Advanced Artificial Intelligence
(EE7260)

DEPARTMENT OF ELECTRICAL AND INFORMATION ENGINEERING
UNIVERSITY OF RUHUNA

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<table>
<tr><td>Code</td><td>EE 72xx</td><td>Title</td><td colspan="3">Advanced Artificial Intelligence</td></tr>
<tr><td rowspan="2">Credits</td><td rowspan="2">2.0</td><td colspan="2">Lecture Hours/Semester</td><td>20 Hr</td><td>Core/TE/GE</td><td>TE</td></tr>
<tr><td colspan="2" rowspan="2">Workshop Hours/Semester</td><td rowspan="2">16 Hr</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>GPA/NGPA</td><td>GPA</td><td>Pre-requisites</td><td>EE5253, EE6350</td></tr>
<tr><td colspan="2">Aim</td><td colspan="5">The aim is to equip students with advanced knowledge and practical skills in advanced artificial intelligence techniques, with a particular focus on natural language processing, generative models, and AI system deployment.</td></tr>
<tr><td colspan="2">Learning Outcomes</td><td colspan="5">Upon successful completion of this module, students will be able to:

LO-1 Preprocess raw text data by applying NLP techniques and generate feature representations and word embeddings

LO-2 Design and implement transformer-based models for an NLP task and create effective prompts for few-shot and zero-shot learning

LO-3 Build and evaluate a Variational Autoencoder and a Generative Adversarial Network to solve a defined task with measurable performance metrics

LO-4 Create a fully functional AI pipeline that includes preprocessing, modelling, and deployment for a real-world scenario</td></tr>
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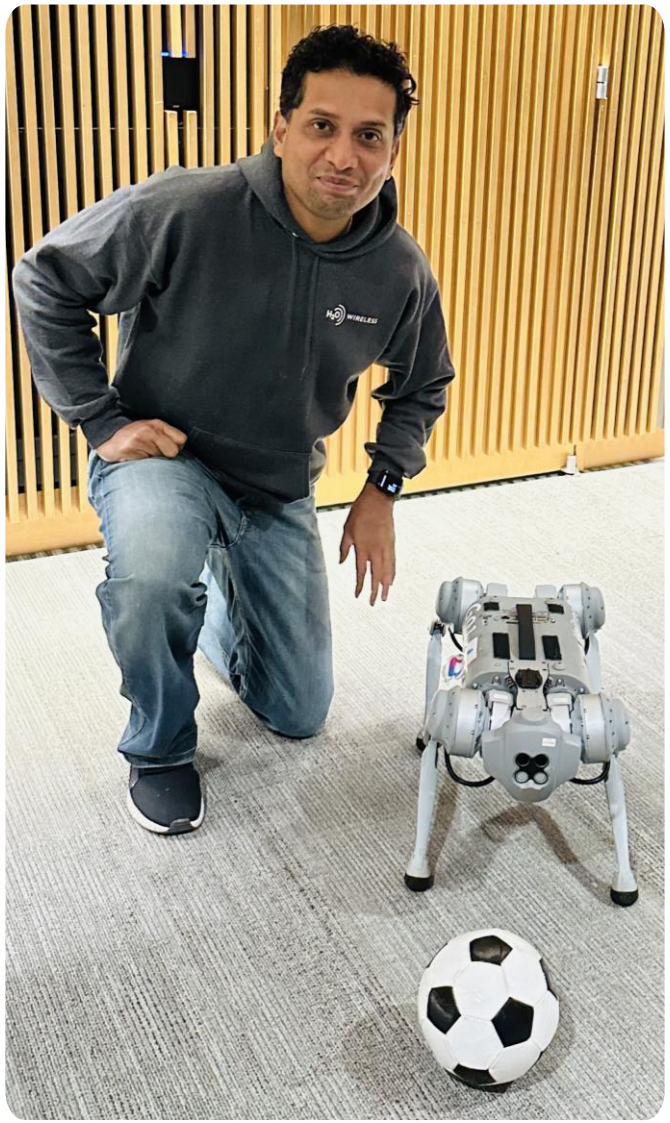

Bio

- Head of Delivery - Enterprise Applications – Virtusa
- Director of Delivery (IT) – Virtusa
- Sr. Program Manager – Cognizant
- Technical Program Manager/Director for various clients

- Boston University – MSc (AI & ML)
- University of Peradeniya, Faculty of Computer Engineering - BSc
- Massachusetts Institute Technology (MIT) – PgDip

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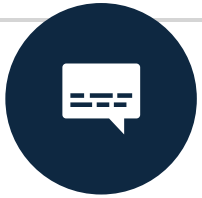
Course Structure



Section 1:

Text Preprocessing and Representation

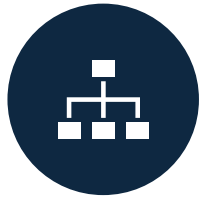
Section 2:

