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AI IMPACT 2024
40th Annual FPC Seminar + Expo
Sept 29 - Oct 1, 2024

AI: Its Contribution to Evidence-Based Design

Course Number: AHCA 2024.04

Credit Designation: 1 LU/HSW

AIA CES Provider Number: E240

September 30, 2024

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AIA Learning Objectives

1 OBJECTIVE

Explain the basics of how AI works in the context of EBD for improved patient health and safety.

2 OBJECTIVE

Appreciate the potential for AI to reshape much of the health care design landscape based of EBD.

3 OBJECTIVE

Understand the challenges of creating good, high quality AI integration processes.

4 OBJECTIVE

Recognize that AI is an imperfect tool to be used with caution and care in applying it to EBD to improve patient health, safety and welfare.

Artificial Intelligence:
What is its role in Evidence-based Design?

By

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Director, Center for Health Systems & Design
Texas A&M University

Agenda

Artificial Intelligence & *Evidence-Based design*

1. A Peek Behind the AI Curtain
2. Keys to/ Challenges to AI Success
3. Big Design Data in AI: EBD?
4. Where to Focus: EBD meets AI

EBD

At its core…

EVIDENCE-BASED DESIGN

Evidence-based Design (EBD) is:

"The deliberate attempt to base design decisions on the best available research evidence."(1)

1 D. Kirk Hamilton, PhD, FAIA, FACHA, FCCM. (July 15, 2020). Evidence-Based Practice: Four Levels Revisited, HERD: Health Environments Research & Design Journal, Sage Publications, https://doi.org/10.1177/1937586720931064

AI:1

At its core…

ARTIFICIAL INTELLIGENCE APPROACHES

Automated Reasoning *(Expert)* Based on ***Rules***

1 Colson, Jim. An Introduction to AI (July 26, 2024). ACHA - AIA-CAH Summer Leadership Summit, Denver, CO.

AI:1
Automated Reasoning

EXPERT SYSTEMS

Using **rules**.

IF: Game pieces in this configuration…

THEN: Rules generate choices for moves.

Sometimes called “Brute Force” approach.
(Deep Blue IBM chess)

Example: Chess, Alpha Go, Solitaire

1 Mark Clayton, PhD, CEO, SmartReview.

AI:1
Automated Reasoning

EXPERT SYSTEMS

Using **situations**/ contexts.

IF:	THEN:
A condition.....	*Interpretation of the condition*
A situation.....	*Judgement on proceeding*
A goal.....	*Direction on making progress*

Example: Simple decision trees, If....Then

AI:1
Automated Reasoning

EXPERT SYSTEMS

Using **requirements**.

IF: Rooms are in this configuration…

THEN: Requirements say add a fire exit.

Example: Automated building code review

1 Mark Clayton, PhD, CEO, SmartReview.

AI:2

At its core…

ARTIFICIAL INTELLIGENCE APPROACHES

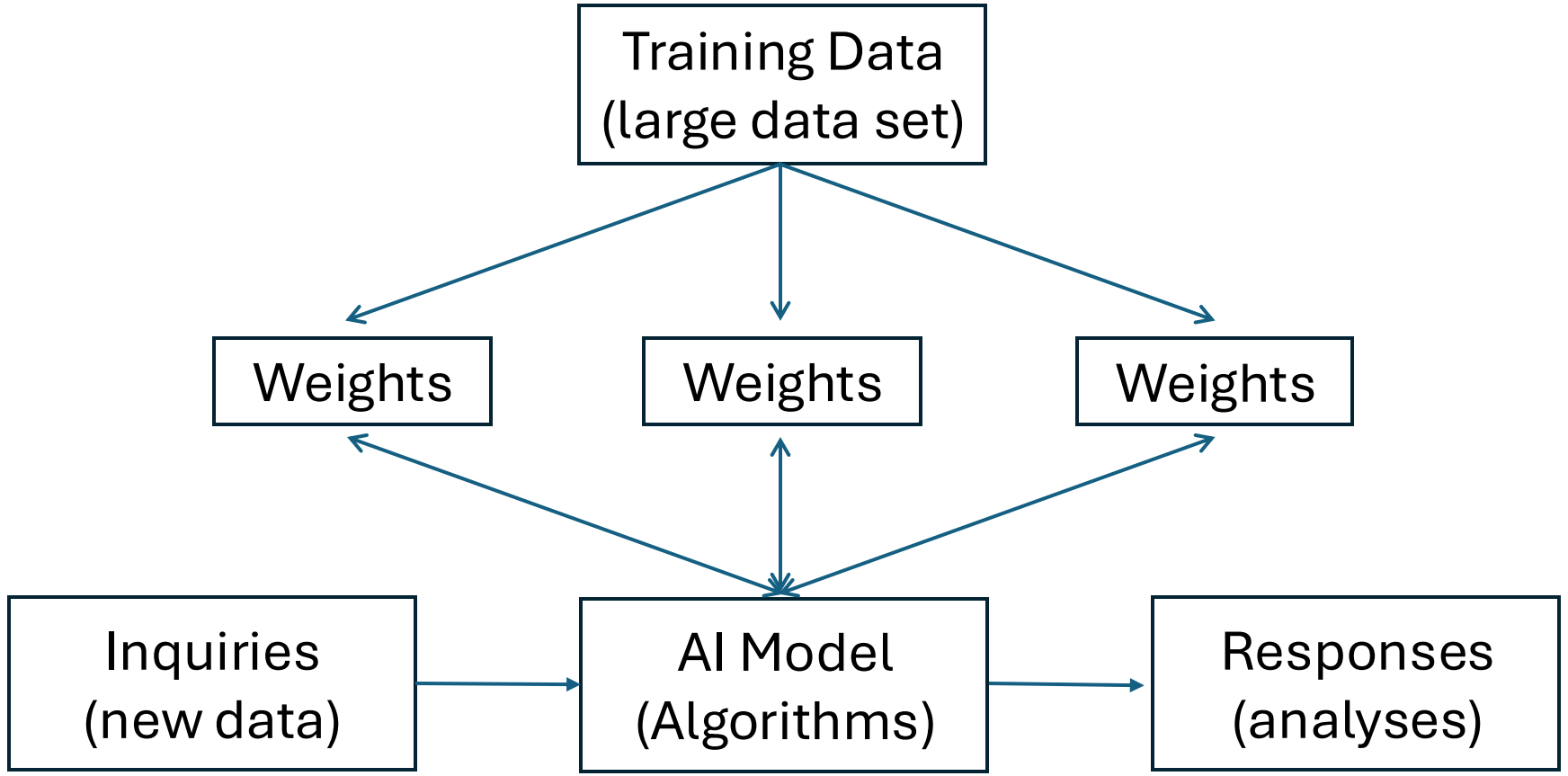
Machine Learning

Based on ***Data***

1 Colson, Jim. An Introduction to AI (July 26, 2024). ACHA - AIA-CAH Summer Leadership Summit, Denver, CO.

AI:2
Machine Learning

MACHINE LEARNING



1 Colson, Jim. An Introduction to AI (July 26, 2024). ACHA - AIA-CAH Summer Leadership Summit, Denver, CO.

AI:2
Machine Learning

MACHINE LEARNING

“Labeled Data” prescribed clusters

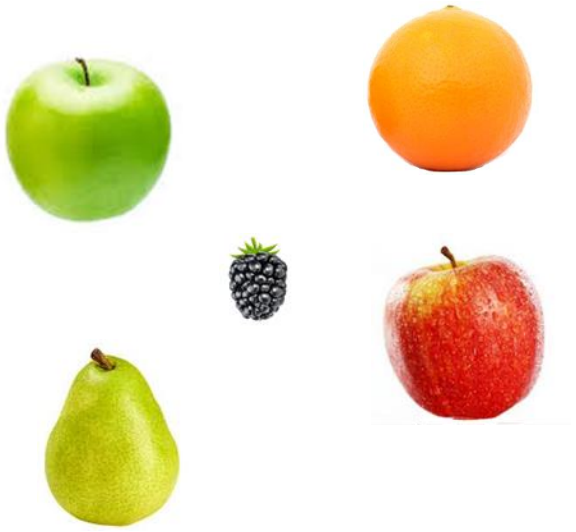
Labels:	Identity:
Red, round, baseball size.....	Apple
Yellow, long, skinny.....	Banana
Green, heavy, basketball size.....	Watermelon

