Setting the Standard for Automation™

# IIoT, Smart Industry and Artificial Intelligence for manufacturing

A beyond-the-Hype, practical look from an Automation Insider

**RAJIV ANAND**

Standards
Certification
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2017 ISA Hamilton Expo Trade Show
Tues, March 28, 2017 - RBG Centre
Royal Botanical Gardens – Burlington, Ontario, Canada

# About the Speaker

## RAJIV ANAND

•30 year journey in process controls from field engineer to senior executive, mostly with Emerson Process Management and their LBP Lakeside Process Controls

•Technology enthusiast

•Crossed over to learning and applying Machine Learning for Industry 4.0/Smart Industry in 2016

•Started Quartic.ai in 2017, based in Waterloo, Ontario

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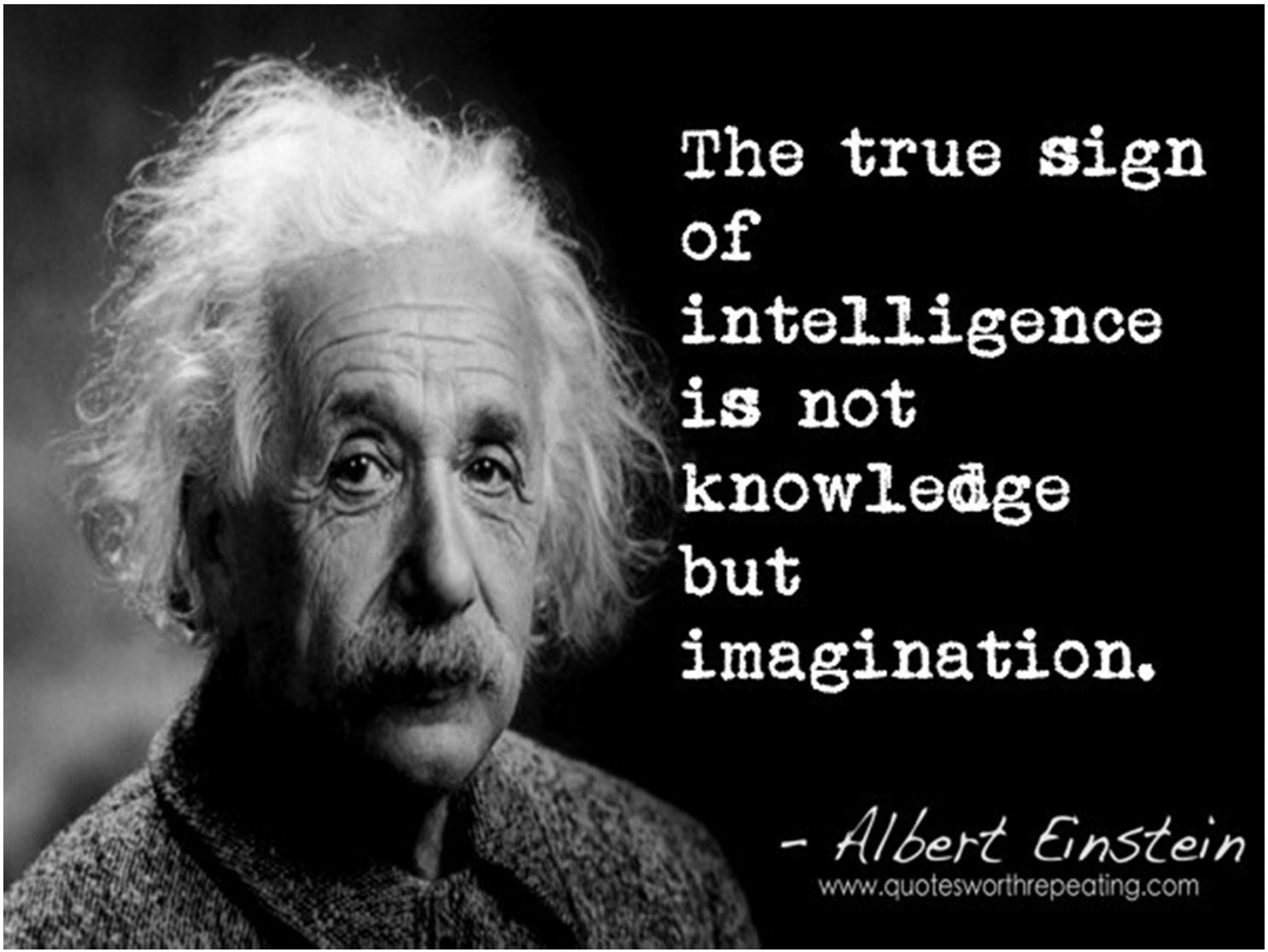
# Outline

- Technology is changing at an exponential rate
- IIoT, Smart Industry and Industry 4.0 are real and here to stay – Machine Learning and Algorithms are the key enablers
- Manufacturing sector can be the greatest beneficiary of AI and Machine Learning
- Process control and automation have evolved at a slow pace
- Automation professionals can now have a big and valuable impact
- IIoT with Machine Learning is not difficult to learn and apply
- It is a great time for automation professionals to collaborate and be the leaders of industry

# Human evolution – a journey of intelligence



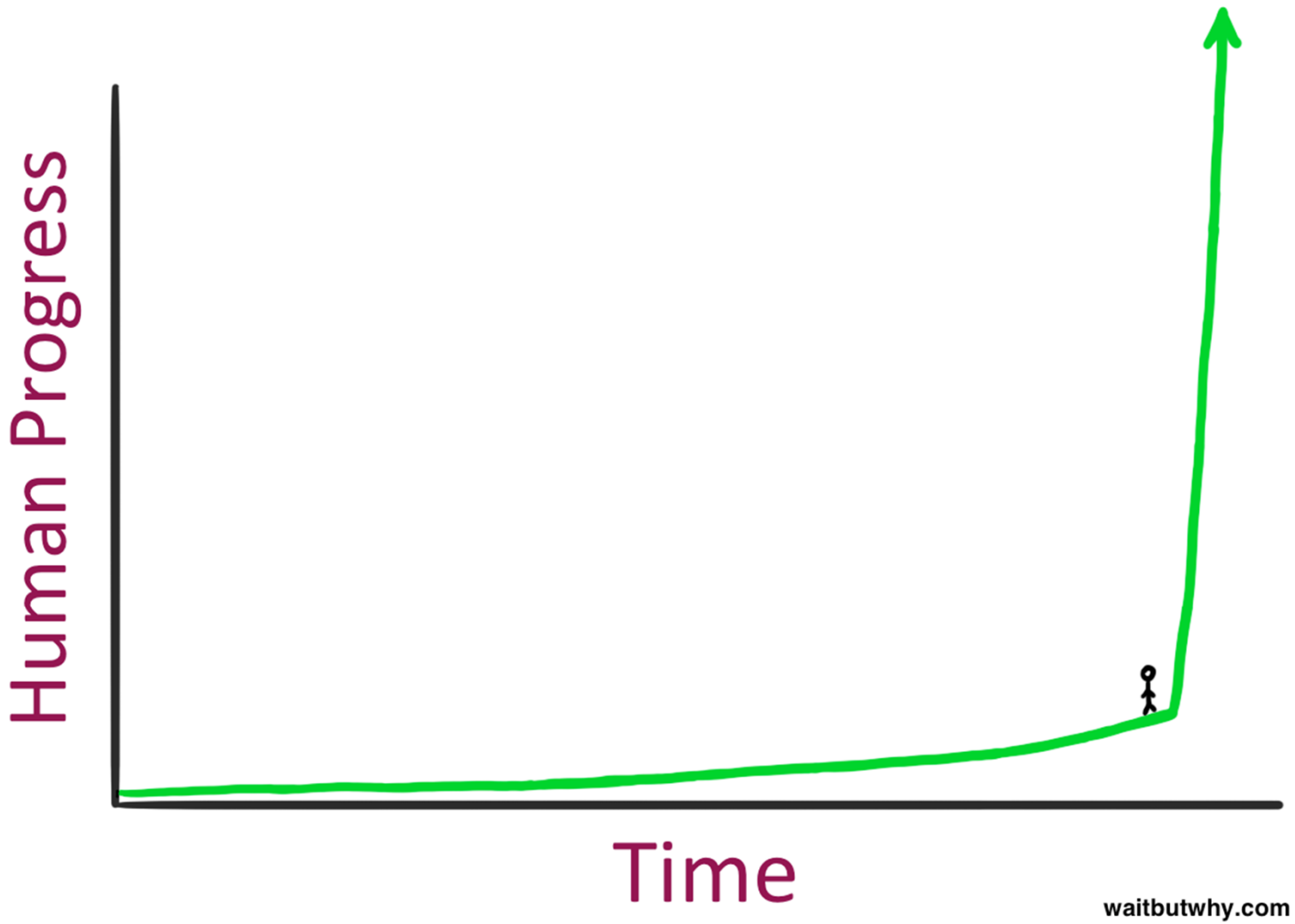
# *Artificial Intelligence – Real potential*