Word Embeddings

Section 3: Transformer Architecture

Section 4: Applications of Transformers and LLMs (LLM Fine Tune)

Section 6: Autoencoders and Variants



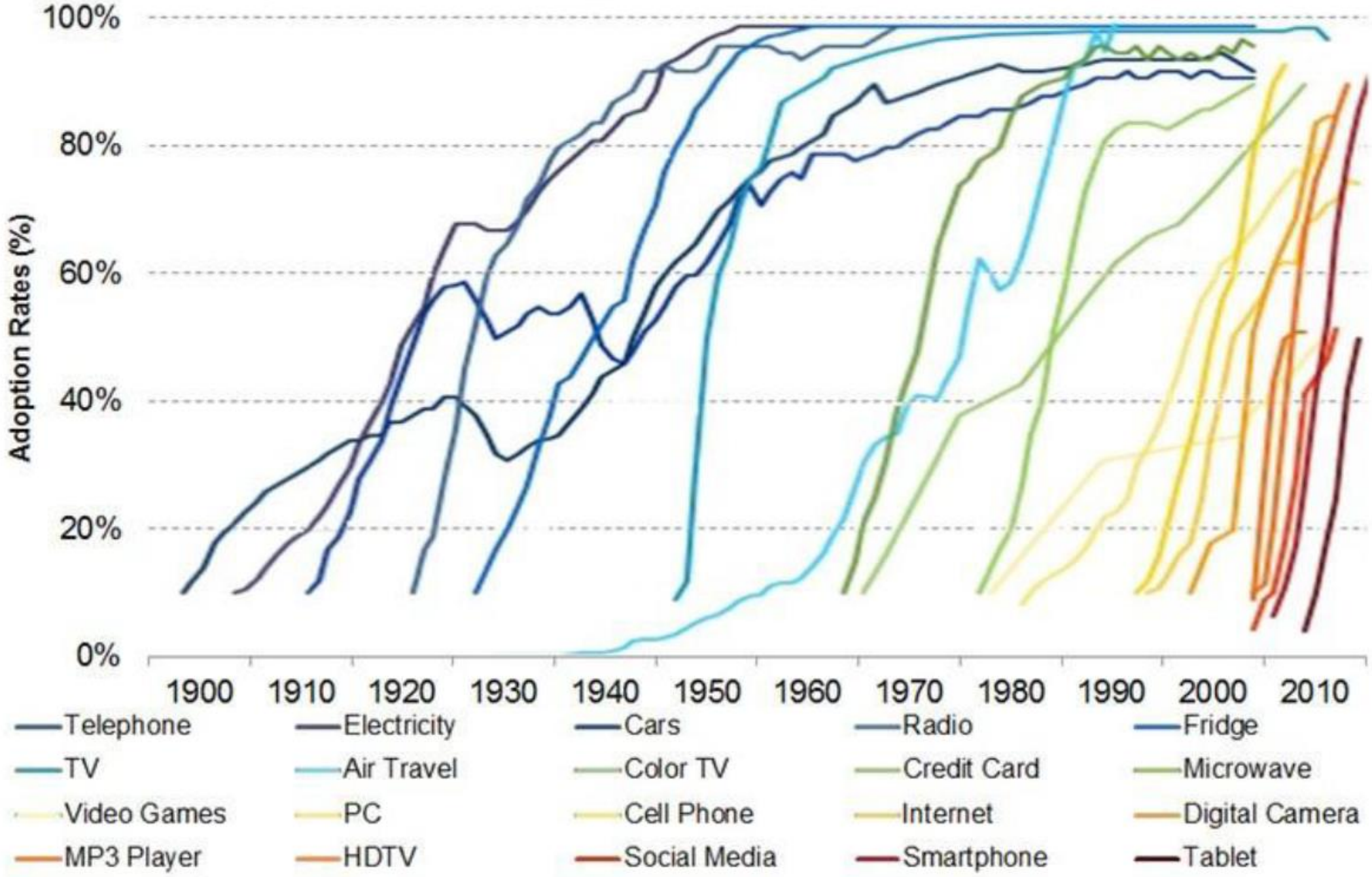
Section 7: Generative Adversarial Networks (GANs)

Section 5:

