# INTRODUCTION TO AI

Introduction to ML, DL, AI and OpenVino

Session 01

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## Agenda

- Introductions
- Think AI
- Some Definitions!
- Timeline of AI
- AI is changing way of life



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**What are your Expectations from this Module???**

## Meet and Greet



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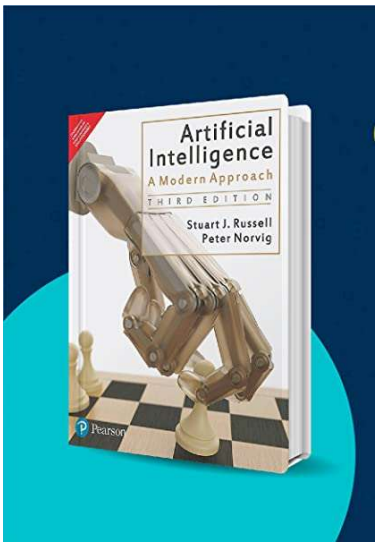
## References

- Artificial Intelligence – A Modern Approach (3rd Edition) by Stuart Russell & Peter Norvig
- Artificial Intelligence by Example, Denis Rothman
- Artificial Intelligence by Saroj Kaushik



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Theory exam– 40% weightage

Lab exam – 40 weightage

Internal exam – 20% weightage

## Evaluation Method



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## No Question is a Bad Question!

"The man who asks question is a fool for a minute, a man who doesn't ask is a fool for life."
~ Confucius



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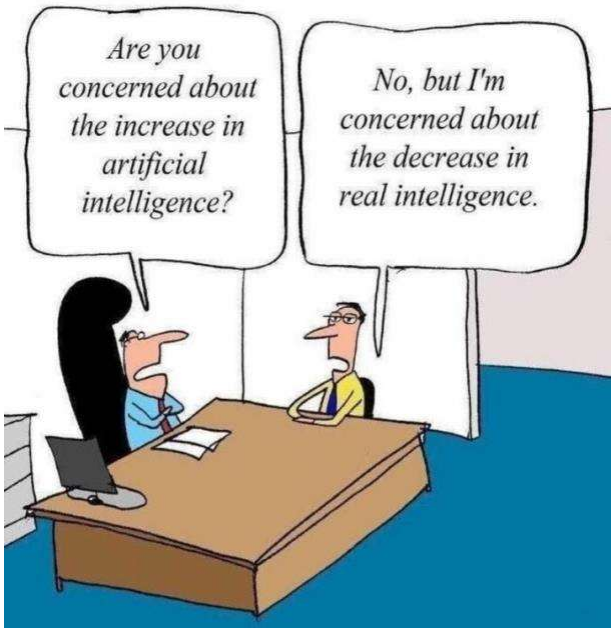




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Think AI…



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## Think AI : What Comes to Your Mind….

It is as simple as marking spam emails!



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## AI has Changed Gaming Industry…





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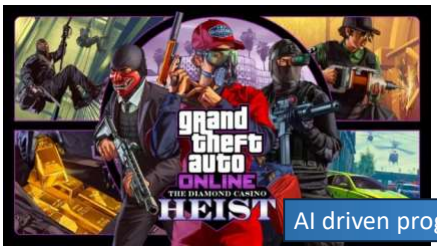
## AI has Changed Gaming Industry…





AI driven program can beat rule based program

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## Computer games are training professionals…

Role Playing Games (RPG)

Before active duty assignment, armed forces recruits have usually played hours of branded RPGs

Game-based desktop training tool used for squad-level training and call for fire

Used to train soldiers deploying to Iraq

Helps in cognitive learning—or "how to think" training

Certain games help with certain motor skills

Helps in practicing tactics, techniques, and procedures, and practicing making decisions

Helps recreate virtual battle field to a level of fidelity unseen before

It is combination of photo-realistic graphics and technologies like normal mapping and inverse kinematic animation

Army places high-fidelity content based upon the information available - the real-world location of roads, buildings, etc.





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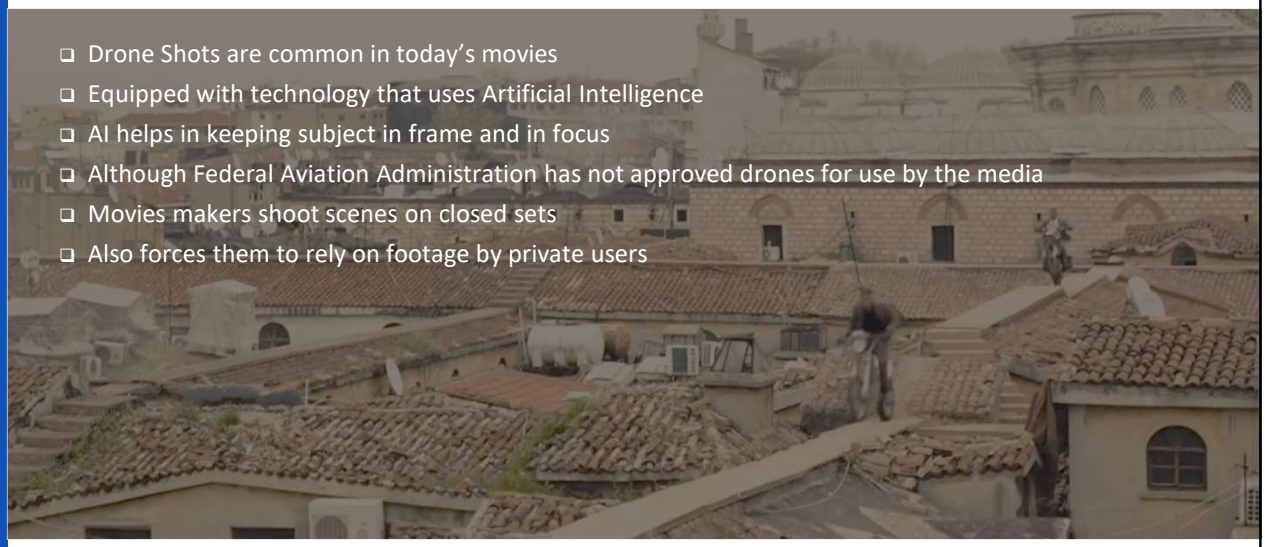
## AI is helping movies become more spectacular…

- Drone Shots are common in today's movies
- Equipped with technology that uses Artificial Intelligence
- AI helps in keeping subject in frame and in focus
- Although Federal Aviation Administration has not approved drones for use by the media
- Movies makers shoot scenes on closed sets
- Also forces them to rely on footage by private users





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## Natural Language Processing

- Computer that understands natural language spoken by humans
  - Siri, Alexa…
- They can also translate text as spoken by humans…
  - 3:00 am becomes "three O'clock"
  - or "Zero three hundred" if you are military
- They can also translate text as per the context
  - How would you pronounce $ 1.99?
  - Its "Dollar Ninety Nine" and not "one dollar ninety nine cents"…
  - What about $10.99?
  - Its "Ten Ninety Nine"
  - If it's a just a number, it will be "ten point nine nine"
- Even communicate like a human being… Turing Test

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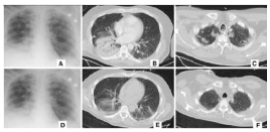
## Other Applications

- Expert Systems
  - "As per a report from Nikkei's Asian Review (h/t TechSpot), Alibaba claims its new system can detect coronavirus in CT scans of patients' chests with 96% accuracy against viral pneumonia cases. And it only takes 20 seconds for the AI to make a determination – according to the report, humans generally take about 15 minutes to diagnose the illness as there can be upwards of 300 images to evaluate."



- Other applications:
  - Computer Virus Detection & Cleaning, Information Management, Help Desks Management, Employee Performance Evaluation, Loan Analysis, Planning & Scheduling, the Configuration of Manufactured Objects, Financial Decision Making, Knowledge Publishing, Process Monitoring & Control, Supervise the Operation of the Plant & Controller, Stock Market Trading, Airline Scheduling & Cargo Scheduling



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## Google Maps

German artist Simon Weckert creates "virtual traffic jams" on the streets of Berlin.

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## Some Definitions!



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"*The science and engineering of making intelligent machines, especially intelligent computer programs.*"

-John McCarthy



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"*Field of study that gives computers the ability to learn without being explicitly programmed.*"

-Arthur Samuel , 1959





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"*Subfield of computer science, Evolved from the study of pattern recognition and computational learning theory in artificial intelligence.*

*Explores the study and construction of algorithms, That can learn from and make predictions on data.*

*Such algorithms operate by building a model from example inputs in order to make data-driven predictions or decisions, rather than following strictly static program instructions.*"

-Wikipedia

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> *Building programs with tunable parameters that are adjusted automatically so as to improve their behavior by adapting to previously seen data.*
>
> *A subfield of Artificial Intelligence; Algorithms can be seen as building blocks to make computers learn to behave more intelligently by somehow generalizing rather than just storing and retrieving data items like a database system would do.*

- PyCon





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## Once Again… in different words…

- Science of programming computers to learn from data…
- Make a system (computer, a robot, or a product) to
  - Learn from past experience (data points)
  - Take action (produce outcome) under near similar situation
- Approaches include :
  - Statistical methods
  - Computational intelligence
  - Traditional coding

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## What's Being Played...

Can a Rule based system answer based on the data provided?