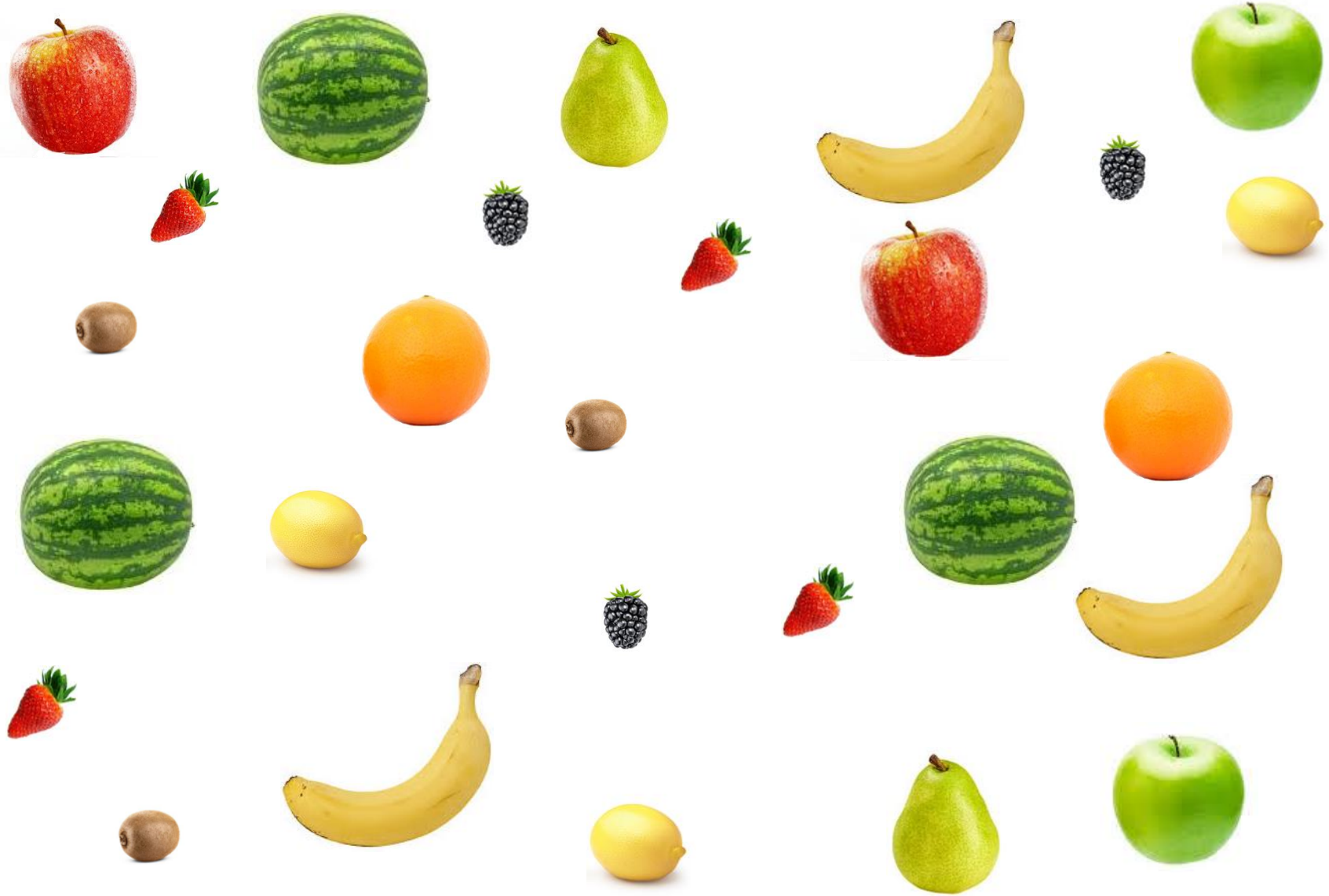
Example: Finding high risk patients, Sorting items