Prompt Engineering

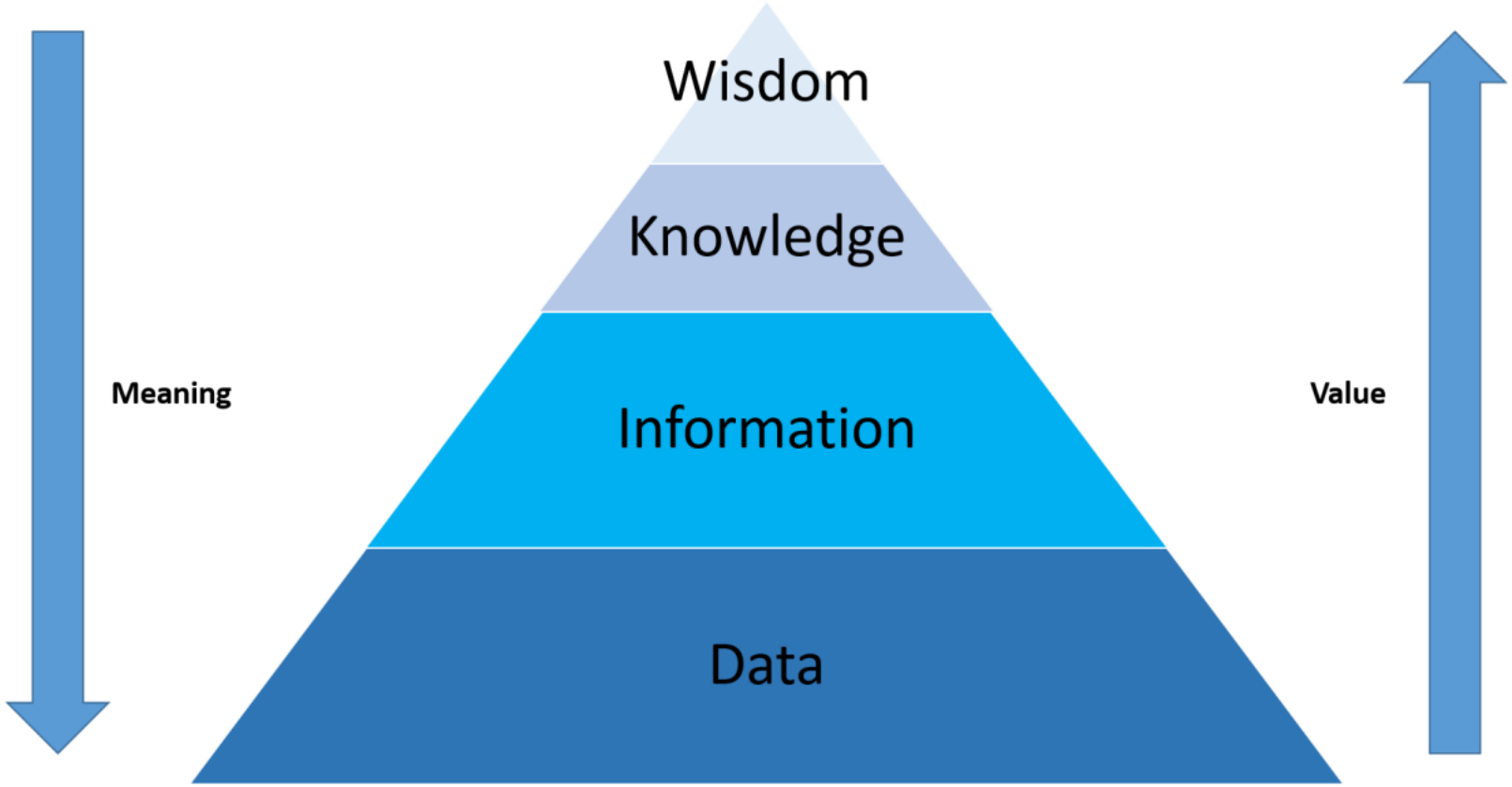
Section 8-10: MLOps (Overview, Pipelines, Scaling)

Why AI ?