We, as humans can easily guess!

| Time | Day | Type |
|---|---|---|
| 9:00 AM | Weekday | News |
| 11:00 AM | Weekday | K-Soaps |
| 3:00 PM | Weekday | Soaps |
| 5:00 PM | Weekday | Soaps |
| 6:00 PM | Weekday | Cartoons |
| 9:00 PM | Weekday | Sports, Movies |
| 4:00 PM | Weekday | ??? |
| 1:00 PM | Weekday | ??? |




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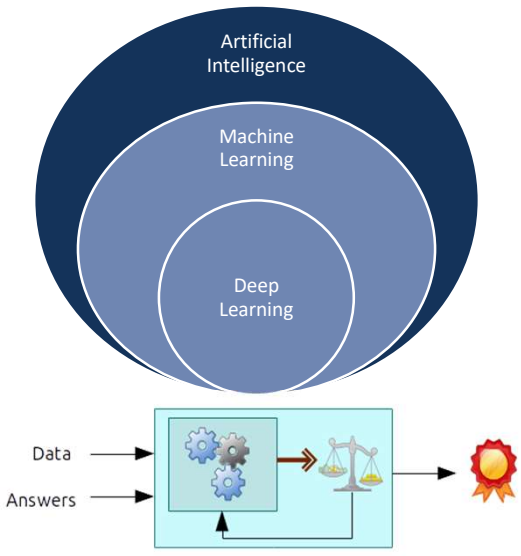
## AI vs ML vs Deep Learning




- Used interchangeably
- AI is a broader concept it includes basic AI to Deep learning.
- Machine learning: enabling Machines to Learn from the past incidents (available data).
- Deep Learning: One can say that it tries to copy information processing patterns found in the human brain



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## Artificial Intelligence

- A man-made thinking power:
  - Create intelligent machines that can simulate Human thinking capability and behavior
  - Intelligent software to automate routine tasks, understand speech or images, make diagnoses in medicine and support basic scientific research
- Algorithms which can work with their own “intelligence”.
  - No pre-programing needed.
  - Algorithms such as Reinforcement Learning algorithm and Deep Learning Neural Networks being used in multiple places such as Siri, Google’s AlphaGo, Chess playing, etc.
- Based on capabilities, AI can be classified into three types:
  - Weak AI
  - General AI
  - Strong AI
- Currently, we are working with weak AI and general AI. The future of AI is Strong AI for which is claimed to be more intelligent than humans (???)



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## Machine Learning

- An application or subset of AI
- Allows machines to learn from data without being programmed explicitly
  - Uses a massive amount of structured and semi-structured data
- It can work only on data it has seen
  - For unknown cases it becomes unresponsive or unreliable
- Being used for online recommender system, for Google search algorithms, Email spam filter, Facebook auto friend tagging suggestion, etc.
- It can be divided into three types:
  - Supervised learning
  - Unsupervised learning
  - Reinforcement learning
- Some papers also talk about semi-supervised /self-supervised learning

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## Deep Learning

- Large Neural Networks

"Using brain simulations, hope to:
Make learning algorithms much better and easier to use,
Make revolutionary advances in machine learning and AI,
I believe this is our best shot at progress towards real AI."

- Andew Ng

- Learning successive layers of increasingly meaningful representations
- Modern network contain hundreds of successive layers
- Successive layers are learned via "neurons" connected via neural network



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## Deep Learning

- Why Deep Learning is more practical today?
  - Availability of large computing power
  - Availability of large datasets
- Most flavors of the old generations of learning algorithms, performance will plateau
- Deep learning that is scalable
  - Performance just keeps getting better as more and more data is fed
- Most value today is coming from supervised learning
- Eventually, we will see benefits of unsupervised learning

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## Deep Learning

- Usually a neural network contains
  - Input Layer
  - Hidden layers [ 1 … n]
  - Output layer
- We may call network with
  - 1 to 2 hidden layers as “shallow”
  - 10 or more layers as “deep”
- No set demarcation
- Early paper in 2006 called it deep learning instead of just “Artificial Neural Networks” as it had multiple layers
  - Scientist just got excited when someone labeled them as deep network



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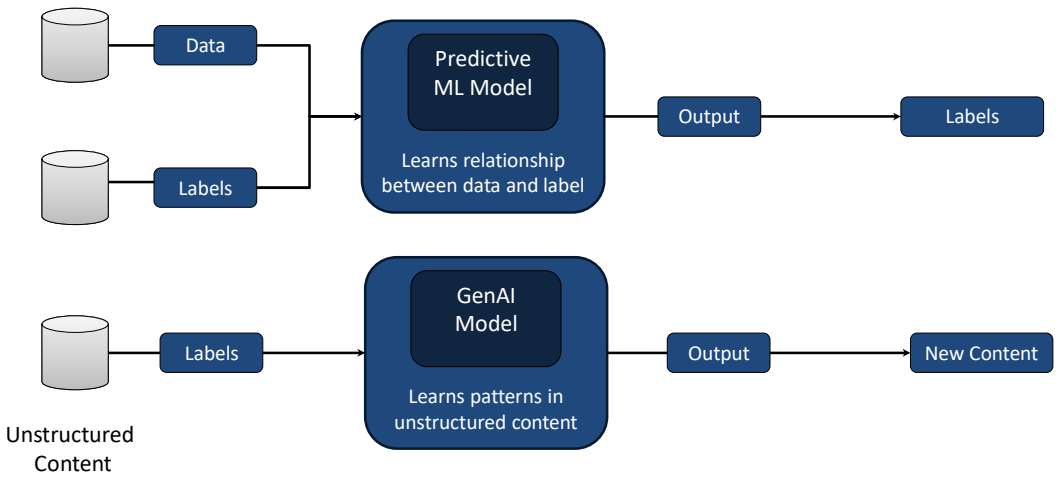
## Deep Learning



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## 31 Deep Learning

Classify → Discriminative Model → Output → Most probably a `Car`

Generate → Generative Model → Output → 



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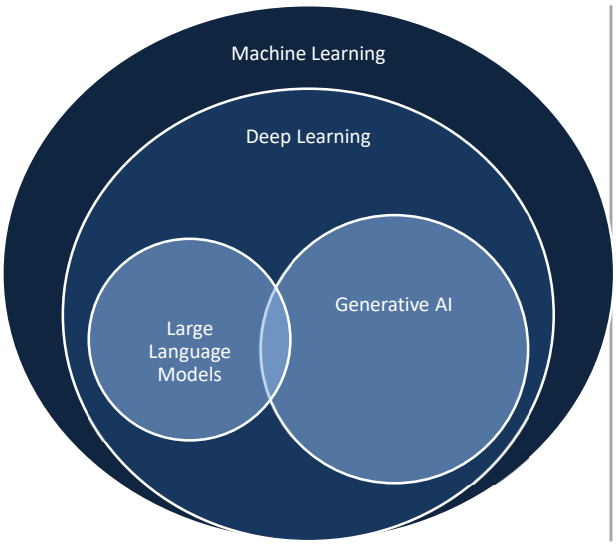
## 32 Generative AI




- Gen AI is a subset of Deep learning
- Can process:
  - Labeled data
  - Unlabeled data
- Using:
  - Supervised methods
  - Unsupervised methods
  - And semi-supervised methods



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## Key Milestones



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## Timeline of AI

| 1941<br>Turin Test | 1950<br>I, ROBOT |
|---|---|
| ❑ If a machine can engage in a conversation with a human without being detected as a machine, it has demonstrated human intelligence<br>❑ The Turing Test judges the conversational skills of a bot<br>❑ According to the test, a computer program can think if its responses can fool a human into believing it, too, is human<br>❑ Not everyone accepts the validity of the Turing Test, but passing it remains a major challenge to developers of artificial intelligence | ❑ I, Robot is a fixup novel of science fiction short stories or essays by American writer Isaac Asimov<br>❑ The stories are woven together by a framing narrative in which the fictional Dr. Susan Calvin tells each story to a reporter (who serves as the narrator) in the 21st century<br>❑ Although the stories can be read separately, they share a theme of the interaction of humans, robots, and morality. When combined these stories tell a larger story of Asimov's fictional history of robotics |

Figment of the imagination of some famous science fiction writers have greatly influenced direction of AI.



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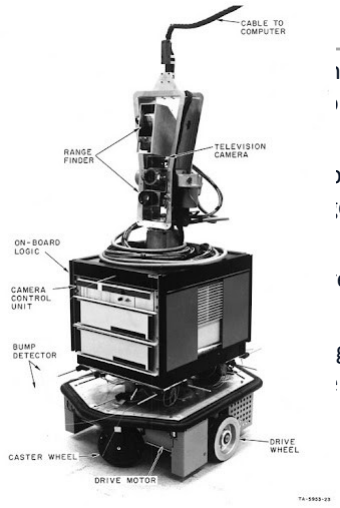
## Timeline of AI

1956
John McCarthy coined Artificial Intelligence

- McCarthy was one of the founders of the discipline of Artificial Intelligence.
- Co-authored the document that coined the term "artificial intelligence" (AI),
- Developed the Lisp programming language family,
- Significantly influenced the design of the ALGOL programming language,
- Popularized time-sharing,
- Invented garbage collection,
- Very influential in the early development of AI.