AI:2

And then…

The World of Fruit



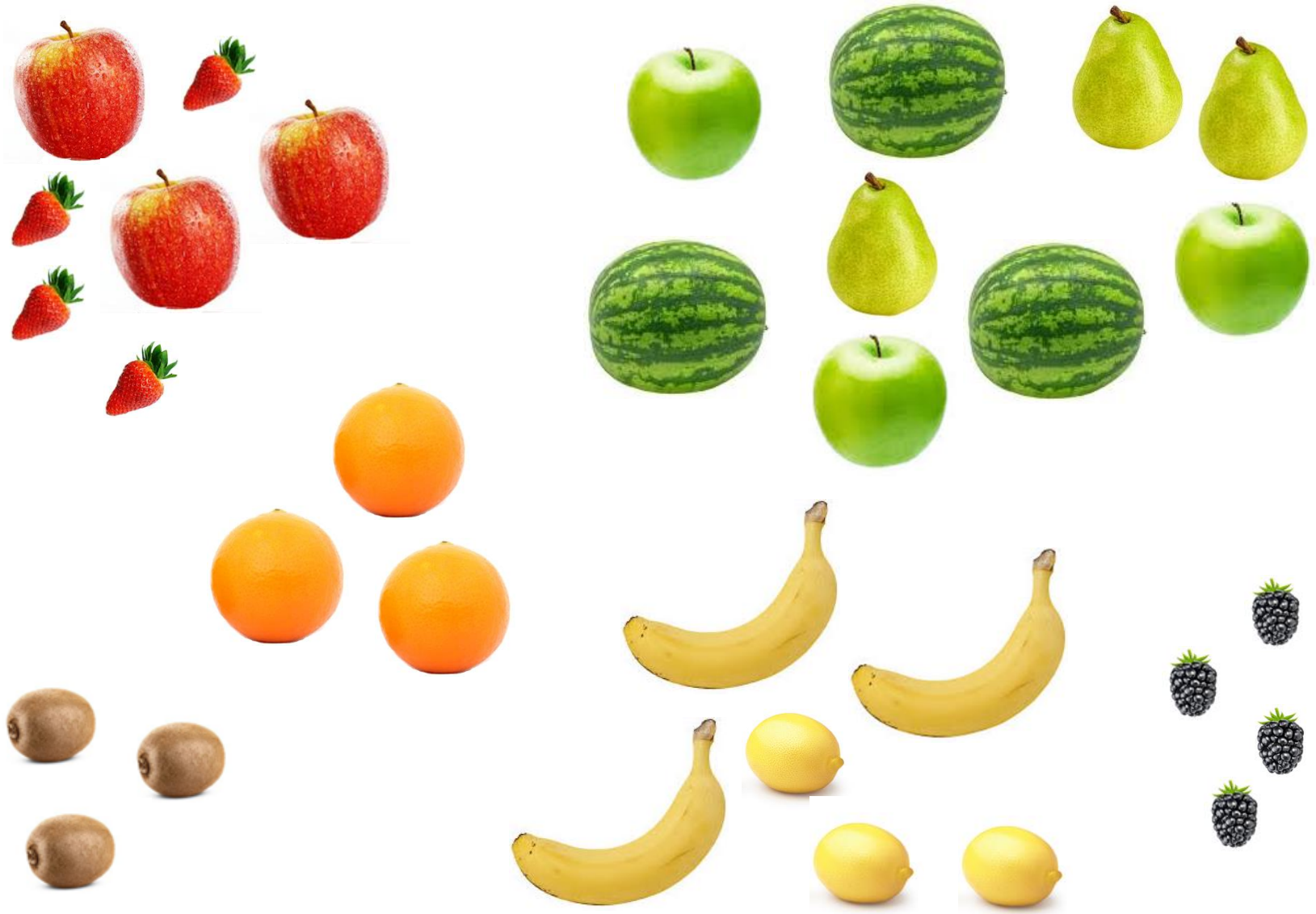


AI:2

And then…

Cluster:
The World of Fruit

By:
Object Color

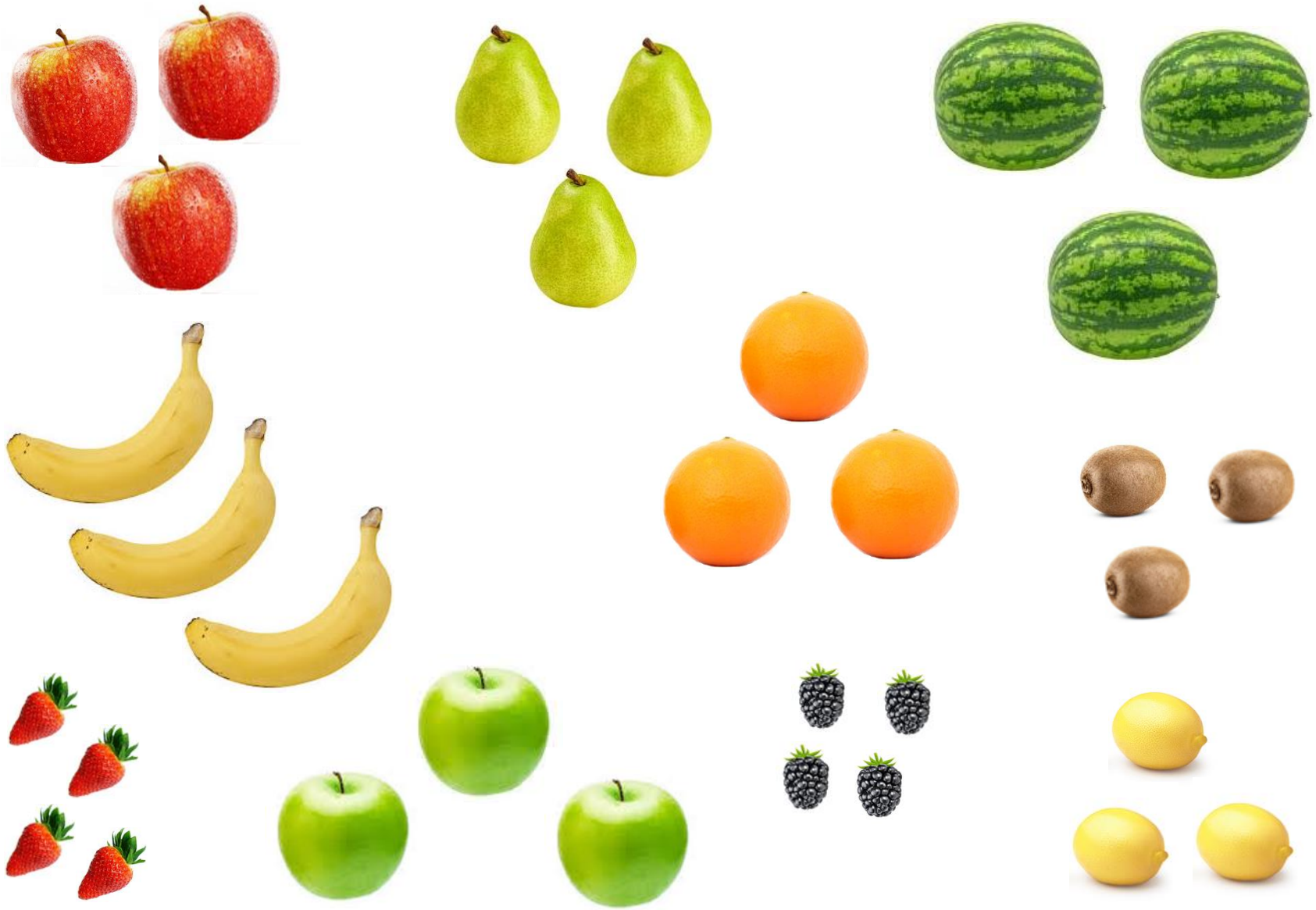


AI:2

And then…

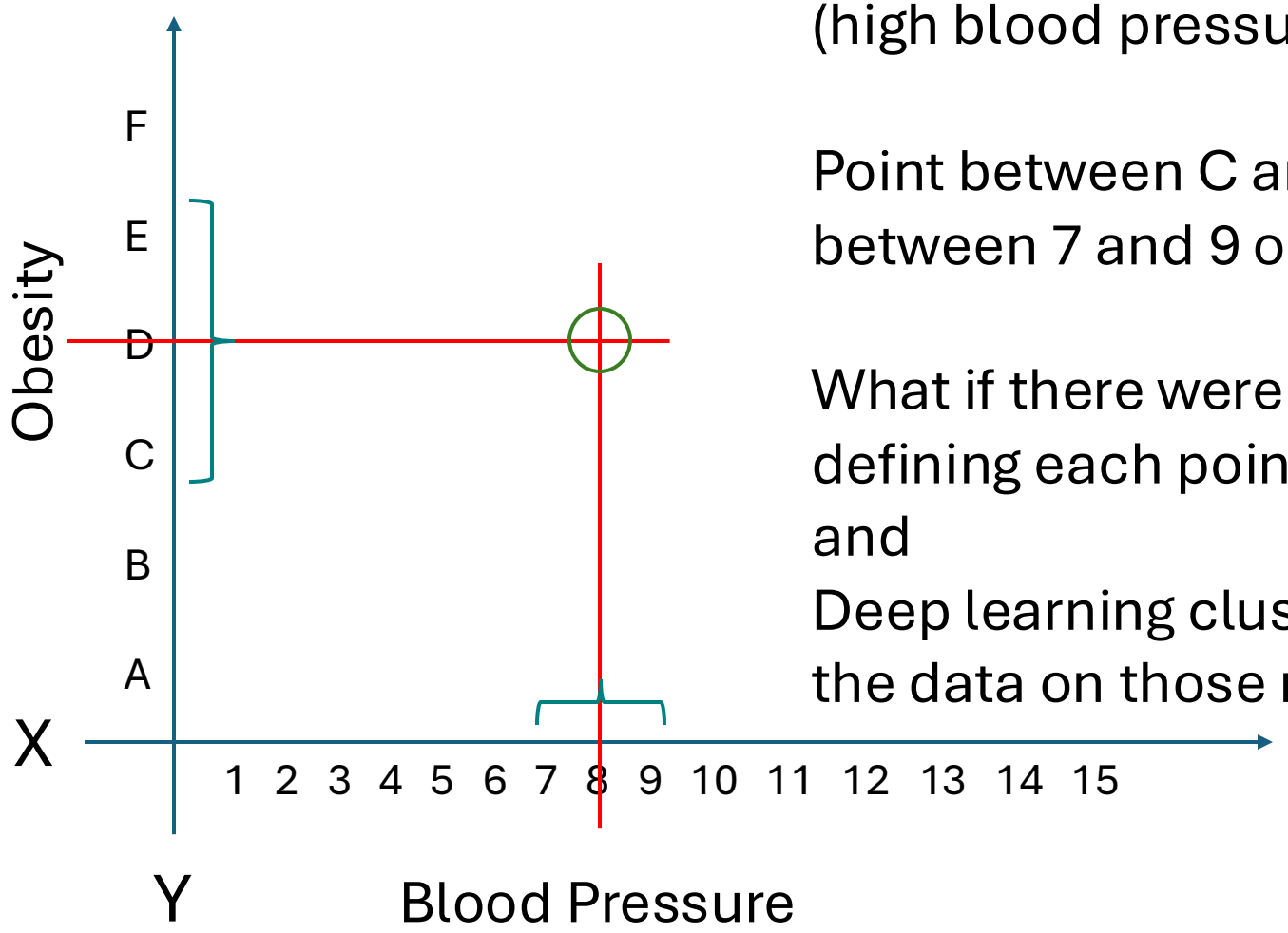
Cluster:
The World of Fruit

By:
Many Different Object Characteristics



AI:3

Deep Learning:
Multi-dimensional clusters, unknown parameters



2-D Relational data point D8…
What if this is a person/ patient?
(high blood pressure, obese)

Point between C and E and between 7 and 9 on two axes.

What if there were many axes defining each point/ patient…
and
Deep learning clusters around the data on those many axes.

AI:3

And now…

Deep Learning:
Cluster Results:

Yes disease

Biomarker
Pattern

AI:3

Deep Learning: Clustering into the unknown

MACHINE LEARNING

“Labeled Data” clusters

but humans didn’t define the clusters!

IF:	THEN:
Pattern: V1, V2, V3, V4, V5, V9	*Cancer probability*
Pattern: V3, V66, V73, V80, V94	*Heart disease probability*

Example: Discovering new pathology bio-markers

AI:4

And now…

Frontier Learning:
Unlabeled data is
the AI “wild west”

MACHINE LEARNING

“Unlabeled Data”

Data uncurated! Value unknown! 10C

Images	Audio/ video recordings
Articles	Social media posts
Medical scans	News articles

Example: ChatGPT – *the fortune-teller*

Agenda

Artificial Intelligence & *Evidence-Based design*

1. A Peek Behind the Curtain
2. **Keys to/ Challenges to Success**
