BSC~ Microsoft Research Centre

Python for Engineers and Scientists

Tassadaq Hussain

Associate Professor Riphah International University

Collaborations:

Microsoft Research and Barcelona Supercomputing Center Barcelona, Spain

European Network on High Performance and Embedded Architecture and Compilation

UCERD Pvt Ltd Islamabad

UCERD
Gathering Intellectuals
www.ucerd.com

Intro: Tassadaq Hussain

Research Areas:

- High Performance Computing
- Digital System Design
- Machine/Deep Learning
- Heterogeneous Computing:
  - FPGAs, GPUs and Microprocessors
- Real-time Embedded Vision
- Virtual/Augmented Reality

Professional Affiliations

- HiPEAC: European Network on High Performance and Embedded Architecture and Compilation
- Barcelona Supercomputing Center Spain
- Université de Valenciennes France
- Centre or Chiropractic Research New Zeland

PhD – UPC BarcelonaTech Spain
MS (Digital System Design) – ISEP Paris France

Projects

1) Design, Development And Production Of Hardware Based Gel Documentation System For Dna, Rna And Protiens Analysis
2) Development of Scalable Heterogeneous Super-computing System
3) Low Power Low Cost Supercomputer Architecture for Undeveloped Countries. 2016 UCERD and BlueSurge Pvt Ltd 2.5 Million
4) FPGA Powered Supercomputer System Riphah and UCERD
5) Iris based Disease Diagnosis System (NRPU-18) 2.52 Million Rs.
6) Design Ultra Low Cost Display Camera Interface for Mobile Baseband XGold Chip at Infineon Technologies France.
7) Implementation of Reverse Time Migration on FGPAs at PLDA Italia

- Research Grants: (0.6 Million US $)
  - HEC NRPU 1
  - Technology Development Fund (2)
  - Pakistan Science Foundation
- Publications: (I.F. 30.2)
  - Referred Top Conferences: 45
  - Book Chapter: 2
  - Journal 17
- Patent: 17

Industrial Experience: (Above 16 Years)

Centre for Chiropractic Research
New Zealand College of Chiropractic

Infineon technologies

BSC Barcelona Supercomputing Center
Centro Nacional de Supercomputación

Agenda

- **Importance of Programming Languages**
- Python Language
- Python for Engineers
  - Interfacing with external world
  - RasppberyPi – Odroid - Arduino
  - Computer Vision
- Python for Scientists
  - Data Analyti
  - ML/DL

Why Programming

AGI

Artificial General Intelligence

ANI

Artificial Narrow Intelligence

An Elizabethan woodcut of a Brazen Head speaking: "Time is. Time was. Time is past."

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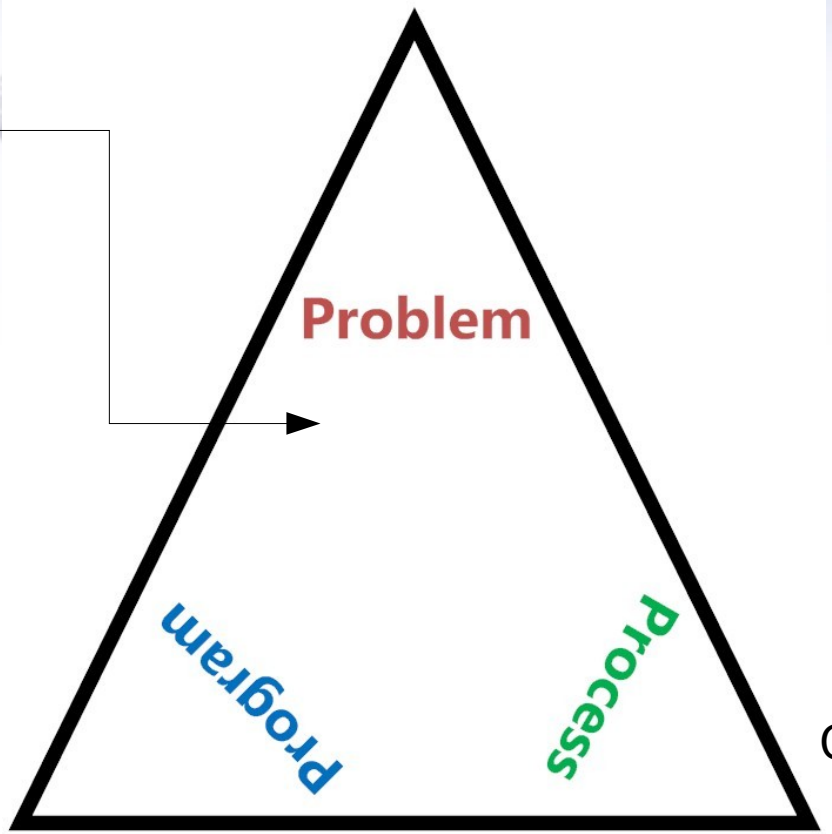
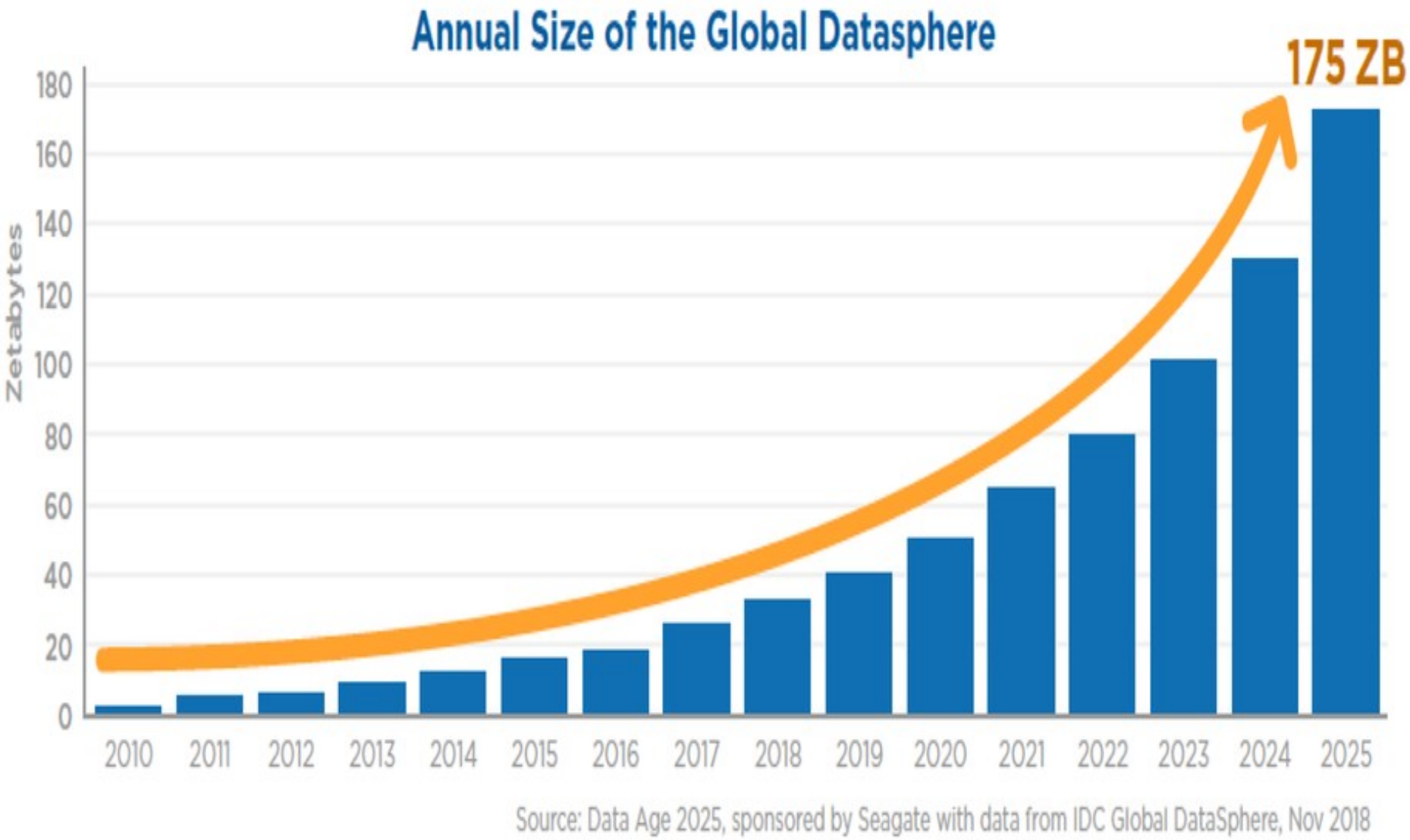
Information

