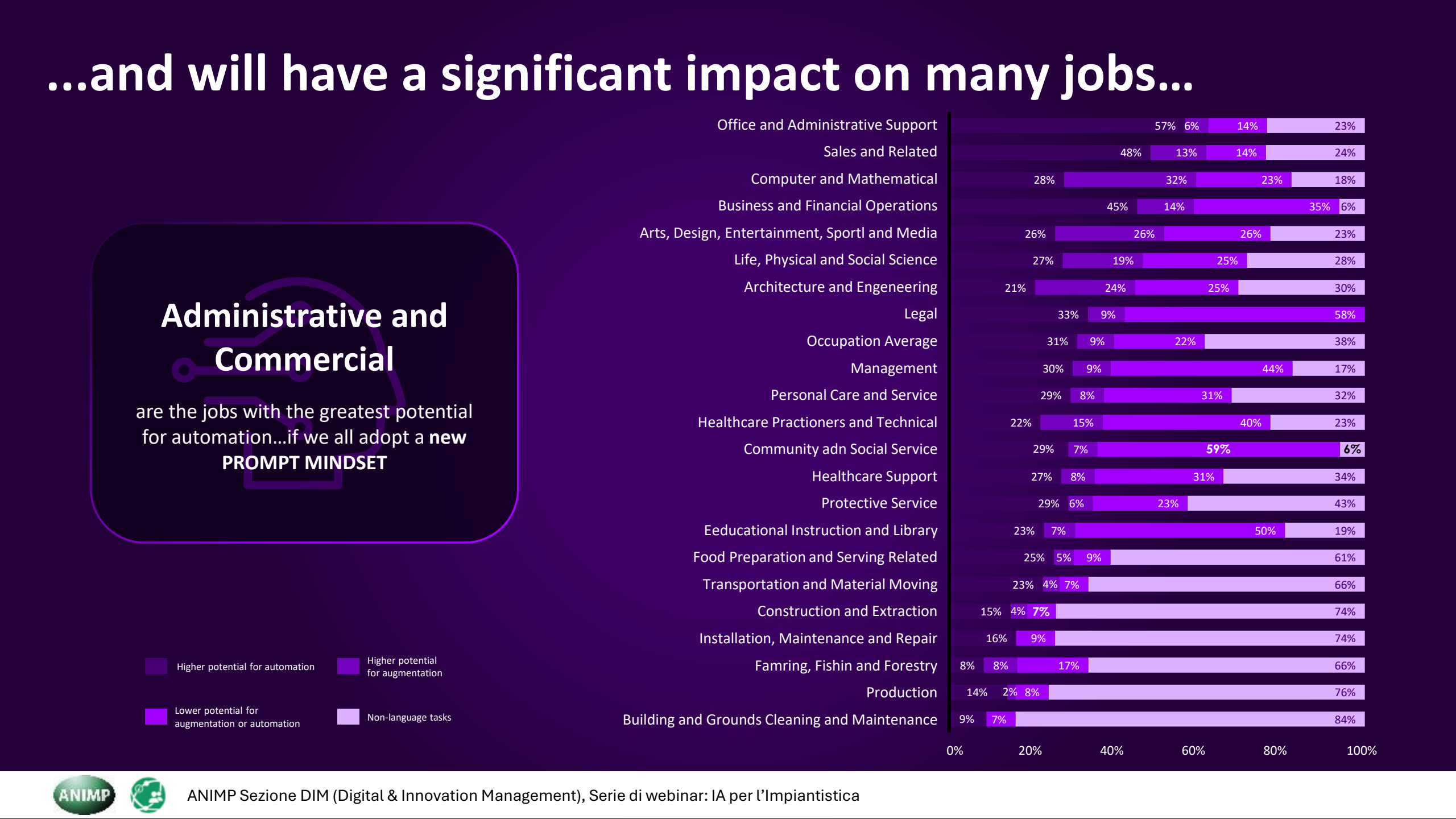
of all working hours can be impacted by LLMs like GPT-4



...and will have a significant impact on many jobs...

Administrative and Commercial

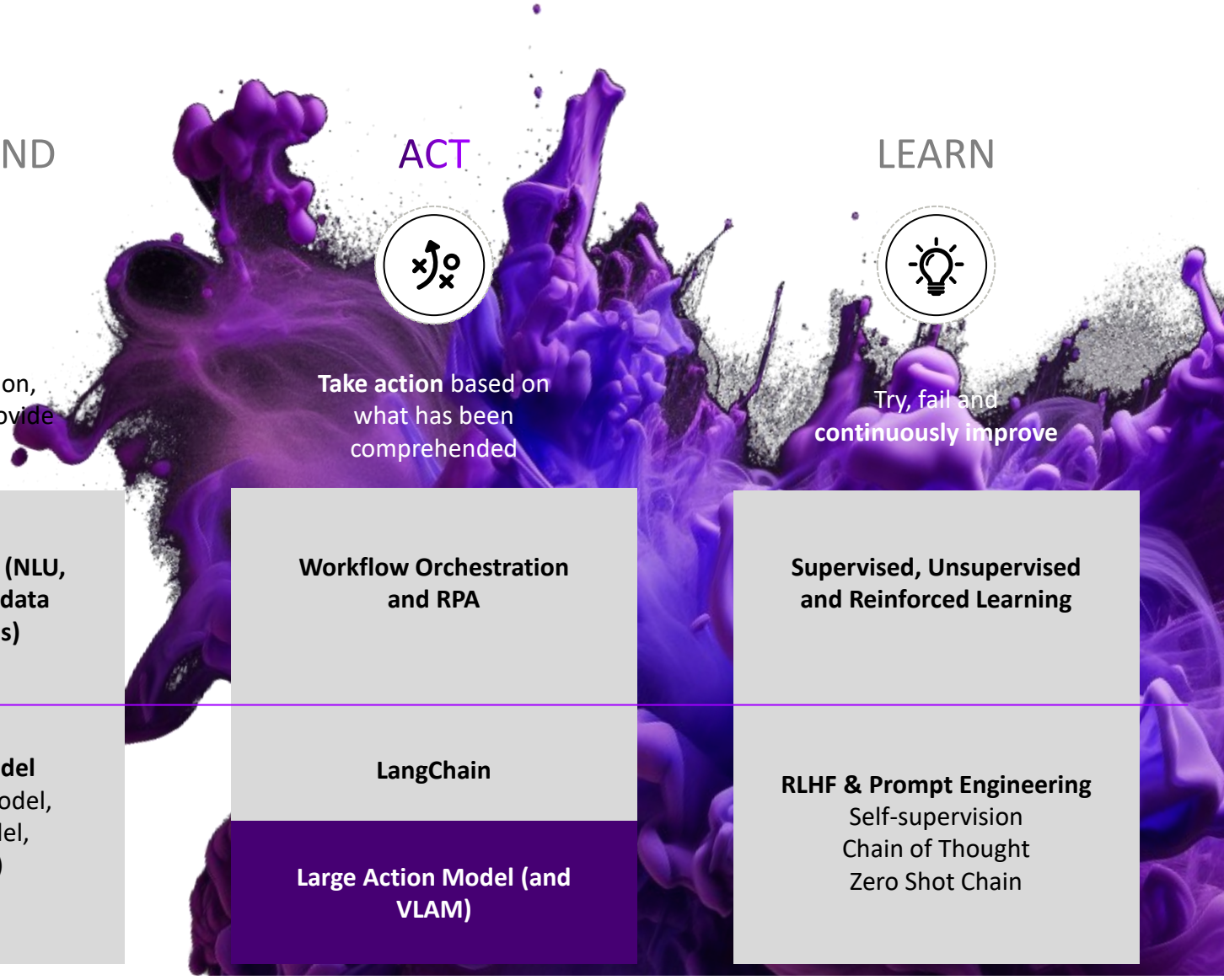
are the jobs with the greatest potential for automation...if we all adopt a **new PROMPT MINDSET**



Emerging Trends

Focus on Large Action Models

Generative AI is moving fast forward improving the Acting scenario



	SENSE	COMPREHEND	ACT	LEARN
	Acquire and process data images, sounds, speech, …	**Analyze** information, **understand** and provide insights	**Take action** based on what has been comprehended	Try, fail and **continuously improve**
AI & Data Understanding	**Speech Recognition, Vision services and IoT Sensors**	**Data understanding (NLU, image processing, data patterns analysis)**	**Workflow Orchestration and RPA**	**Supervised, Unsupervised and Reinforced Learning**
GenAI and Data Generation	**Data signal quality augmentation & Data generation**	**Foundational Model** (Large Language Model, Large Vision Model, Multimodality)	**LangChain** **Large Action Model (and VLAM)**	**RLHF & Prompt Engineering** Self-supervision Chain of Thought Zero Shot Chain

From LLM to LAM

Rabbit R1 has been presented in Las Vegas during last CES 24.

