# DL: TimeSeries and RNN

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**Collaborations:**

**Barcelona Supercomputing Center Barcelona, Spain**

**European Network on High Performance and Embedded Architecture and Compilation**

**Pakistan Supercomputing Center**

**UCERD**

Gathering
Intellectuals

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- Understanding recurrent neural networks (RNNs)
- Applying RNNs to a temperature-forecasting example
- Advanced RNN usage patterns

UCERD

# Past Present and Future

## AGI

Artificial General Intelligence

## ANI

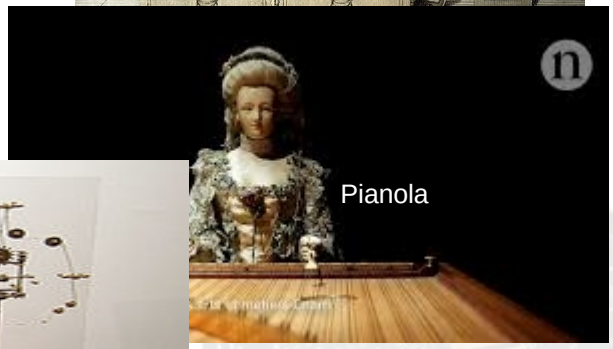
Artificial Narrow Intelligence

**Information/Big Data**

**Complex Adaptive Algorithms**

**Computing Resources**

**“Methods that scale with computation are the future of Artificial Intelligence”**
**— Rich Sutton,**



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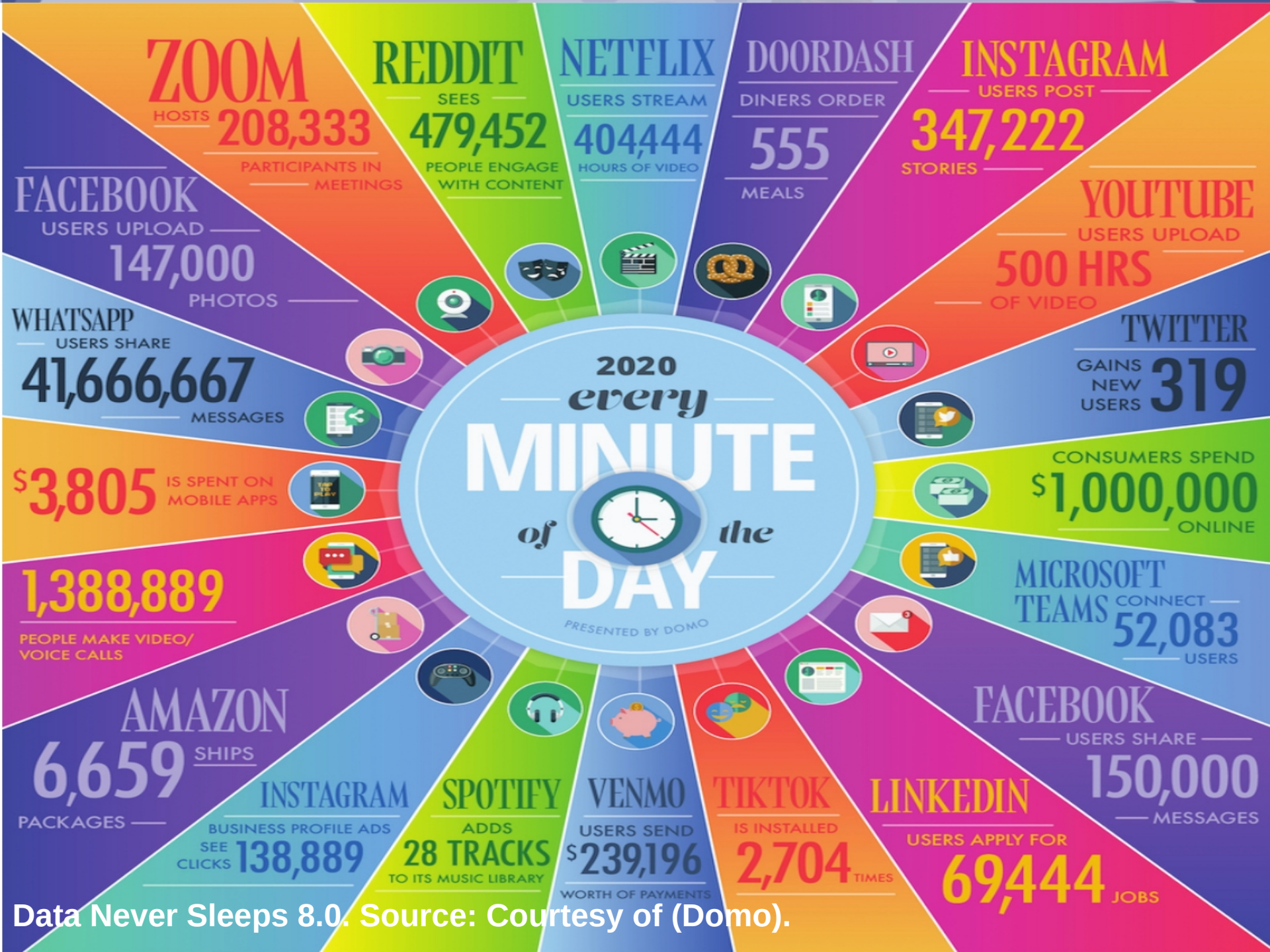
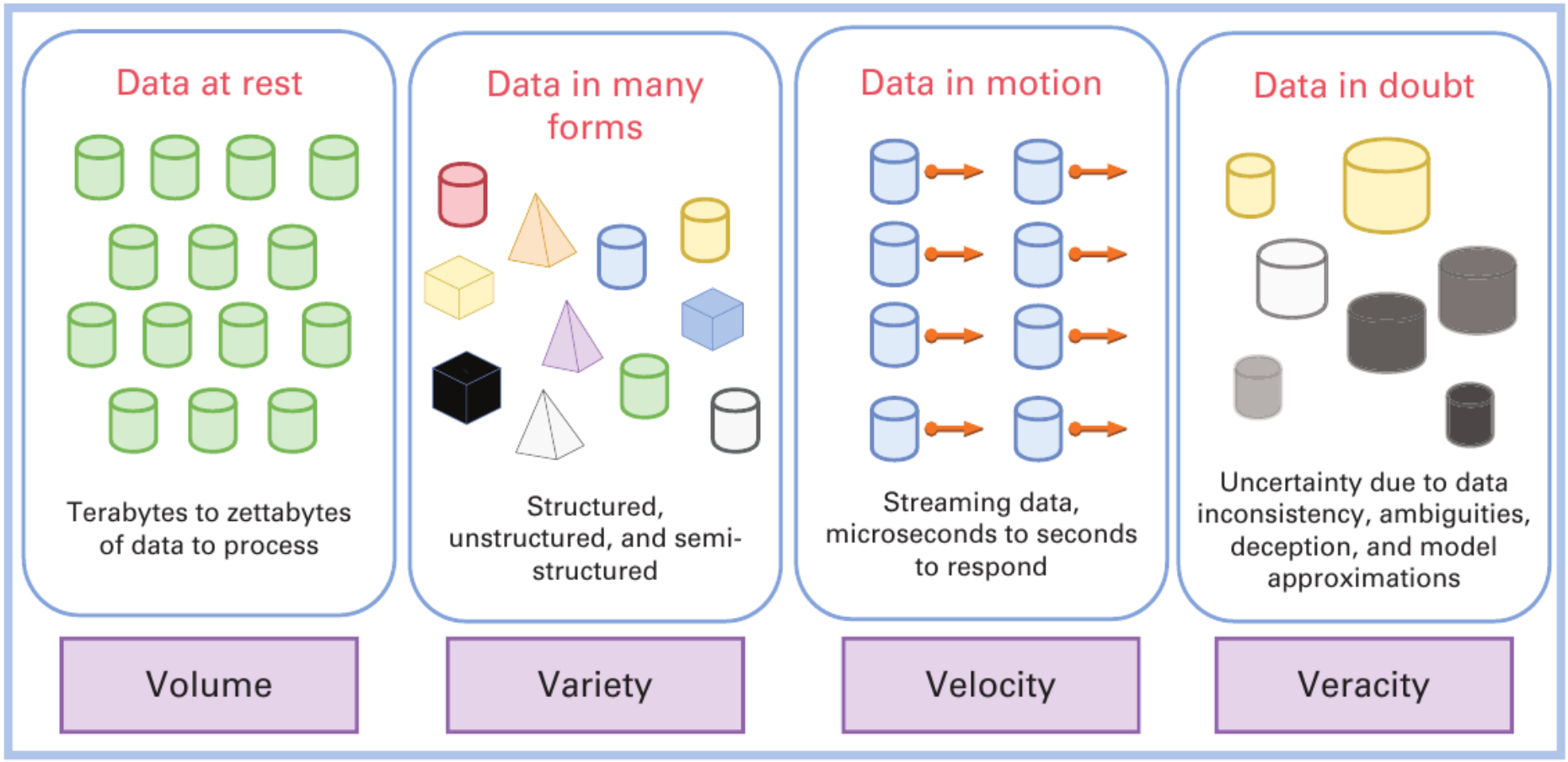