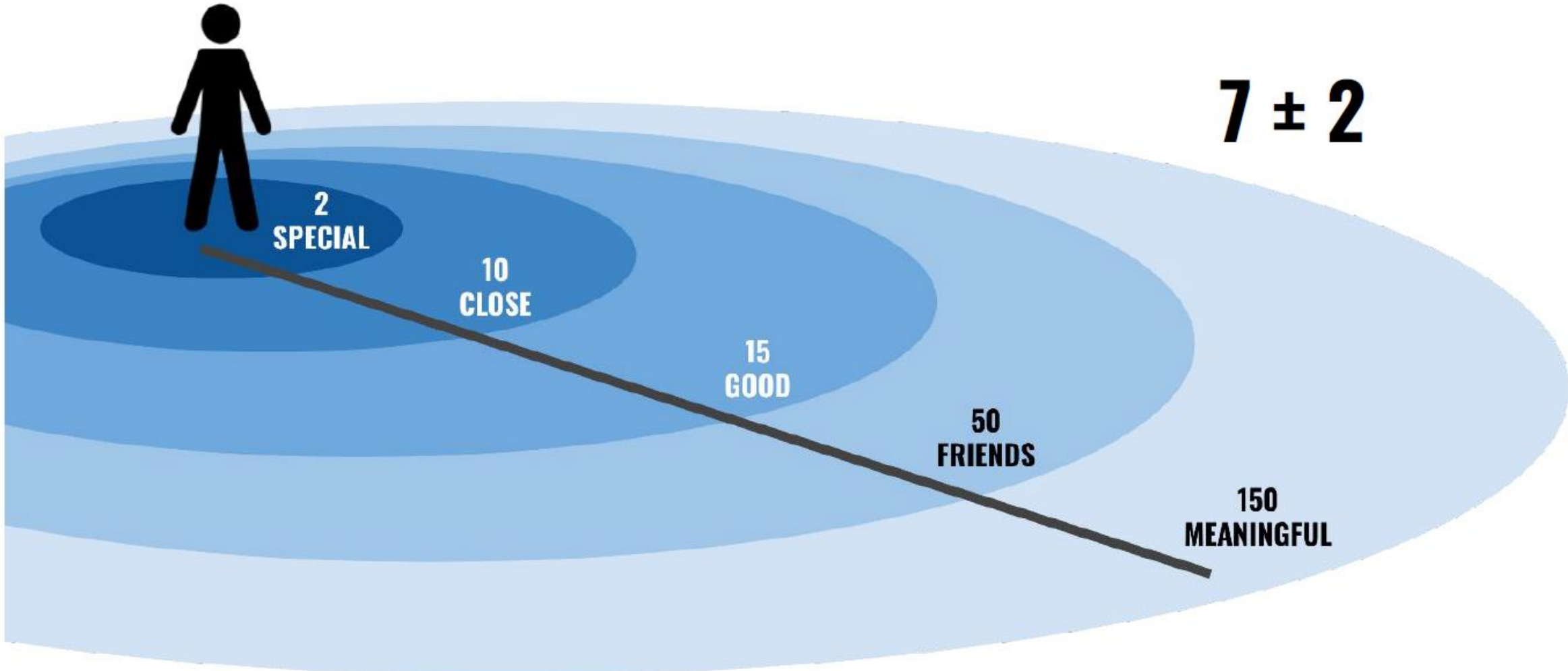

100%
80%
60%
40%
20%
0%
Adoption Rates (%)
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Telephone
Electricity
Cars
Radio
Fridge
TV
Air Travel
Color TV
Credit Card
Microwave
Video Games
PC
Cell Phone
Internet
Digital Camera
MP3 Player