Supervised
Unsupervised
Reinforcement

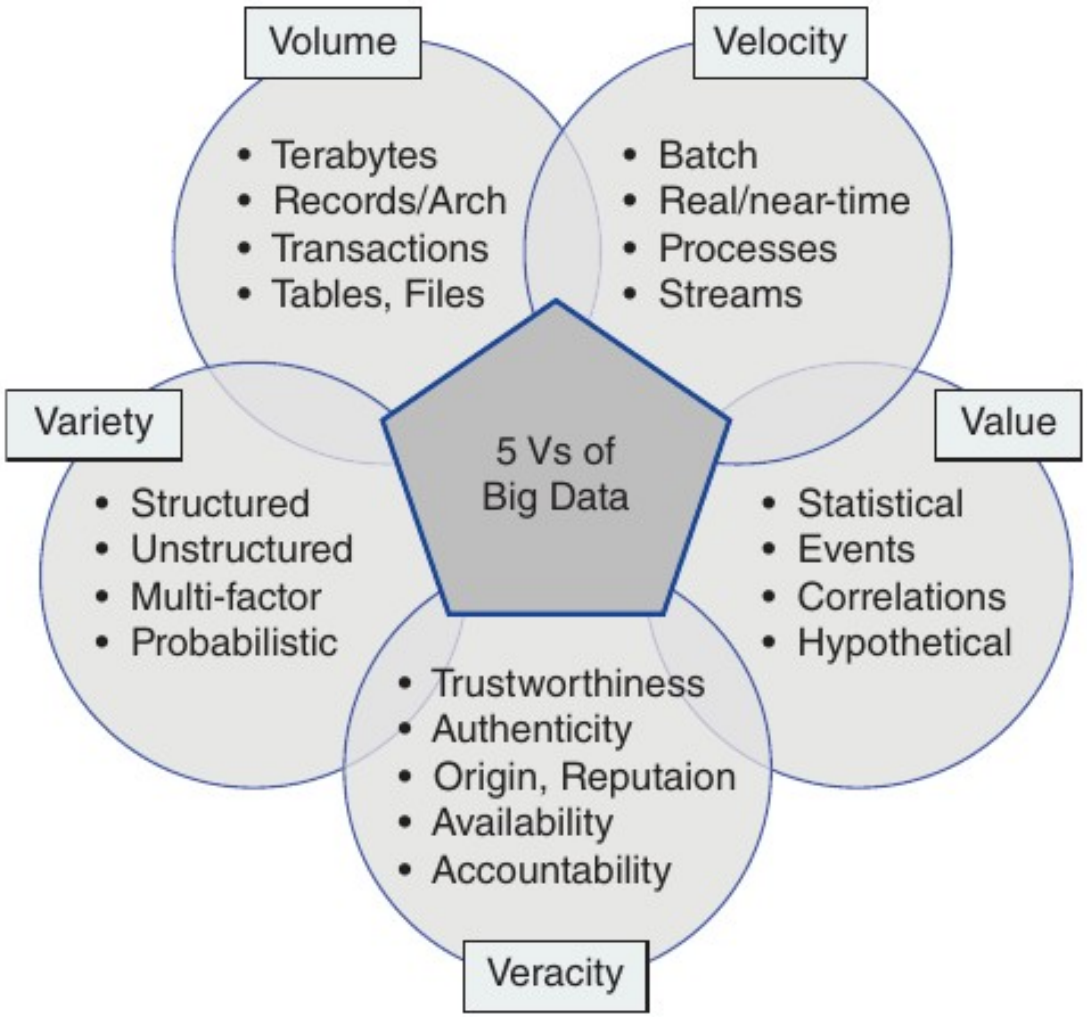


Instruction

Computation


Annual Size of the Global Datasphere
175 ZB
Zetabytes
180
160
140
120
100
80
60
40
20
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
Source: Data Age 2025, sponsored by Seagate with data from IDC Global DataSphere, Nov 2018