1969




- First
- The
- The
- Was

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## Timeline of AI

1973
AI Winter

- Million spent, very little to show for…
- Research budgets slashed
- The field has experienced several hype cycles, followed by disappointment and criticism, followed by funding cuts, followed by renewed interest years or decades later
- A chain reaction that begins with pessimism in the AI community, followed by pessimism in the press, followed by a severe cutback in funding, followed by the end of serious research

1981
Narrow AI

- Instead of trying to create a general intelligence, research shifted towards "expert systems" which are “task-focused”, “purpose-built”
- John Searle - would be useful for testing hypothesis about minds, but would not actually be minds”
- Siri, Cortana, and Google Assistant are all examples of narrow AI, as they operate within a limited pre-defined range of functions

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## Timeline of AI

**1973**
**AI Winter**

- Million spent, very little to show for…
- Research budgets slashed
- The field has experienced several hype cycles, followed by disappointment and criticism,

Roger Schank and Marvin Minsky: at the annual meeting of AAAI (then called the "American Association of Artificial Intelligence“) in 1984 warned the business community that enthusiasm for AI had spiraled out of control in the 1980s and that disappointment would certainly follow. Three years later, the billion-dollar AI industry began to collapse.

**1981**
**Narrow AI**

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## Timeline of AI

**1990**
**Bottom Up Approach**

- Rodney Brooks spearheaded the "bottom-up" approach: aiming to develop neural networks that simulates brain cells and learned new behaviors
- Brooks chose a traditional AI problem for his doctoral research (1981), which he subsequently expanded and published as Model-Based Computer Vision (1984)
- Disappointment with using “top down” approach, Brooks turned that approach on its head, arguing that research should focus on a bottom-up approach—that is, on action and behavior rather than on representation and function

**1997**
**Deep Blue**

- IBM developed a supercomputer - Deep Blue a chess-playing computer
- First computer to win both a chess game and a chess match against a reigning world champion under regular time controls
- First match Deep Blue won its first game against world champion Garry Kasparov but lost by a score of 4–2
- In May 1997, heavily upgraded Deep Blue won the six-game rematch 3½–2½
- Becoming the first computer system to defeat a reigning world champion
- Kasparov accused IBM of cheating



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## Timeline of AI

| 2002<br>Roomba | 2005<br>Big Dog |
|---|---|
| ❑ iRobot created first commercially successful robot for home cleaning - an autonomous vacuum cleaner<br>❑ Roombas feature a set of sensors to detect the presence of obstacles, detect dirty spots on the floor, and sense steep drops to keep them from falling down stairs, obstacle avoidance, performance maps, camera with navigation software , recharging bases , beacons, etc. | ❑ US Military started investing in autonomous robots<br>❑ Big Dog by Boston Dynamics, was first one<br>❑ Dynamically stable quadruped military robot<br>❑ Other collaborators were Foster-Miller, the NASA Jet Propulsion Laboratory and the Harvard University Concord Field Station<br>❑ It was funded by DARPA<br>❑ The project was shelved after it was deemed too loud for combat |



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## Timeline of AI

| 2002<br>Roomba | 2005<br>Big Dog |
|---|---|
| ❑ iRobot created first commercially successful<br>  | ❑ US M ous<br>robo<br>❑ Big D e<br>❑ Dyn bot<br>❑ Othe he<br>NAS<br>Harv<br>❑ It wa<br>❑ The<br>afte<br>loud |



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## Timeline of AI

2008
Google App

- Google launched a speech recognition app
- It was first step towards Siri, Google Assistant, Alexa, Cortana, etc…
- Google Assistant (latest) is an artificial intelligence–powered virtual assistant developed by Google
- It is primarily available on mobile and smart home devices
- Unlike the company's previous virtual assistant, Google Now, the Google Assistant can engage in two-way conversations

2010
Nao Robots

- 20 Nao Robots Danced in perfect harmony for 8 mins at Shanghai's 2010 World Expo!



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## Timeline of AI

2011
Watson

- IBM Watson took on humans on Jeopardy and won against two best performers of all time on the show.
- Watson is a question-answering computer system capable of answering questions posed in natural language,
- Developed in IBM's DeepQA project by a research team led by principal investigator David Ferrucci.
- Watson was named after IBM's founder and first CEO, Thomas J. Watson.

2014
Eugene Goostman

- 64 years after it was conceived, a Chatbot called Eugene Goostman passed the Turing test.
- Goostman is portrayed as a 13-year-old Ukrainian boy
- On 7 June 2014, 33% of the event's judges thought that Goostman was human
- As per Turing's prediction in his 1950 paper Computing Machinery and Intelligence, that by the year 2000, machines would be capable of fooling 30% of human judges after five minutes of questioning.
- Google invested a billion $ in driverless car
- Skype launched real-time voice translation



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## Different Fields Different Expertise









- Fine-tuned model from one field may not work in other field.
- Learning/experience from one field is not transferable.



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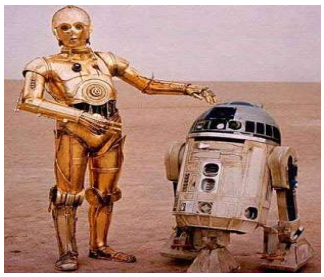
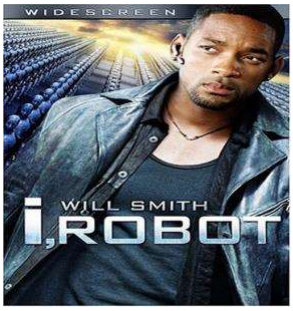
## Artificial Intelligence in the Movies



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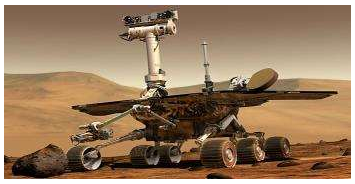
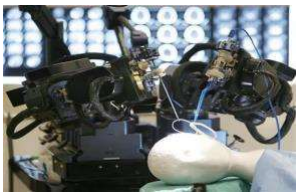
## Artificial Intelligence in Real Life

- A young science (≈ 50 years old)
- Exciting and dynamic field, lots of uncharted territory left
- Impressive success stories
- "Intelligent" in specialized domains
- Many application areas





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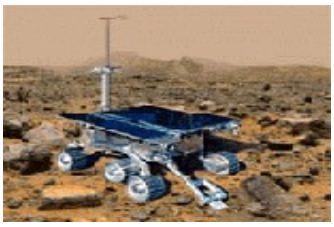
## Why the interest in AI?

Labor



Science

Google
yahoo!

Search engines

What else?

Medicine / Diagnosis


Appliances



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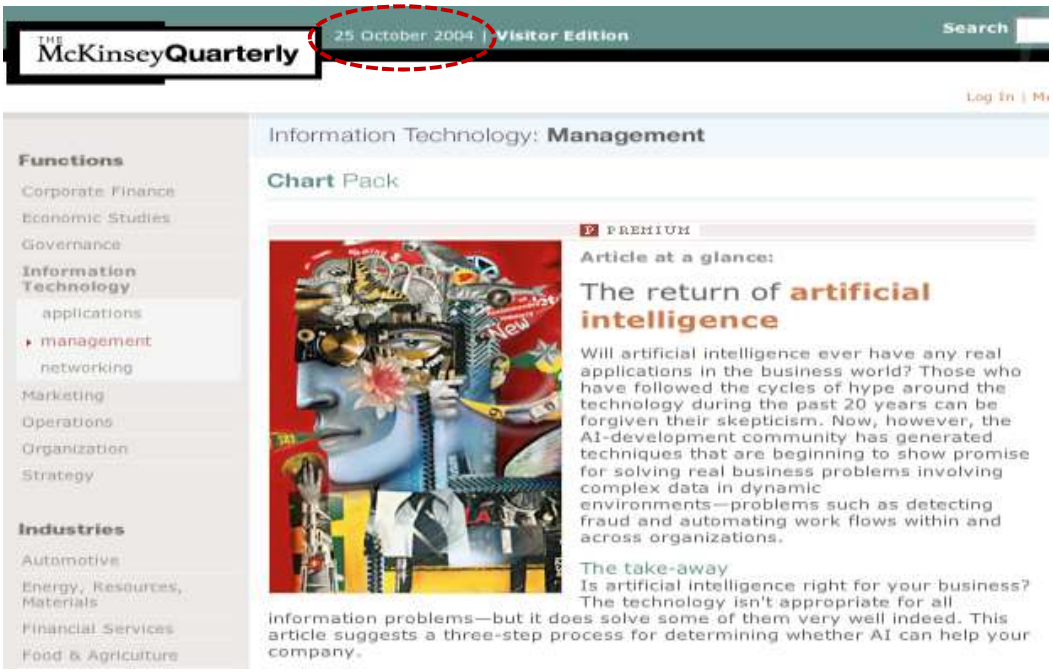




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## The Most Important Conversation of Our Time

- How can we make future AI systems more robust
  - No crashing, malfunctioning or getting hacked
- Should we fear an arms race in lethal autonomous weapons?
- Will machines eventually outsmart us at all tasks, replacing humans on the job market and perhaps altogether?
- Will AI help life flourish like never before or give us more power than we can handle?
- What sort of future do you want?
- Let's openly discuss
  - The full range of viewpoints
  - The most controversial issues – from super-intelligence
  - Meaning, consciousness and the ultimate physical limits on life in the cosmos