HDTV
Social Media
Smartphone
Tablet

Data > Value

DIKW Pyramid of Data (Science)



Human Limitations



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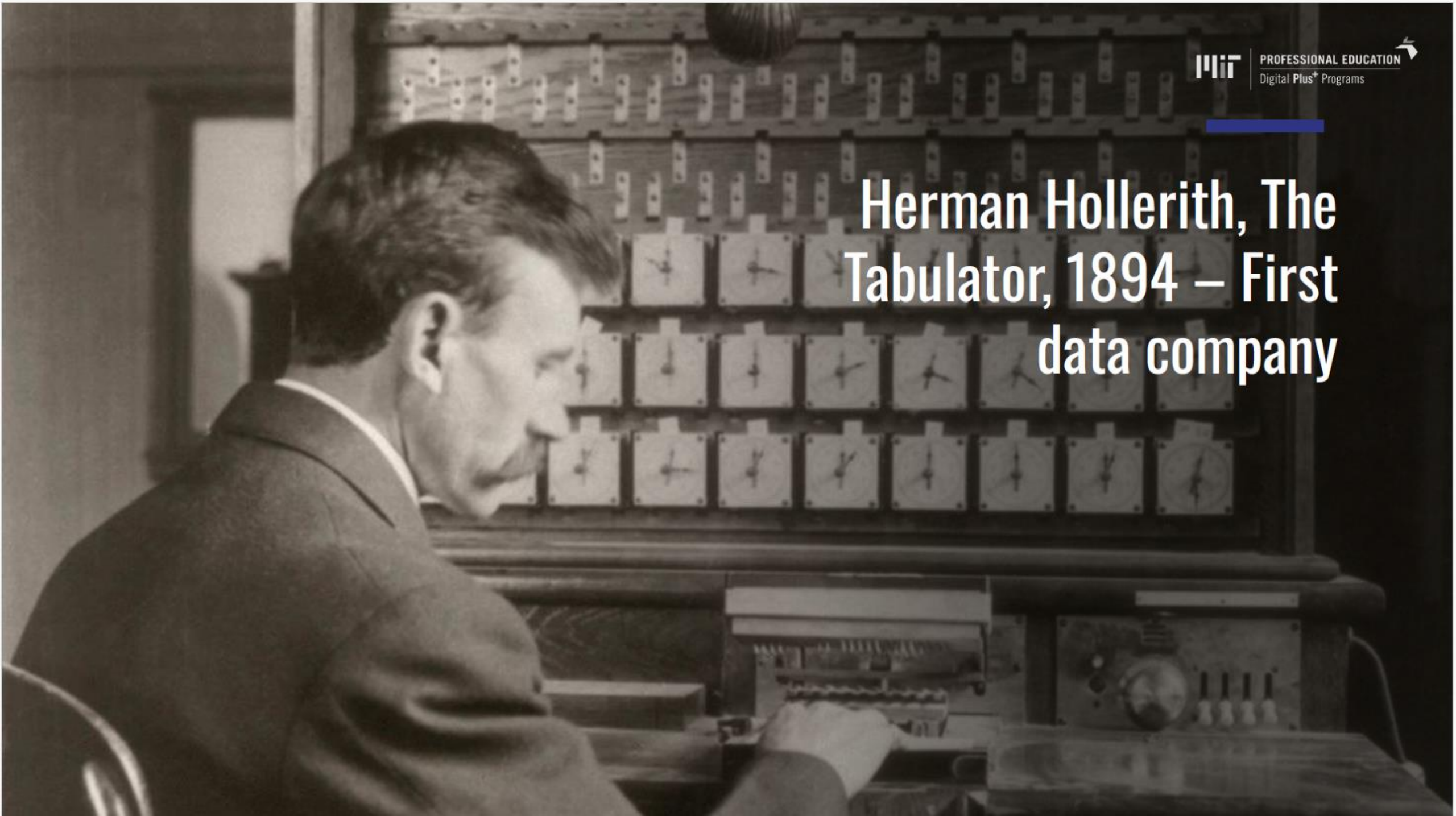
PROFESSIONAL EDUCATION
Digital Plus* Programs
We used to collect
data by hand