It embeds Perplexity.ai - as LLM application - and **Rabbit OS, a proprietary LAM,** thus being able to address web surfing on multiple platforms (not all, yet) based on prompt instructions.

Rabbit R1 has the ambition to fully decouple underlying and 3rd parties' applications, playing as **single and unique interface** towards to final users and providing **full-prompt-experience**.

https://www.youtube.com/watch?app=desktop&v=22wlLy7hKP4&ab_channel=rabbit

AI & GenAI really injected in Anthropomorfic Robotics

Figure 01 has recently (March 2024) presented an anthropomorphic robot interacting and acting in real context thanks to AI capabilities injected by OpenAI.

In February 2024, Figure 01 has been funded with investments by **Nvidia**, **Amazon** and **OpenAI**.

Figure 01 seems to be a concrete example of AI & Robotics integration, empowered by in-context machine learning algorithms.

https://www.youtube.com/watch?v=Sq1QZB5baNw

Una società di robotica sostenuta da Microsoft e OpenAI ottiene investimenti da Bezos e Nvidia - notizie

Investing.com | Mercato azionario

Pubblicato 23.02.2024 21:00

https://it.investing.com/news/stock-market-news/una-societa-di-robotica-sostenuta-da-microsoft-e-openai-ottiene-investimenti-da-bezos-e-nvidia--notizie-432SI-2279690#

Servizio | Intelligenza Artificiale

Dopo ChatGPT i robot, quello di OpenAI mette a posto i piatti (video)

OpenAI, la società creatrice di ChatGPT, potrebbe presto quotarsi in borsa con una valutazione di 80-100 miliardi di dollari. Il video di Figure 01, un robot collaborativo e conversazionale sviluppato da OpenAI e Figure, mostra un futuro in cui l'AI interattiva è integrata nella nostra vita quotidiana

di Biagio Simonetta

14 marzo 2024

https://www.ilsole24ore.com/art/dopo-chatgpt-robot-ecco-quello-openai-che-mette-posto-piatti-video-AF2juG3C?cmpid=nl_24plus

From Talk To Action

AI and robots

From talk to action

Robots are benefiting from advances in artificial intelligence, such as chatbots. This is good news

THE ROBOTS are coming! In science fiction that is usually an ominous warning. In the real world, it is a prediction—and a welcome one. The field of robotics has made impressive progress in the past year, as researchers in universities and industry have applied advances in artificial intelligence (AI) to machines. The same technology that enables chatbots like ChatGPT to hold conversations, or systems like DALL-E to create realistic-looking images from text descriptions, can give robots of all kinds a dramatic brain upgrade.

As a result, robots are becoming more capable, easier to program and able to explain what they are doing (see Science & technology section). Investors are piling into robotics start-ups. OpenAI, the creator of ChatGPT, which gave up on robots a few years ago, has changed its mind and started hiring a new robotics team. When brought to bear upon the physical world, previously disembodied AI now appears to have enormous potential.

Robots can inspire fear. Human beings are trained from birth by Hollywood to be afraid of them—the latest incarnation of the ancient tale of the inventor who loses control of his creation. And even if robots are not literally the murderous machines of the "Terminator" films, they can kill off decent-paying jobs in factories and warehouses. Nevertheless, the latest advances in robotics will bring real and substantial benefits.

One is that new "multimodal" AI models combine understanding of language and vision with data from robotic sensors and actuators. This makes it possible to deal with robots using ordinary words. You can ask a robot what it is able to see or tell it to "pick up the yellow fruit". Such models in effect grant robots a degree of common sense—in this case, knowing that a nearby banana is a kind of yellow fruit. And like a chatbot, a robot can be told to modify its behaviour simply by changing a text prompt, something that would previously have required elaborate reprogramming.

Another benefit is that the new models enable robots to explain the reasoning behind their actions. That is useful when they behave in unexpected or unwelcome ways. So long as robots' brains are not inscrutable black boxes, programming and debugging them is fairly straightforward. The new models are also less likely to hallucinate—tech-speak for "make things up"—because their perception is grounded in observations of the world, and they aim to ensure that cognitive and physical reality match. That makes them safer and more reliable.

And one more benefit is that robots are getting better at learning quickly through imitation and at generalising from one skill to another. This opens the door for robots to move out of factories and warehouses. Several companies and research groups are using the latest AI models to build humanoid robots, on the basis that most of the world, unlike an assembly line, has been designed for people to move around in. Labour markets across the rich world are tight—and getting tighter as societies age. As well as boosting productivity while workforces shrink, more capable robots could cook and clean, and care for the aged and the needy.

Advanced economies will need more automation if they are to maintain their standards of living. South Korea, Japan and China are all in the top five countries with the most robots for each manufacturing worker. It is no coincidence that they are also ageing rapidly. Without robots to help out, more people may have to work longer and retire later. In the coming years, attitudes could well flip from fearing the arrival of robots to wishing that they would get here sooner. ■

The Economist, June 14th 2024

The Economist June 8th 2024 67

Science & technology

Robotics (1)

Speech, camera, action

The large language models behind chatbots can help power real robots, too

"WHAT DO YOU see right now?" a man asks a humanoid robot standing behind a table. "I see a red apple on a plate in the centre of the table, a drying rack with cups and a plate, and you standing nearby, with your hand on the table," the robot replies. "Great—can I have something to eat?" says the man. "Sure thing," says the robot. It forces its arms, picks up the apple with its right hand, passes it to its left hand, and then hands it to the man. He asks the robot to explain its actions. "So I gave you the apple, because it's the only edible item I could provide you with from the table," it replies.

This demonstration, shown in a video released by Figure, a robotics startup, in March, caused widespread amazement. It shows a robot that can hold spoken conversations, recognise and manipulate objects, solve problems and explain its actions. And Figure is not alone in producing such impressive results. After years of slow progress, robots suddenly seem to be getting a lot cleverer. What changed?

The magic ingredient is artificial intelligence (AI). Academic researchers, startups and tech giants are taking advances in AI, such as large language models (LLMs), speech synthesis and image recognition, and applying them to robotics. LLMs are known for powering chatbots like ChatGPT—but it turns out that they can help power real robots, too. "The algorithms can transfer," says Peter Chen, chief executive of Covariant, a startup based in Emeryville, California. "That is powering this renaissance of robotics."

The robot in Figure's video had its speech-recognition and spookily lifelike speech-synthesis capabilities provided by OpenAI, which is an investor in the compa-

→ ALSO IN THIS SECTION
68 Why build a human-shaped robot?
70 The risks of polar geoengineering

ny. OpenAI shut down its own robotics unit in around 2020, preferring instead to invest in Figure and other startups. But now OpenAI has had second thoughts, and in the past month it has started building a new robotics team—a sign of how sentiment has begun to shift.

A key step towards applying AI to robots was the development of "multimodal" models—AI models trained on different kinds of data. For example, whereas a language model is trained using lots of text, "vision-language models" are also trained using combinations of images (still or moving) in concert with their corresponding textual descriptions. Such models learn the relationship between the two, allowing them to answer questions about what is happening in a photo or video, or to generate new images based on text prompts.