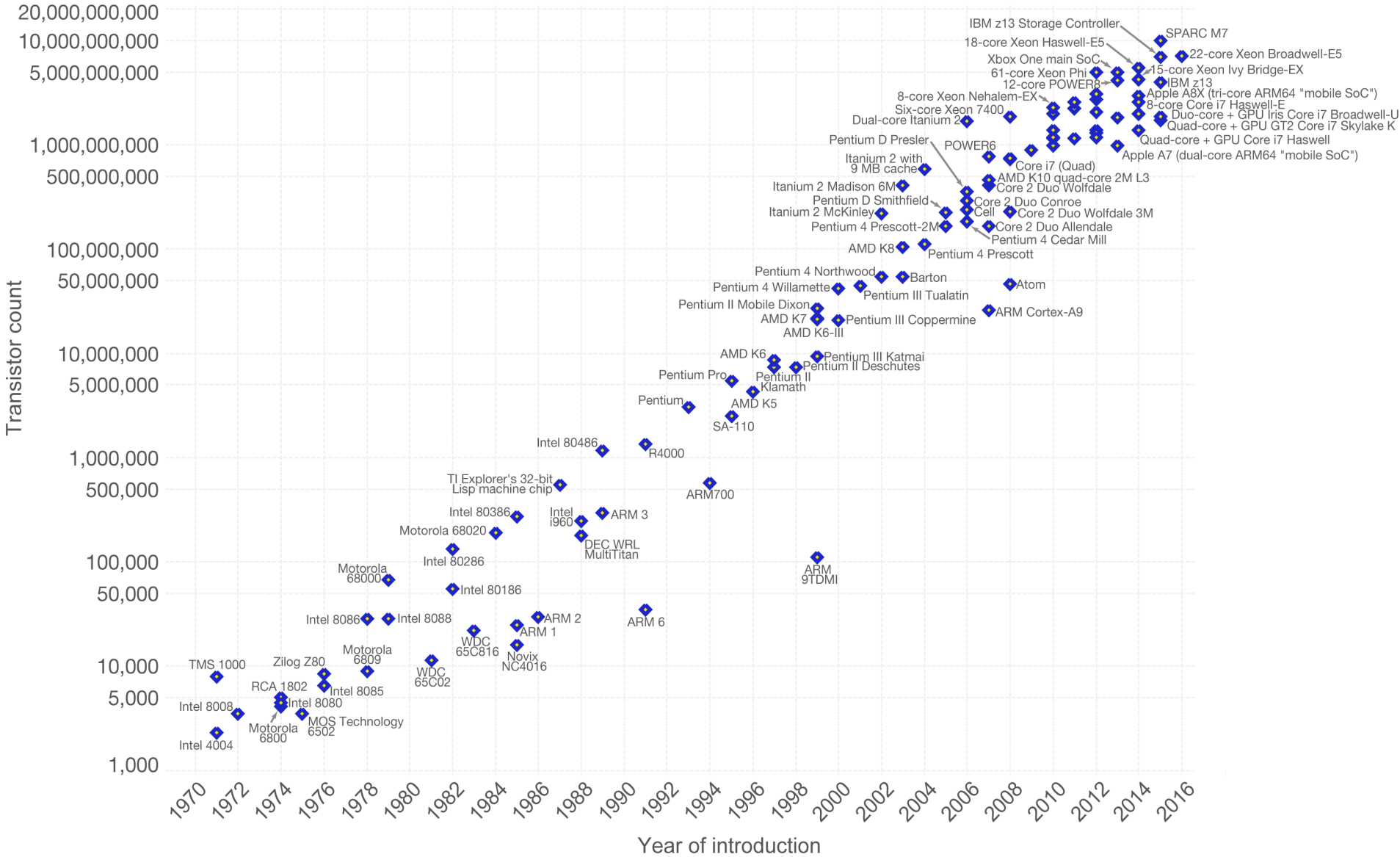
Big Data



Moore's Law – The number of transistors on integrated circuit chips (1971-2016)

Our World in Data

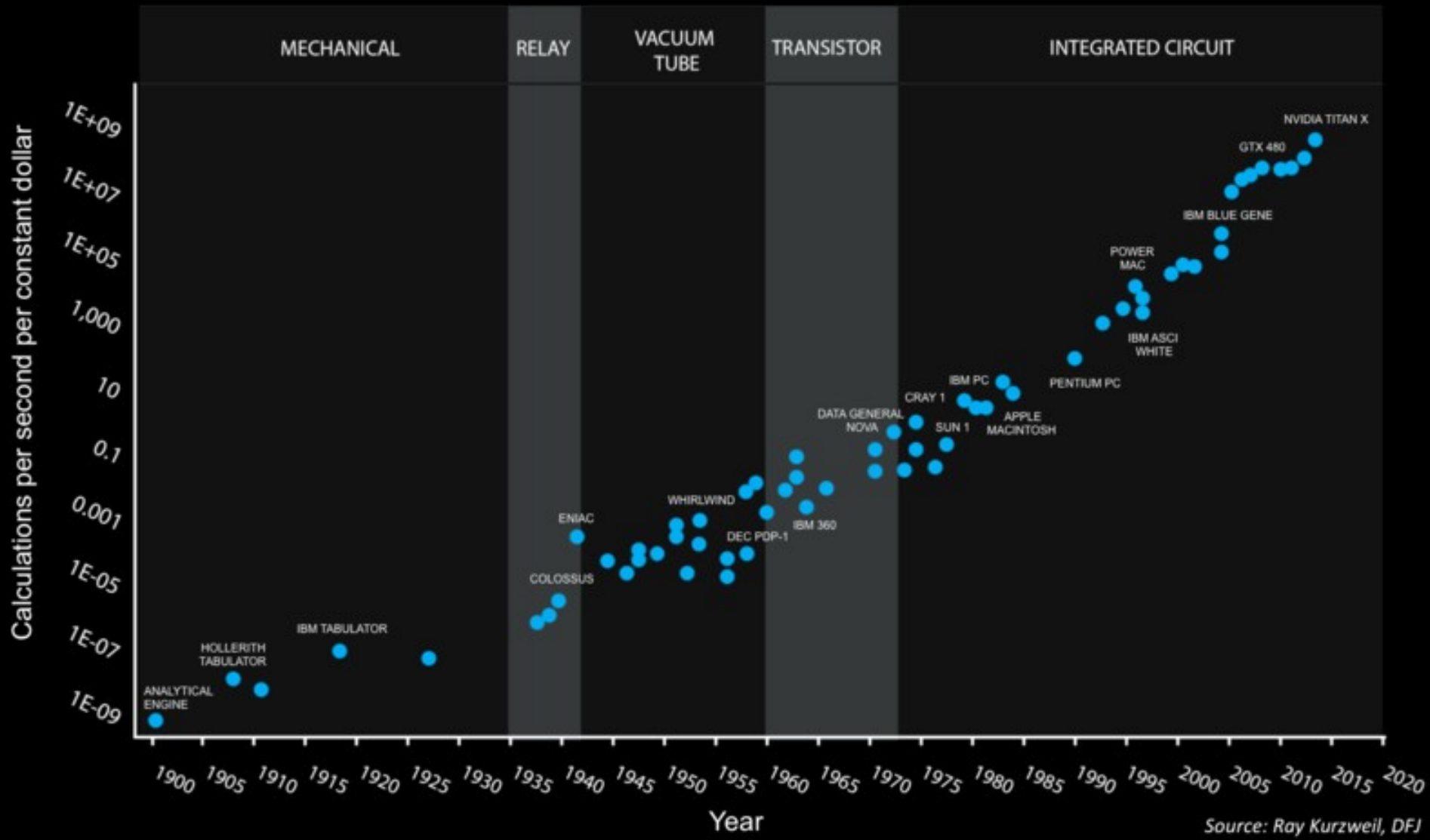
Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important as other aspects of technological progress – such as processing speed or the price of electronic products – are strongly linked to Moore's law.