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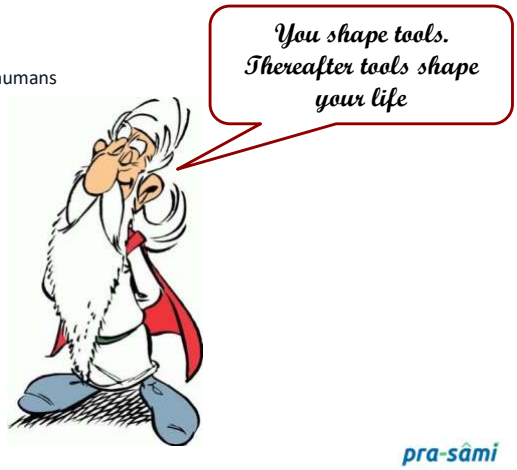
## Some Misconceptions about AI

- **AI does not require humans**
  - Each AI-based system is somewhere dependent on humans and will remain as such
  - There are no evidences yet that it will become independent of human interference
  - Such as it requires human gathered data to learn about the data; Outcome is dependent on the data provided
- **AI is dangerous for humans**
  - AI is not inherently dangerous for humans
  - It has not reached the super AI or strong AI, which is more intelligent than humans
  - Misuse is dangerous
- **AI has reached its peak stage**
  - It will take a very long journey to reach its peak
- **AI will take your job**
  - It is enriching jobs, taking away infructuous work
  - It is giving us more opportunities for new jobs
- **AI is new technology**
  - Actually first thought in the year 1840 through an English newspaper.



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## AI State of the art - applications

- Facilitate and replace human decision making
  - World-class chess and game playing
- Robots
- Automatic process control
- Beginning to understand spoken language
- Smarter search engines
- Engage in a meaningful conversation
- Observe and understand human emotions
- Solving mathematical problems
- Discover and prove mathematical theories
- …



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## Key Research Areas in AI

- Problem Solving, Planning, and Search – generic problem solving architecture based on ideas from cognitive science (game playing, robotics).
- Knowledge Representation – to store and manipulate information (logical and probabilistic representations)
- Automated Reasoning / Inference – to use the stored information to answer questions and draw new conclusions
- Machine Learning – intelligence from data; to adapt to new circumstances and to detect and extrapolate patterns
- Natural Language Processing – to communicate with the machine
- Computer Vision – processing visual information
- Robotics – autonomy, manipulation, full integration of AI capabilities



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## ML Vs. Statistical Models

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## Machine learning is built upon a statistical framework

| Machine Learning | Statistical Models |
|---|---|
| Machine Learning has been around for several decades. | Obviously, statistics little longer… |
| Initially shunned due to its large computational requirements, Limitations of computing power present at the time | Computational needs shortened by making certain assumptions |
| Models are designed to make the **most accurate possible** predictions. | Models are designed for inference about the relationships between variables. Data follows a stochastic model and response variables are a function of predictor variables, random noise, and parameters. |
| Main purpose of ML model is to make **reasonable and repeatable** predictions. | The model is to characterize the relationship between the data and our outcome variable, **not** to make predictions about future data. Generally, accuracy is restricted by assumptions |
| Training set to train the model and then test set to find its performance. | Traditional statistical approaches, there is no concept of a training and test set, but we do use metrics to help us examine how our model performs |
| Approach is to use a few models to converge to a hypothesis. Explore different function to find best accuracy (minimize loss) | Approach gives the optimal solution in a closed form. No test out of any other hypotheses and converge to a solution. Fit a Function and find its accuracy. |



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## Statistical Models - Tide Predictions

- Any periodic motion or oscillation can always be resolved into the sum of a series of simple harmonic motions -- Eudoxas , 356 B.C
- Sir William Thomson (Lord Kelvin) devised the method of reduction of tides by harmonic analysis about the year 1867
- The results were published as lookup tables
- Predicting machines were superseded in 1966 by the advent of digital electronic computers
- Predictions of tides are usually pretty accurate
- Now other factors are being incorporated in the predictions



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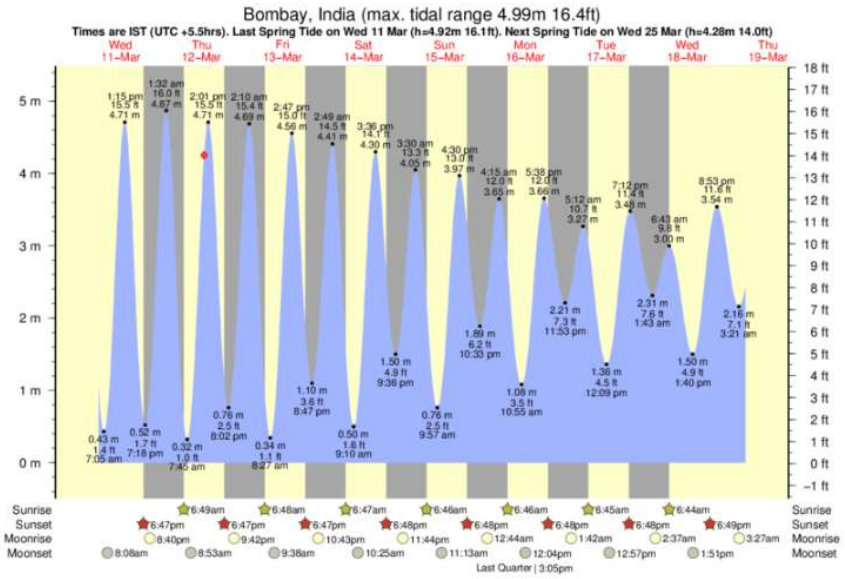
## Bombay Port



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## Tide Table

| | Days 0–3 Weather Summary: Mostly dry. Warm air temperatures (max 28°C on Sat afternoon, min 20°C on Fri morning). Winds decreasing (strong winds from the NW on Fri afternoon, light winds from the NNE by Sat night). | | | | | | | | | Days 4–6 Weather Summary: Mostly dry. Warm air temperatures (max 28°C on Sun morning, min 23°C on Sun morning). Wind will be generally light. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Change units | Thursday 12 | | | Friday 13 | | | Saturday 14 | | | Sunday 15 | | | Monday 16 | | | Tuesday 17 | | |
| Time of Day | morn-ing | after-noon | night | morn-ing | after-noon | night | morn-ing | after-noon | night | morn-ing | after-noon | night | morn-ing | after-noon | night | morn-ing | after-noon | night |
| Wave Height Map See all maps | | | | | | | | | | | | | | | | | | |
| High Tide height (m) | | 2:01PM 4.71 | 2:10AM 4.69 | | 2:47PM 4.56 | 2:49AM 4.41 | | 3:36PM 4.30 | 3:30AM 4.05 | | 4:30PM 3.97 | 4:15AM 3.65 | | 5:38PM 3.66 5:12AM 3.27 | | | 7:12PM 3.48 | |
| Low Tide height (m) | 7:45AM 0.32 | | 8:02PM 0.76 | 8:27AM 0.34 | | 8:47PM 1.10 | 2:10AM 0.50 | | 2:36PM 1.50 | 2:57AM 0.76 | | 12:22PM 1.89 | 10:55AM 1.08 | | 11:53PM 2.21 | 12:09PM 1.36 | | 1:43AM 2.31 |
| Swell (m) direction | 0.8 SW | 0.8 SW | 0.8 SW | 1.0 SW | 1.3 SW | 1.0 SW | 1.1 SW | 1.2 SW | 0.9 SSW | 0.9 SW | 0.9 SW | 0.7 SW | 0.6 SSW | 0.6 SSW | 0.4 SSW | 0.6 SSW | 0.5 SSW | 0.6 SW |
| Wave Height (m) | 0.8 | 0.8 | 0.8 | 1.0 | 1.3 | 1.0 | 1.1 | 1.2 | 0.9 | 0.9 | 0.9 | 0.7 | 0.6 | 0.6 | 0.4 | 0.6 | 0.5 | 0.6 |
| Period (s) | 19 | 18 | 17 | 16 | 15 | 14 | 14 | 13 | 13 | 12 | 12 | 12 | 12 | 11 | 11 | 11 | 10 | 17 |
| Wind (km/h) | 15 NNW | 20 NW | 15 NNW | 25 N | 40 NW | 25 N | 20 NNE | 40 NNW | 10 NNE | 10 NNW | 20 NW | 5 W | 20 SW | 20 W | 10 ENE | 10 WSW | 25 WNW | 15 N |
| | Today's sea temperature in Mumbai is 27.1 °C (Statistics for 12 Mar 1951–2006 – mean: 26.6 max: 27.5 min: 25.7 °C) | | | | | | | | | | | | | | | | | |
| Summary | clear | clear | clear | clear | clear | clear | clear | clear | clear | clear | clear | clear | clear | clear | clear | clear | clear | clear |
| Rain mm | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| High °C | 24 | 24 | 23 | 23 | 24 | 25 | 26 | 28 | 27 | 28 | 28 | 28 | 27 | 27 | 26 | 27 | 27 | 27 |
| Low °C | 23 | 24 | 21 | 20 | 24 | 21 | 21 | 27 | 24 | 23 | 28 | 26 | 26 | 27 | 24 | 24 | 27 | 24 |
| Chill °C | 24 | 24 | 23 | 23 | 24 | 25 | 26 | 28 | 27 | 28 | 28 | 28 | 27 | 27 | 26 | 27 | 27 | 27 |
| Sunrise | 6:48 | - | - | 6:48 | - | - | 6:47 | - | - | 6:46 | - | - | 6:45 | - | - | 6:45 | - | - |
| Sunset | - | 6:46 | - | - | 6:47 | - | - | 6:47 | - | - | 6:47 | - | - | 6:47 | - | - | 6:49 | - |