We used to process it
by hand
PROFESSIONAL EDUCATION
Digital Plus+ Programs

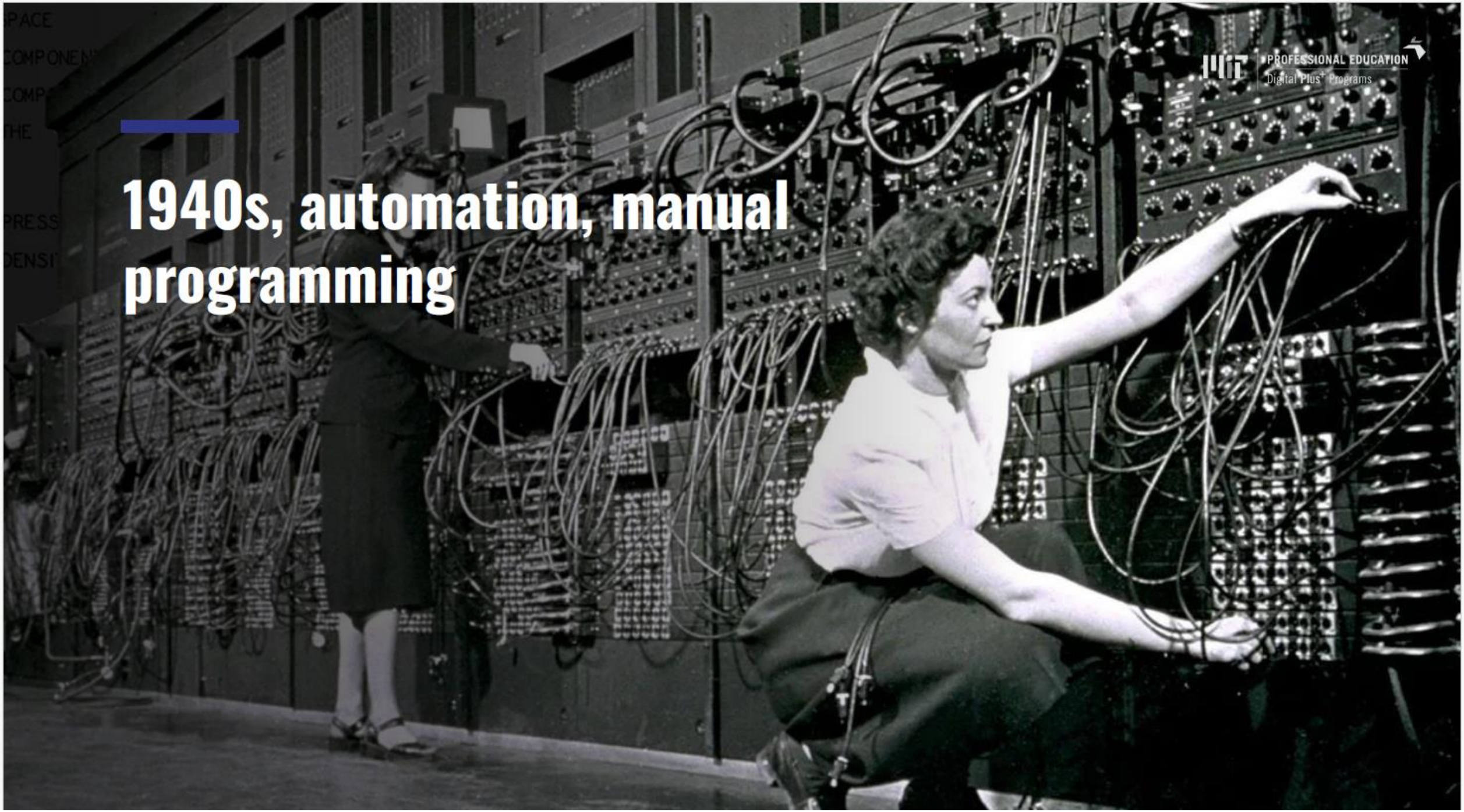


PROFESSIONAL EDUCATION
Digital Plus+ Programs

Herman Hollerith, The Tabulator, 1894 – First data company

PROFESSIONAL EDUCATION
Digital Plus+ Programs

1920s, human layers of integration



1940s, automation, manual programming

1960s, capturing instructions

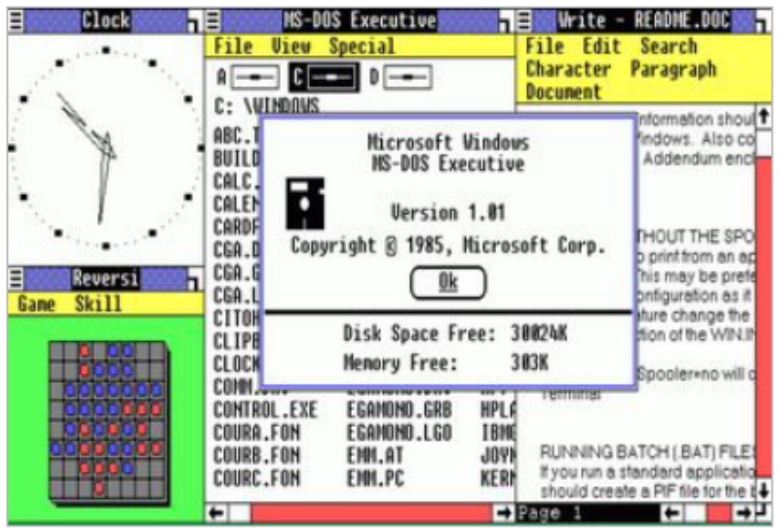
1982

Really easy, right?

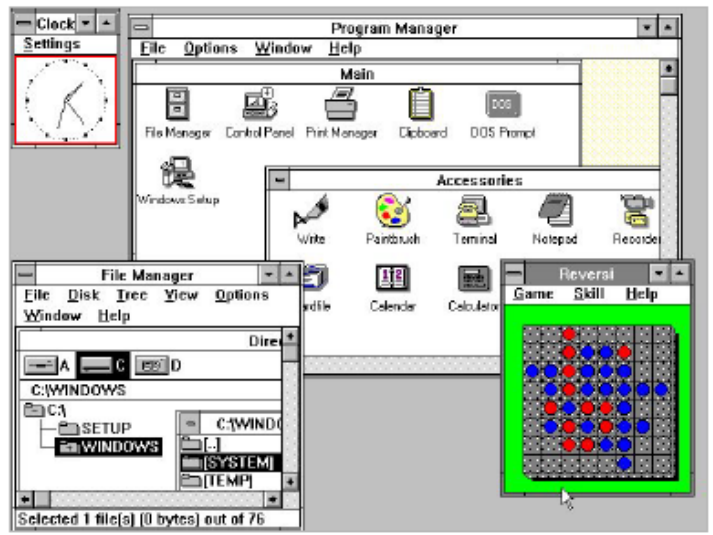
```
Starting MS-DOS...


HIMEM is testing extended memory...done.

C:\>C:\DOS\SMARTDRV.EXE /X

MODE prepare code page function completed

MODE select code page function completed
C:\>dir

 Volume in drive C is MS-DOS_6
 Volume Serial Number is 40B4-7F23
 Directory of C:\

DOS             <DIR>          12.05.20   15:57
COMMAND  COM         54 645 94.05.31    6:22
WINA20   386          9 349 94.05.31    6:22
CONFIG   SYS            144 12.05.20   15:57
AUTOEXEC BAT            188 12.05.20   15:57
        5 file(s)          64 326 bytes
                       24 760 320 bytes free

C:\>_
```

Graphical User Interface (GUI)