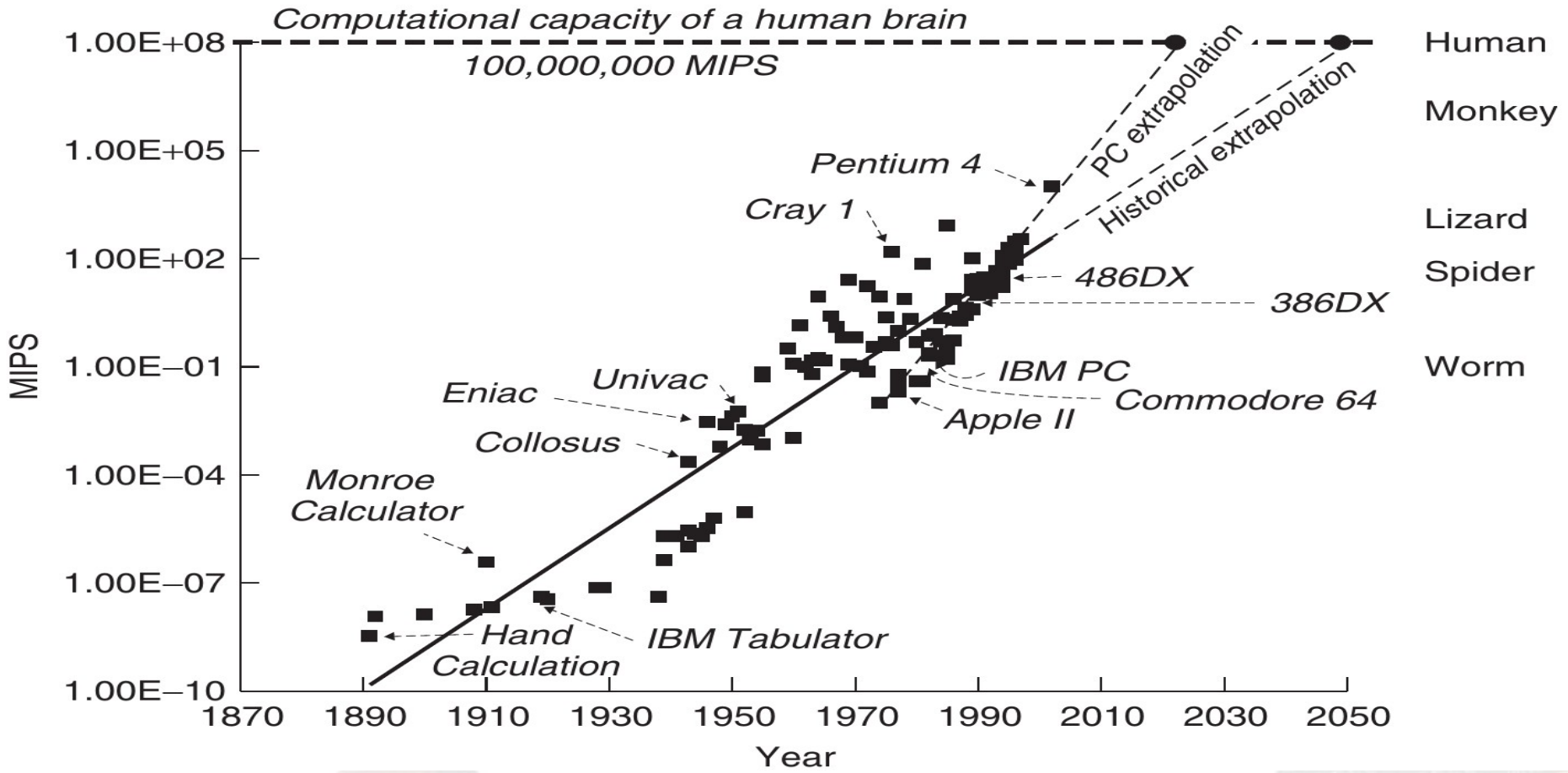
Data source: Wikipedia (https://en.wikipedia.org/wiki/Transistor_count)

The data visualization is available at OurWorldinData.org. There you find more visualizations and research on this topic.

120 Years of Moore's Law



Computational Capability

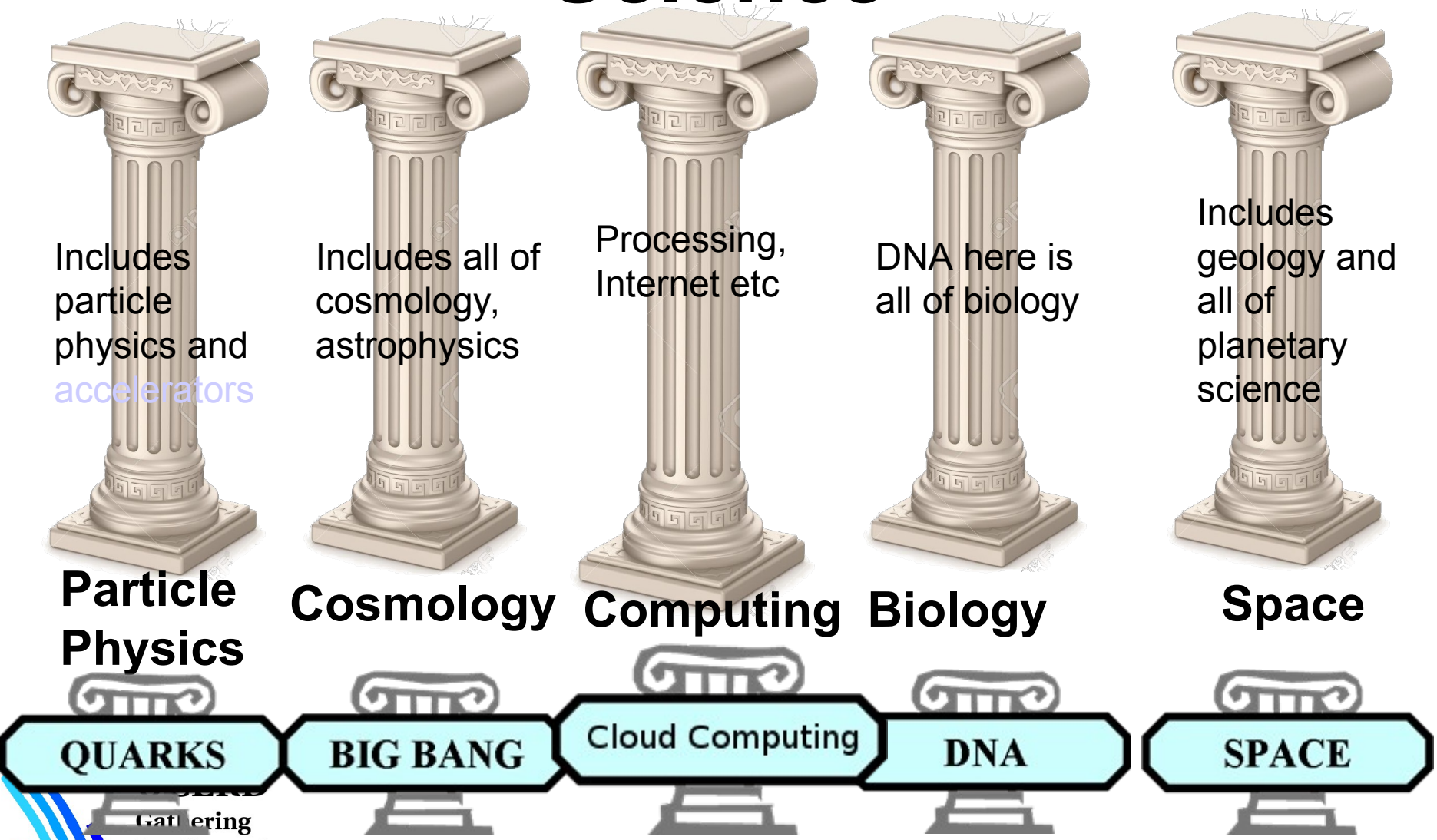


It is estimated that sometime between the years **2025 and 2050**, a **personal computers** will exceed the calculation power of a human brain.