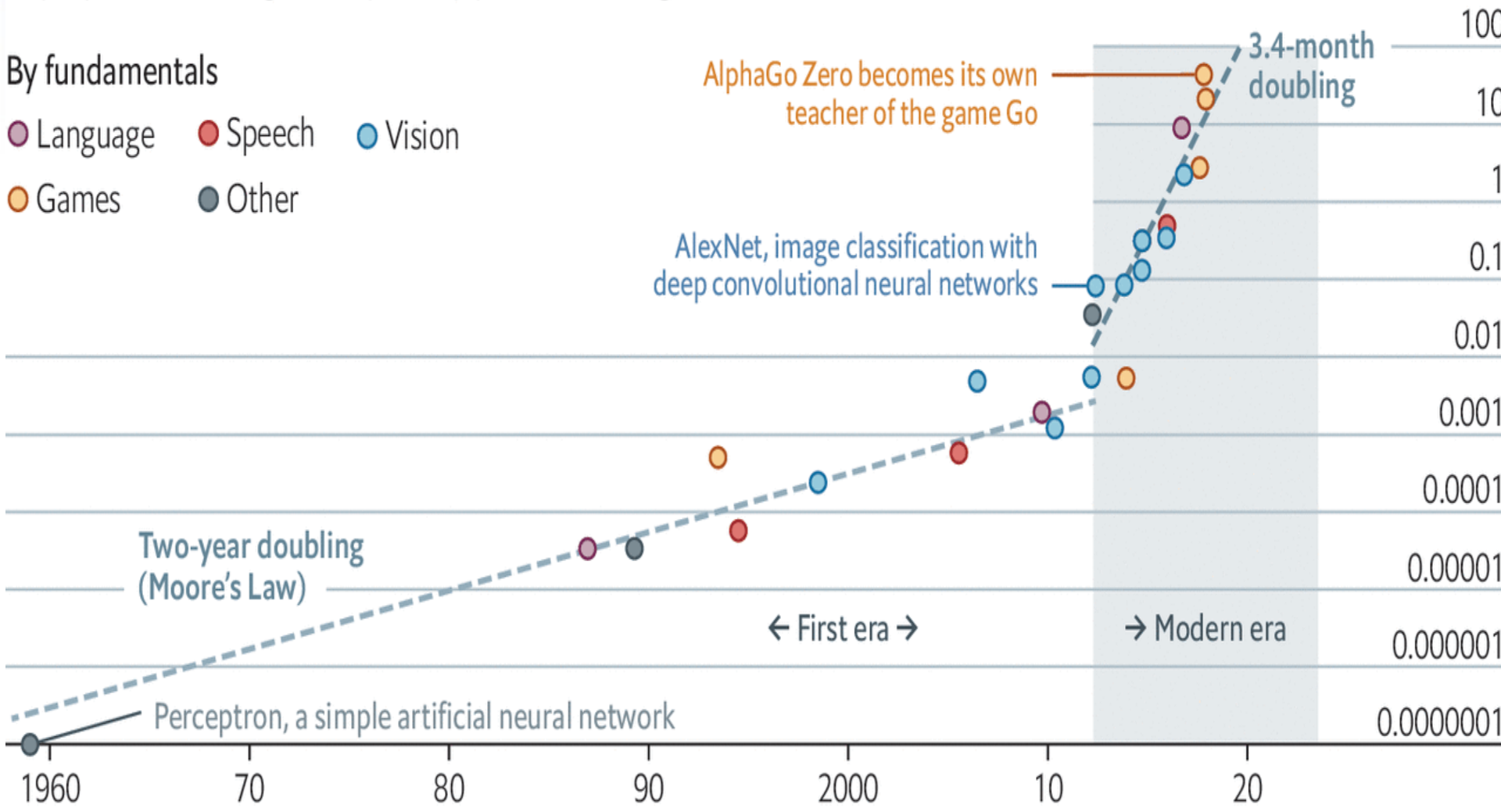

Data Never Sleeps 8.0. Source: Courtesy of (Domo).


