Data Science in HealthTech

Who wants to live forever?

HSE 30.05.24

Plan

- How it started
- DS problems in health
- Personal examples
- Future of HealthTech
- Challenges
- Who works in HealthTech
- Q&A

About me

EDUCATIONAL PROGRAM

Aalto University

OTUS

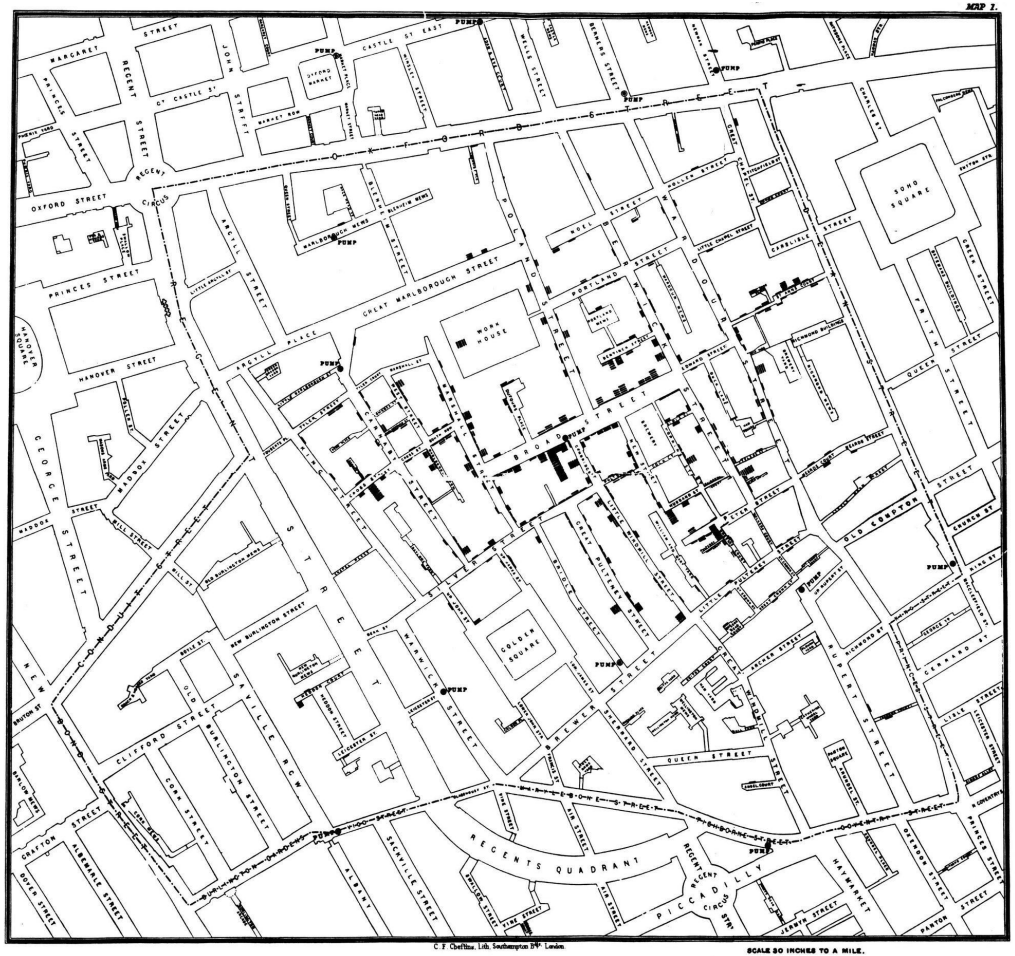
ОНЛАЙН-ОБРАЗОВАНИЕ

WeatherWell

ŌURA

How it started

Ini the beninging…



https://www.tableau.com/learn/articles/best-beautiful-data-visualization-examples

How it started

- Miniaturization of sensors has led to new opportunities

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- **2023** – medical wearables market size exceeds $100 bln