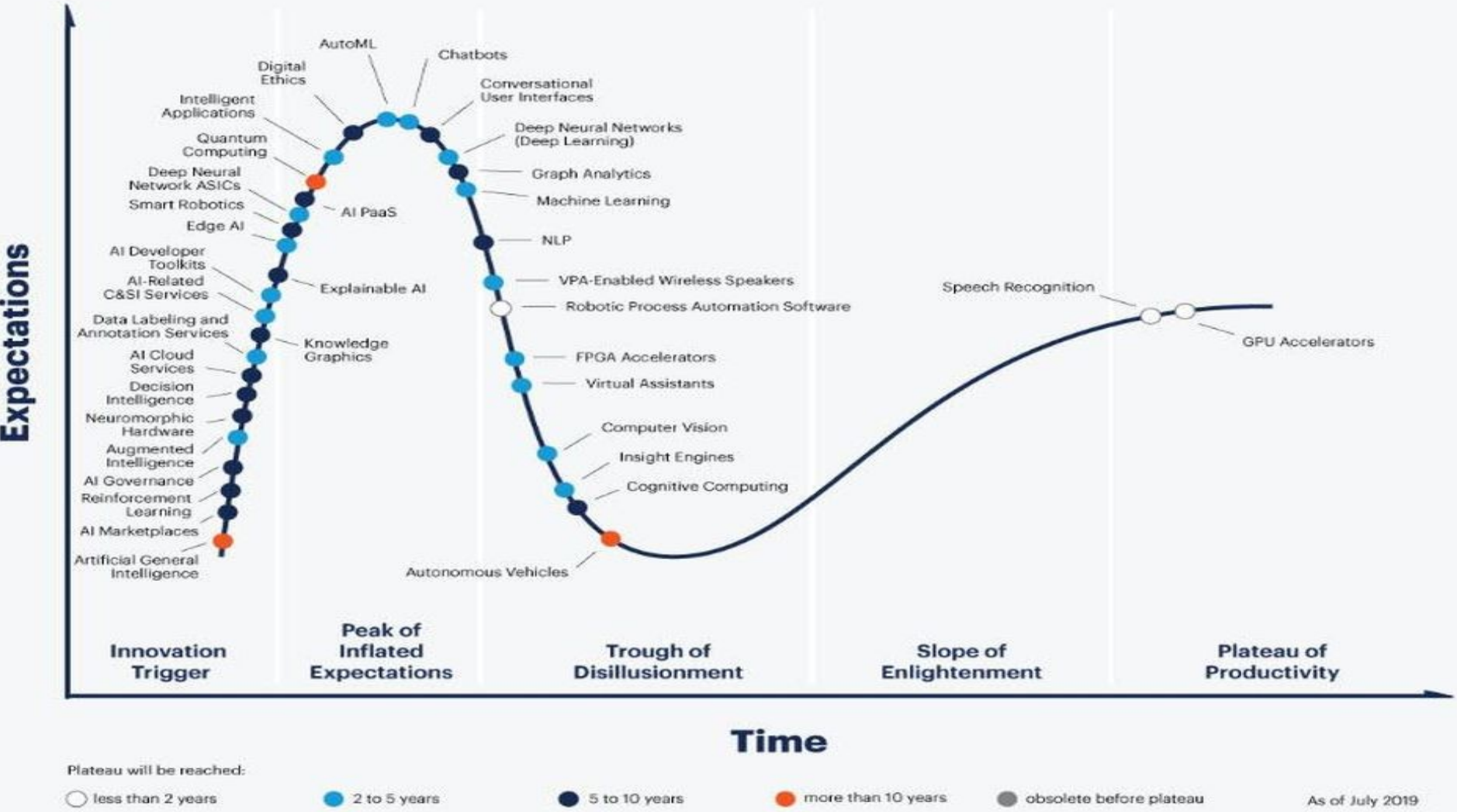
Pillars of Science

Fermi National
Accelerator Laboratory

Science



Gartner Hype Cycle for Artificial Intelligence, 2019



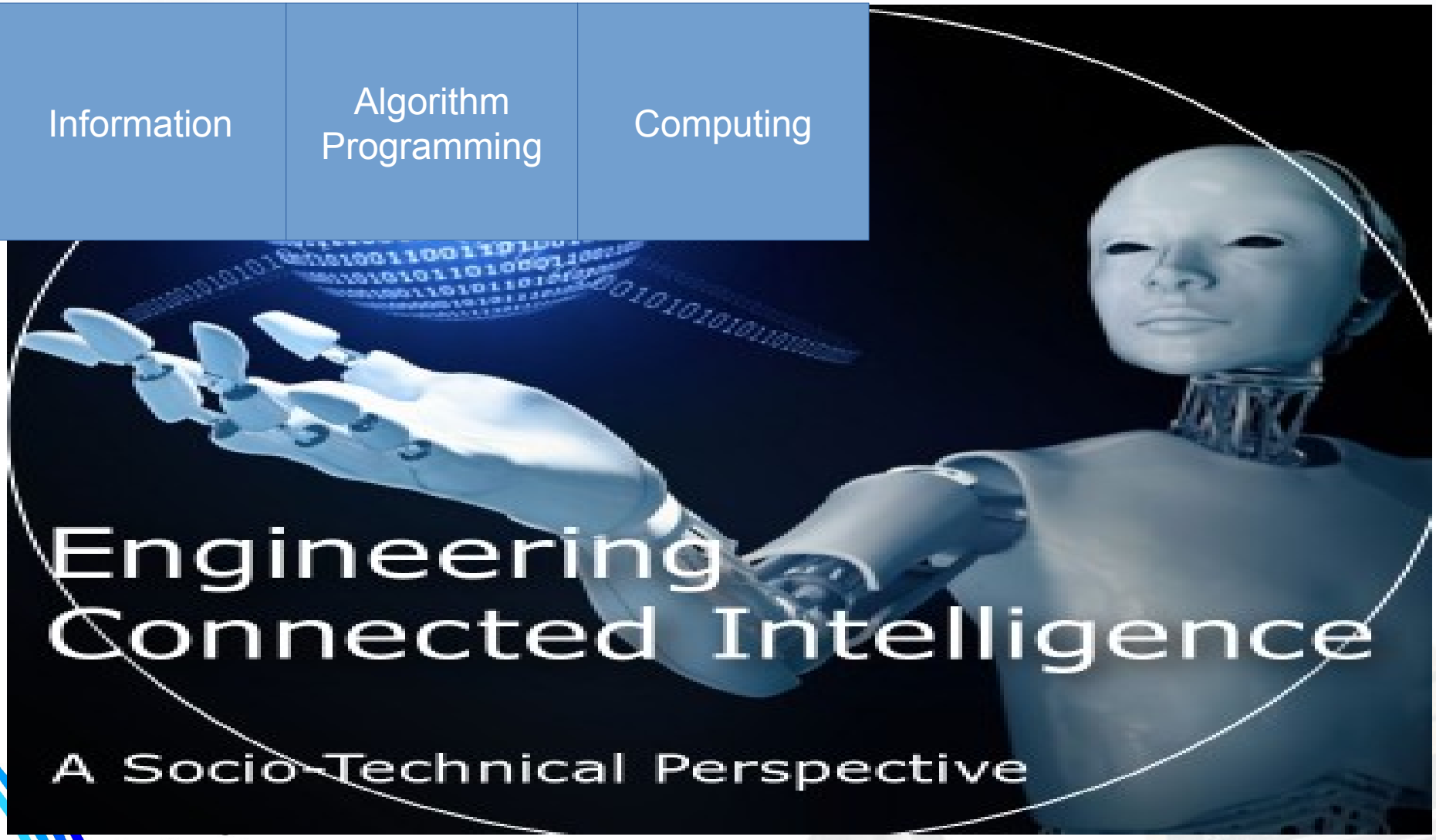
gartner.com/SmarterWithGartner

Source: Gartner

Gartner

Intellectual Capability

Information	Algorithm Programming	Computing



Programming Languages ?