***We are on the edge of change comparable to the rise of human life on Earth.***

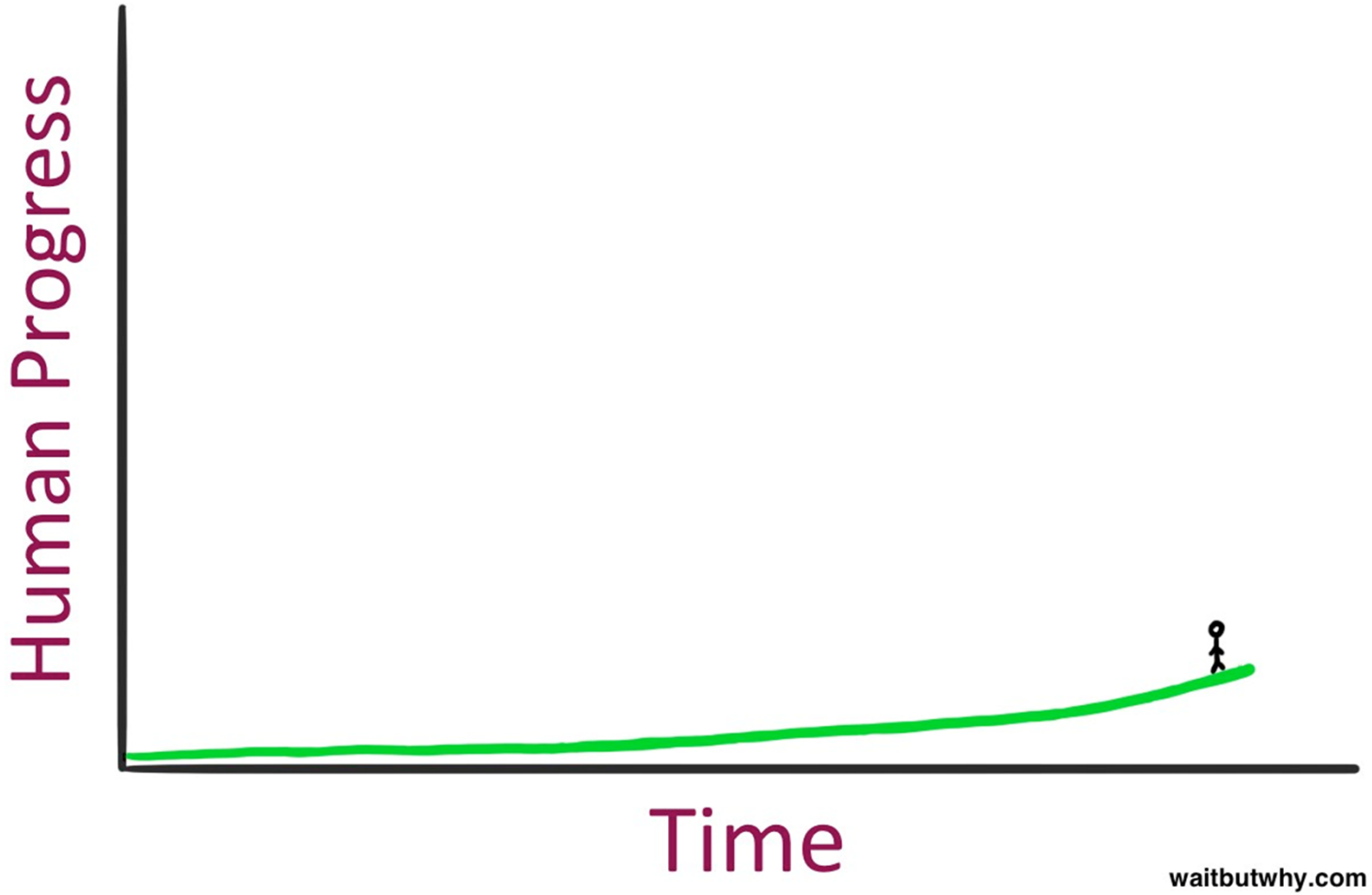
— Vernor Vinge;

computer scientist and novelist. Author of *A Fire Upon the Deep* (1992), *A Deepness in the Sky* (1999), *Rainbows End* (2006), *Fast Times at Fairmont High* (2002), *The Cookie Monster* (2004), and *The Peace War* (1984)