3. Big Design Data in AI: EBD?
4. Where to Focus: EBD meets AI

Keys/ Challenges

AI models are **ridiculously data-hungry**, and AI companies have relied on vast troves of data scraped from the web in order to train the ravenous programs.(1)

1 Maggie Harrison Dupre, 2024 AI Appears to Be Slowly Killing Itself (futurism.com)

Keys/ Challenges 1

Data quality: The 10 C’s

1) **Complete:** No gaps in the information collected or provided

2) **Correct:** Data is accurately collected or provided, cleaned for errors

3) **Current:** Data is the latest, or most recently gathered and available

4) **Credible:** Data can be believed and trusted

5) **Captured:** Data actually collected, not just theoretically available

Keys/ Challenges 1

Data quality: The 10 C's

6) **Clear/ Confidence:** Data is valid conveying right information

7) **Confidential:** Data can be managed for privacy/ anonymity

8) **Context:** Data origins, values, meaning, descriptors known

9) **Cataloged:** Data accessible/ searchable in usable format

10) **Compatible:** Data can be linked to other data for study

Keys/ Challenges 2

Data volume: Overwhelming

300 million books of personal health [1]

4000 new health research articles/ day [2]

29 hours to stay current [3]

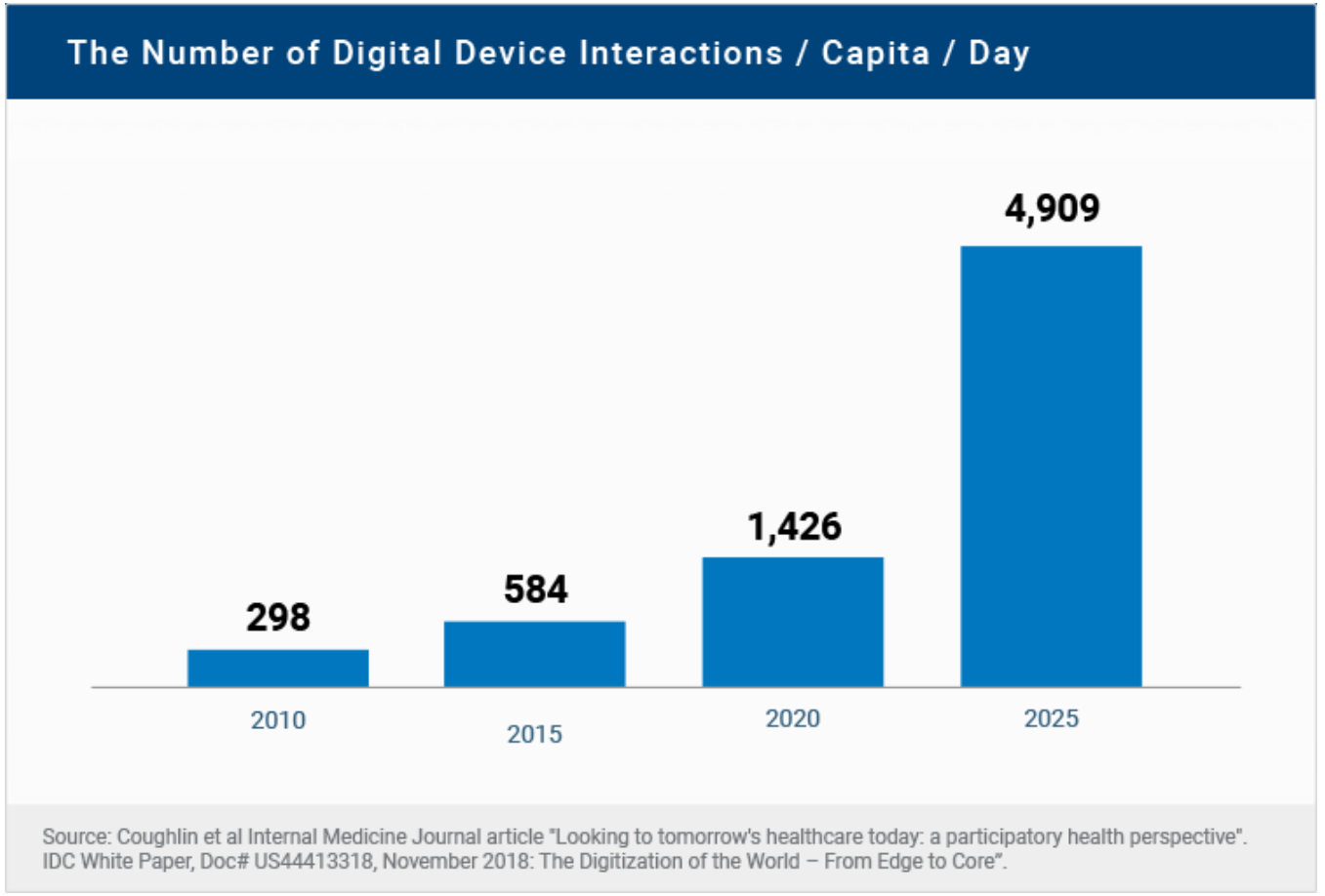
1 https://artsandculture.google.com/asset/ibm-announces-new-watson-health-unit-ibm-watson-media/2gGpIY4yvnJfXA?hl=en