- A programming language is a set of rules that provides a way of telling a computer what operations to perform.
- A programming language is a set of rules for communicating an algorithm
- It provides a linguistic framework for describing computations

Level of Programming Languages

High-level program

```
class Triangle {
   ...
   float surface()
      return b*h/2;
   }
```

Low-level program

```
LOAD r1,b
LOAD r2,h
MUL r1,r2
DIV r1,#2
RET
```

Executable Machine code

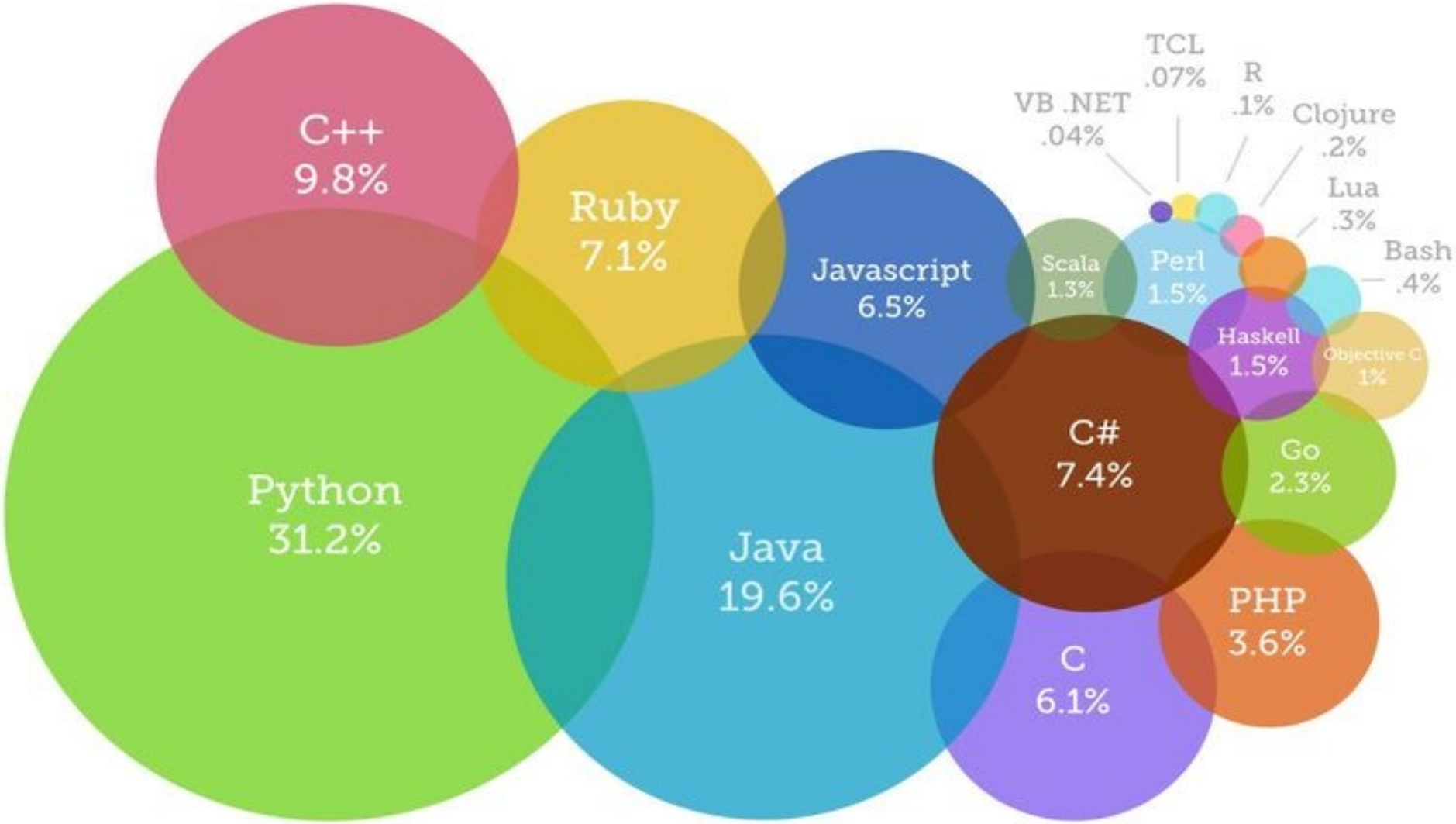
```
0001001001000101
0010010011101100
10101101001...
```

- First Generation Languages
- Second Generation Languages
- Third Generation Languages
- Fourth Generation Languages
- Fifth Generation Languages

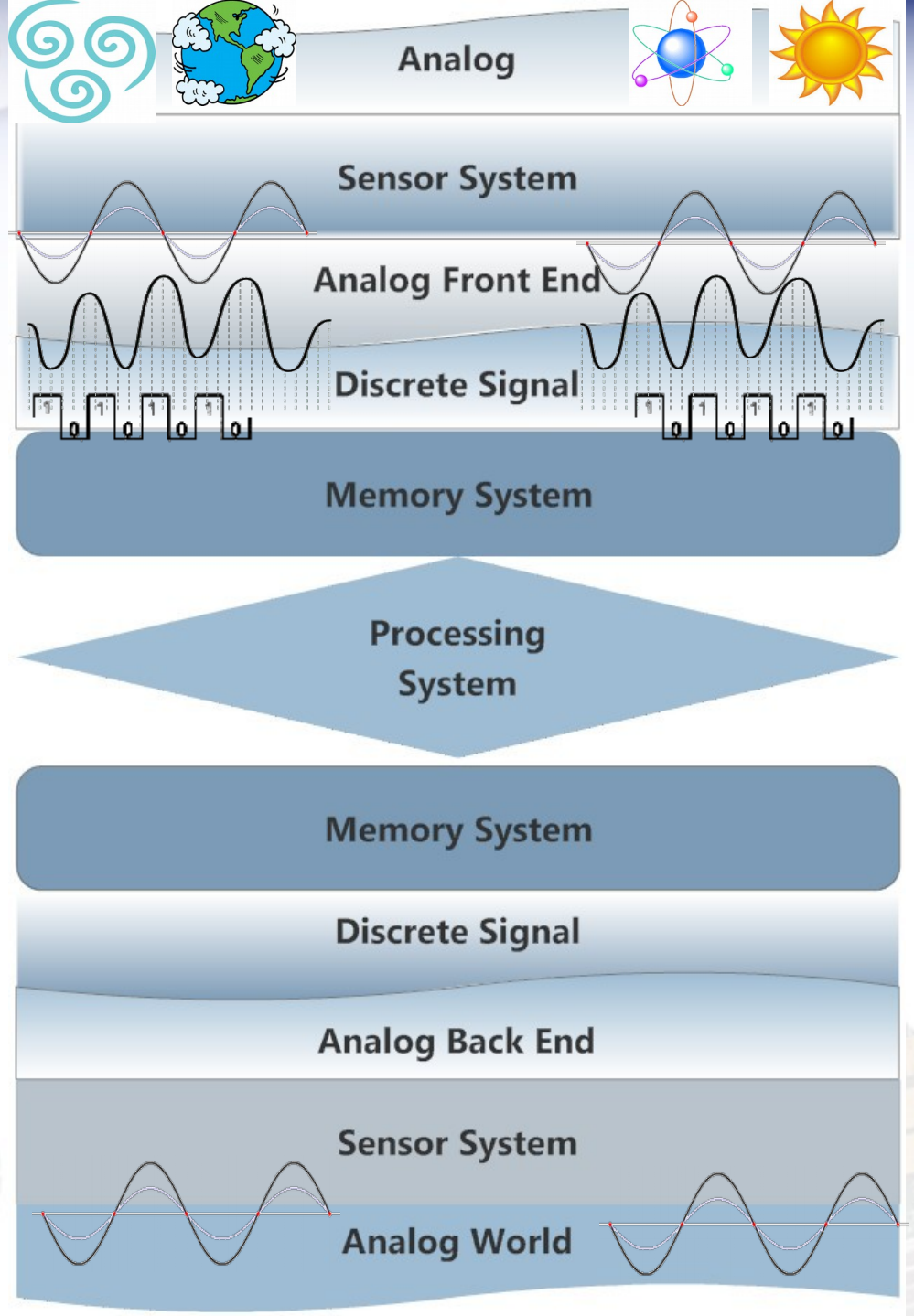
5th Generation Language

- Declarative languages
- Functional(?): Lisp, Scheme, SML
  - Also called applicative
  - Everything is a function
- Logic: Prolog
  - Based on mathematical logic
  - Rule- or Constraint-based