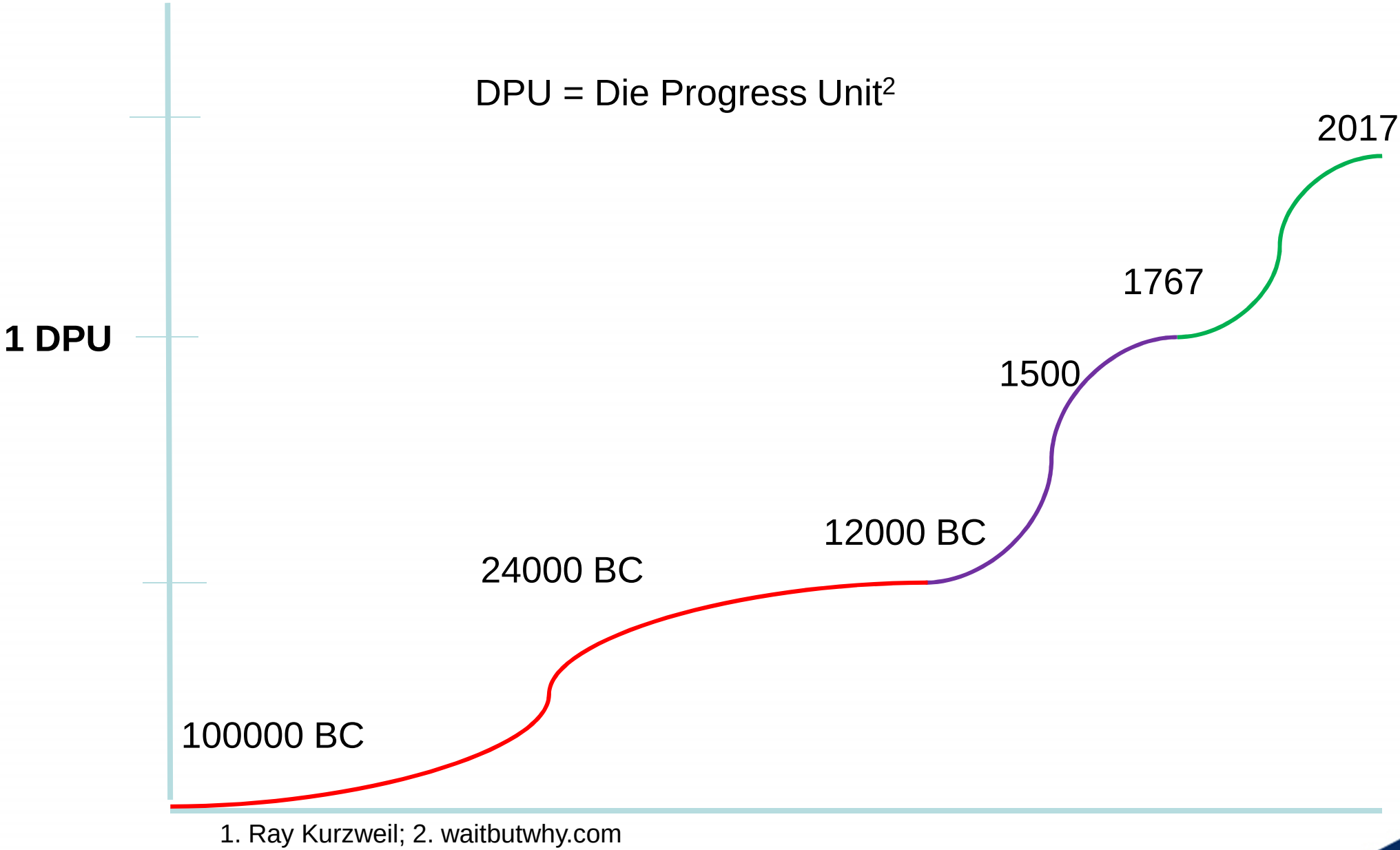
# *Surprise, hype…or a natural law*



# *Surprise, hype…or a natural law*

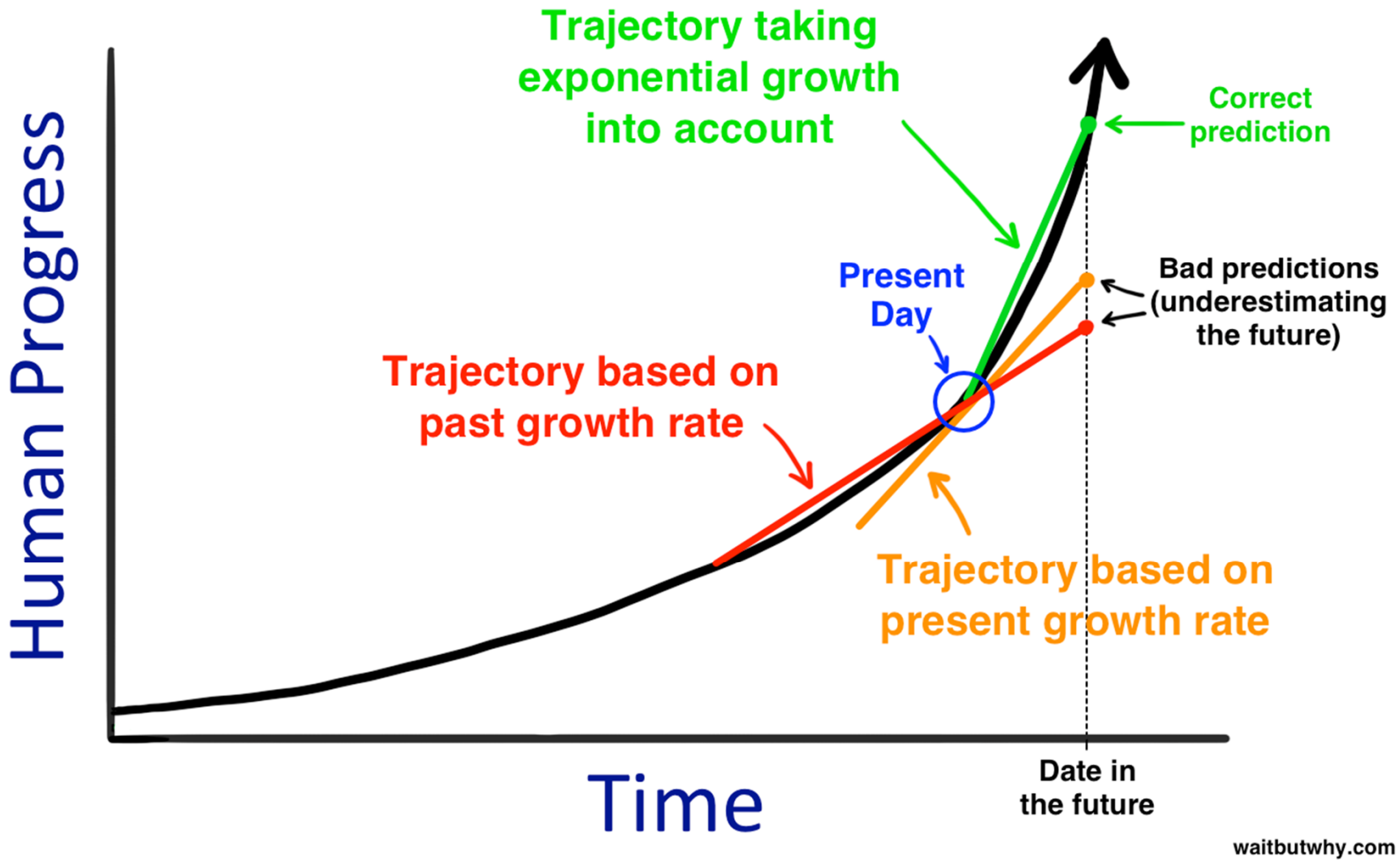


# *The Law of accelerating returns[1]*

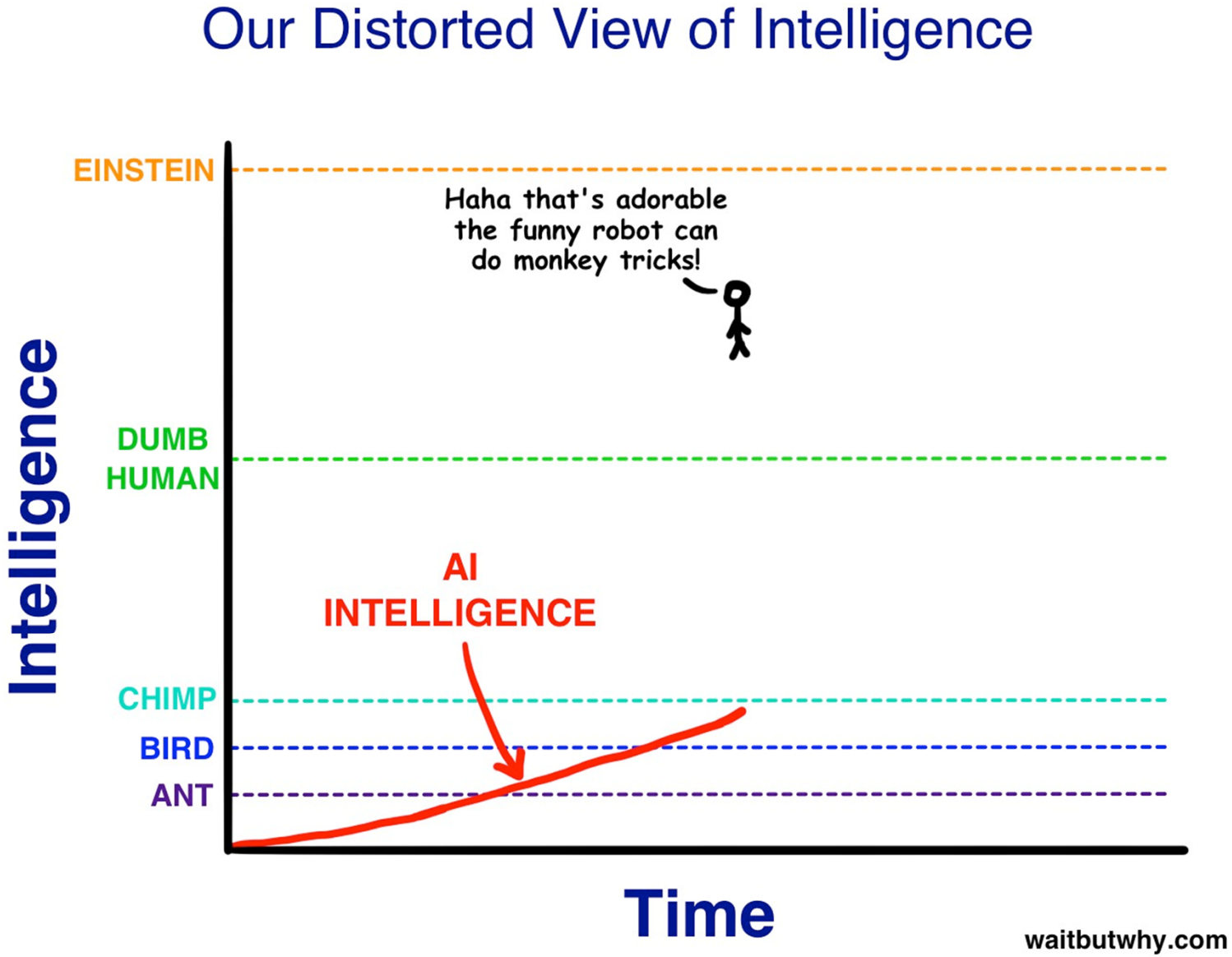



1. Ray Kurzweil; 2. waitbutwhy.com

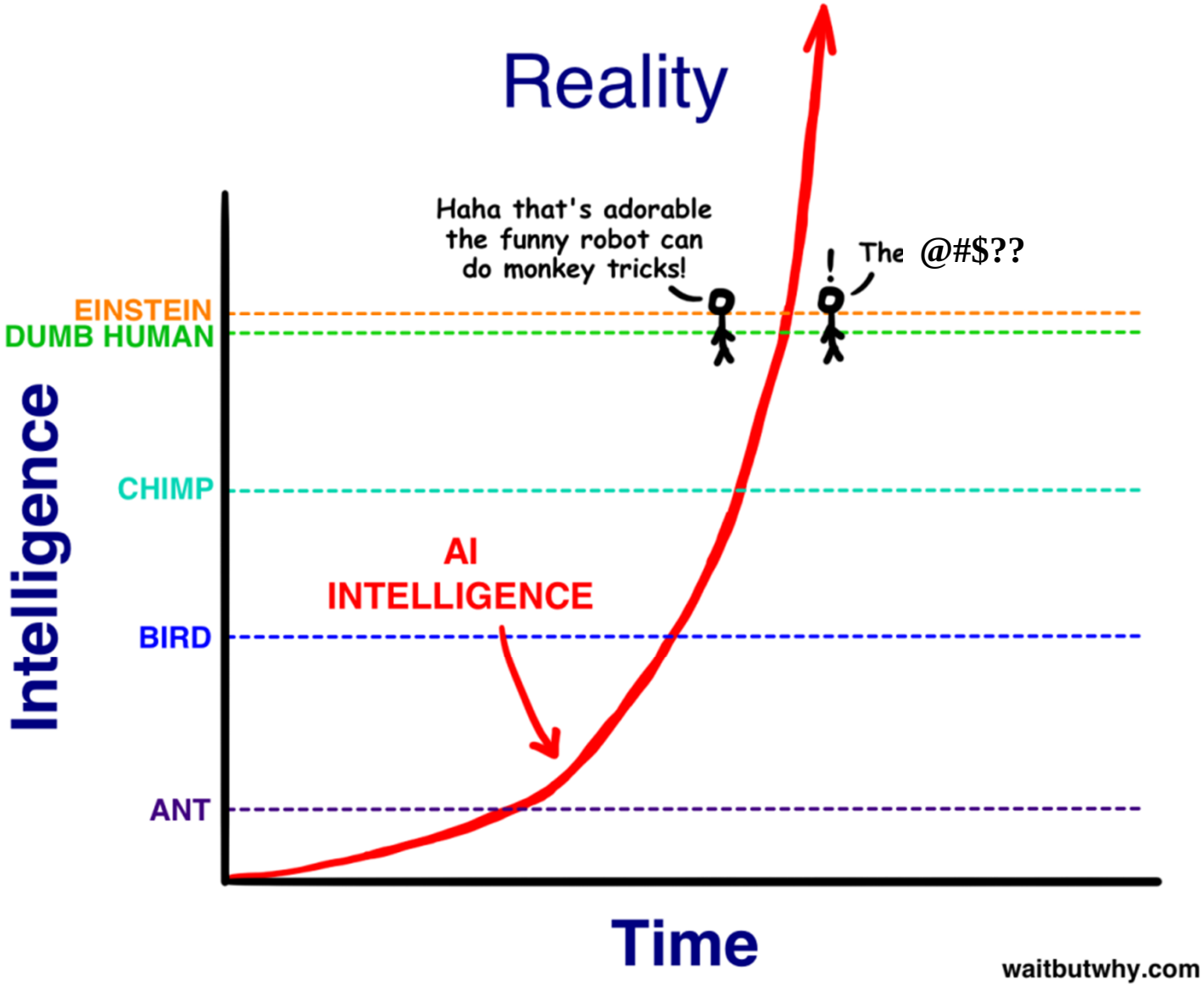
# Is our imagination the limiting factor?