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## Keep It Simple and Stupid – US Navy 1960

- Titanic Dataset

| | pclass | name | sex | age | sibsp | parch | ticket | fare | cabin | embarked | survived |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1 | Allen, Miss. Elisabeth Walton | female | 29 | 0 | 0 | 24160 | 211.3375 | B5 | S | 1 |
| **1** | 1 | Allison, Master. Hudson Trevor | male | 0 | 1 | 2 | 113781 | 151.5500 | C22 C26 | S | 1 |
| **2** | 1 | Allison, Miss. Helen Loraine | female | 2 | 1 | 2 | 113781 | 151.5500 | C22 C26 | S | 0 |
| **3** | 1 | Allison, Mr. Hudson Joshua Creighton | male | 30 | 1 | 2 | 113781 | 151.5500 | C22 C26 | S | 0 |
| **4** | 1 | Allison, Mrs. Hudson J C (Bessie Waldo Daniels) | female | 25 | 1 | 2 | 113781 | 151.5500 | C22 C26 | S | 0 |



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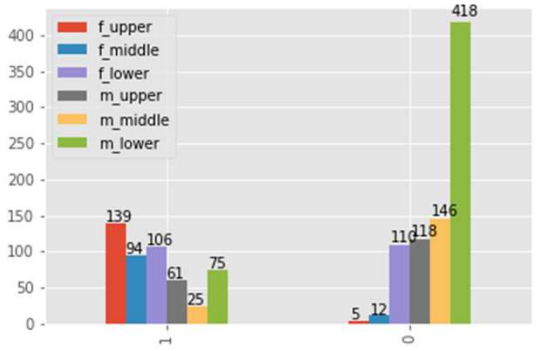
## Keep It Simple and Stupid – US Navy 1960




| | f_upper | f_middle | f_lower | m_upper | m_middle | m_lower |
|---|---|---|---|---|---|---|
| **1** | 139 | 94 | 106 | 61 | 25 | 75 |
| **0** | 5 | 12 | 110 | 118 | 146 | 418 |

| | f_1 | f_2 | f_3 |
|---|---|---|---|
| 1 | 139 | 94 | 106 |
| 0 | 5 | 12 | 110 |
| Total | 144 | 106 | 216 |



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## Keep It Simple and Stupid – US Navy 1960

- Male Survival Percentage
  = (61+25+75) / (61+25+75+118+146+418) * 100 = 19.0865
- Female Survival Percentage
  = ( 139 + 94 + 106 ) / ( 139 + 94 + 106 + 5 + 12 + 110) *100 = **72.7468 %**
- Make a few simple assumptions:
  - Only ladies survived and their survival percentages are as follows:
  - First Class : all (100%)
  - Second Class : 80%
  - Third Class : 50%
  - ➔ (144 + 106 *80% +216 * 50 % ) / ( 144 +106 + 216) * 100 = **72.2747** %

Not Bad!

| | f_1 | f_2 | f_3 |
|---|---|---|---|
| 1 | 139 | 94 | 106 |
| 0 | 5 | 12 | 110 |
| Total | 144 | 106 | 216 |



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## Case Studies : Smart Marine Cargo Handling



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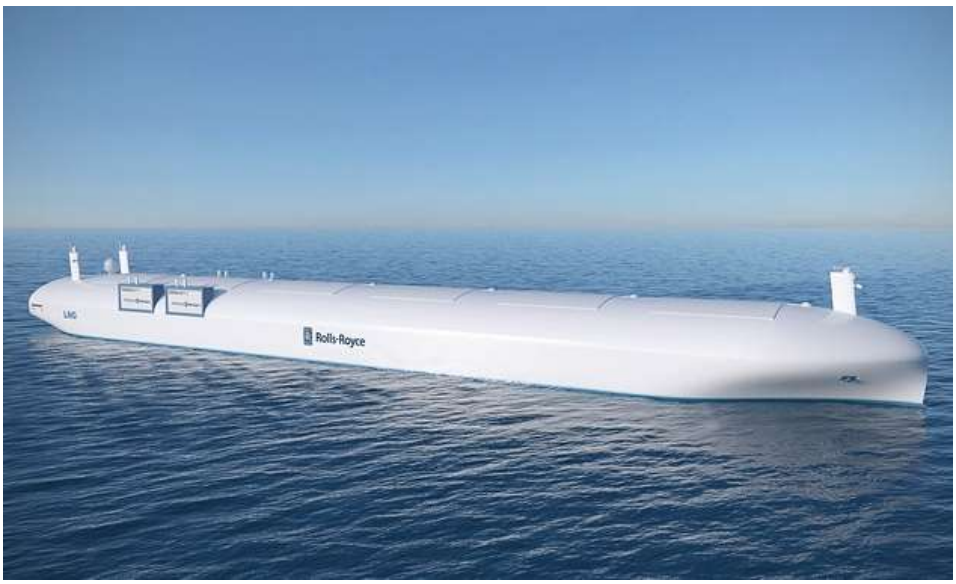
## Future is already here!



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## Google and Rolls -Royce

- The future lies in autonomous vehicles
- A collaboration between Google and Rolls-Royce to create autonomous and smart ships
- Rolls-Royce will be using the Machine Learning Engine on Google Cloud in its applications to make its vision of smarter and autonomous ships come true.
- At first, AI algorithms will be trained using machine learning to identify objects that can be encountered at sea and classify them based on hazard they may pose
- The Machine learning algorithms that are currently being used by Google Voice and image search applications
  - They will also be augmented by massive data sets produced from various devices like sensors, cameras, and cameras on vessels.
- By combining the cloud-based AI and Big Data application enable data to be shared in real-time to any ship and also to on-shore Control Centre

Smart Ports need Smart Ships



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## Opportunity

- Ports were little slow in adopting automation compared to other industries. However, they are catching up fast!
- Digitalization and interconnection is on rise
  - "Smart Machines" are increasingly influencing our lives
- Container port is more suitable eco-system to automate

Pros

- Reduction in operating expenses
- Increase in Productivity, Reliability, Consistency, Predictability
- Safety of operations
- Reduced environmental impact

Cons

- Significant capital expenditure
- Operational challenges - Limited capabilities and skills, Poor data quality Responsive system to handle exceptions



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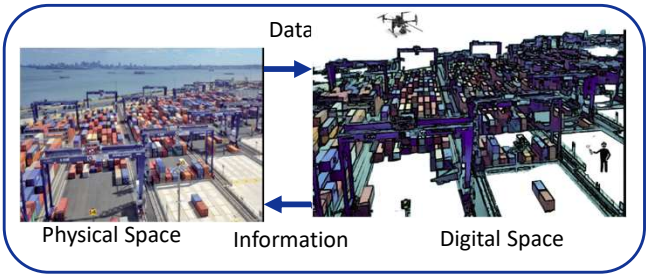
## Digital Twin for Real-time Representation

- Build a 4D Digital Twin Model of what exists, present smart analytics using artificial intelligence engines for smarter decision making and actions
- Digital representation using data from the sensors located on the physical site, aerial survey, etc.
- Visualization, modeling, analysis, simulation and further planning & forecasting
- Data based feedback loop of decisions




Use 4D model to have access to **existing data with forward simulation**

- Monitor progress against the schedules
- Decision Making based on forward simulation
- Analyze different paths of actions and estimate their probabilities
- Interdependencies



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## Container Handling

- Position Determination System
  - GPS Tracking, including geo-fencing
  - Embedded into any type of container handling Equipment
  - Also monitor the storage and retrieval locations for every container handled on the terminal
  - Automated and real-time data with audit trail
- Automatic Truck Identification
  - Different approaches as per the vehicle type
- Automatic Steering of transport robots
  - Needs a reliable positioning, navigation and perception systems with wireless communication
- Automatic Steering for RTGs:
  - A passive automated steering system automatically steer an RTG crane along a container stack runway.