2 Levin, Michael, "I love AI because it will add decades to our lives,"(August 29, 2023) https://www.foxnews.com/opinion/i-love-ai-because-add-decades-our-lives

3 McConaghie, Andrew, IBM Watson: a holistic approach, Deep Dive Magazine, PharmaPhorum, November 2016.

Keys/ Challenges 2

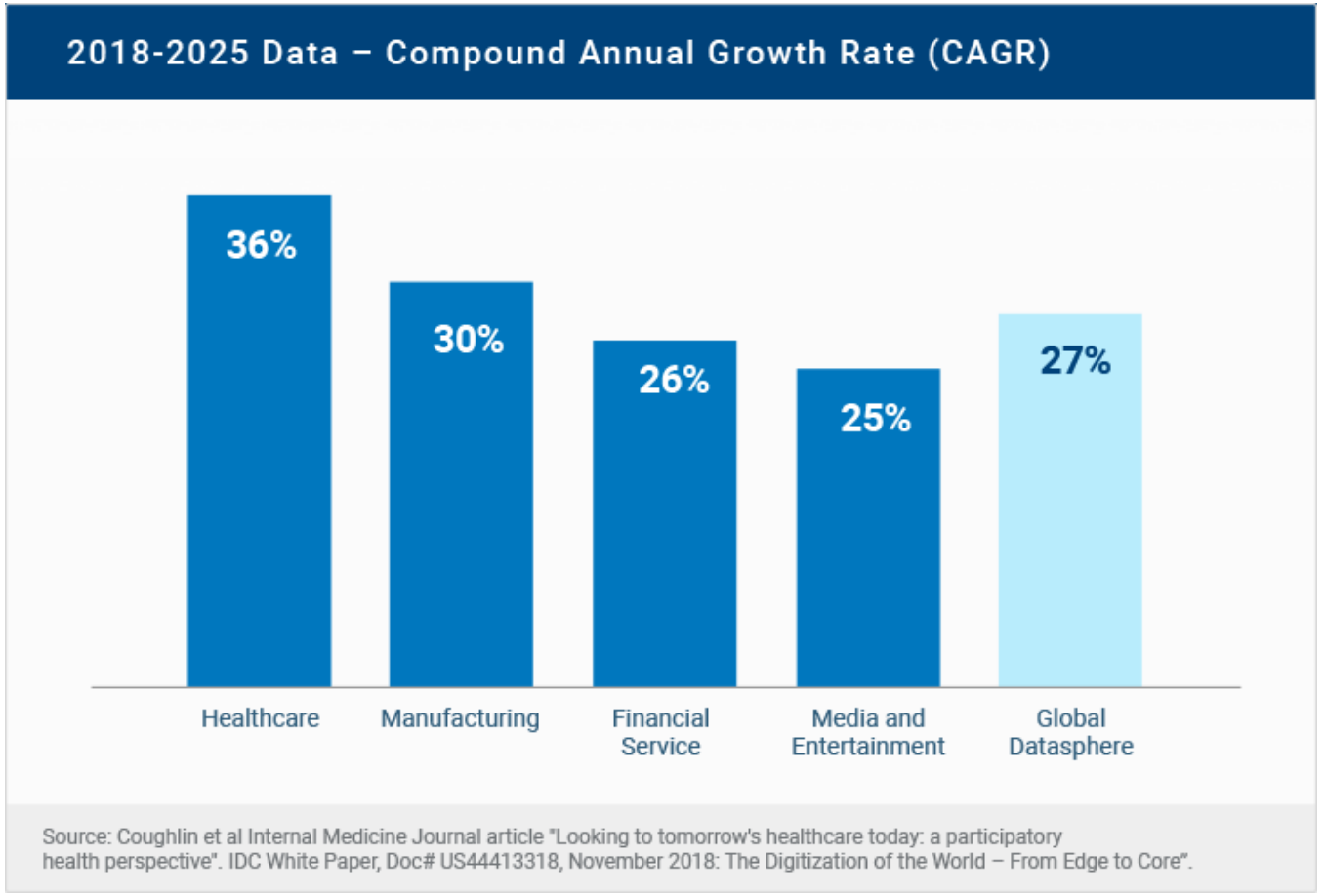
Data Volume:[1]



1 Wiederrecht, G., Darwish, S., Callaway, A., https://www.rbccm.com/en/gib/healthcare/episode/the_healthcare_data_explosion#:~:text=Today%2C%20approximately%2030%25%20of%20the,%25%20faster%20than%20media%20%26%20entertainment.

Keys/ Challenges 2

Data Volume(1)



1 Wiederrecht, G., Darwish, S., Callaway, A., https://www.rbccm.com/en/gib/healthcare/episode/the_healthcare_data_explosion#:~:text=Today%2C%20approximately%2030%25%20of%20the,%25%20faster%20than%20media%20%26%20entertainment.

Keys/ Challenges 3

Recent progress in AI largely

boils down to one thing:

Scale.[1]

1 Dorrier, Jason, AI Models Scaled Up 10,000x Are Possible by 2030, Report Says (singularityhub.com)

Keys/ Challenges 3

Power is the biggest constraint to scaling[1]

Meta's latest frontier model was trained on 16,000 of Nvidia's most powerful chips drawing 27 megawatts of electricity.

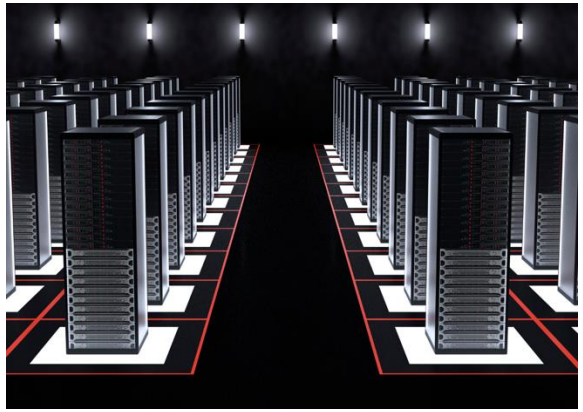
This, according to Epoch, is equal to the annual power consumption of 23,000 US households.