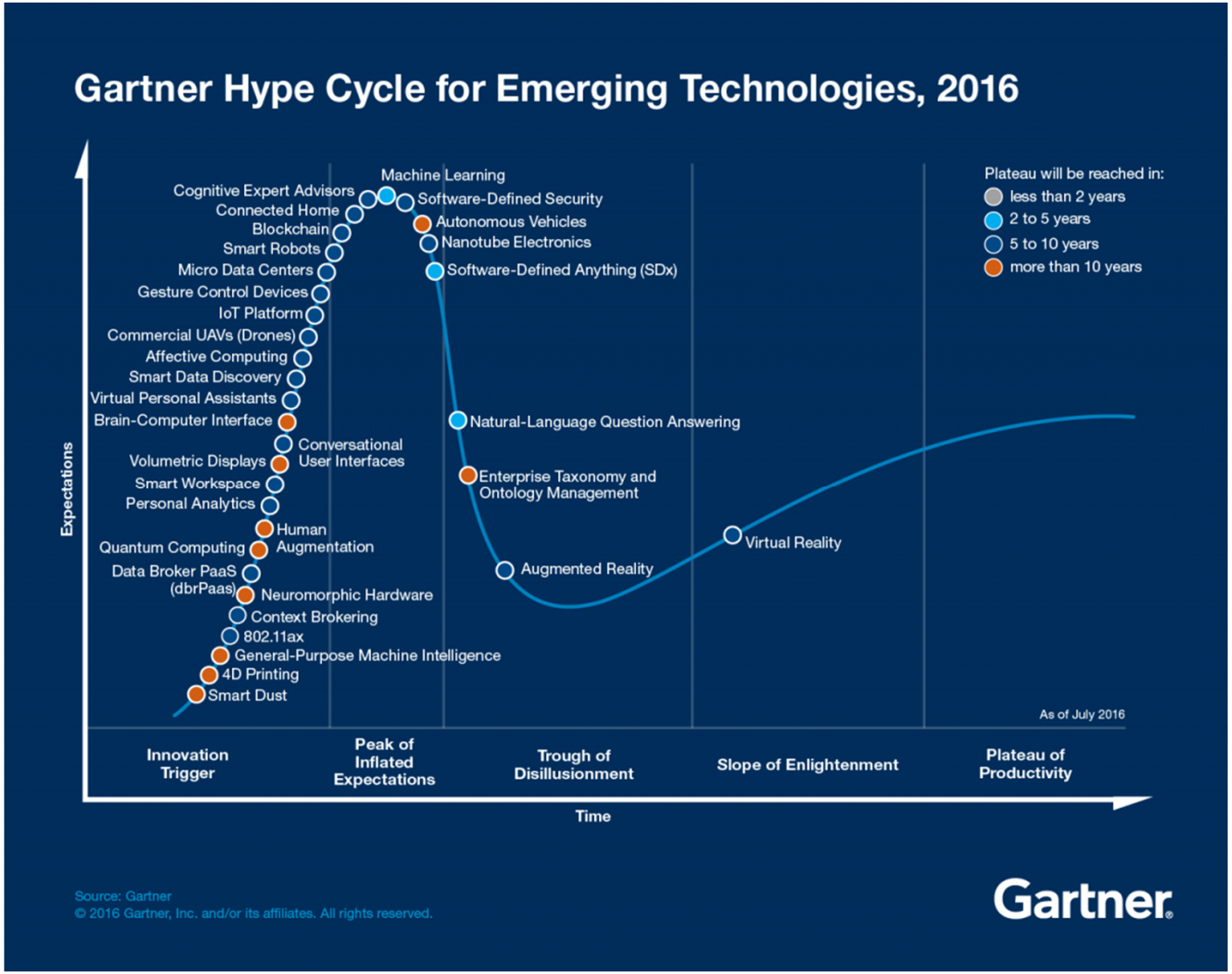
# AI is redefining our world



# AI is redefining our world



# Not hype – a natural law!



# AI is redefining our world

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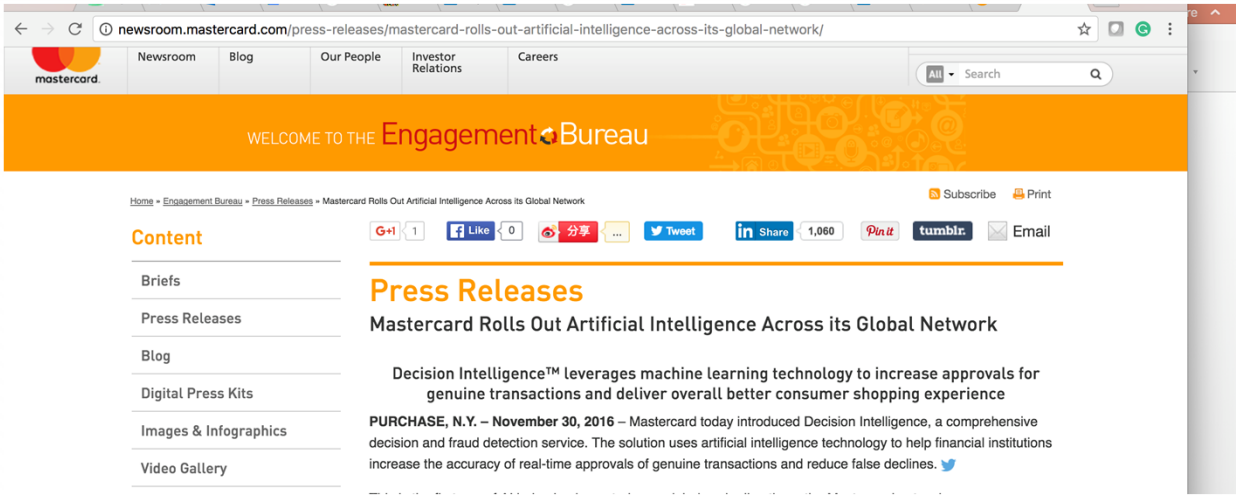
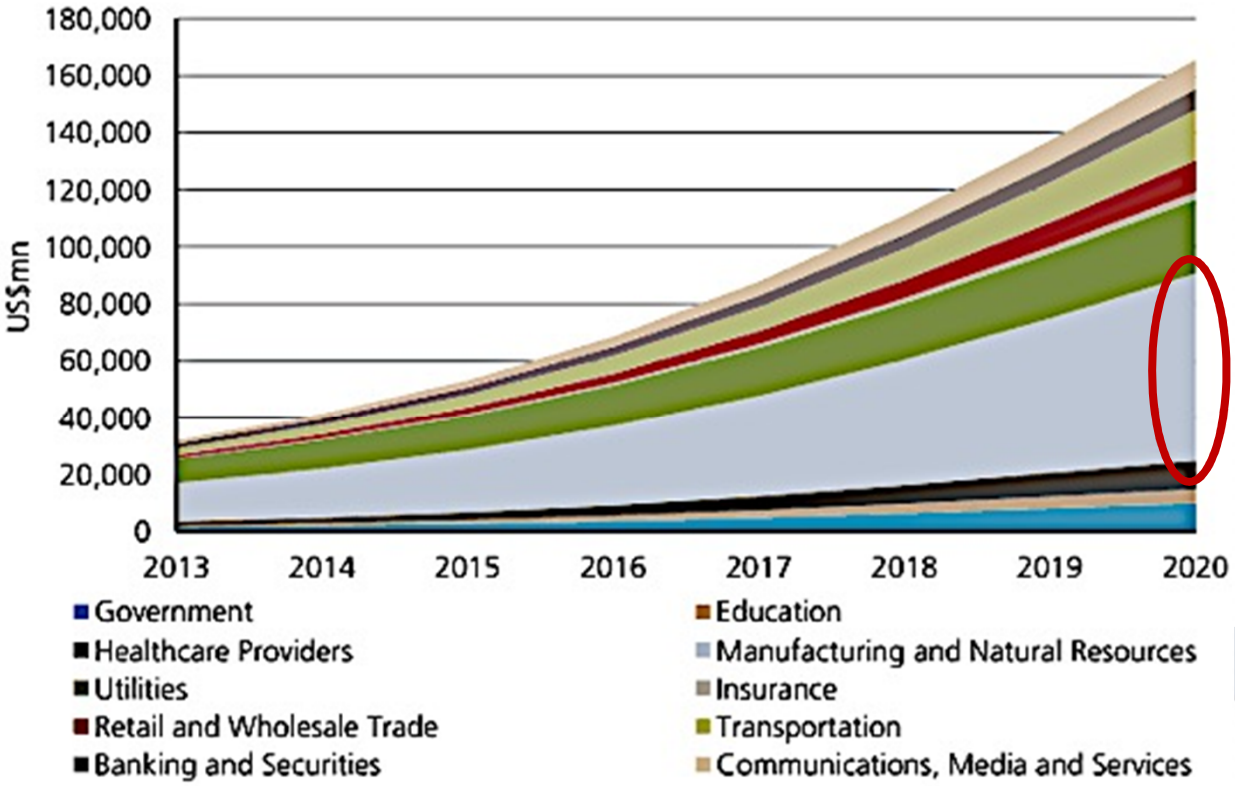
JANUARY 25, 2017

## Deep learning algorithm does as well as dermatologists in identifying skin cancer

*In hopes of creating better access to medical care, Stanford researchers have trained an algorithm to diagnose skin cancer.*

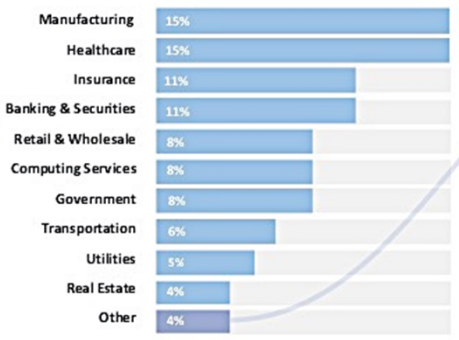
# The Industrial Opportunity




Source: Gartner

## Industry Opportunities

Gartner forecast that the $1.9 Trillion global value add will be split across the following industry sectors:




The resulting global economic value-add to industry as a result of increasing sales and decreasing inputs and costs will be $1.9 trillion

Source: Gartner, Forecast: The Internet of Things Worldwide, 2013

Axillium

# How are we doing in Process Automation?

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## PID controller

From Wikipedia, the free encyclopedia

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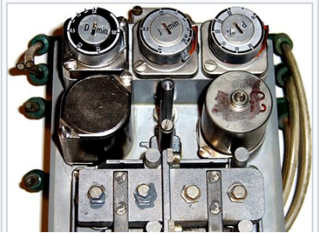
A **proportional–integral–derivative controller** (**PID controller**) is a control loop feedback mechanism (controller) commonly used in industrial control systems. A PID controller continuously calculates an *error value* $e(t)$ as the difference between a desired setpoint and a measured process variable and applies a correction based on proportional, integral, and derivative terms (sometimes denoted *P*, *I*, and *D* respectively) which give their name to the controller type.

### History and applications [ edit ]

#### Origins [ edit ]

PID controllers have their origins in 19th century speed governor design.[2][4] The theoretical basis for the operation of governors was first described by James Clerk Maxwell in 1868 in his seminal paper 'On Governors', but it was not until 1922 that PID controllers were first developed using a theoretical analysis, by Russian American engineer Nicolas Minorsky (Minorsky 1922) for automatic ship steering. Minorsky was designing automatic steering systems for the US Navy and based his analysis on observations of a helmsman, noting the helmsman steered the ship based not only on the current course error, but also on past error, as well as the current rate of change;[5] this was then given a mathematical treatment by Minorsky.[6] His goal was stability, not general control, which simplified the problem significantly. While proportional control provides stability against small disturbances, it was insufficient for dealing with a steady disturbance, notably a stiff gale (due to steady-state error), which required adding the integral term. Finally, the derivative term was added to improve stability and control.

Early PID theory was developed by observing the actions of helmsmen in keeping a vessel on course in the face of varying influences such as wind and sea state.