Data at rest
Terabytes to zettabytes of data to process
Data in many forms
Structured, unstructured, and semi-structured
Data in motion
Streaming data, microseconds to seconds to respond
Data in doubt
Uncertainty due to data inconsistency, ambiguities, deception, and model approximations
Volume
Variety
Velocity
Veracity

# Deep and steep

## Computing power used in training AI systems

Days spent calculating at one petaflop per second*, log scale

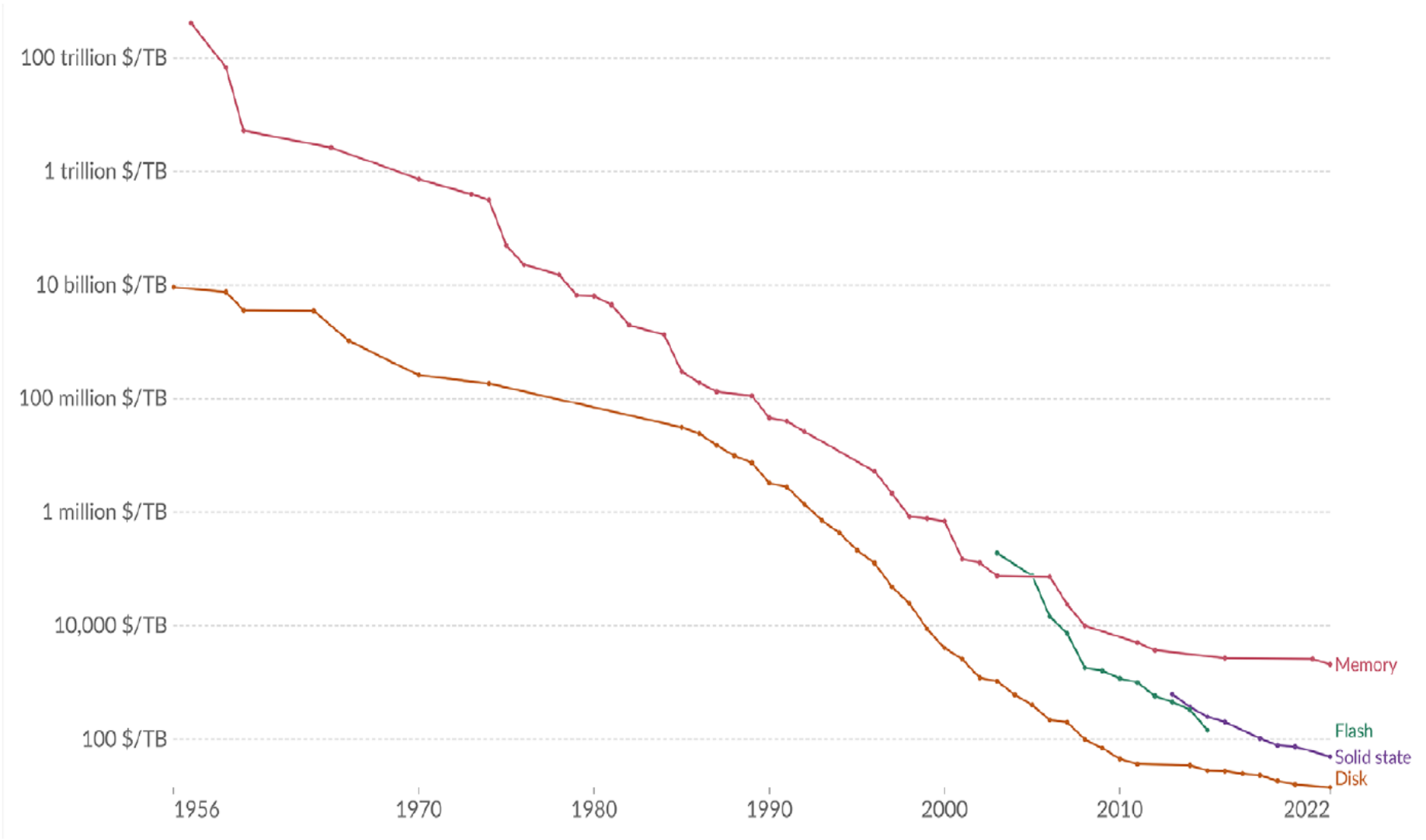


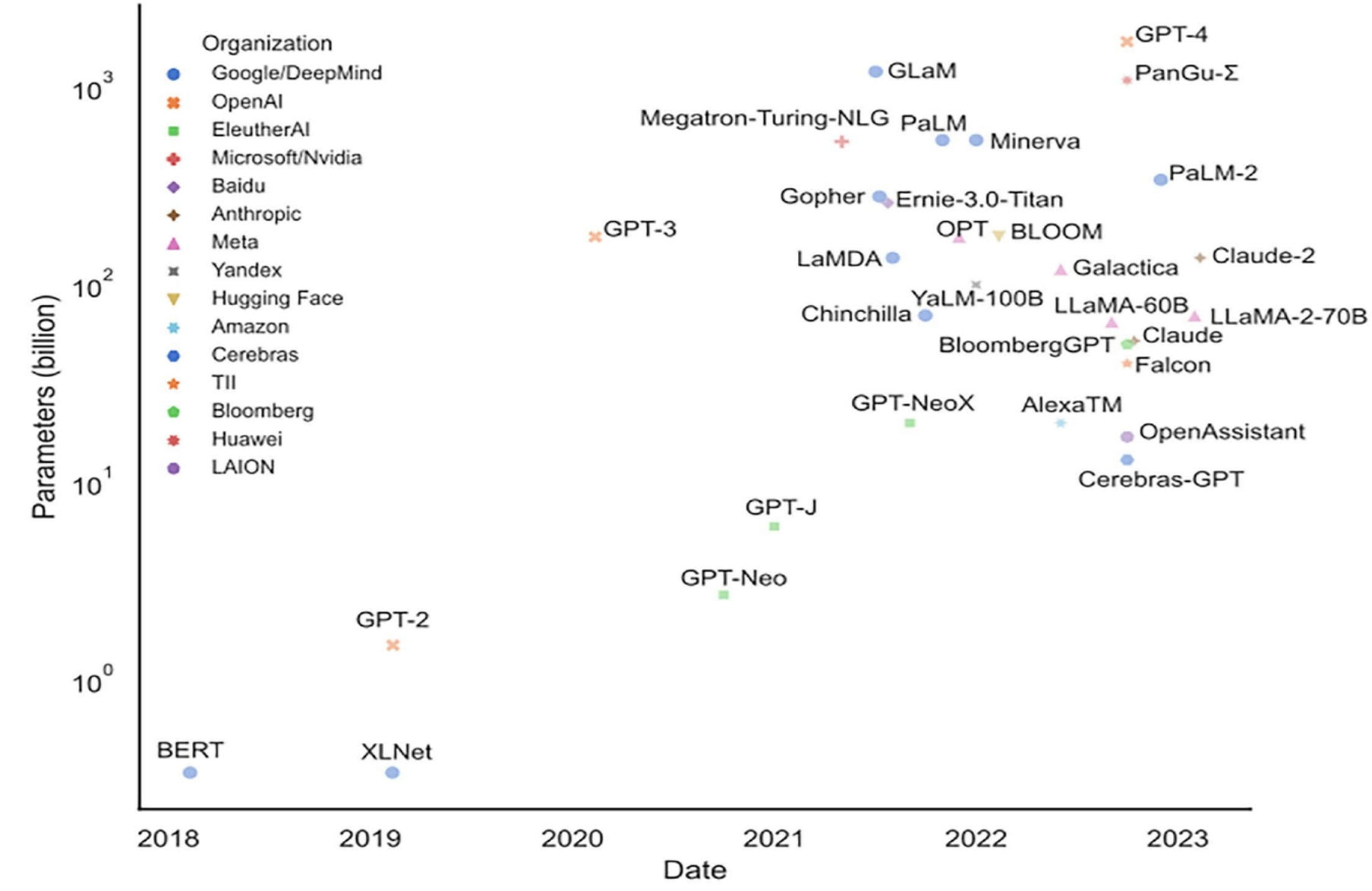

Source: OpenAI

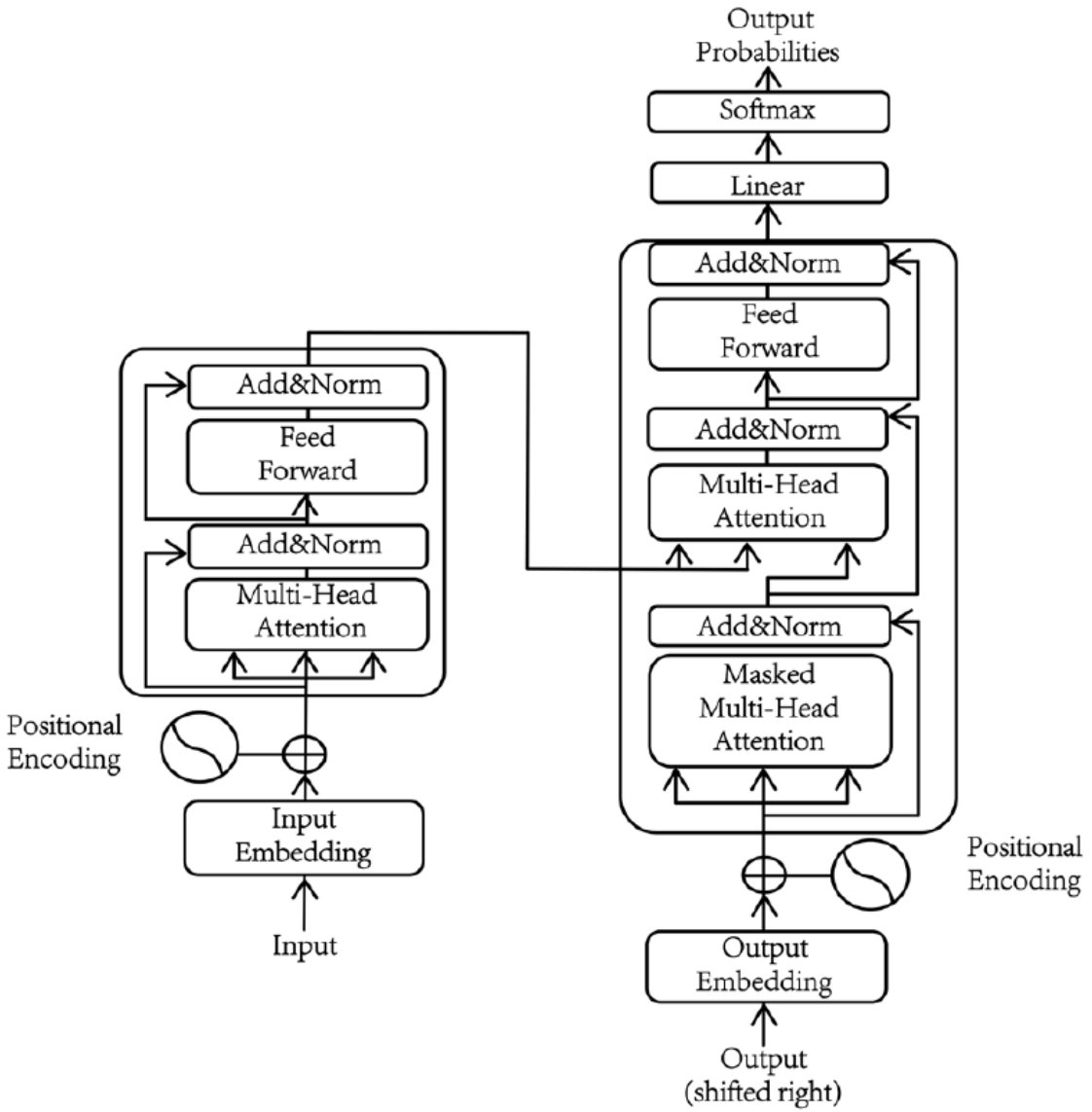
*1 petaflop=$10^{15}$ calculations

The Economist