System to be self-learning



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## Internal Trailers

- Geo-positioning and geo-fencing of the vehicles
- Monitor and record vehicle utilization
- Enhance the productivity of the vehicle fleet by tracking their location, speed and stoppages
- Evaluate efficiency in the existing routes
- Real time integration
- Real-time alerts/updates



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## Container - Railway

- Shunting of trains in marshalling yards, inland and port railway terminals is costly
- The key for increasing the competitiveness of inter-modal container transport:
  - Frequent operation of heavy haul container trains between port and inland railway terminals
  - Fast, flexible and automatic transshipment, shunting and coupling of container wagons
  - Self-driven railcars with automatic center coupling
- Technology is available, however cost of investment and ROI need to be evaluated carefully
- The effective design will depend upon:
  - How many containers are to be transshipped using Railway
  - What is ratio between Rail : Road : Coastal



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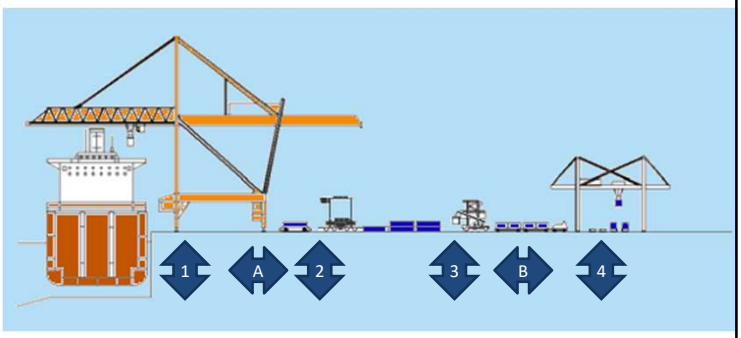
## Dispatch using Railway

- Vertical Moves
  - 1 – Quay Crane
  - 2 – To Container Yard
  - 3 – From Container Yard
  - 4 – Rail Mounted Crane on to Rack
- Horizontal Moves
  - A - Quay to Container Yard
  - B - Container Yard to Railway loading point ( Using Trailers)
- Time taken in each of the steps???
- Evaluate Process to reduce transshipment time



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## Case Studies : Infrastructure Construction



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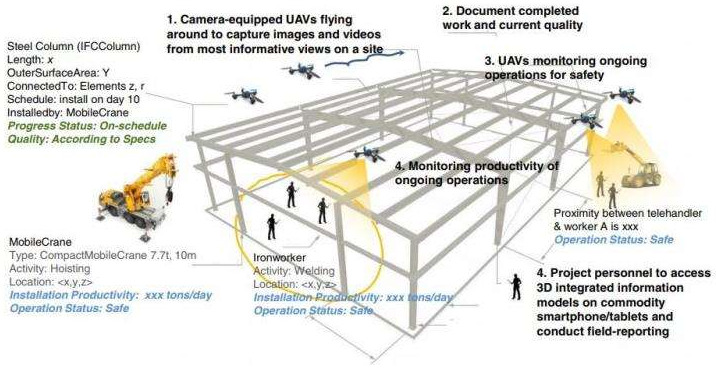
## Drones for Collection of Site Visual Data




camera-equipped UAVs autonomously monitor work-in-progress for improving safety, quality, and productivity

- Autonomous or **semiautonomous path planning**, navigation, and take-off & landing procedures
- Characterize criteria for data collection and the configurations among the images to extract complete as-built information
- Extraction of the most informative views for data collection (e.g., canonical view, top down view, etc. for appearance-based **recognition of work-in-progress**)



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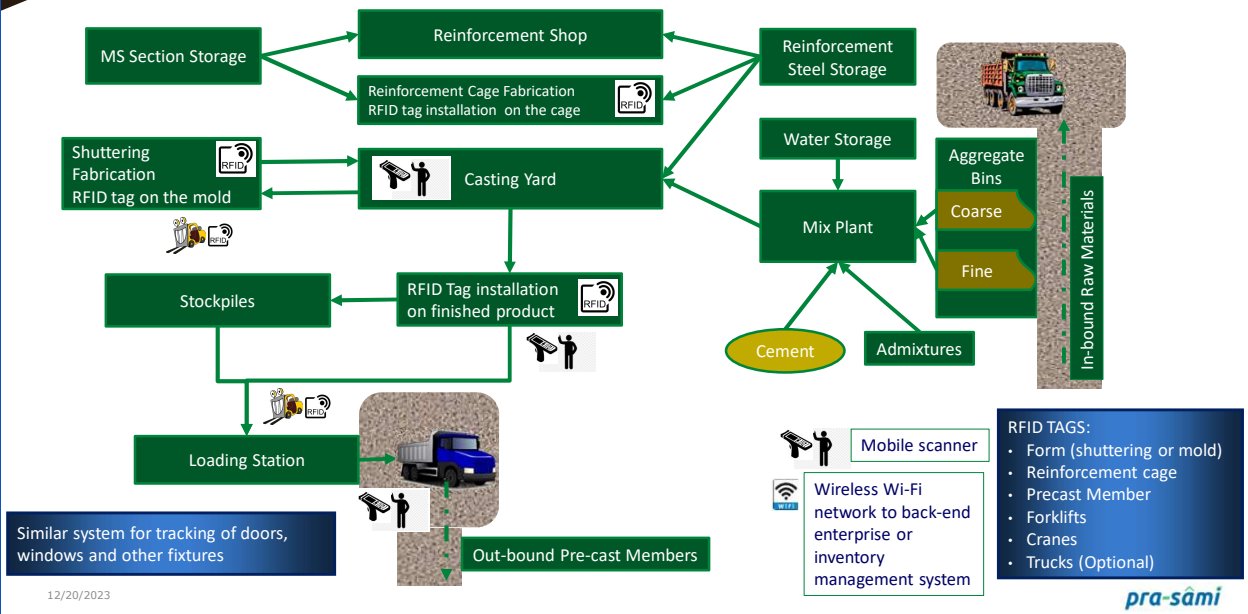
## Precast Construction - Tracking



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## Precast Concrete Tracker System Features

- Inspections are recorded electronically
- Barcode identification or stick-on identifications are not possible due to rugged and demanding construction environment
- UHF RFID tags on the concrete products
- Data file that chronicles when the product was made, when it was inspected and by whom.
- RFID tags are read and corresponding data captured at each definable stage of production.
- With RFID enabled employee ID badges, accountability and 'personal sign-off' can be integrated into each stage of the process as well
- The Batch Number can also be tracked and correlated to Product and thereby provides complete materials traceability
- The forms are tagged with a rugged encapsulated RFID tag, containing an encoded inlay
- During the casting process, read the RFID tag, linking it to its steel form, and add concrete batch number.
- Use it for inventory control and yard management, assisting in locating items in their large acreage yards
- Forklift trucks with RFID interrogators to capture the ID number on the tag as soon as the vehicle comes close to the member
- A GPS function in the reader would determine the zone in which the member has been placed

RFID Tag – Typical Data Fields

| | | |
|---|---|---|
| RFID Tag # | Concrete Batch # | Concrete Grade |
| Form ID | Reinf. Cage ID | Reinf. Grade |
| PC Member ID | Location ID | Date of casting |
| Date ready for erection | Date of issue to Construction Site | |
| Date of Erection | Current location ID | Date of Inspection |



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## Case Studies: Parking Space Solution



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## Image Analysis and Object Identification - Parking Space Management

Cities are getting congested. Availability of convenient parking space is always a challenge.

- Percentage of vehicle owners and vehicles per household are increasing.
- Lack of accessible parking causes inconvenience to the residents.
- Inadequate information
- Inefficient use of available parking spots
- Demand for handicapped parking spaces
- Space Hogging
- Road side parking inadequate
- Increasing 'No-Parking' zones

Motorist would like to know nearest available parking slot!
Customers would want effective utilization of parking spots!



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## Demo - Parking dashboard in Action

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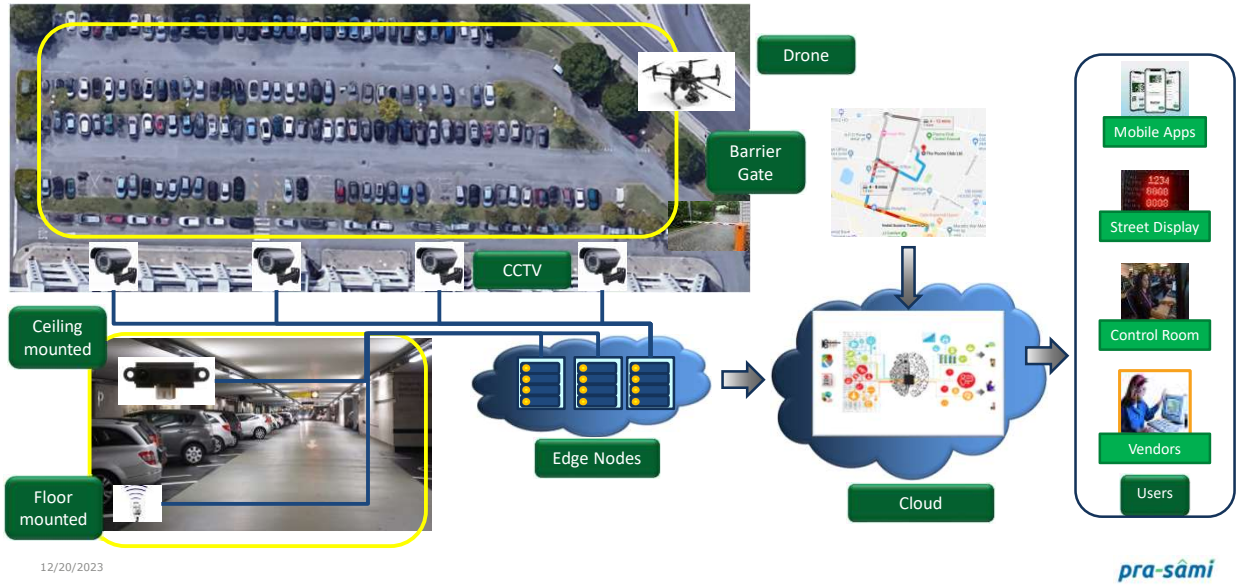
## Parking Space Management