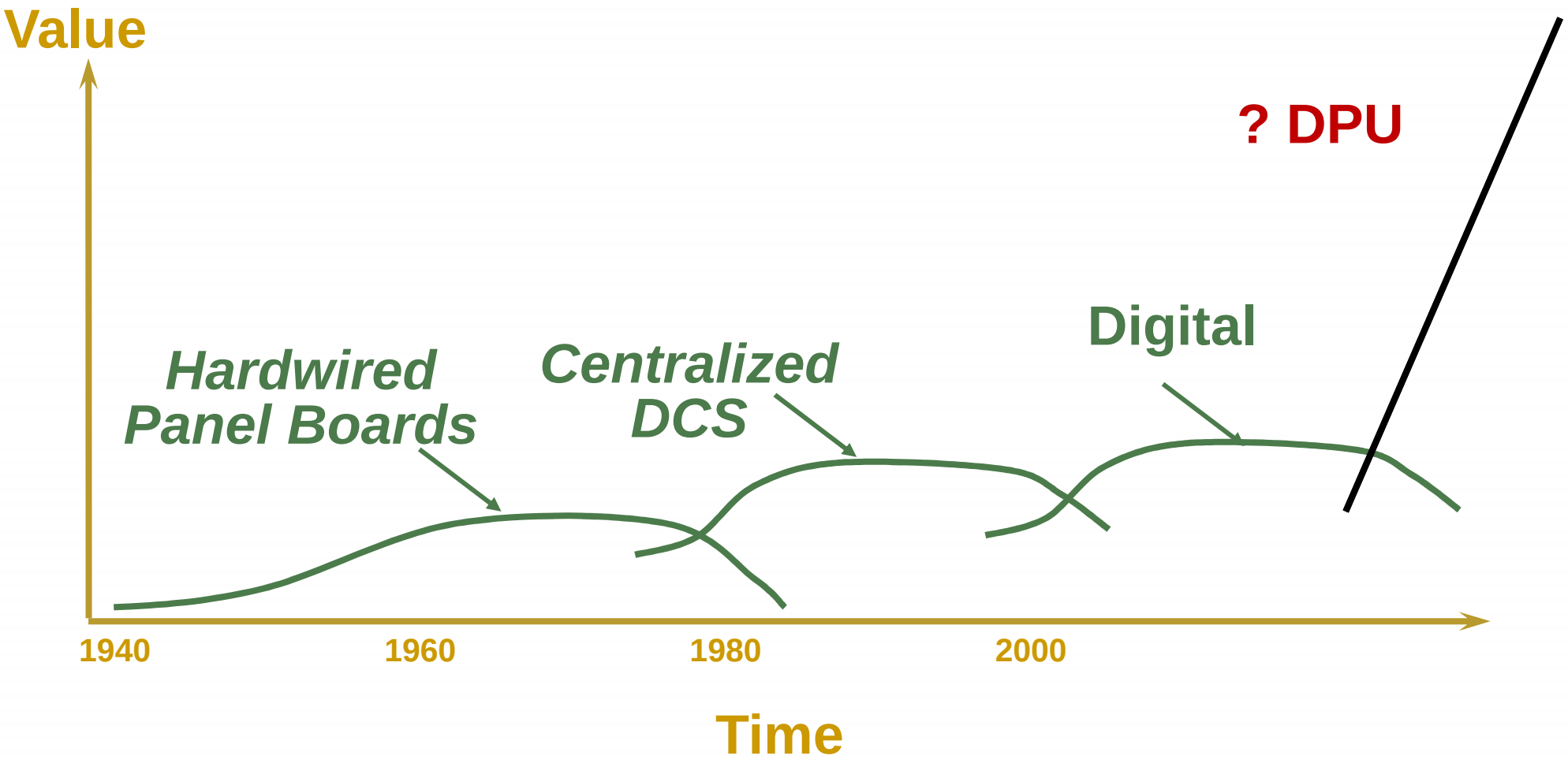


Trials were carried out on the USS *New Mexico*, with the controller controlling the *angular velocity* (not angle) of the rudder. PI control yielded sustained yaw (angular error) of ±2°. Adding the D element yielded a yaw error of ±1/6°, better than most helmsmen could achieve.[7]

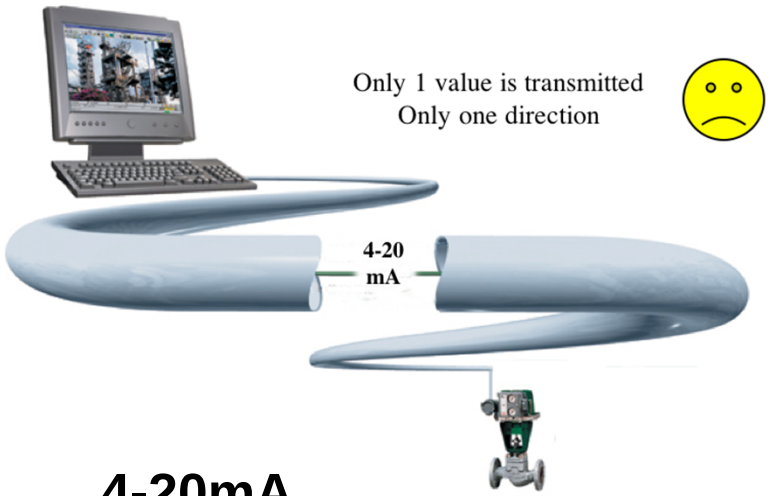
The Navy ultimately did not adopt the system, due to resistance by personnel. Similar work was carried out and published by several others in the 1930s.

One of the earliest examples of a PID-type controller was also developed by Elmer Sperry in 1911, though his work was intuitive rather than mathematically-based.[8]

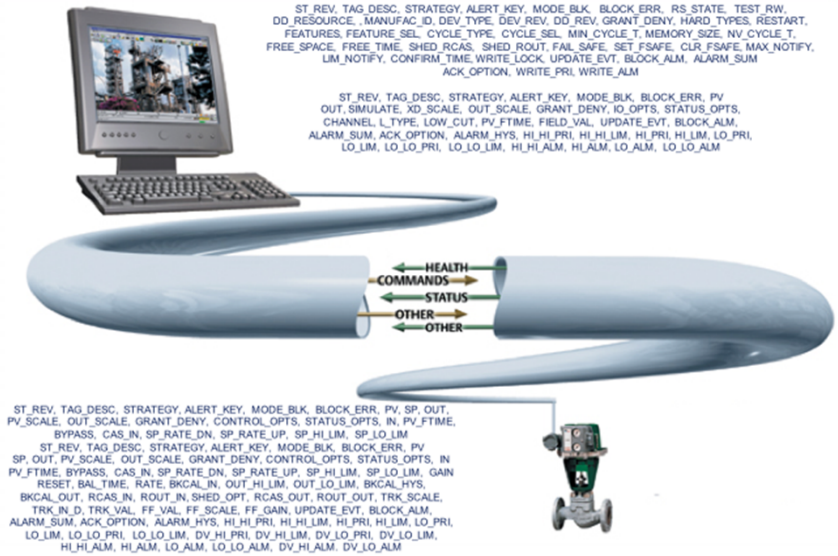
# How are we doing in Process Automation?



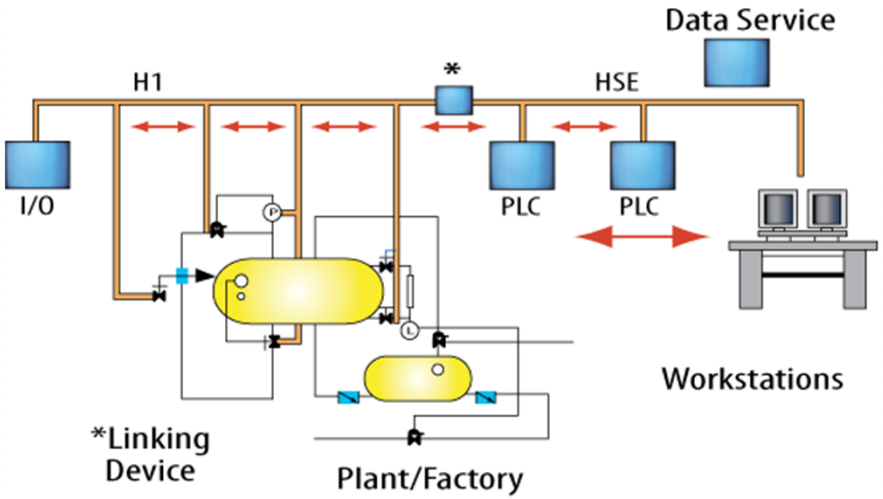
# Unfulfilled potential – stranded intelligence!



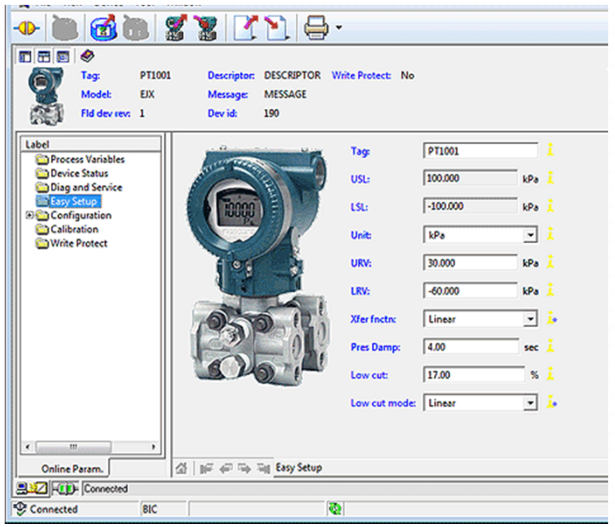

**4-20mA**




**HART**




**FIELDBUSSES**




**ASSET MANAGEMENT?**

# IoT and IIoT


**SMART CITIES**
**SMART HOMES**
**SMART HOTELS**
**SMART HOSPITALS**
**SMART TRANSPORTATION**
**SMART RETAIL**
**…..**

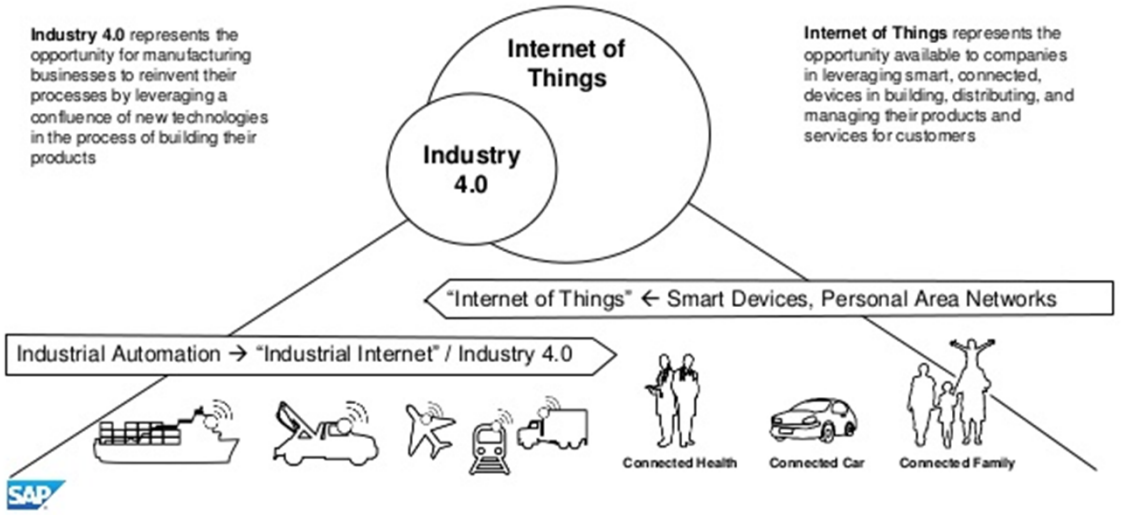

**SMART FACTORIES/MANUFACTURING**
**SMART SUPPLY CHAIN**
**SMART POWER**
**SMART DEFENSE**
**SMART RAILWAY**
**SMART AVIATION**
**…**

NOT INCLUDING WEARABLES, PERSONAL, HOME SECURITY..