Whom, bam, thank you VLAM

The new models being used in robotics take this idea one step further. These "vision-language-action models" (VLAMs) take in text and images, plus data relating to the robot's presence in the physical world, including the readings on internal sensors, the degree of rotation of different joints and the positions of actuators (such as grippers, or the fingers of a robot's hands). The resulting models can then answer questions about a scene, such as "can you see an apple?" But they can also pred- ▸▸

Innovation is getting faster… 6 key trends

01	**Smaller models** are often good enough	mosaicML, DistilBERT, Google
02	**Open source models** change the game	GLAMDA, BLOOM, Dolly
03	**Plugins** give LLM brains the “arms and legs”	salesforce, Expedia, Chroma, Klarna.
04	**Mixed-modality** enables all the senses	Stable Diffusion, DALL·E 2
05	**Frugality** exists even with billions of parameters	
06	**Robots** in action with LLM and **VLAM**	

Artificial Intelligence in the Project Management

18/07/2024

a cura di:
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Artificial Intelligence in the Project Management Domain

Potential Applications

Project Phase	*AI Techniques*	*Potential Activities*
Pre-Project Phase	Natural Language Processing (NLP)	- Requirement gathering through analysis of emails and documents + stakeholder
	Predictive Analytics	- Feasibility analysis and initial risk assessment.
	Machine Learning	- Decision support for project selection based on historical data.
		- Predicting resource costs and requirements.
Planning Phase	Machine Learning	- Resource allocation optimization.
	Simulation and Optimization Algorithms	- Schedule optimization to minimize duration and maximize resource utilization.
	Neural Networks	- Task prioritization and dependency analysis.
	Generative AI	- Automatic generation of project documents and planning artifacts.
Monitoring and Controlling Phase	Machine Learning	- Real-time risk management by predicting potential issues based on ongoing data.
	NLP and Sentiment Analysis	- Monitoring team communications for morale and project alignment.
	Computer Vision	- Quality control through image recognition in construction or manufacturing.
	Predictive Analytics	- Performance forecasting to predict the project outcomes based on current trends.
	Deep Learning	- Automated progress tracking and anomaly detection in project metrics.

Artificial Intelligence in the Project Management Domain

Literature Review Scheme of Analysis

The literature review analysis will be structured according to the different phases of a project's life cycle.

1 Pre-project phase

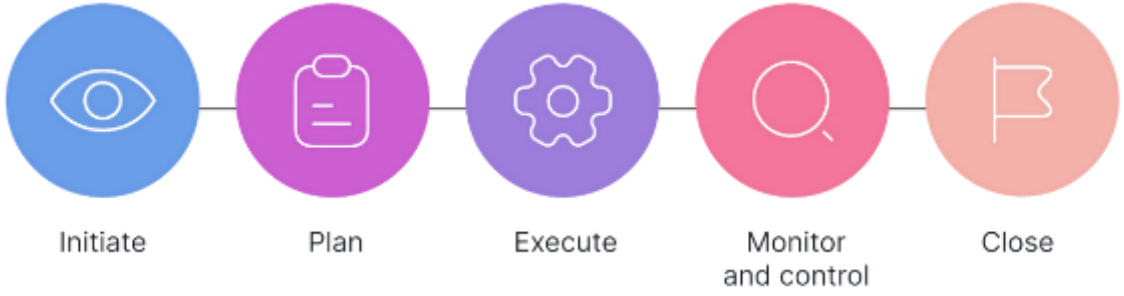
The fists section will explore paper that deals with the applications of AI to the pre-project phase involving bidding and project portfolio selection.

2 Planning phase

The second section of the literature review will examine papers that focus on the applications of Artificial Intelligence in the planning phase.

3 Monitoring and controlling phase

The third part of the literature review will analyze papers that concentrates on the use of Artificial Intelligence during the project monitoring and control stage.



Artificial Intelligence in the Project Management Domain

Paper Application Domain

1 Pre-project phase

- Bi/No Bid decisions: (Sonmez and Sözgen, 2017) employ a Support Vector Machine classifier in order to predict Oil & Gas projects bid/no bid decisions
- Refine estimates during tender: (Cheng, Tsai and Sudjono, 2010): ANN to achieve more precise estimates.
- Select an optimal project to be included in a portfolio: (Costantino, Di Gravio and Nonino, 2015) pinpoint projects' KPI; Artificial Neural Network, enabling the categorization of projects and ranking
- Optimizing project portfolio: (Relich & Pawlewski, 2017) assessing the procedure for choosing portfolios of new product initiatives, that is optimal in terms of risk balance and strategic objectives.

Title	Authors	Model Used
A novel R & D project portfolio selection decision approach based on fuzzy logic and heuristics scheduling	(Danmei *et al.*, 2008)	Fuzzy logic in a constraint guided heuristic search approach.
Using classification trees to predict performance in Information Technology projects	(Gemino, Sauer and Reich, 2010)	Comparison between regression, neural networks, and classification trees.
A new approach for selecting portfolio of new product development projects	(Wei and Chang, 2011)	Fuzzy set theory and multi-criteria group decision making method into a NPD.
A hybrid fuzzy rule-based multi-criteria framework for sustainable project portfolio selection	(K. Khalili-Damghani *et al.*, 2013)	Hybrid model: Data Envelope Analysis (DEA); Evolutionary Algorithm (EA); Genetic Based Machine Learning (GBML)
Project selection in project portfolio management: An artificial neural network model based on critical success factors	(Costantino, Di Gravio and Nonino, 2015)	Artificial Neural Network (ANN)
A fuzzy weighted average approach for selecting portfolio of new product development projects	(Relich and Pawlewski, 2017)	Fuzzy logic; Artificial Neural Network (ANN)
A methodology for project portfolio selection under criteria prioritization, uncertainty, and projects interdependency - combination of fuzzy QFD and DEA	(Jafarzadeh, Akbari and Abedin, 2018)	Quality Function Development (QFD), fuzzy logic, and Data Envelopment Analysis (DEA)
Sustainability driven multi-criteria project portfolio selection under uncertain decision-making environment	(Ma *et al.*, 2020)	Fuzzy logic model based on the Technique for Order of Preference

Table 1:Artificial Intelligence techniques applied to project portfolio selection

Artificial Intelligence in the Project Management Domain

Paper Application Domain

2 Planning phase

- Project Scheduling: (Wang, Yu and Chan, 2012) who propose an ANN model that predict project schedule using early planning status updates as the model input, (Wauters and Vanhoucke, 2014) who employ a support vector machine for forecasting projects' duration in an early stage of the planning project, based on the information available

- Project Budgeting: Prediction of both the size and timing of incoming cash flows (Cheng, Hoang and Wu, 2015); (Cheng, Tsai and Sudjono, 2010) employ Machine Leaning with the purpose of improving the precision of conceptual cost forecasting, enabling accurate costs estimations to be performed in the early phases of a project

- Risk Assessment: AI used with 2 main objectives -> first goal is to minimize the inherent subjectivity in expert evaluations, and the second is to account for the complex interrelationships among various risks in the overall risk assessment. (Islam et al., 2019) - Structural Equation Modeling for connection between risks. (Yildiz et al., 2014) - SVM for classifying risk impacts and evaluate potential risk pathways

Artificial Intelligence in the Project Management Domain

Paper Application Domain

3 Monitoring and controlling phase

- A substantial body of literature examines the possibility of applying Artificial Intelligence to monitoring project progress during project execution. By employing machine learning algorithms, AI can predict future project outcomes and potential completion dates, empowering project managers to anticipate challenges and take proactive measures.

- (Flyvbjerg et al., 2022): Using an unsupervised random forest approach, the past projects grouped according to their project performance, assigning a flag to projects with varying cash flow performances, ranging from the best to the worst. Subsequently, using classification algorithms, the ongoing cash flows of current projects are compared to the data from past projects.

- (Kamoona and Budayan, 2019) employ Deep Neural Networks for forecasting the value of EAC during the early projects' phases so to be able to implement immediate corrective actions.

- On the same line (Cheng et al., 2010) employ a support vector machine algorithm to forecast EAC applying the proposed AI-based solution on data derived from a construction project.

Overview of the papers inculded in the literature review with an outline of the demonstration dataset employed.