Windows 1.0



Windows 3.0



Windows 95

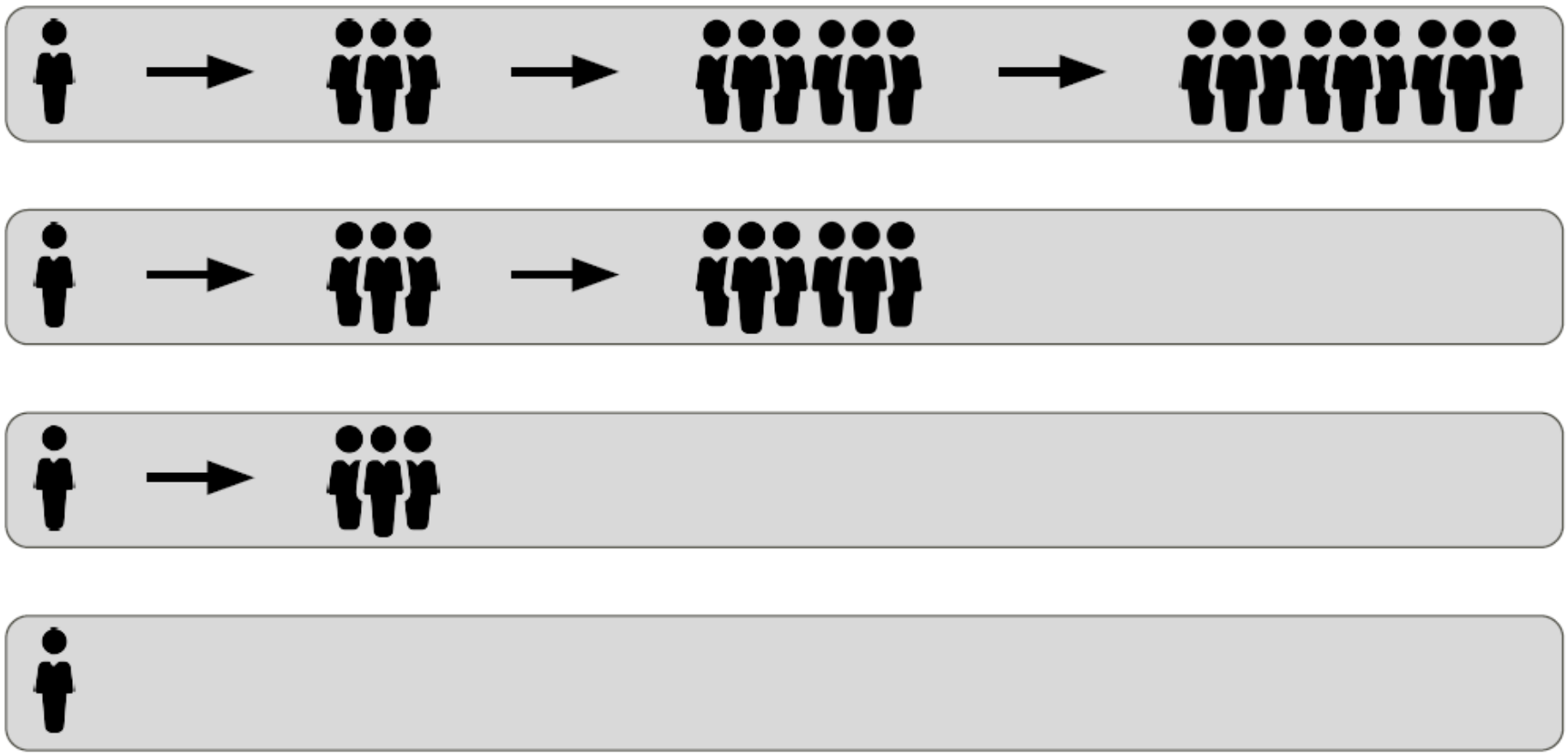
80s/90s, GUIs

Generative AI

We have have arrived at making requests in plain language

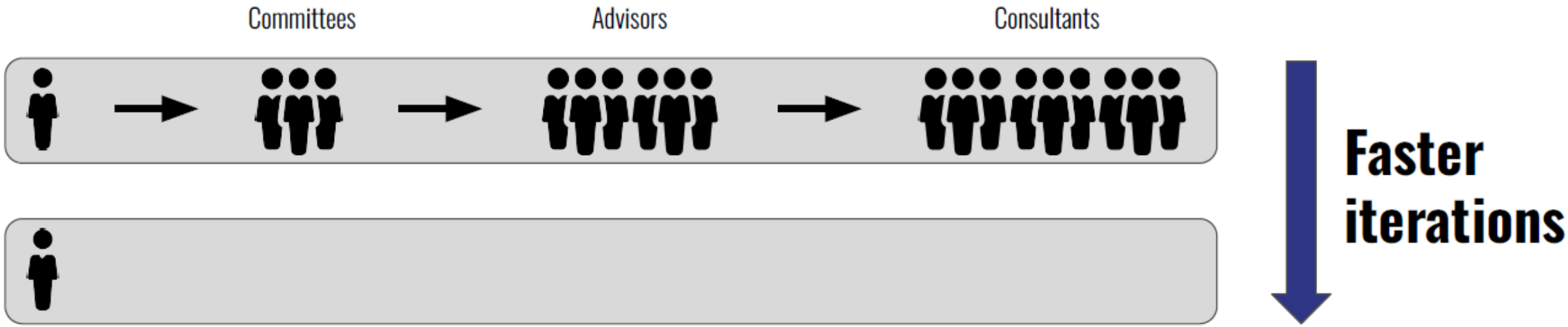
(not like Alexa)