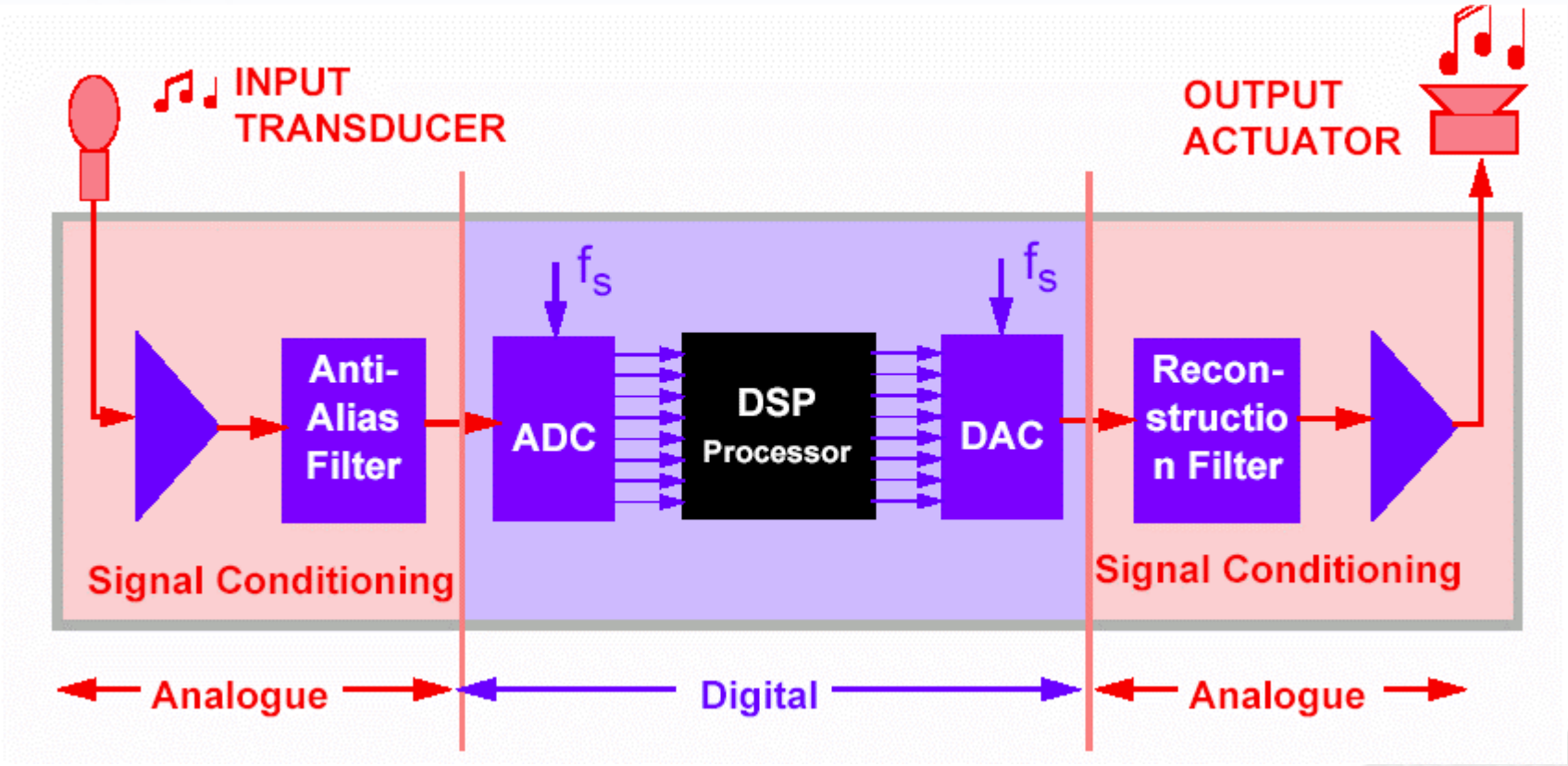
Popular Coding Languages



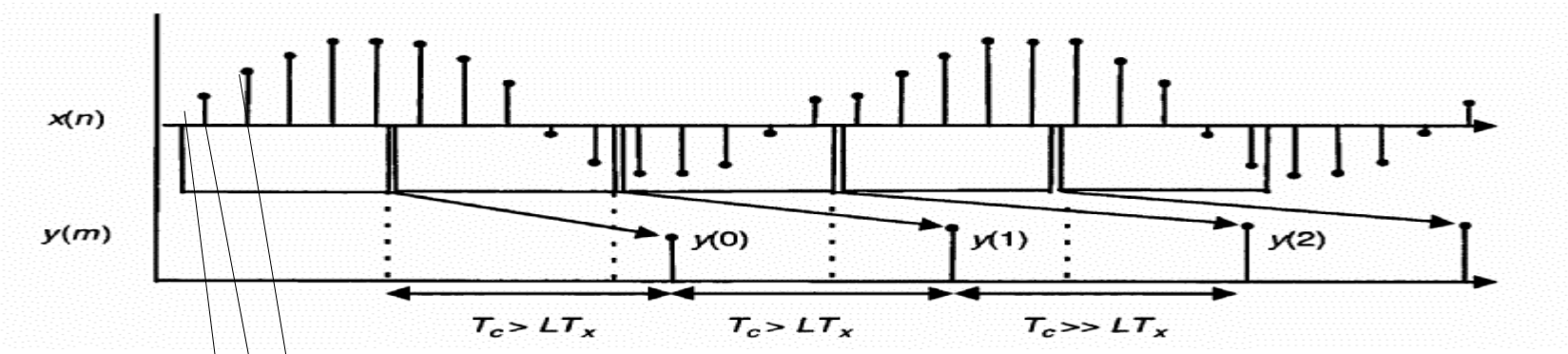
Signal Processing System



Signal Processing System



Signals



0,1,2,2.2,3,3,2.9,2,1,-.5,-2 - ----------

x[100]=0,1,2,2.2,3,3,2.9,2,1,-.5,-2]

Levels of processing

Scalar Processing

- Perform single operation on a single signal value

Stream Processing

- All computations with one input sample are completed before the next input sample arrives

Block processing

- Each input sample x(n) is stored in memory before any processing occurs upon it. After *L* input samples have arrived, the entire collection of samples is processed at once.