None of the papers tested the algortihm in real empirical setting nor compared the performance of AI to that of the methods employed in companies

Paper	Purpose	Enabling Technology	Demonstration dataset
(Costantino, Di Gravio and Nonino, 2015)	KPI Definition	Artificial Neural Netwok	A leader EPC Italian constructor
(Ko and Cheng, 2007)	KPI Definition	Genetic algorithms + fuzzy logic + neural networks	Model for prediction tested on a dataset that contains 54 construction projects
(Cheng, Hoang and Wu, 2015)	Cash Flow Forecasting	Adaptive Time-dependent Least Squares Support Vector Machine (LS-SVMAT)	Model tested on a database collected from a construction contractor in Taipei
(Cheng, Tsai and Sudjono, 2010)	Budget Forecasting	Evolutionary fuzzy hybrid neural network	Model tested in 5 construction projects in Taiwan
(Wauters and Vanhoucke, 2014)	Duration Forecasting	Support Vector Machine Regression	Computational experiment
(Cheng et al., 2010)	Estimate at Completion Forecasting	Fast messy genetic algorithm (fmGA) + Support Vector Machine (SVM) =Evolutionary Support Vector Machine Inference Model (ESIM).	Model tested in an ongoing construction project
(Ko, Cheng and Wu, 2007)	Predict Subcontractor Performances	Fuzzy Neural Inference Model (EFNIM)	Tested in a general constructor
(Mancini, Mariani and C. M. Manfredi, 2023)	Project Risks Assessment	Fuzzy Bayesian Belief Network (FBBN) Canonical Model	A Nuclear Decommissioning Project
(Qazi et al., 2016)	Project Risks Assessment	Bayesian Belief Networks	Qualitative interviews to validate the model in construction industry
(Chen and Zhang, 2013)	Project Scheduling and Staffing	Ant-Co Optimization algorithm	Software Project Scheduling
(Afzal et al., 2020)	Cost-Risk Contingency allocation	Fuzzy-AHP and simulation	Metropolitan transit projects
(Tabatabay and Tabatabay, 2021)	Optimization of Risk Response Strategies	Genetic Algortihm	Oil and Gas Projects
(Cheng and Yan, 2009)	Optimization of Resource Allocation	Messy genetic algorithms	Slab deck precast process in a construction project
(Chuanbin et al., 2021)	Optimization of Resource Allocation	Pigeon-inspired optimization (IPIO)	Multiple Scientific Research Projects
(Peng and Liu, 2022)	Optimization of Resource Allocation	Inverse optimization + double-layer nested genetic algorithm	Project of a criminal investigation business building in Changsha City, Hunan Province
(Huang, Wang and Chen, 2010)	Optimization of Resource Allocation	Genetic Algorithms	Longkaikou Hydropower Station
(Colomo-Palacios et al., 2014)	Competence Gap Prediction	Artificial Neural Network (ANN)	Scrum SW development project
(Lin et al., 2015)	Knowledge Management	Multi-Agent System	Scrum SW development project

Our Research Projects - an overview

Research Objectives and Design

1.Demonstrate the adoption of AI in the management of projects and portfolios in real empirical cases.

2. Unveil what are the implications of adopting AI in organizations that operate by projects.

3. Compare the results deriving from AI applications with those resulting from traditional methods adopted in the analyzed companies.

Selection of the AI Technique that Best Fit the Case Purpose

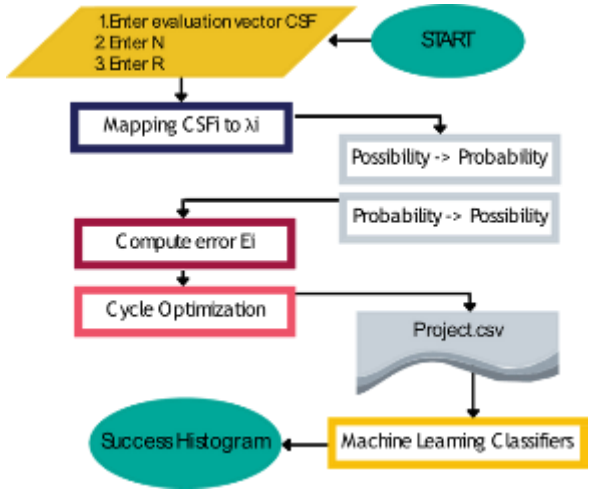
Selection of wrong projects, poor risk management and poor stakeholder management are among the PMI 2021 Pulse of the Profession reasons for projects' failure (PMI, 2021).

Paper	Case Objective	Technical task	Selected AI technique
Paper A	Case A's empirical setting consist of a consulting firm that does many projects in parallel and needs a reliable quantitative evaluation system to select new projects for inclusion in existing portfolios.	Supervised Machine Learning (Classification)	Supervised machine learning techniques were used to train a predictive model on a database of past projects. In this case, the goal was to rank the projects according to their level of prospective success. Decision Tree (DT), Gaussian Naïve-Bayes (GNB), K-Nearest Neighbours (KNN), Logistic Regression (LR), Multi-Layer Perceptron (MLP), Random Forest (RF), Support Vector Machine (SVM) were all tested for the model, but the MLP was the one selected for the empirical application because it showed a higher accuracy score.
Paper B	Company B is a Nuclear Decommissioning company that is willing to implement an innovative and AI based framework aimed at enabling a more effective project risk management process for NDPs	Probabilistic inference + fuzzy logic	For the risk assessment task, we conducted a performance comparison between a Fuzzy Bayesian Belief Network (FBBN) and a Decision Tree. The selection of the FBBN was motivated by the observation that the Decision Tree model exhibited signs of overfitting, emphasizing the need for a more robust and generalized approach to risk assessment.
Paper C	Paper C focuses on the selection of mitigation action phase in a Nuclear Decommissioning company	Optimization	The mitigation action selection problem was modelled as a non-linear Single Objective Optimization problem. The presence of constraints in the model leads to the non-linearity given by the risks' and mitigation actions' intrinsic relationship. The optimization model was solved in Microsoft Excel Solver, through an evolutionary algorithm.
Paper D	Paper D presents a case of application of AI to project stakeholder classification and grouping.	Unsupervised Machine Learning (Clustering)	We conducted a comparative analysis between the PAM algorithm and k-means, ultimately choosing PAM due to its lower sensitivity to outliers. Additionally, PAM demonstrated robust performance on a small dataset consisting of 100 records, showcasing its suitability for datasets with limited size.

Paper A. Demonstrating AI Application to Project Portfolio Selection

Project portfolio selection and prioritization through supervised machine learning

Process

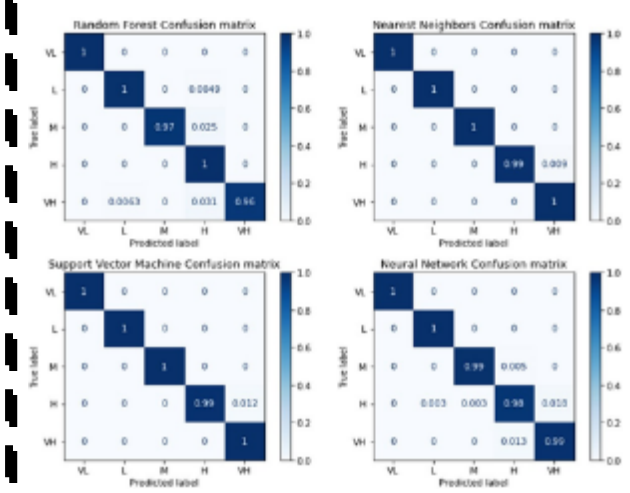


Classifiers

Gaussian Naïve Bayes classifier (GNB)
Decision Tree classifier (DT)
Random Forest classifier (RF)
K-Nearest Neighbours classifier (KNN)
Logistic Regression classifier (LR)
Support Vector Machine classifier (SVM)
Multi-Layer Perceptron classifier (MLP)