# Cost of computer storage since the 1950s in dollars (unadjusted) per terabyte

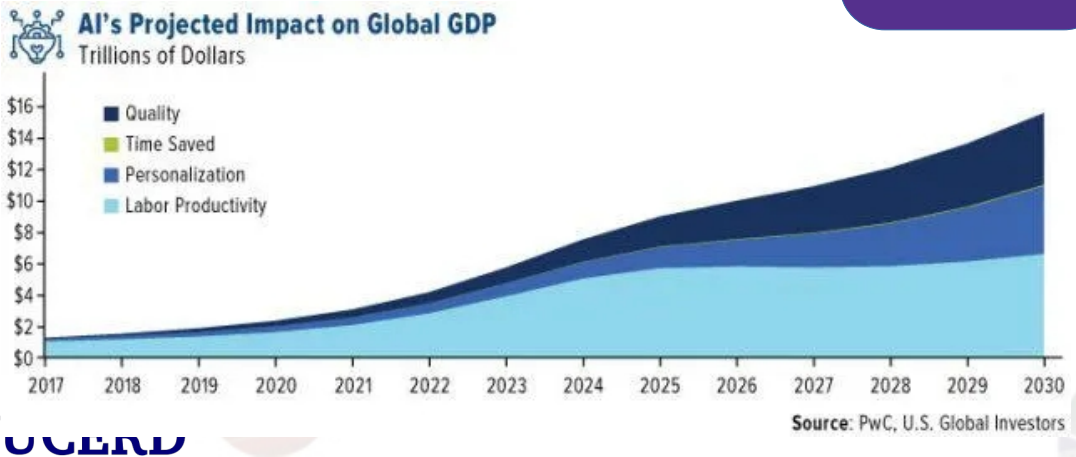


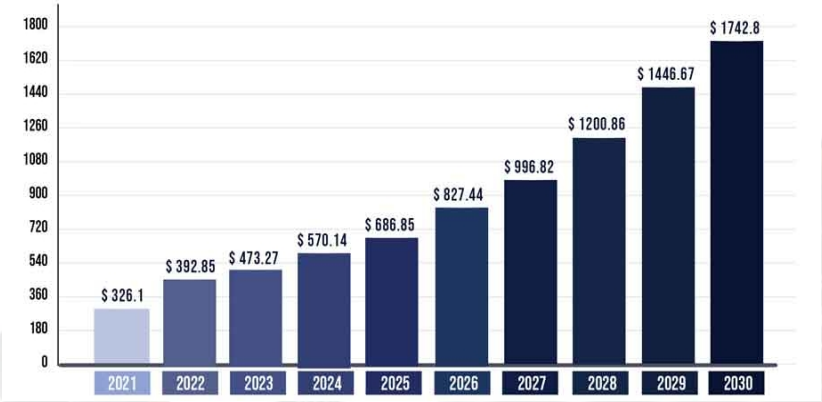

Organization
Google/DeepMind
OpenAI
EleutherAI
Microsoft/Nvidia
Baidu
Anthropic
Meta
Yandex
Hugging Face
Amazon
Cerebras
TII
Bloomberg
Huawei
LAION
Parameters (billion)
$10^3$
$10^2$
$10^1$
$10^0$
GPT-4
PanGu-Σ
GLaM
Megatron-Turing-NLG
PaLM
Minerva
PaLM-2
Gopher
Ernie-3.0-Titan
GPT-3
OPT
BLOOM
LaMDA
Claude-2
Galactica
YaLM-100B
Chinchilla
LLaMA-60B
LLaMA-2-70B
BloombergGPT
Claude
Falcon
GPT-NeoX
AlexaTM
OpenAssistant
Cerebras-GPT
GPT-J
GPT-Neo
GPT-2
BERT
XLNet
2018
2019
2020
2021
2022
2023
Date