# ~~Industrial IoT~~ Digital Manufacturing State

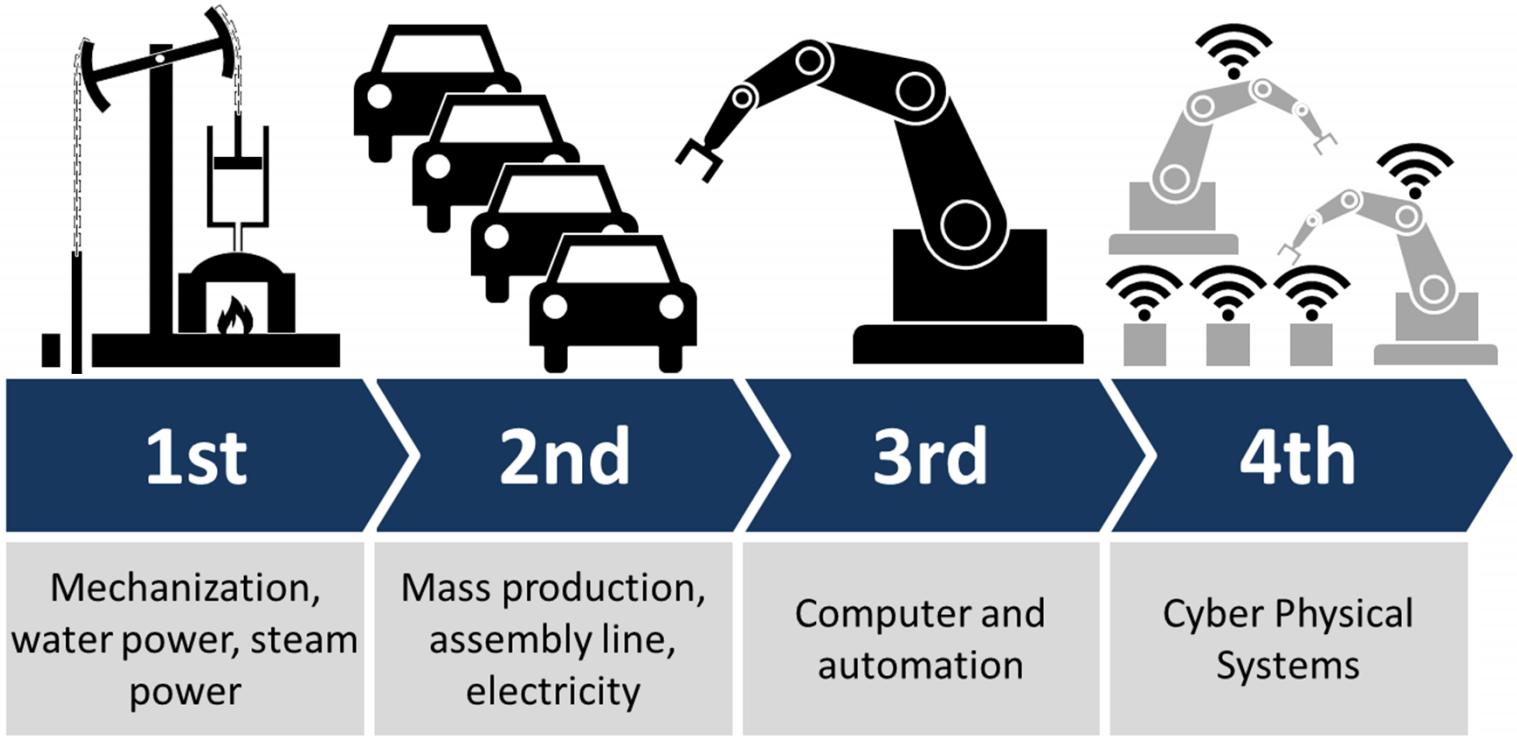
## Continental definitions

GERMANY
+
SIEMENS

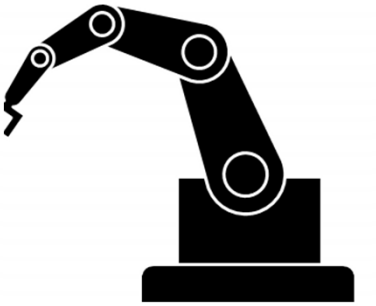



IBM
INTEL
GE
SAP
EMC
SCHNEIDER
BOSCH

# What is it?  Really.



# To The 4TH Industrial Revolution



3rd

Computer and automation

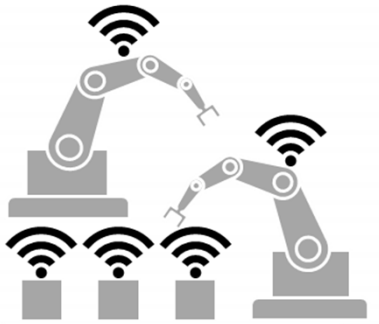
+

Machine Learning

+

Distributed Computing

(Cloud + Fog + Edge)