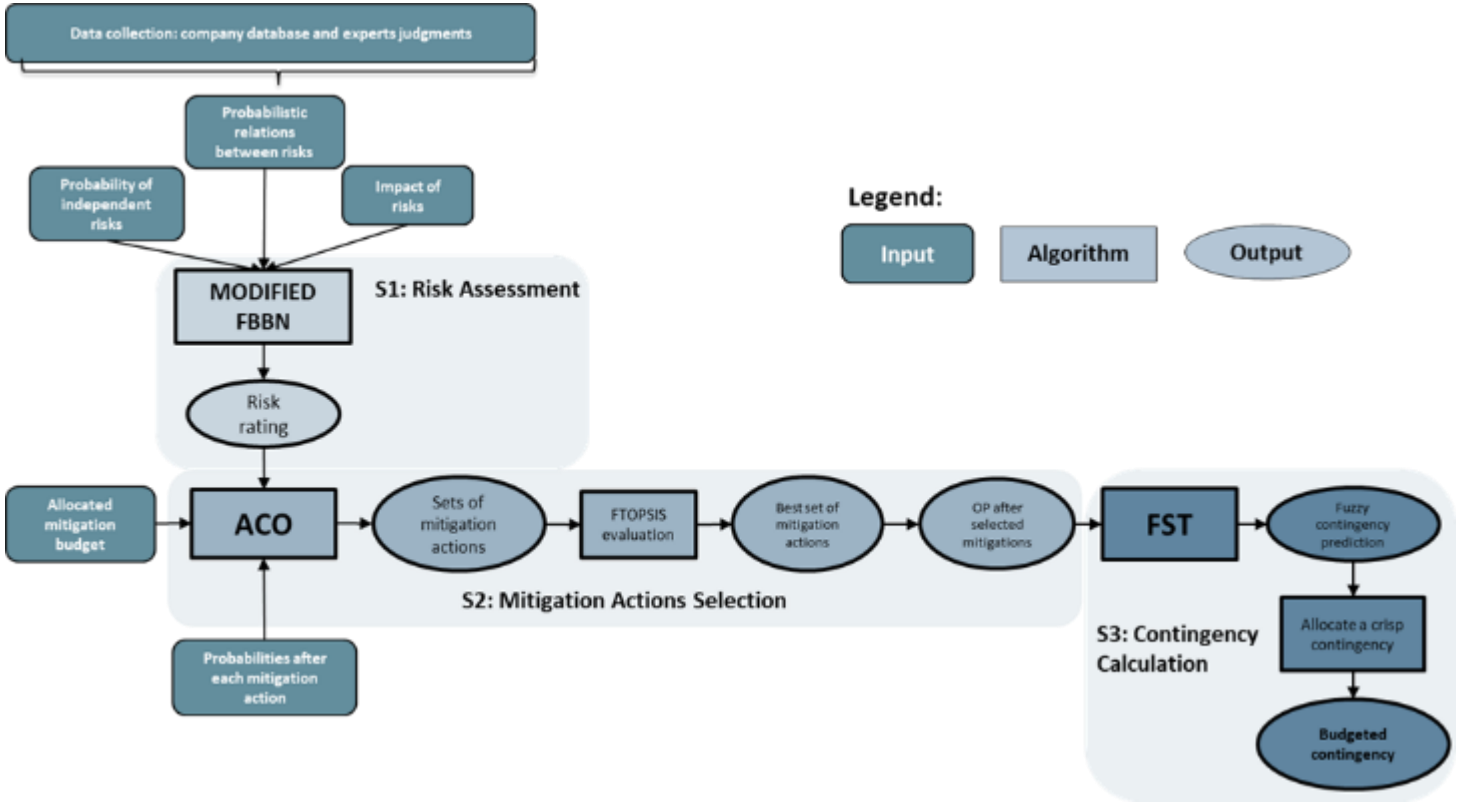
Results

Accuracy



Paper B. Demonstrating AI Application to Project Risk Management

A comprehnsive AI based framework for managing risks in Nuclear Decommissioning Projects



- The proposed framework proved to be a good and flexible fit for the NDP analysed.
- The risk assessment phase returned as output a medium probability of delay of the project, which was similar to the findings of the risk management team for the project.
- The percentage error in this scenario between the predictions of the model and of the PRM team is 4.73%. Considering that a maximum of 20% error in the prediction of the schedule contingency amount based on subjective judgements is supported by (S. A. A. and RobinsonA. S. M., 2007) and (Fidan et al.,2011)
- The framework is able to consider cause– effect dependencies between risks and activities, whereas the actual risk management process being used by the company did not consider them.

- Mancini, M., Mariani, C. and Manfredi, M. (2023) 'Progress in Nuclear Energy Nuclear decommissioning risk management adopting a comprehensive artificial intelligence framework : An applied case in an Italian site', Progress in Nuclear Energy, 158(February), p. 104589. doi: 10.1016/j.pnucene.2023.104589.

Paper C. Demonstrating AI Application to Project Risk Management

Selection of projects' primary and secondary mitigation actions through optimization methods

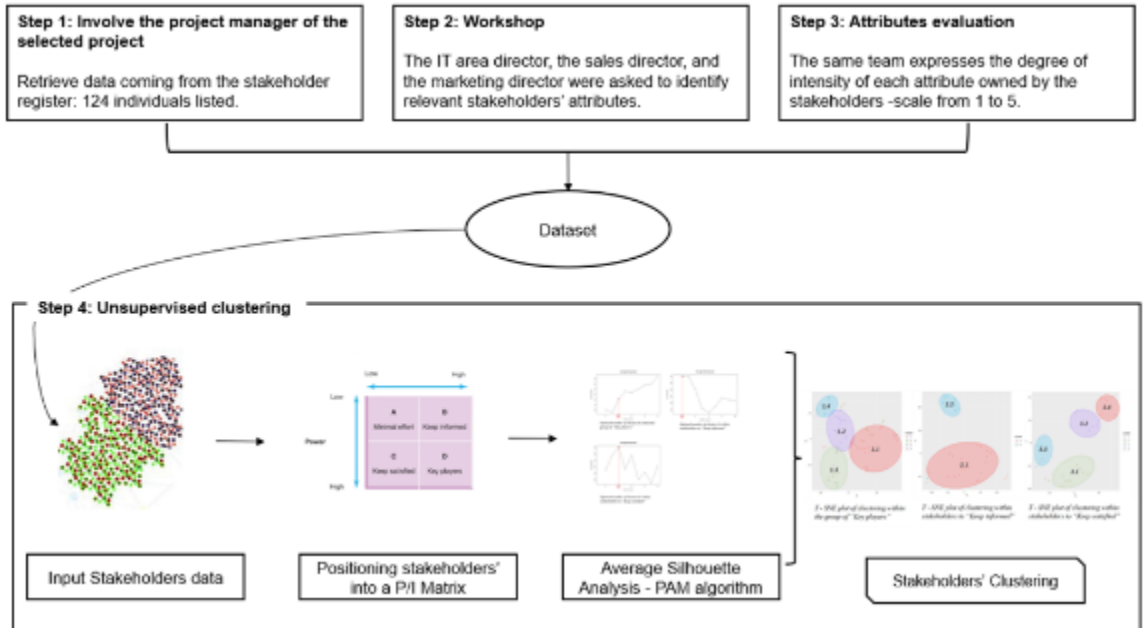
	Considering Secondary Risks ("Model SR")	Considering only Primary Risks ("Model no SR")
Model	Single Objective Optimization Model	Single Objective Optimization Model
Data	PRs, SRs, PMAs, SMAs, PMR, PSMR, SMR, SPRR, Max Cost	PRs, PMAs, PMR, Max Cost
Constraints	1. Secondary MAs Cost Optimization Constraint 2. Secondary MAs Time Optimization Constraint 3. Max Investment Constraint 4. Relationships among PMAs and SMAs Constraint 5. Binary Constraint	1. Max Investment Constraint 2. Binary Constraint
Objective function	MIN (X*tpm + Y*tsm + ppr*tpr + psr*tsr*PSMR*X)	MIN (X*tpm + ppr*tpr)
Results	PMAs = 47 SMAs = 4 Objective function = 441,63 Time delay = 412 days	PMAs = 49 SMAs = 0 Objective Function = 398,75 Time delay = 661 days
Solving method	Evolutionary	Simplex LP
Time to solve	~20 sec	<1 sec
Economic impact	−966 k€	−751 k€

- A non-linear optimization model was implemented to solve the Single Objective Optimization problem - since also secondary risks and secondary mitigation action were considered the model is intrinsically non linear
- The primary objective was to restore the land upon which the nuclear fa- cilities were built and to hand them over in a "Unrestricted Use" status (International Atomic Energy Agency, 2018) thus the main criteria followed to structure the entire risk response strategy was to minimize the duration of the whole project.
- The optimization model was solved in Microsoft Excel Solver, through an evolutionary algorithm.
- The optimization model proposed is flexible, easy to implement, easy to interpret and unlimited in the number of criteria and objectives that can be considered.