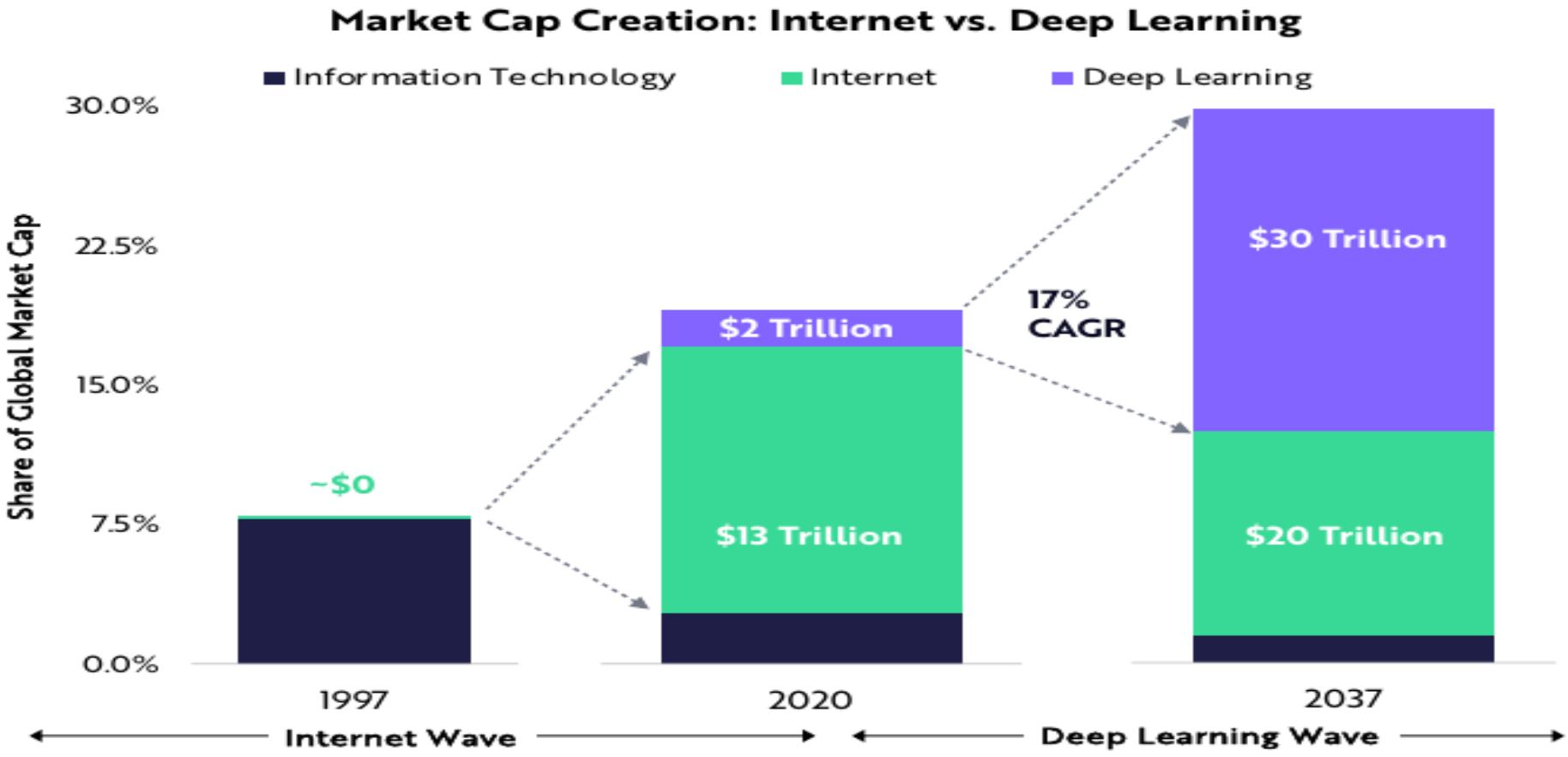

Output
Probabilities
Softmax
Linear
Add&Norm
Feed
Forward
Add&Norm
Multi-Head
Attention
Add&Norm
Masked
Multi-Head
Attention
Positional
Encoding
Output
Embedding
Output
(shifted right)
Add&Norm
Feed
Forward
Add&Norm
Multi-Head
Attention
Positional
Encoding
Input
Embedding
Input

# Market

| | Billion $ | Trillion $ |
|---|---|---|
| BigData | 250 | 3 |
| AI | 150 | 5 |
| Computing<br>Cloud, Bare-metal, Embedded | 600 | 4 |



# Supercomputing for AI

"Artificial Intelligence is a Supercomputing problem."
Jordi TORRES