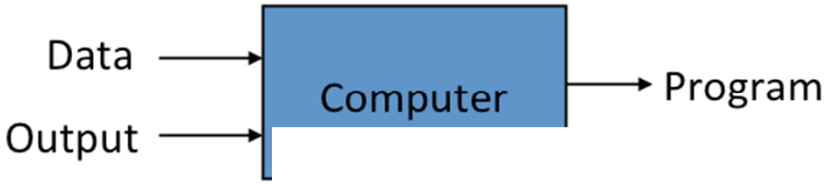
4th

Cyber Physical Systems

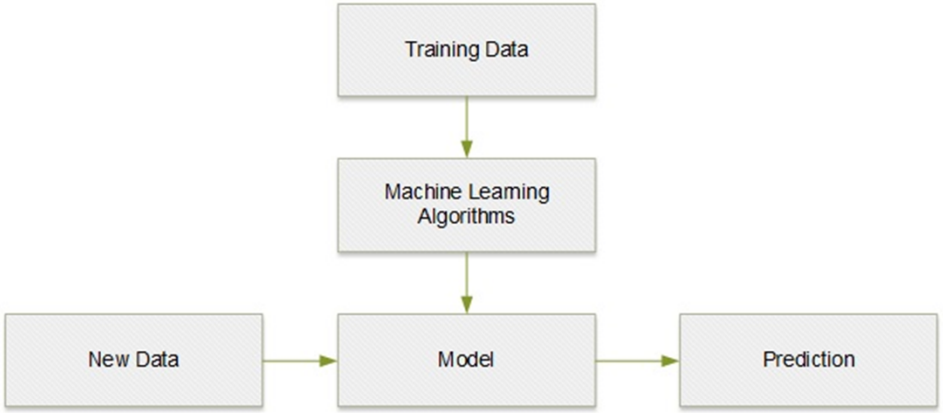
# Machine Learning

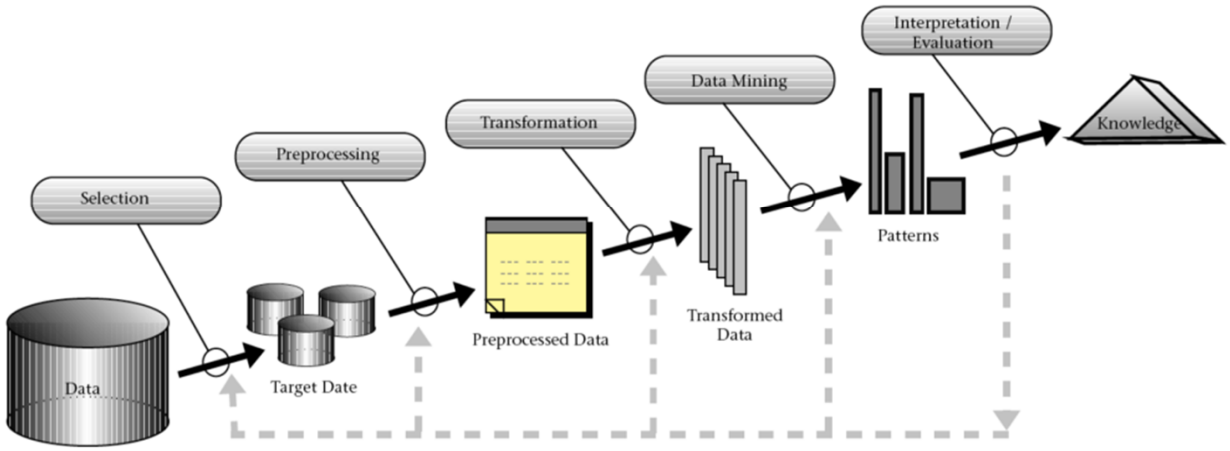
## Traditional Programming


## Machine Learning

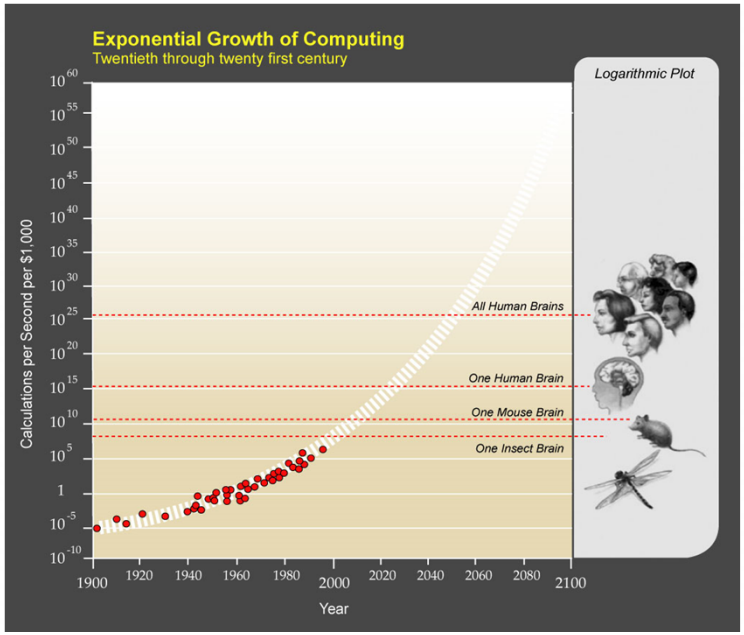



**Typical Machine Learning Process Flow**

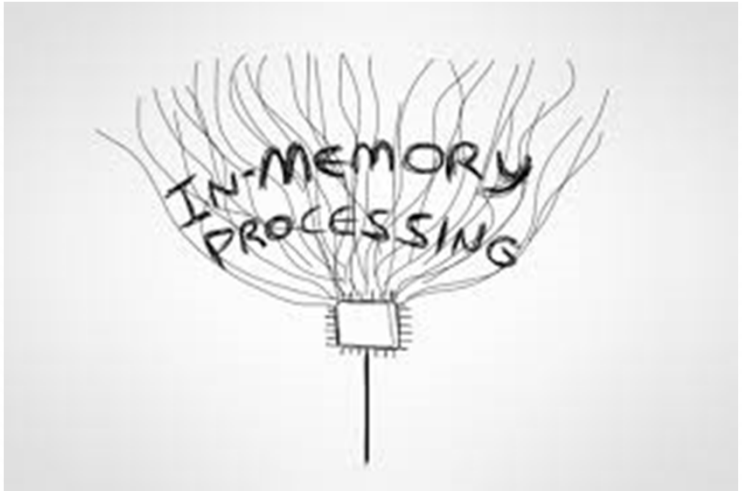


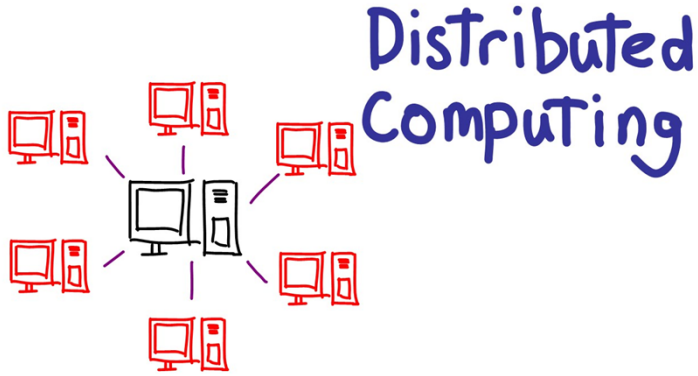



# Why now?

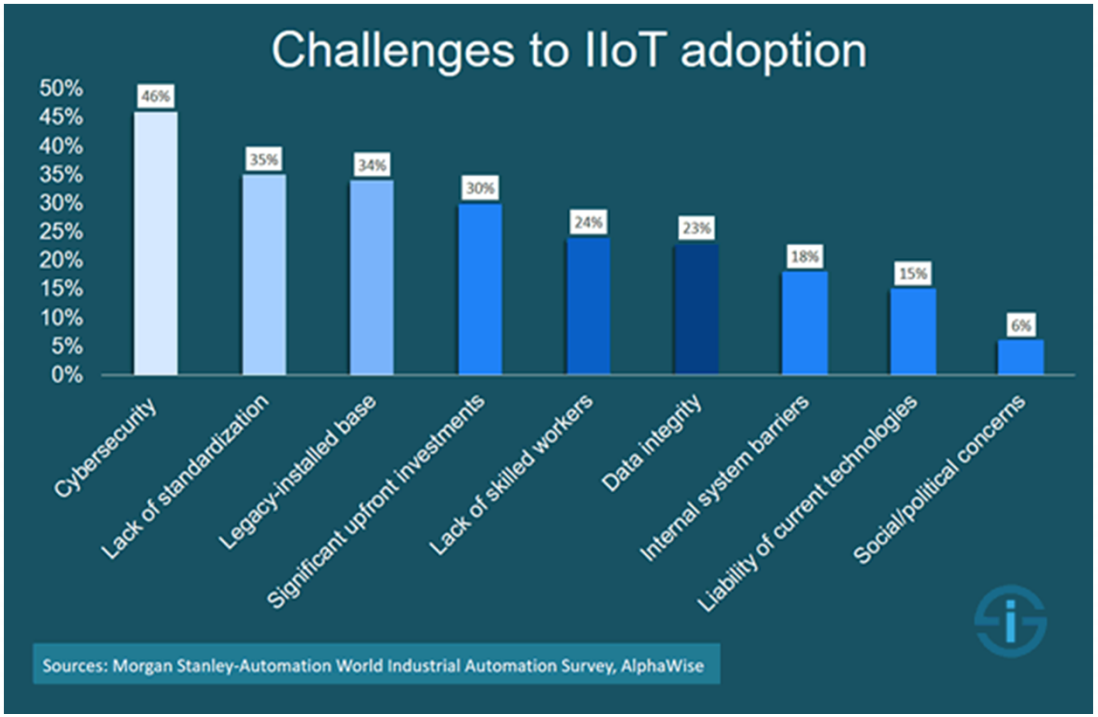

Exponential Growth of Computing
Twentieth through twenty first century
Logarithmic Plot
Calculations per Second per $1,000
All Human Brains
One Human Brain
One Mouse Brain
One Insect Brain
1900
1920
1940
1960
1980
2000
2020
2040
2060
2080
2100
Year


Cloud Computing

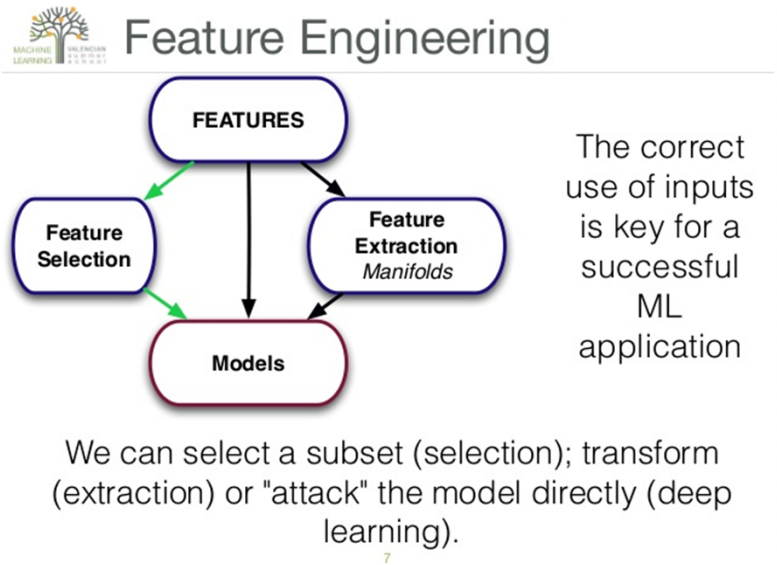

IN-MEMORY PROCESSING

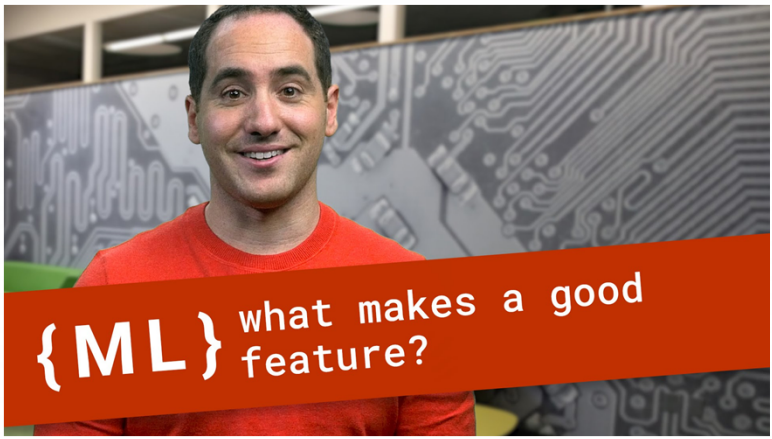

Distributed Computing

# Automation Industry Vendor's Response



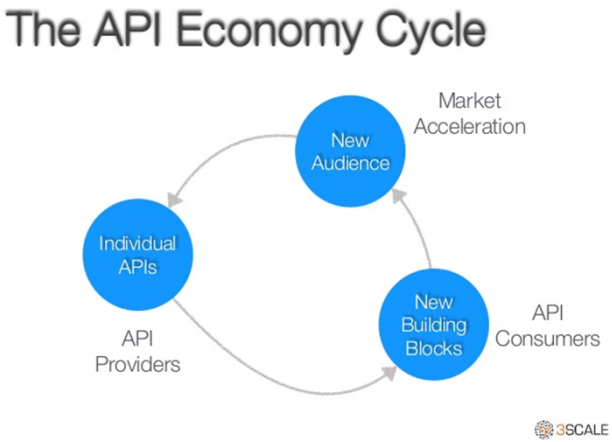
# Automation professionals will lead this transformation