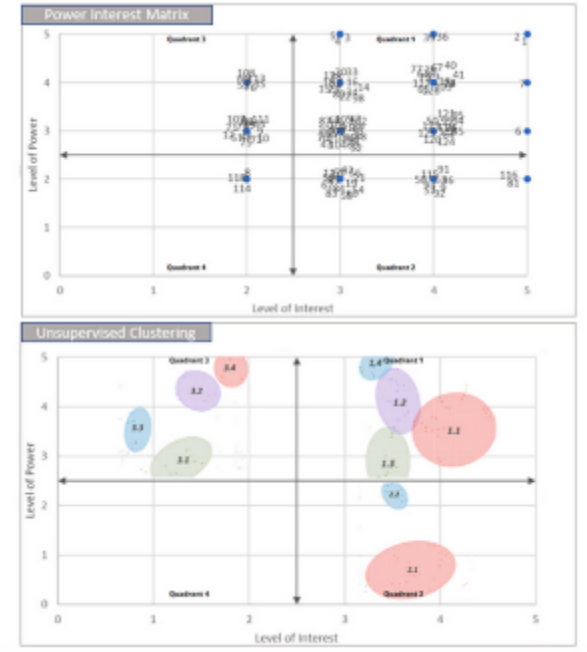
- Mariani, C. and Mancini, M. (2023) 'Selection of projects ' primary and secondary mitigation actions through optimization methods in nuclear decommissioning projects', Nuclear Engineering and Design, 407(March), p. 112284. doi: 10.1016/j.nucengdes.2023.112284.

Paper D. Demonstrating AI application to Stakeholder Classification

Project Stakeholder Classification: Application of unsupervised machine learning, benefits and limitations

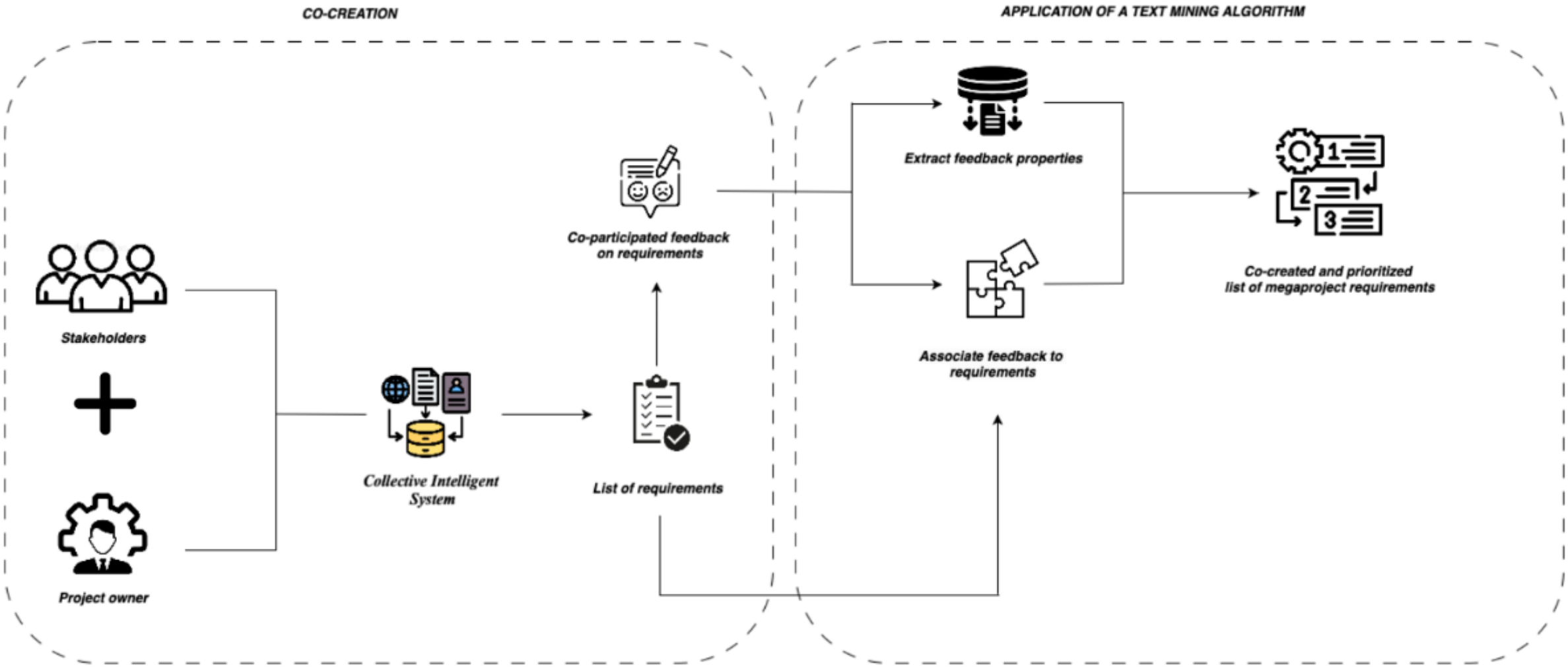


Cluster	Neighbor	Silhouette width
1	4	-0.03368859
1	3	-0.12676933
3	2	-0.02092149
4	1	-0.05587866
1	2	-0.03259065
1	2	-0.08019896
1	2	-0.08727233
1	2	-0.11177614
1	2	-0.14645273
1	2	-0.02762439
1	2	-0.09966809
2	3	-0.01463907
2	3	-0.03266248
4	3	-0.14293994

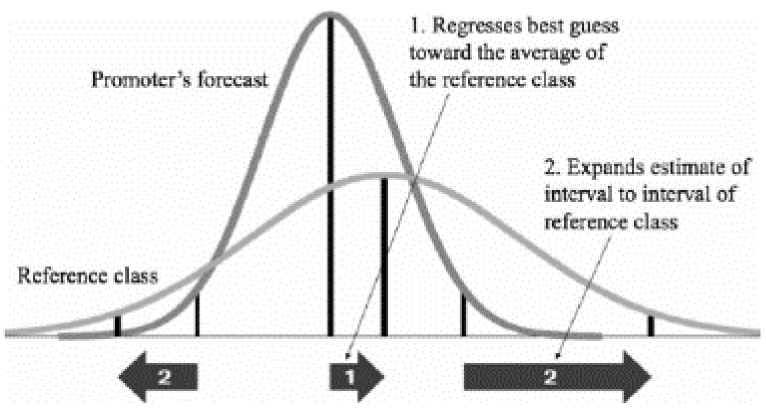


- Mariani, C., Navrotska, Y. and Mancini, M. (2023) 'Project Stakeholder Classification : Application of unsupervised machine learning , benefits and limitations', Project Leadership and Society, 2023(August), p. 100093. doi: 10.1016/j.plas.2023.100093.