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## Object Detection



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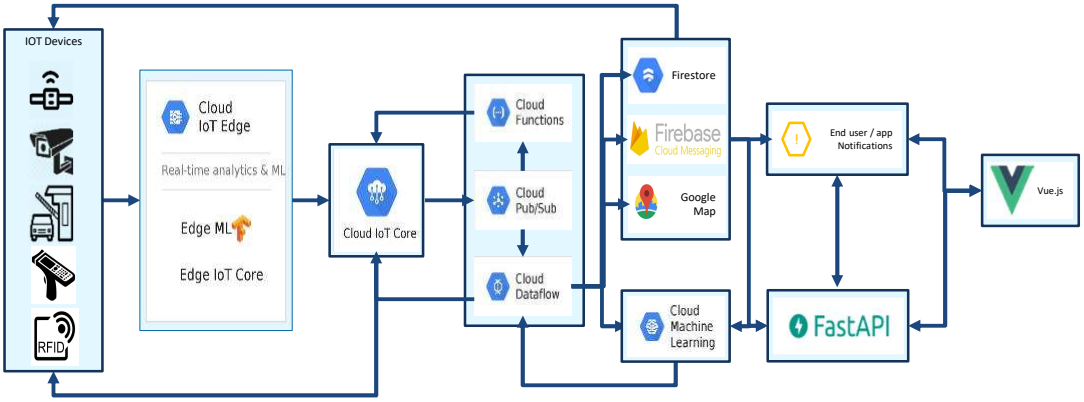
## Application Architecture

- Reference architecture shows Google cloud based implementation




- IOT devices are connected to cloud infrastructure through edge devices.
- Analytics are performed in the cloud, prediction on edge devices
- Cloud environment publishes model to IOT devices to update the state



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# Predictive Maintenance



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## Are we doing enough…

- Is planning and scheduling of maintenance works are a challenge?
- Is unplanned or emergency maintenance taking up most of your resources?
- How does one consolidate and manage these two types of jobs?
- How to accomplish both types of works?
- Are there infructuous activities in the preventive maintenance?
- Are Technicians working in a fire fighting mode?
- Preventative maintenance taking a hit?
- Not enough time and resources to do PM on time (or not at all!)?
- Unexpected breakdowns and emergency maintenance too frequent?
- Too much is spent in preventive maintenance?



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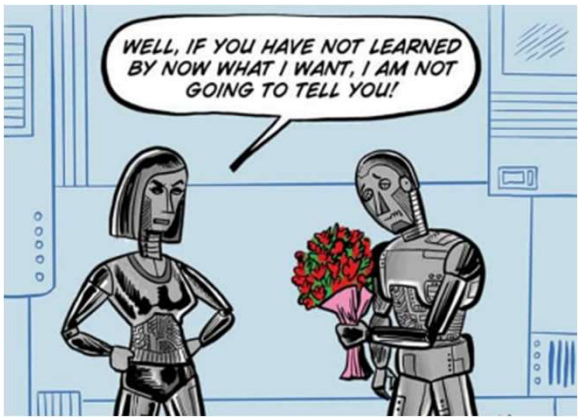
## What if…

- Machines and equipment could talk with us!
- They tell us in advance that something is wrong!
- Well, it is true!
- In fact, they do… ask any experienced foreman.
- Remember that noise which recently started in your car!



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## Machines do tell us…

- Yes, machines do complain when they are not "well"…
  - Heat up,
  - Make noise,
  - Vibrate uncharacteristically,
  - Consume more – lubricant, fuel, and/or electricity,
  - Change their behavior …
- Are you listening???
- Read the signals and act on it!
- So that we can prevent them from getting really sick…



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## Breakdowns are unpredictable too… Really!

- Some Breakdowns are systematic.
  - Regular wear and tear
  - Fatigue, aging
  - Address using Preventive maintenance
- Others are random in nature.
  - Preceded by some telltale pattern either in vibration, temperature, electrical consumptions or a combination thereof
  - It is possible to predict breakdowns by analyzing sensor data



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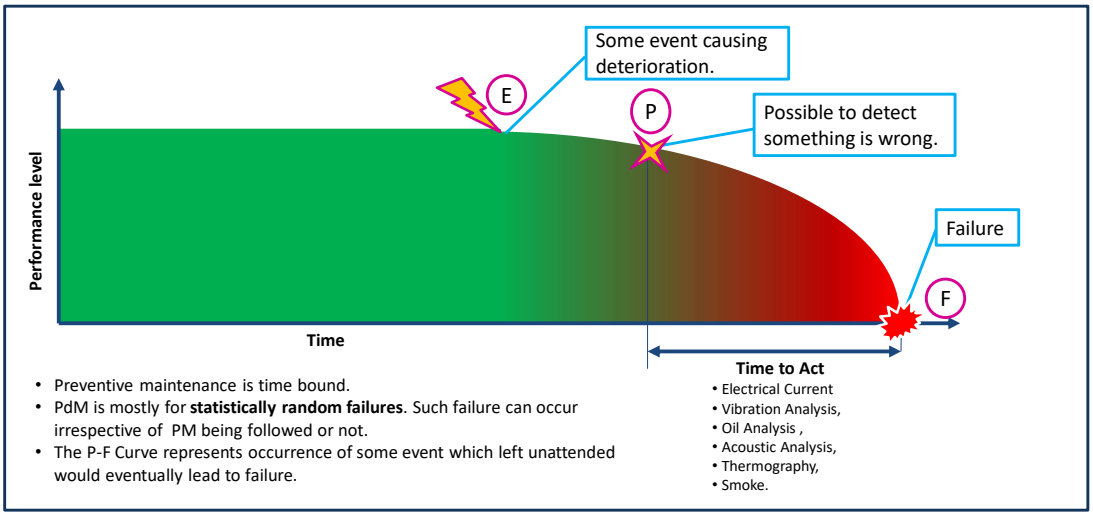
## P – F Curve




- Preventive maintenance is time bound.
- PdM is mostly for **statistically random failures**. Such failure can occur irrespective of PM being followed or not.
- The P-F Curve represents occurrence of some event which left unattended would eventually lead to failure.

- Electrical Current
- Vibration Analysis,
- Oil Analysis ,
- Acoustic Analysis,
- Thermography,
- Smoke.



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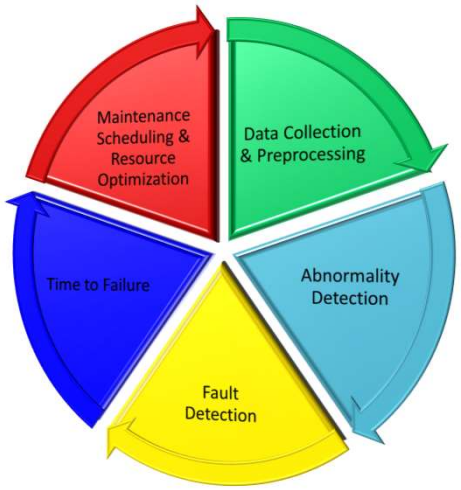
## Symptoms

- Vibrations
- Temperature
- Electric consumption
- “Hear" friction and stress
- Condition of the lubricant itself
- Solid material present in the lubricant
- Folds, breaks, cracks and corrosion



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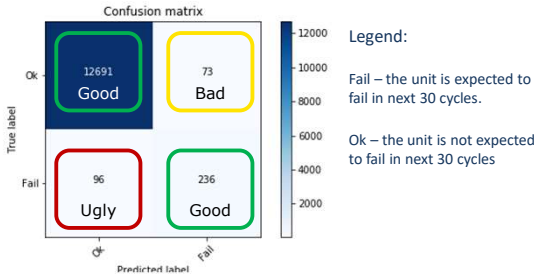
## Sample Results

- Good:
  - 12691 cases accurately predicted as “ok”.
  - 236 cases accurately predicted as “Fail”.
- Bad:
  - 73 cases which were “ok” but predicted as “Fail”.
- Ugly:
  - 96 cases which were “Fail” but predicted as “Ok”
- Without PdM
  - Fail cases: 236 + 96 = 332
- Cost of Failure repair:
  - 332 x $4 = $1328
- With PdM
  - Fail cases : 96
  - Failure predicted by PdM : 236
  - Incorrectly marked as fail : 73
- Percentage Saving : ($1328 – $693 )/ $1328 = 49%




Legend:

Fail – the unit is expected to fail in next 30 cycles.

Ok – the unit is not expected to fail in next 30 cycles

| # | Description | | Cost |
|---|---|---|---|
| 1 | Fail cases | 96 * $4 | $384 |
| 2 | Failure predicted by PdM | 236 * $1 | $236 |
| 3 | Incorrectly marked as fail | 73 * $1 | $73 |
| Total | | | $693 |

- Assuming failure cost is 4 times the maintenance cost, PdM can give you 49 % cost saving!



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## Cambrian Explosion

- Current period of fervent innovation
- Range of innovative AI hardware-accelerator architectures continues to expand.
  - GPU is not the only one
- New AI-optimized chipset architectures:
  - New generations of GPUs
  - Neural network processing units (NNPUs)
  - Field programmable gate arrays (FPGAs),
  - Application-specific integrated circuits (ASICs), and
  - Various related approaches that go by the collective name of neurosynaptic architectures.



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## Exciting times

- Exciting and meaningful work going on is tremendous
- 20 years ago, it was internet
- Today it is AI
- AI is no longer limited to tech companies like Google or Facebook
- Every industry needs it! Common Joe is demanding it!!