But even with efficiency gains, training a frontier AI model in 2030 would need 200 times more power, or roughly 6 gigawatts.

That's 30 percent of the power consumed by all data centers today.

1 Dorrier, Jason, AI Models Scaled Up 10,000x Are Possible by 2030, Report Says (singularityhub.com)

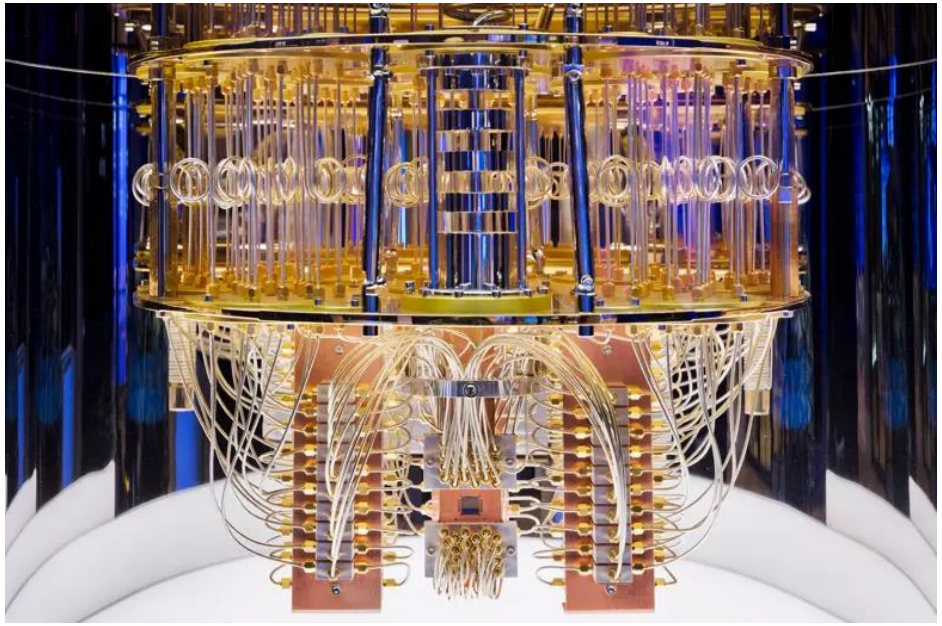
Keys/ Challenges 4



Computing Speed

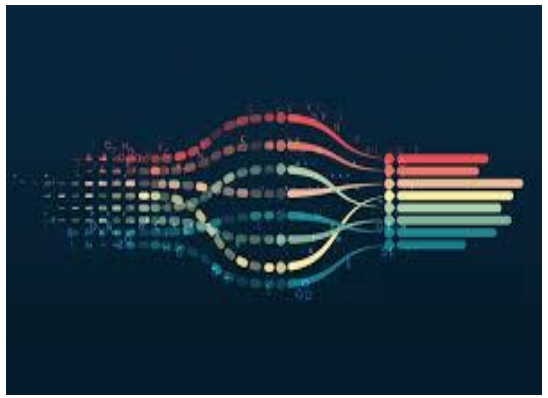
"1 million years" --- Quantum Computing

Meet "Q" IBM Quantum System One Cleveland Clinic(1)



1 https://newsroom.clevelandclinic.org/2023/03/20/cleveland-clinic-and-ibm-unveil-first-quantum-computer-dedicated-to-healthcare-research

Keys/ Challenges 5



Natural Language Processing (NLP)

What does the Electronic Health Record enter:

*Patient reveals she has a **SUGAR** addiction:*
Sweetener, Cocaine, Lovin'?

*Patient said he could eat a **HORSE**:* Menu? Hungry?

*He said it's a **DOWNER**:* Drug? Societal construct?

*I'm **HOT**:* Body sensation? Good looking? Her name?

Keys/ Challenges 5

Natural Language Processing (NLP)

What does the NLP enter:

The island cannibal tribesmen brought out food until everyone had been served.

Who is everyone?

The financial advisor kept making investments until there was nothing left.

What does nothing mean?

Keys/ Challenges 6

Transparency

Pharma industry challenges (FINALLY: 1st clinical trial 2023)

1) AI drug design doesn't replace clinical trials for safety and efficacy

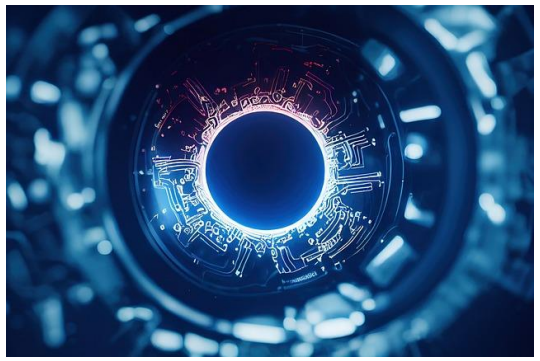
2) Transparency: "Mechanism of action" clarity before human testing

3) Procedural: Manufacturing and quality control issues

AI Design: How does it work? Why is it successful?

https://vial.com/blog/articles/what-ai-designed-drugs-have-been-fda-approved/?https://vial.com/blog/articles/what-ai-designed-drugs-have-been-fda-approved/?utm_source=organic

Keys/ Challenges 7



Adoption

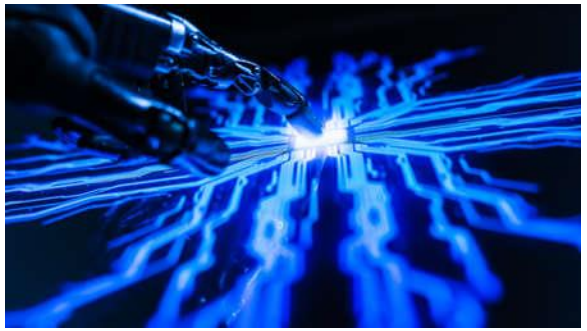
The **greatest challenge** to AI in these healthcare domains is not whether the technologies will be capable enough to be useful, but rather ensuring their **adoption** in daily clinical practice. (1)

Are architects ready for a research-based career?

1. Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future Healthcare Journal*, 6(2), 94–98. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6616181/

AI

Architecture
Applications



EXPERT SYSTEMS

Automated Building Code Plan Review: Codes, FGI

Building Performance Audits: Design Specifications

MACHINE LEARNING

ARE WE CURATING LARGE ARCHITECTURE DESIGN RESEARCH DATA SETS?

Agenda

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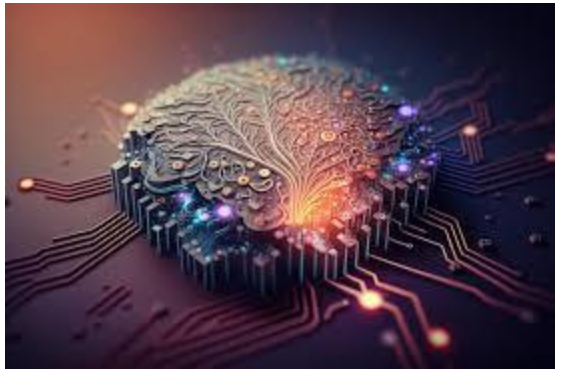
AI

In Health Architecture 1



Finding lots of design data points?