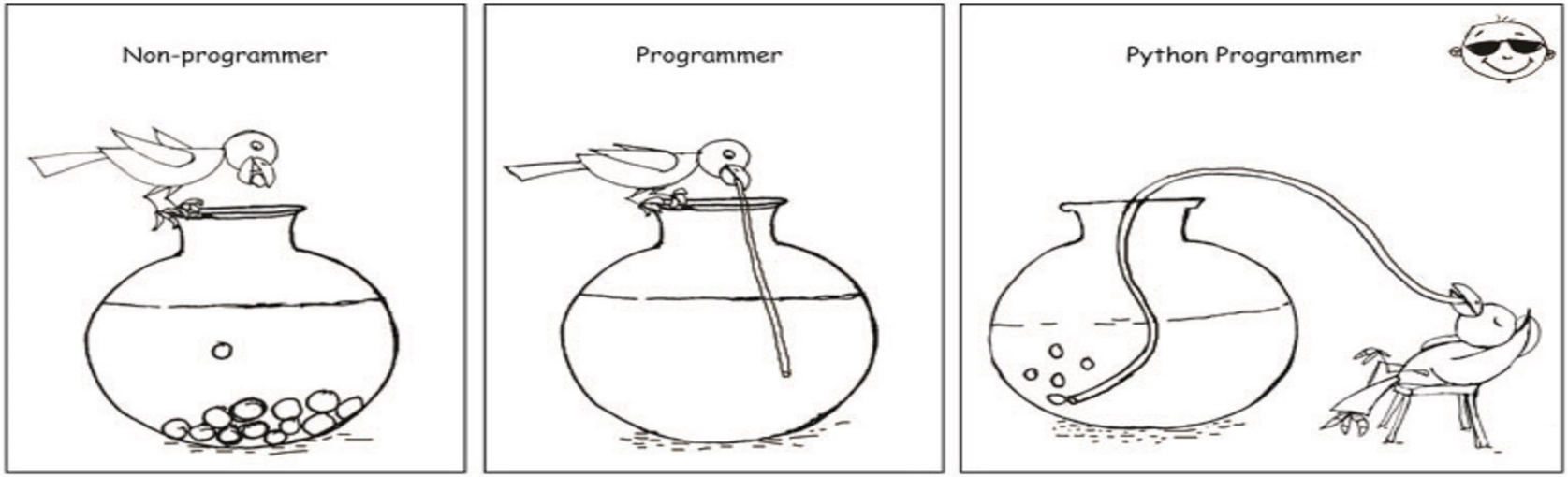
Vector processing

- Systems with several input and/or output signals being computed at once: can work with streams or blocks

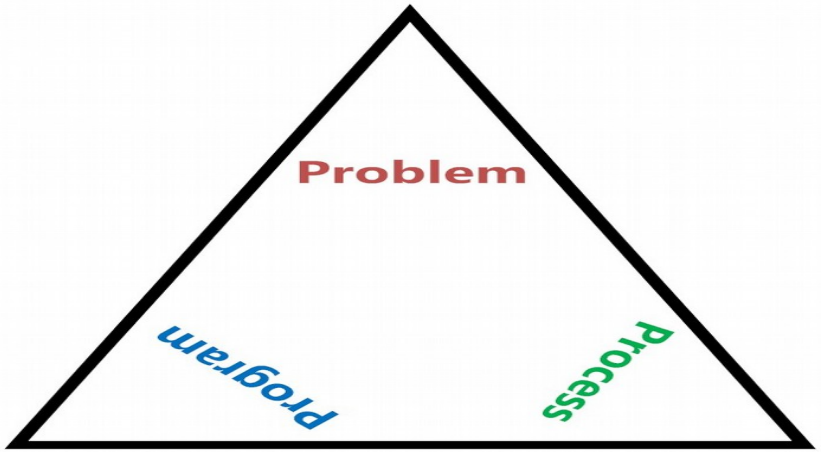
Parallel Programmings

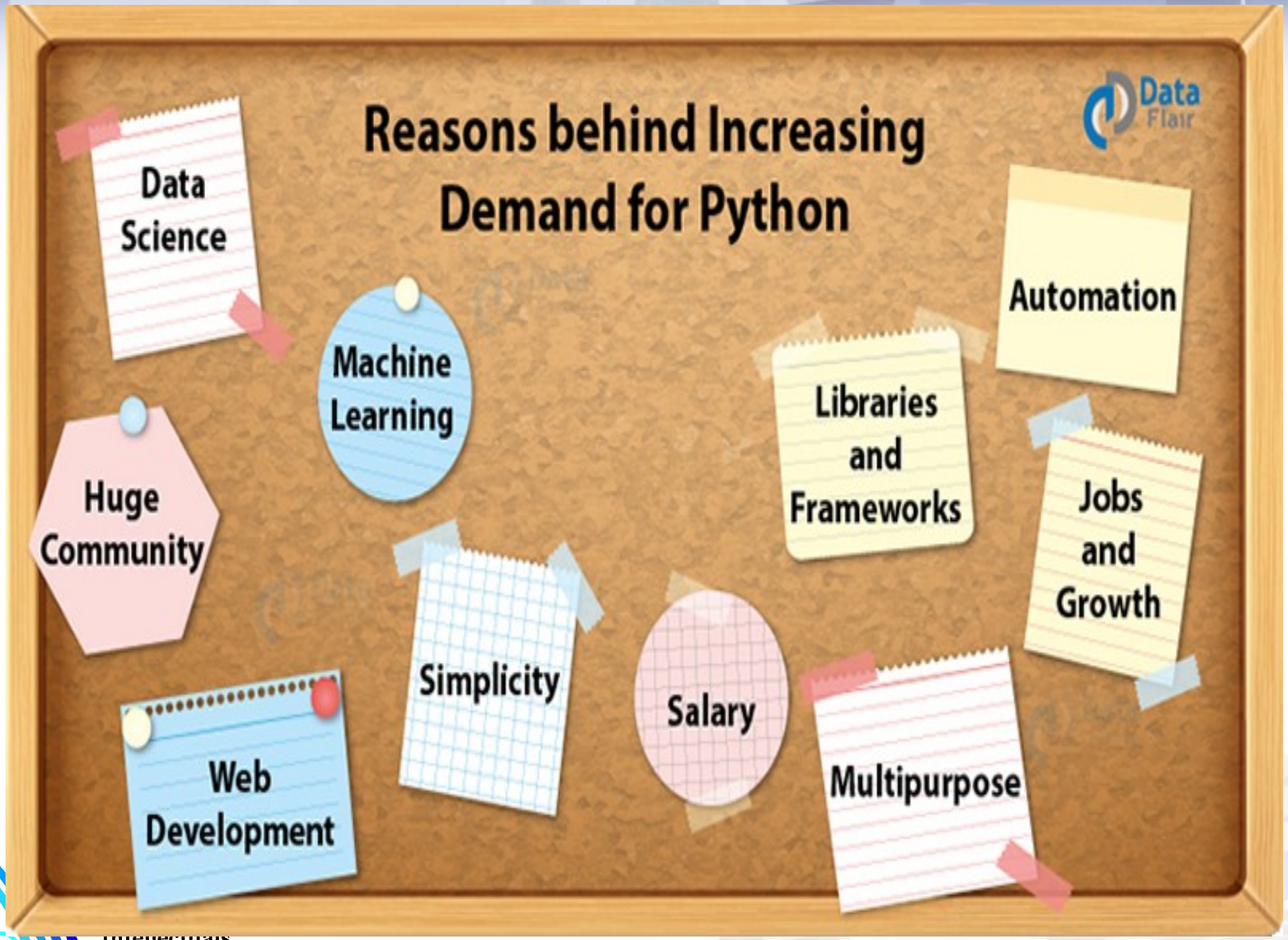
- C++
  - Pthread Libraries
- Parallel Programming Models
  - OpenMP
  - MPI
  - OpenACC
  - OpenCL

Problem Program and Process



You have seen it all, Now, Choice is yours :-)




Reasons behind Increasing Demand for Python
Data Flair
Data Science
Machine Learning
Automation
Libraries and Frameworks
Huge Community
Jobs and Growth
Simplicity
Salary
Web Development
Multipurpose