Time to value



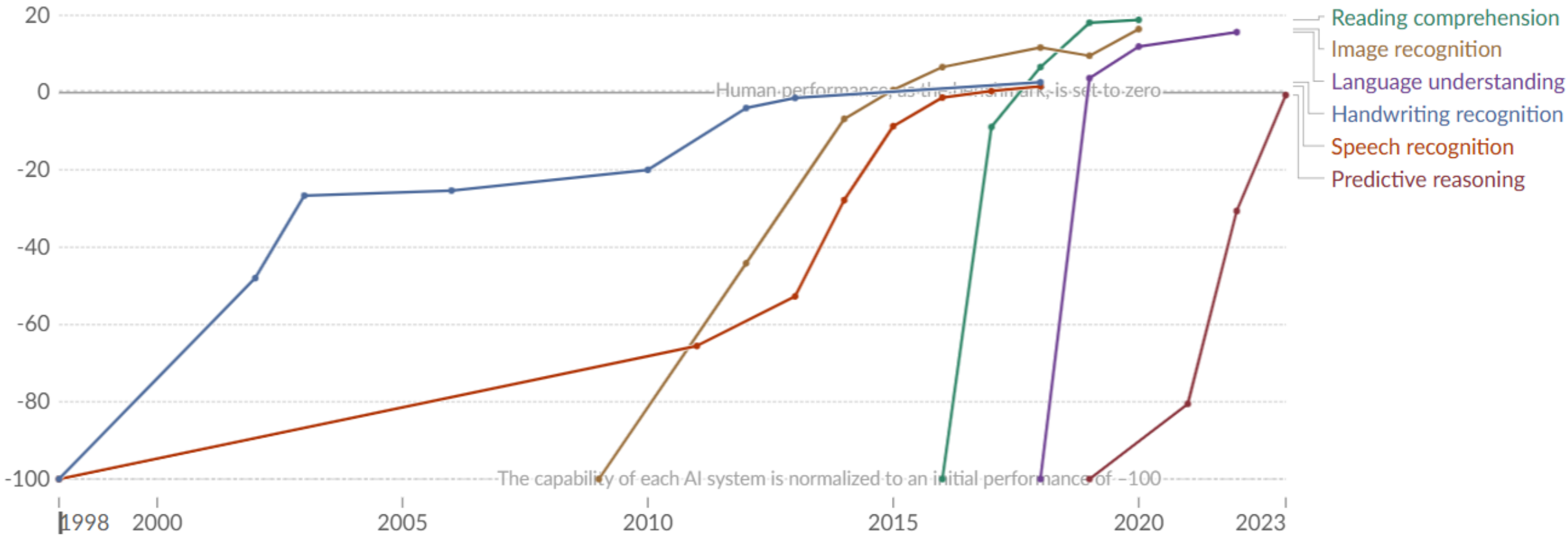
Faster Decisions

Post-ChatGPT, Moving at the speed of thought



How far can it go?

Test scores of AI systems on various capabilities relative to human performance



https://ourworldindata.org/grapher/test-scores-ai-capabilities-relative-human-performance

Generative A.I. Can Add $4.4 Trillion to Global Economy

McKinsey: Generative AI set to add $4.4 trillion to global economy annually.

https://www.nytimes.com/2023/06/14/technology/generative-ai-global-economy.html

The New York Times

A.I. and Chatbots › | Explore Milan With A.I. | Testing a Tutorbot | Chatbot Prompts to Try | A.I.'s Literary Skills | Wh

Generative A.I. Can Add $4.4 Trillion in Value to Global Economy, Study Says

The report from McKinsey comes as a debate rages over the potential economic effects of A.I.-powered chatbots on labor and the economy.

Research Areas for (Gen) AI field

Effectiveness

- Reasoning Capabilities (Decision making with logical reasoning)
- Meaningful context (Context awareness, long-range dependencies)
- Explainable AI (Transparency)

Efficiency improvement:

- More efficient AI architecture (Low watt per token)
- “The bigger the better!” should not be true for model training and constriction of foundation models
- Training models with small number of data sets
- Multi-modal capabilities
- Agentic AI