Investigation: Original EBD research: focused

Replication: Repeating an EBD data discovery event

Aggregation: Gathering “similar” EBD data for study

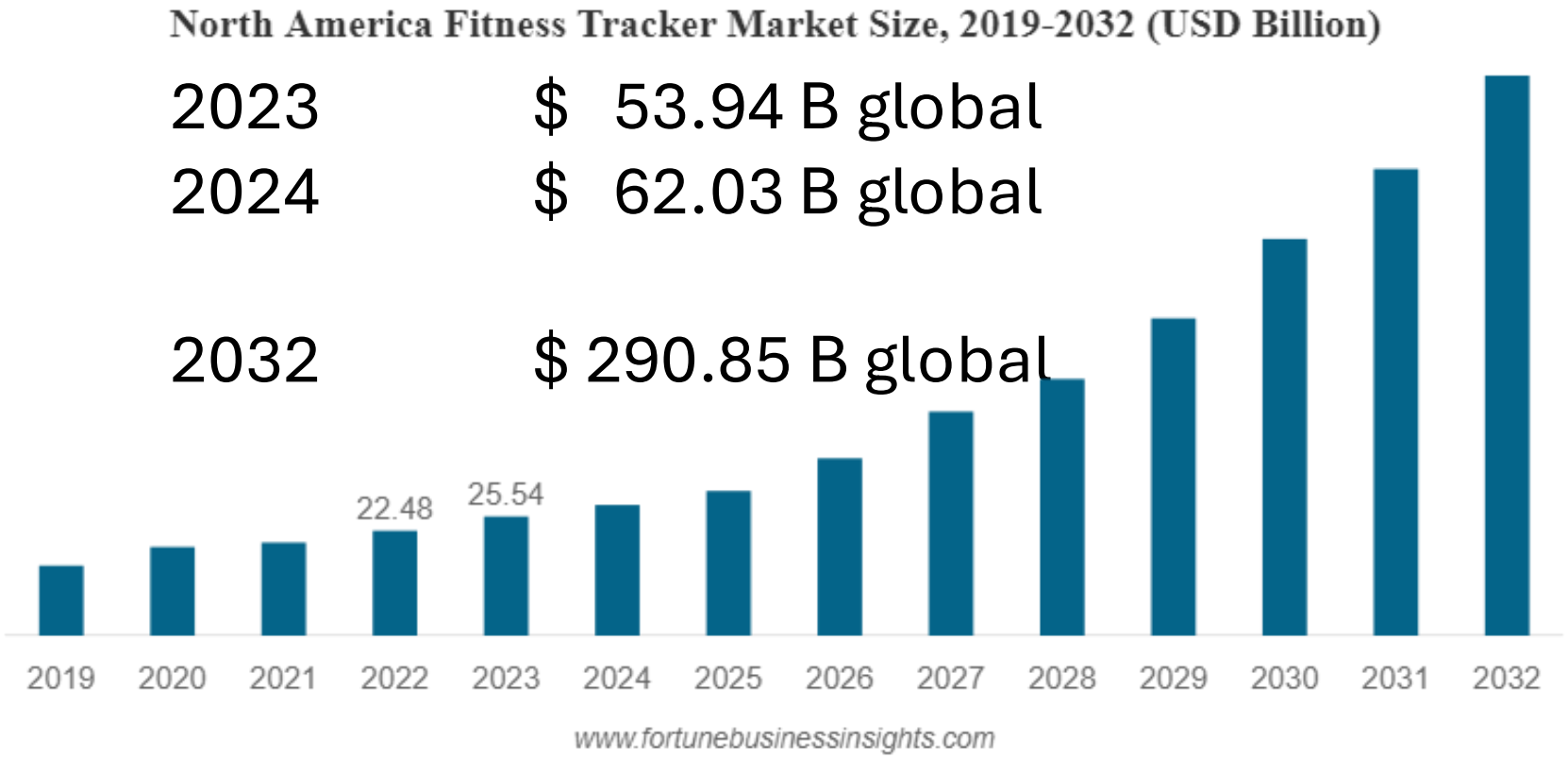
Integration: Blending “different” data for study
i.e. Personal health with Environmental data

AI

In Health Architecture 1

Finding lots of design data points-integration

Personal Health



1 https://www.fortunebusinessinsights.com/fitness-tracker-market-103358

AI

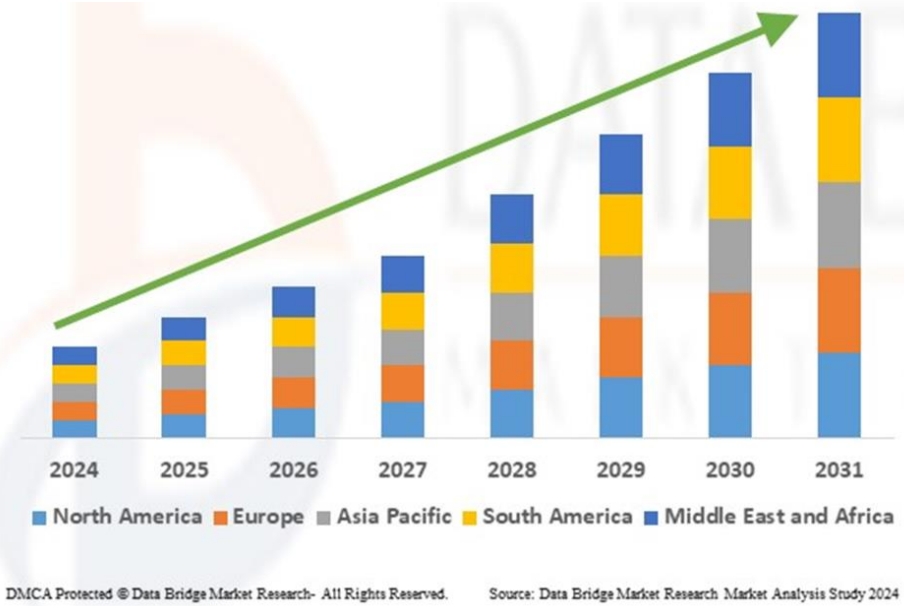
In Health Architecture 1

Finding lots of design data points-sensors

Environmental Sensors(1)

2023 $ 287 B global

2031 $ 525 B global



1 https://www.databridgemarketresearch.com/reports/global-environmental-sensor-market

AI

In Health Architecture 2

Making lots of design data points-sensors

Synthetic Data

Reconfigure an original design millions of times

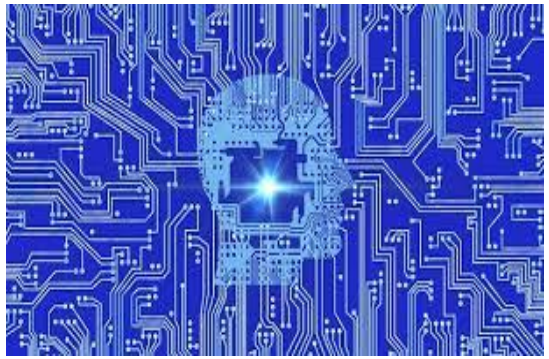
Create an artificial large data set

Deploy deep learning algorithm design keys

Question: Was the original design EBD…Or flawed?

AI

In Health Architecture 2



Making lots of design data points - caution

There are huge incentives to make this [synthetic data modelling] work… much cheaper than human data … isn't ethically and legally questionable.