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## "AI is New Electricity"

- Electricity changed the way industry used to operate
- AI is going to impact the industry and our lives same way!

- You will be one of the leaders of this transformation!
- Go transform in a meaningful way:
  - Education, Healthcare, Employment, Law and even Literature



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## Reflect…

- Do you think that real intelligence is decreasing?
  - Effect of social engineering!
  - Over dependence on apps
- Presence of road side shops and congested sidewalks affect Google maps ability to predict traffic conditions?

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## Reflect…

- Artificial Intelligence is about_____.
  - Playing a game on Computer
  - Making a machine intelligent
  - Programming on machine with your own intelligence
  - Putting your intelligence in machine
- How many layers a shallow network has?
  - One
  - Two
  - Three
  - No set demarcation
- Can rule bases engine (Expert Systems ) interpolate for in-between conditions (not specifically coded)
  - Yes
  - No
  - Either
- What is the full form of "AI"?
  - Artificially Intelligent
  - Artificial Intelligence
  - Artificially Intelligence
  - Advanced Intelligence
- What is Artificial Intelligence?
  - A field that aims to make humans more intelligent
  - A field that aims to improve the security
  - A field that aims to develop intelligent machines
  - A field that aims to mine the data
- What is major difference between Rule based system and AI based system



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## Reflect…

- Which of the following is the branch of AI?
  - Machine Learning
  - Cyber forensics
  - Full-Stack Developer
  - Network Design
- _____ is the goal of artificial intelligence.
  - To solve artificial problems
  - To extract scientific causes
  - To explain various sorts of intelligence
  - To solve real-world problems
- Which of the following is an application of AI?
  - It helps to exploits vulnerabilities to secure the organization
  - Language understanding and problem-solving (Text analytics and NLP)
  - Easy to create a website
  - It helps to deploy applications on the cloud



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## Reflect…

- The Turing Test judges the conversational skills of a bot?
- Roombas commercially successful robot for home cleaning from iRobot?
- Learning/experience from one field is not transferable?
- Who is the inventor of AI?
  - Geoffrey Hinton
  - Andrew Ng
  - John McCarthy
  - Jürgen Schmidhuber
- DARPA, the agency that has funded a great deal of American Artificial Intelligence research, is part of the Department of _____
  - Defence
  - Energy
  - Education
  - Justice
- Which year Google invested in driverless Car?
  - 2000
  - 2004
  - 2010
  - 2014



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## Reflect…

- What do you think you would like to use AI for?
  - Find area which really excites you
- Which of the following is an advantage of artificial intelligence?
  - AI reduces the time taken to solve problem
  - AI helps in providing security
  - AI have the ability to think hence makes the work easier
  - All of the above
- Which of the following is an expansion of Artificial Intelligence application?
  - Game Playing
  - Planning and Scheduling
  - Diagnosis
  - All of the mentioned
- Natural language understanding is used in:
  - Natural language interfaces
  - Natural language front ends
  - Text understanding systems
  - All of the above
- An AI technique that allows computers to understand associations and relationships between objects and events is called:
  - Heuristic processing
  - Cognitive science
  - Relative symbolism
  - Pattern matching
- Geo-fencing is technique to____ in specified locations
  - Keep all your equipment
  - Targeted advertisements
  - Keep Personnel
  - All of the above



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## Next Session…

- Alan Turing
- Turing Test & Associated Questions
- Agents
- Rational Agent
- Type of Agents
- PEAS



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## Case Studies : Jeopardy



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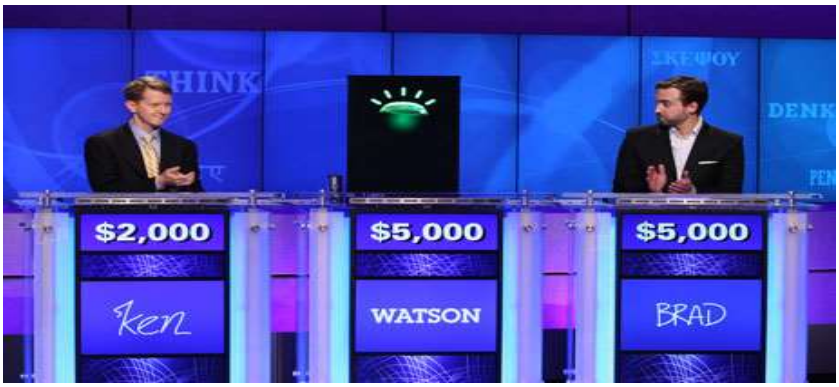
## Watson

- "The goal is to have computers start to interact in natural human terms across a range of applications and processes, understanding the questions that humans ask and providing answers that humans can understand and justify" - IBM



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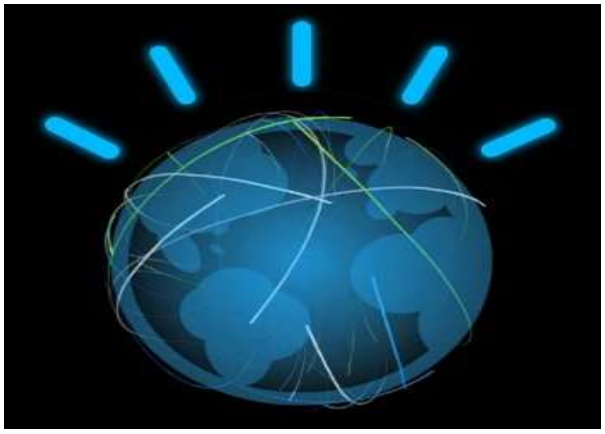
## Watson

- IBM's Artificial Intelligence computer system
- Capable of answering questions in natural language
- Competed against champions on Jeopardy and won





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## Watson

- IBM describes this AI as:
  - "an application of advanced Natural Language Processing, Information Retrieval, Knowledge Representation and Reasoning, and Machine Learning technologies to the field of open domain question answering"
- What this means…



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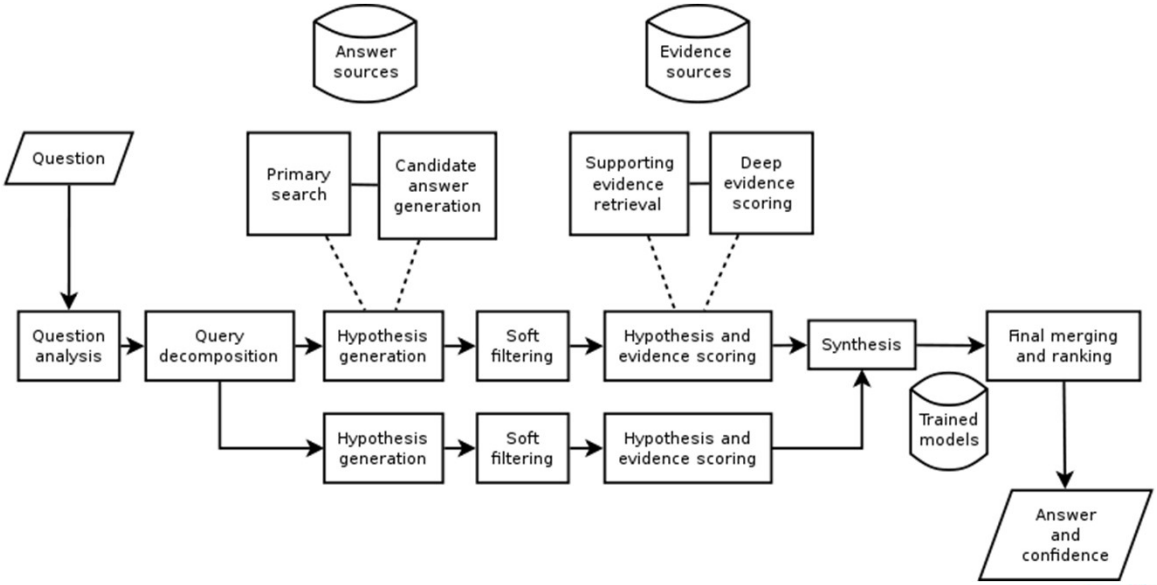
## High-Level Architecture used in Watson



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## Watson

- 16 Terabytes of RAM
- Can process 500 gigabytes (1 million books) per second
- Content was stored in Watson's RAM rather than storage to be more easily accessed
- Cost about $3 Million



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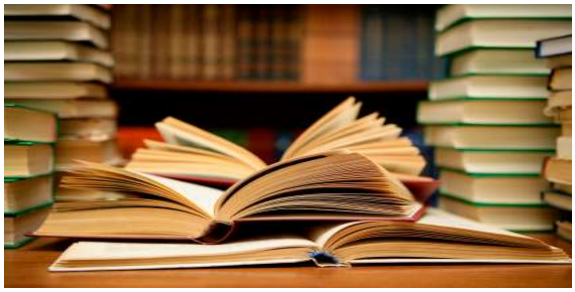
## Watson's sources of information

- Encyclopedias
- Dictionaries
- Thesauri
- Newswire articles
- Literary works
- Databases, taxonomies, and ontologies.
- Wikipedia articles
- And more…





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## How Watson Works

- Receives the clues (questions) as electronic texts
- It then divides these texts into different keywords and sentence fragments and searches for statistically related phrases
- Quickly executes thousands of language analysis algorithms
- The more algorithms that find the same answer increase Watson's confidence of his answer and it calculates whether or not to make a guess