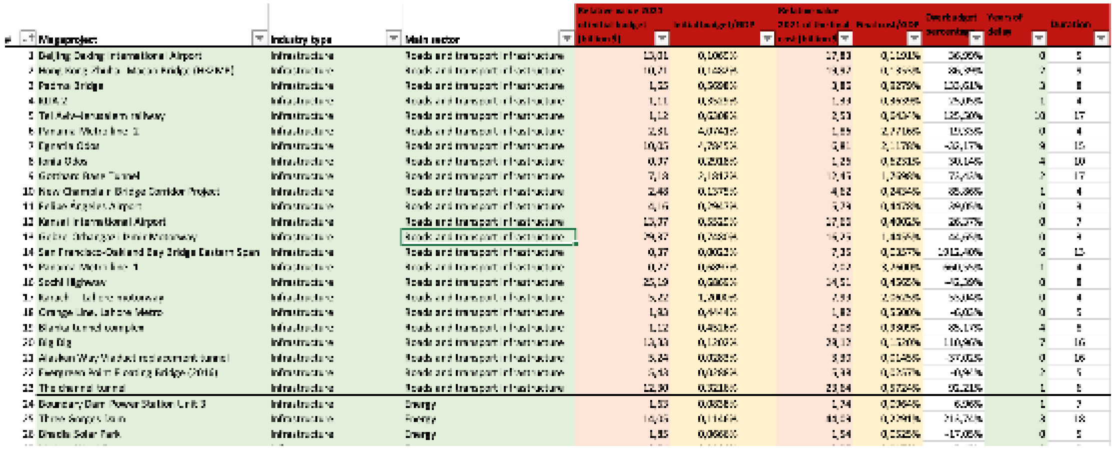
The Role of AI (NLP) in Value Co-Creation



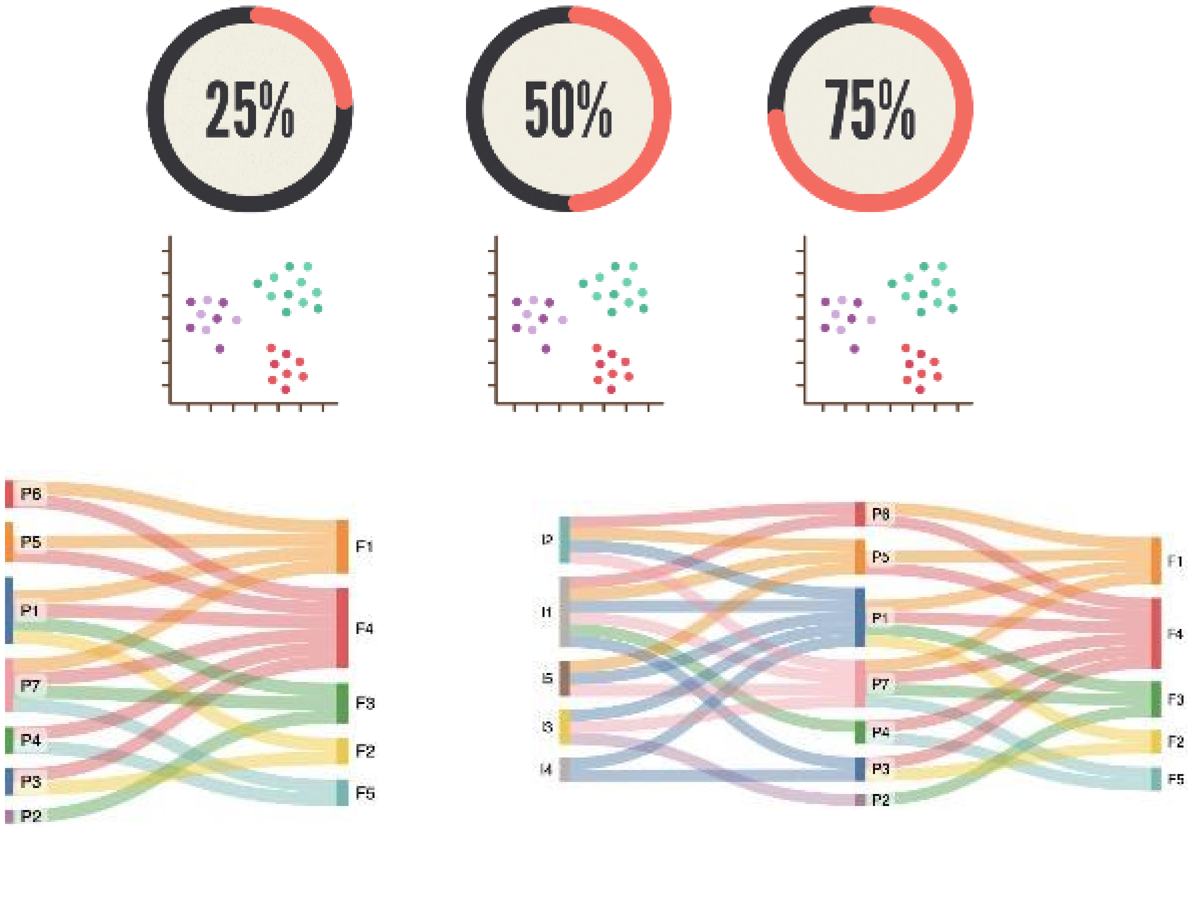
C-BA Cluster Behavioral Analysis for Forecasting Megaprojects Performances