However, researchers found that without high-quality human data, AI systems trained on AI-made data get dumber and dumber as each model learns from the previous one. It's like a digital version of the problem of inbreeding.

1 Snoswell, A. What Is 'Model Collapse'? An Expert Explains the Rumors About an Impending AI Doom (singularityhub.com) August 27, 2024.

Agenda

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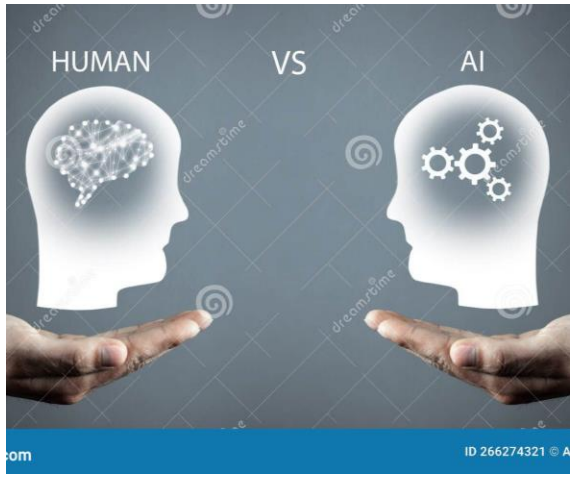
AI

Going Forward

DIRECTION

1. **Large data sets:** Probabilities more accurate
2. **Linked data sets:** Achieve relational insights
3. **Synthetic data sets:** Unlimited explorations
4. **Neuroscience:** Pursuing transparency
5. **Digital twins:** Large scale linked data sets

AI
Going
Forward



DIGITAL TWINS(1)

Two characters: Real in life, Digital in a computer

Two-way communication (unlike simulations):

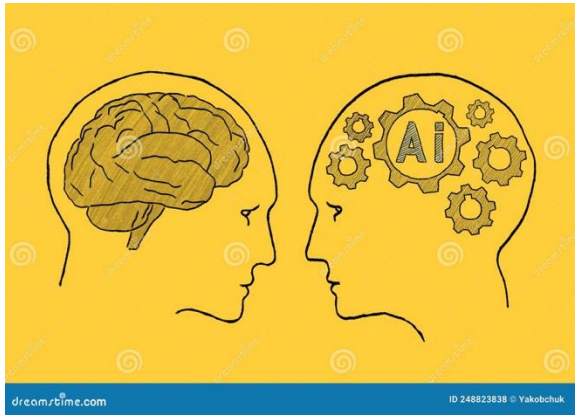
↳ Real informs digital; Digital informs real

Direct connectivity of multiple data sets

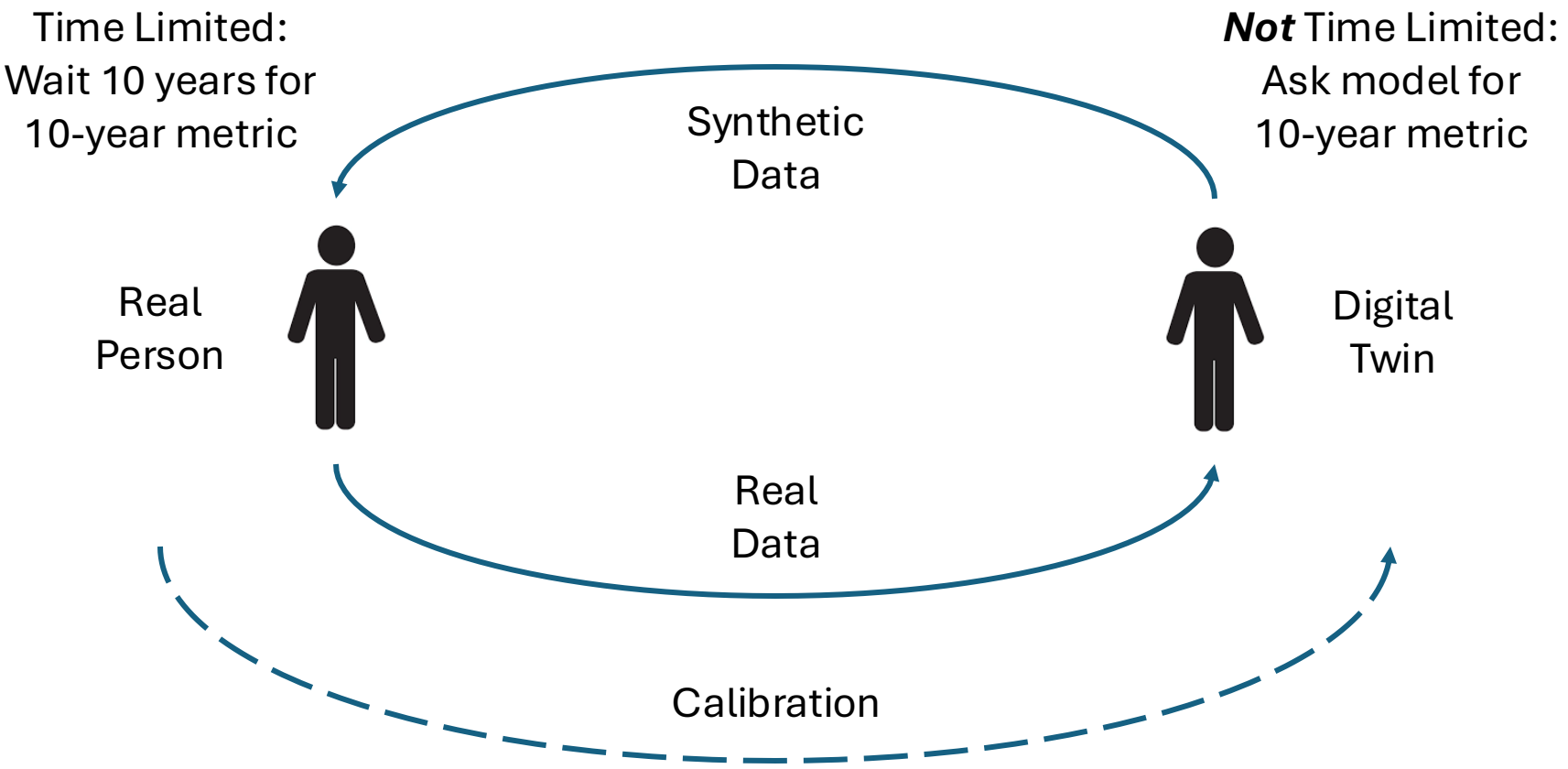
Market estimate 2027: $73.5 B global

1 https://www.ibm.com/topics/what-is-a-digital-twin/

AI
Going Forward



DIGITAL TWINS(1)



1 Mark Clayton, PhD, CEO, SmartReview.

AI

Going Forward

DIGITAL TWINS(1)

The digital twin real person informs the model that the environment may need to change?

What if: The objects in the environment are buildings, not people?

What if: Building performance informs the model, and digital twin buildings adapt to each other…for the occupants…for the citizens?

1 Ideas based on the graduate work of Rania Labib, PhD

AI
Going
Forward

FINAL THOUGHTS…

AI algorithms built on rigorous research should be the core of an AI - EBD model.

We should pursue high quality large data models for architectural AI development.

AI's ravenous appetite for data should give us pause to consider what data is in the AI model before we rely on it for design guidance.

And Finally…

Thank you!

Any Questions?

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