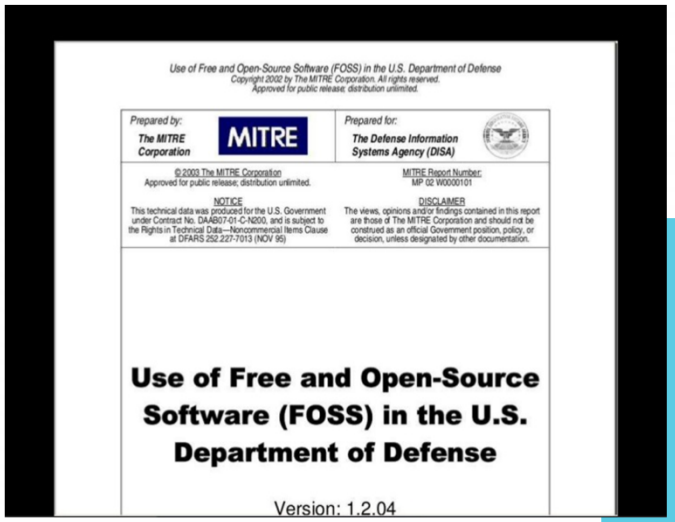


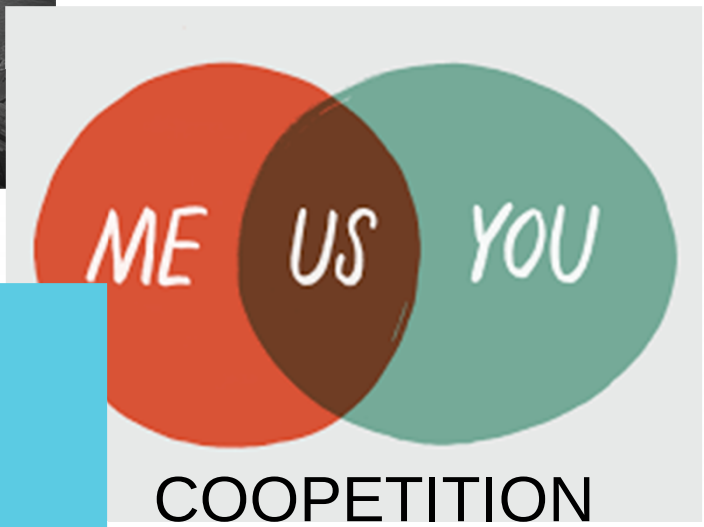

**"But the real question lies not in exploring whether data scientists require domain knowledge to build expert systems, but whether the representation phase of data can be accurately achieved without involving domain experts. Domain experts are presumed to be far more capable of identifying, articulating, and demonstrating day-to-day process problems in business. As these experts can jolly well explain a research problem to peers, it is probably absurd to even consider that an expert system can be constructed without their involvement or guidance. The same should hold true in the case of superior algorithms required to create such systems."** Experfy, 2014

# Automation professionals will lead this change!






# A real paradox for industrial productivity

***"And yet, we're at a point where almost everything we do requires advances in chemistry rather than IT. For instance, Elon Musk is creating a billion-dollar factory to make batteries. Well, for Elon's sake, wouldn't it be better if we had a more efficient way to use lithium so that batteries can last longer?"***

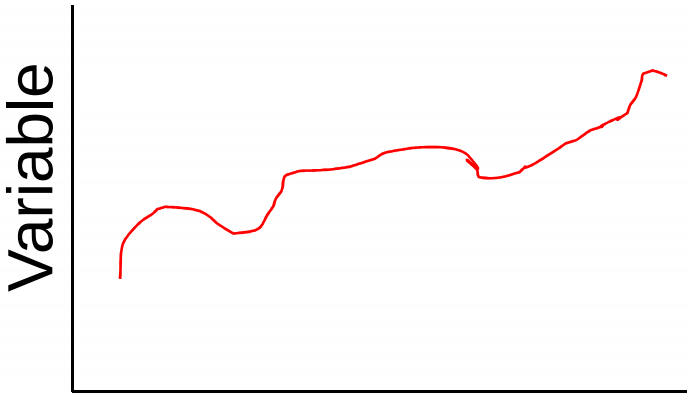
**"A simple example: DuPont and Dow Chemical, the two largest chemical companies, have had 50 percent and 38 percent year-over-year earnings growth, respectively, compared with Apple (12 percent). But nobody cares."**

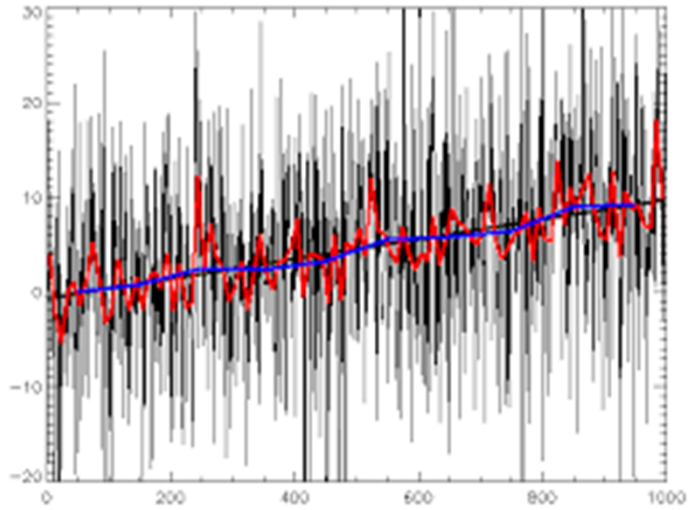
**"The number of grad students in chemistry is at an all-time low versus the number of grad students in computer science or information technology."**

**3 Trends That Will Completely Change the World by 2020**
**Ideas are the true currency of this next century. Inc. http://www.inc.com/quora/3-trends-that-will-completely-change-the-world-by-2020.html**

***"…the typical knowledge worker spends about 2.5 hours per day, or roughly 30% of the workday, searching for information." IDC Search***

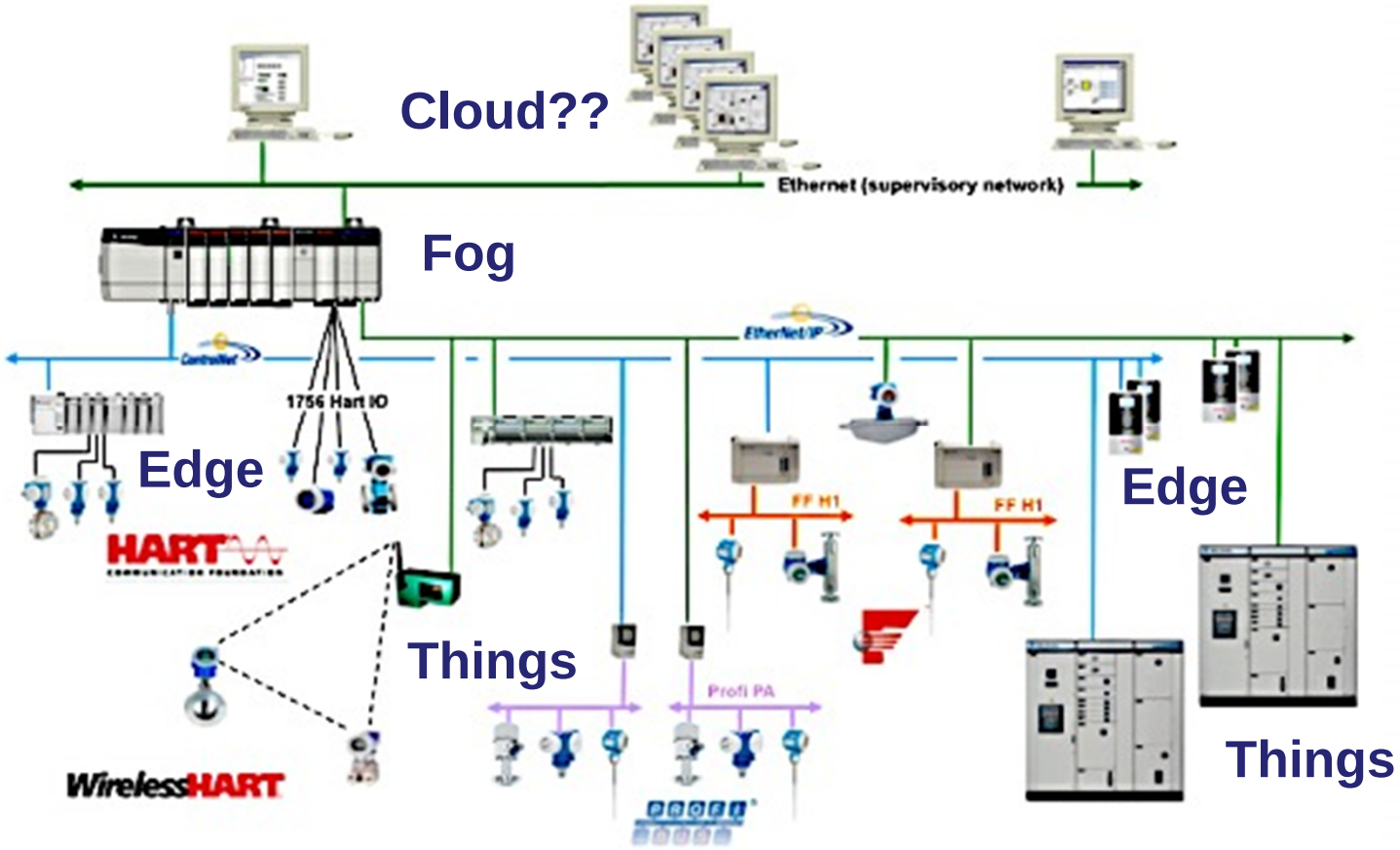
# Should I become a data scientist?


Know Your Data

# Which System Should I use?




# Where can I add insights and knowledge?

# Exploring Applications

**Augmented Intelligence:**

- Operations context to maintenance and reliability.
- Historical insights to real-time data
- Event insights to process variability
- Time spent in manual analysis
- Use of historical data beyond “forensics” and reporting
- Tribal knowledge and experience capture
- Insightful alarms


**Is every decision guided by data?**

**Business results:**

- Prescriptive maintenance
- Predictable Operations
- Flexibility in manufacturing
- Remove variability caused by humans
- Operator driven reliability

# Learning

- *Know your data – explore undiscovered patterns*
- *Think of unsolved problems in your plant*
- *Experiment – offline with historical data of past problems; you are not closing the loop. Could data have discovered what took you hours and days?*

Basic rules:

- A lot more data will beat a clever algorithm any day!
- A probable answer to a clear question is better than an accurate answer to a vague question!

## Self Education:

**http://www.r2d3.us/visual-intro-to-machine-learning-part-1/**

**https://www.analyticsvidhya.com/blog/2015/06/machine-learning-basics/**

**http://machinelearningmastery.com/a-tour-of-machine-learning-algorithms/**

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