Reference Class Forecasting

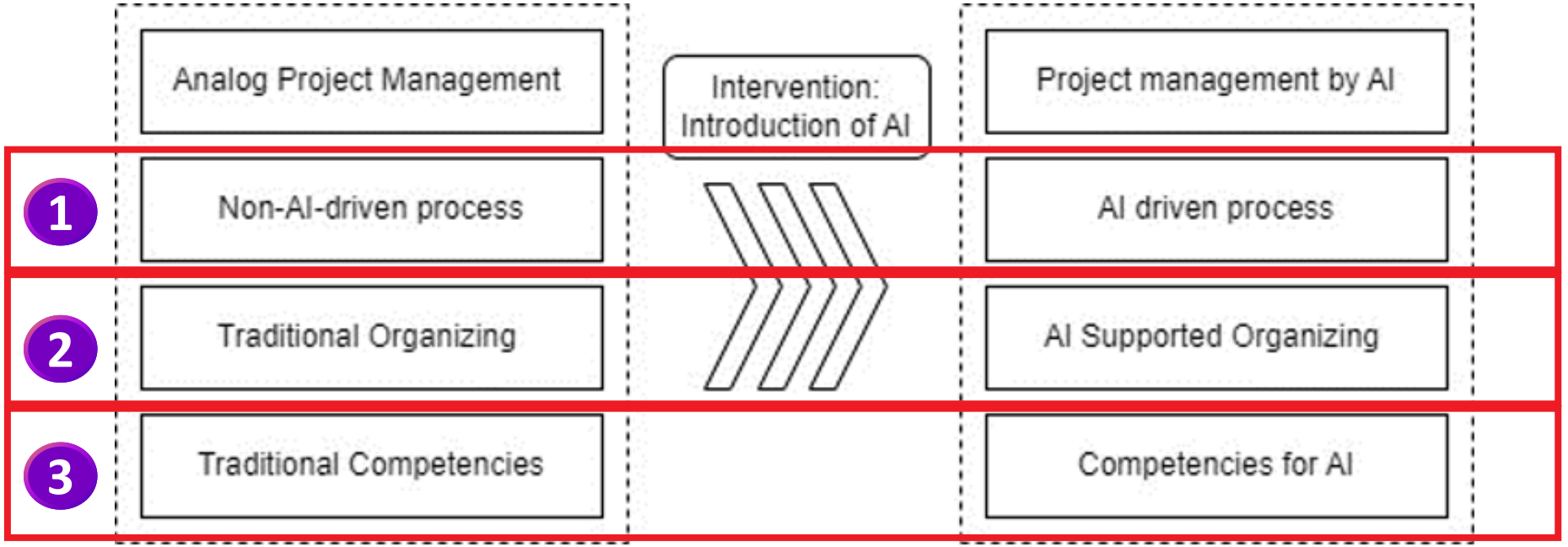


#	Megaproject	Industry type	Main sector	Relative value 2021 of initial budget [billion $]	Initial budget/GDP	Relative value 2021 of the final cost [billion $]	Final cost/GDP	Overbudget percentage	Years of delay	Duration
1	Beijing Daxing International Airport	Infrastructure	Roads and transport infrastructure	13,31	0,1065%	17,83	0,1191%	36,29%	0	5
2	Hong Kong–Zhuhai–Macau Bridge (HZMB)	Infrastructure	Roads and transport infrastructure	10,71	0,1429%	14,47	[illegible]	35,94%	2	9
3	Padma Bridge	Infrastructure	Roads and transport infrastructure	1,25	0,3620%	3,82	0,3279%	120,61%	3	8
4	KIIA 2	Infrastructure	Roads and transport infrastructure	1,11	[illegible]	1,44	[illegible]	25,05%	1	4
5	Tel Aviv–Jerusalem railway	Infrastructure	Roads and transport infrastructure	1,12	0,0206%	2,53	0,0437%	125,20%	10	17
6	Panama Metro line 1	Infrastructure	Roads and transport infrastructure	2,31	4,0743%	1,55	2,7716%	15,55%	0	4
7	Egnatia Odos	Infrastructure	Roads and transport infrastructure	10,25	4,7895%	3,81	2,1178%	-63,17%	9	15
8	Ionia Odos	Infrastructure	Roads and transport infrastructure	0,37	0,2018%	1,25	0,5251%	30,14%	4	10
9	Gotthard Base Tunnel	Infrastructure	Roads and transport infrastructure	7,18	2,1917%	12,45	1,7494%	73,45%	7	17
10	New Champlain Bridge Corridor Project	Infrastructure	Roads and transport infrastructure	2,48	0,1375%	4,82	0,2404%	85,86%	1	4
11	Felipe Ángeles Airport	Infrastructure	Roads and transport infrastructure	4,16	0,7967%	5,74	0,1127%	[illegible]	0	4
12	Kansai International Airport	Infrastructure	Roads and transport infrastructure	13,77	0,3322%	17,83	0,4006%	26,27%	0	7
13	Gebze Orhangazi Izmir Motorway	Infrastructure	Roads and transport infrastructure	29,47	[illegible]	16,75	[illegible]	[illegible]	0	4
14	San Francisco–Oakland Bay Bridge Eastern Span	Infrastructure	Roads and transport infrastructure	0,37	0,0062%	7,35	0,0357%	1012,40%	6	13
15	Panama Metro line 1	Infrastructure	Roads and transport infrastructure	0,77	[illegible]	2,07	[illegible]	[illegible]	1	4
16	Sochi Highway	Infrastructure	Roads and transport infrastructure	25,19	0,2865%	14,51	0,4522%	-42,39%	0	8
17	Karachi–Lahore motorway	Infrastructure	Roads and transport infrastructure	5,22	[illegible]	7,93	[illegible]	[illegible]	0	4
18	Orange Line, Lahore Metro	Infrastructure	Roads and transport infrastructure	1,93	0,4944%	1,82	0,5200%	-6,05%	0	5
19	Blanka tunnel complex	Infrastructure	Roads and transport infrastructure	1,12	0,4518%	2,23	0,5906%	95,17%	4	8
20	Big Dig	Infrastructure	Roads and transport infrastructure	13,33	0,1207%	28,12	[illegible]	110,96%	7	16
21	Alaskan Way Viaduct replacement tunnel	Infrastructure	Roads and transport infrastructure	5,24	0,0282%	3,30	0,0148%	-37,02%	0	16
22	Evergreen Point Floating Bridge (2016)	Infrastructure	Roads and transport infrastructure	5,48	0,1296%	5,39	0,0257%	-0,94%	2	5
23	The channel tunnel	Infrastructure	Roads and transport infrastructure	12,30	0,3218%	23,84	0,5724%	93,21%	1	8
24	Boundary Dam Power Station Unit 3	Infrastructure	Energy	1,55	0,0858%	1,74	0,2064%	6,98%	1	7
25	Three Gorges Dam	Infrastructure	Energy	14,05	0,1164%	40,24	0,7241%	215,75%	3	18
26	Dhadis Solar Park	Infrastructure	Energy	1,85	0,0666%	1,54	0,2525%	-17,05%	0	5



C-BA Method

Insights from the Four Papers:
The Empirical Application of AI in Projects



Implications on project management processes

Implication on the organzation

Need for a new competence skillset

Impacts of AI on PM Processes Execution

1 Implications On Project Management Processes

+ Efficiency

Example: In paper B, the adoption of artificial intelligence allows for a more efficient assessment of risks. Adopting models like modified Bayesian networks for risk assessment speed up the process and enhance efficiency by simplifying the computation of risks and their conditional probabilities, compared to traditional manual methods.

+ Effectivness

Example: Paper C shows that AI, specifically an Evolutionary algorithm, improves the accuracy of evaluating and prioritizing mitigation actions while considering budget and resource constraints, handling 68 primary and 11 secondary actions simultaneously. The results prooved to be more accurate than the traditional process employed in the company.

+Data Informed

Example: In paper A, during the process, the data concerning potential risks were updated twice, ensuring a more current and relevant basis for decision-making. This frequent updating of risk data significantly enhanced the accuracy and reliability of the process.

Implication on the Organization and Task Division

Change in Organizational Structure and Roles

Task automation new roles focused on interpreting and leveraging AI systems.
Example paper B, C -> interpretation of risk correlated probabilities, need for analysis and not intensive manual updating

Cultural and Ethical Considerations (AI Act)

The ethical implications of using AI – such as data privacy concerns, algorithmic bias, and the impact on employment – need to be addressed
Example paper D -> Treating stakeholders data with machine learning, storing personal information

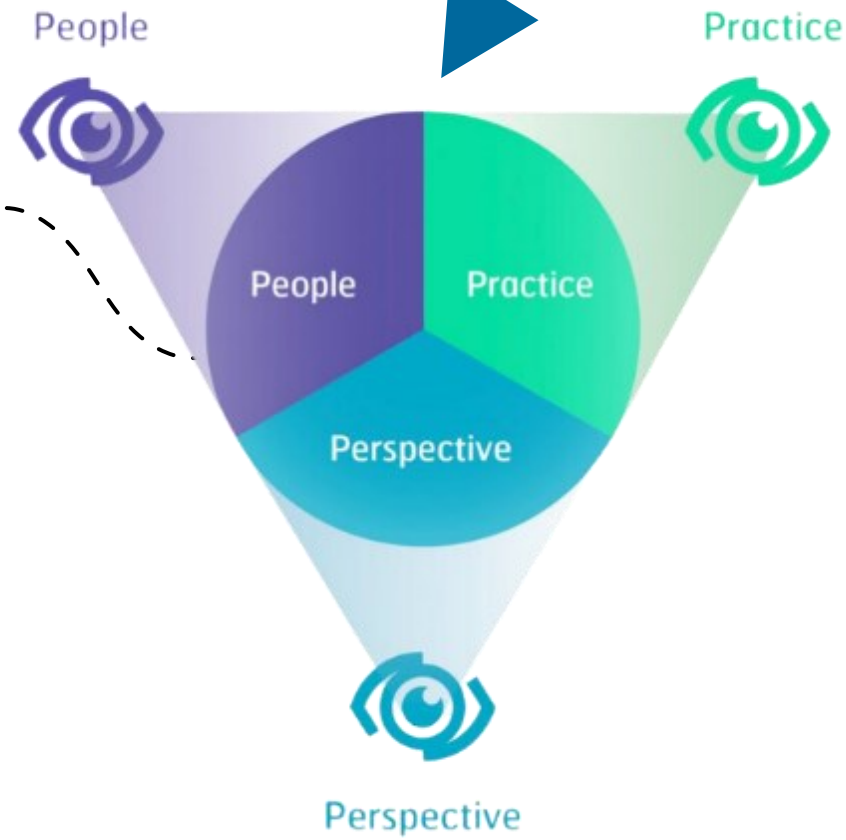
Need for Upskilling and Reskilling

Need to invest in training programs to upskill their workforce, ensuring that employees are able to adapt to and capitalize on AI-enhanced processes
Example paper A -> Need to be able to fully interpret classification results together with accuracy and overfitting info

New Competences Are Needed

Artificial Intelligence Can Support Perspective Competence

The “Perspective” of the intiatives you’re running: the context within which the initiative is run and the link to what needs to be achieved.



Strategically Decide

- IPMA: ICB4 Competence Framework