Apple

https://blog.technavio.com/blog/top-10-wearable-technology-companies-worldwide

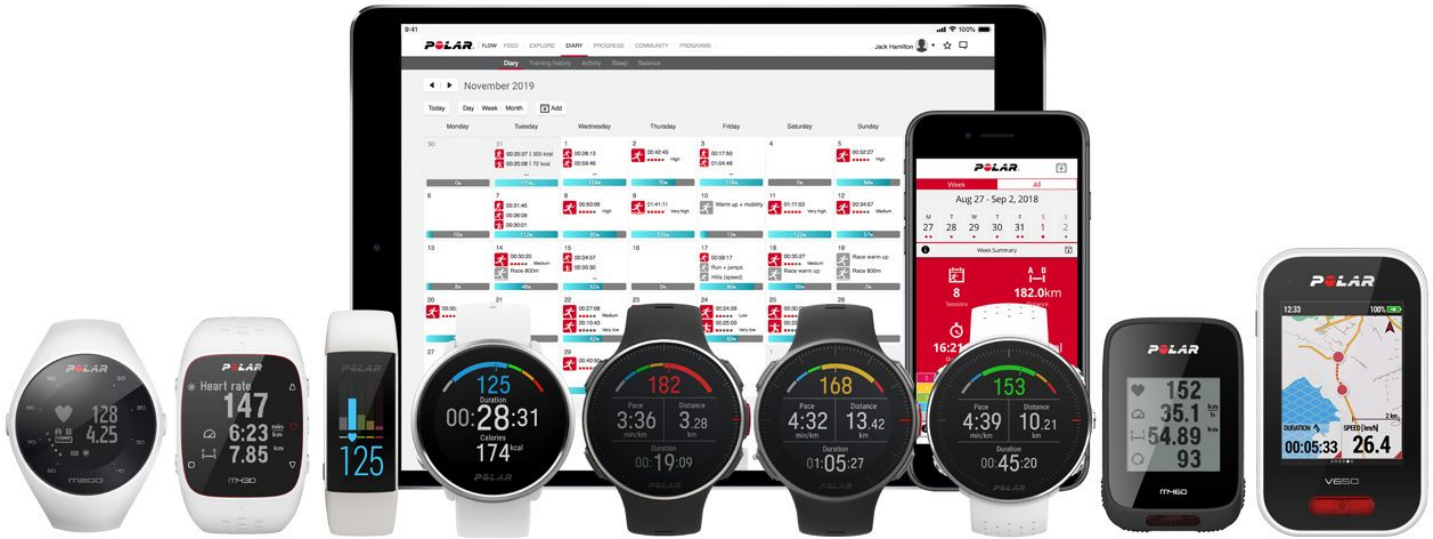
FitBit


12
58
12
58
76
10
47
6h 34m
65
NOV 23
1258
96 BPM
fitbit
09
59
WED 31
fitbit

Samsung

Xiaomi

Polar Electro



Can I copy your homework?

Yeah, just change it up a bit so it doesn’t look obvious

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Yeah, just change it up a bit so it doesn’t look obvious

DS problems in health

What are we solving?

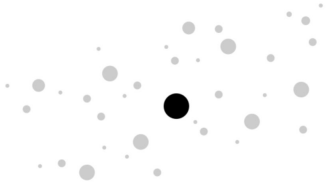
DS problems in health

- Let’s start with the data

Traditional tests reimagined: Blood work

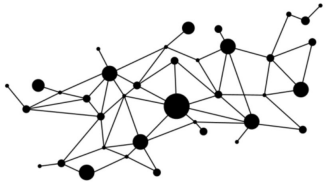
- Advanced blood testing: [Nightingale]

Good for diagnosing diseases

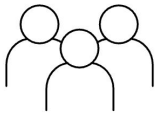


Traditional Single Biomarker Approach

Tool for prevention



Novel Multi Biomarker Approach



1. Identify risks

Replace routine single-disease risk tests with Nightingale's multi-disease risk detection.

2. Target interventions

Use the results to target clinical guideline interventions to the high risk individuals.

3. Measure outcomes

Track the impact of the interventions and validate progress towards lowering risk levels by periodically repeating Nightingale's risk assessment.

DNA

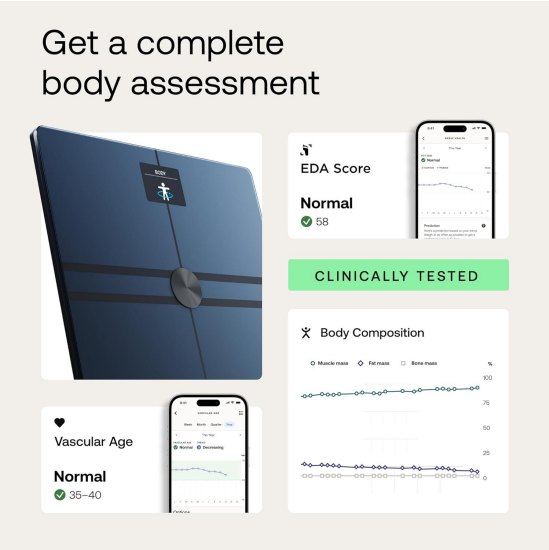
- Genome sequencing: 23andMe, atlas, etc.
- Targeted medicine
- Personalized life-long health recommendations

Health + Ancestry Service

Learn your risks and better understand how genetics impact your health.

Weight, Blood Pressure, and more

- Measurements that used to be occasional and chaotic can now be continuous: [Withings]

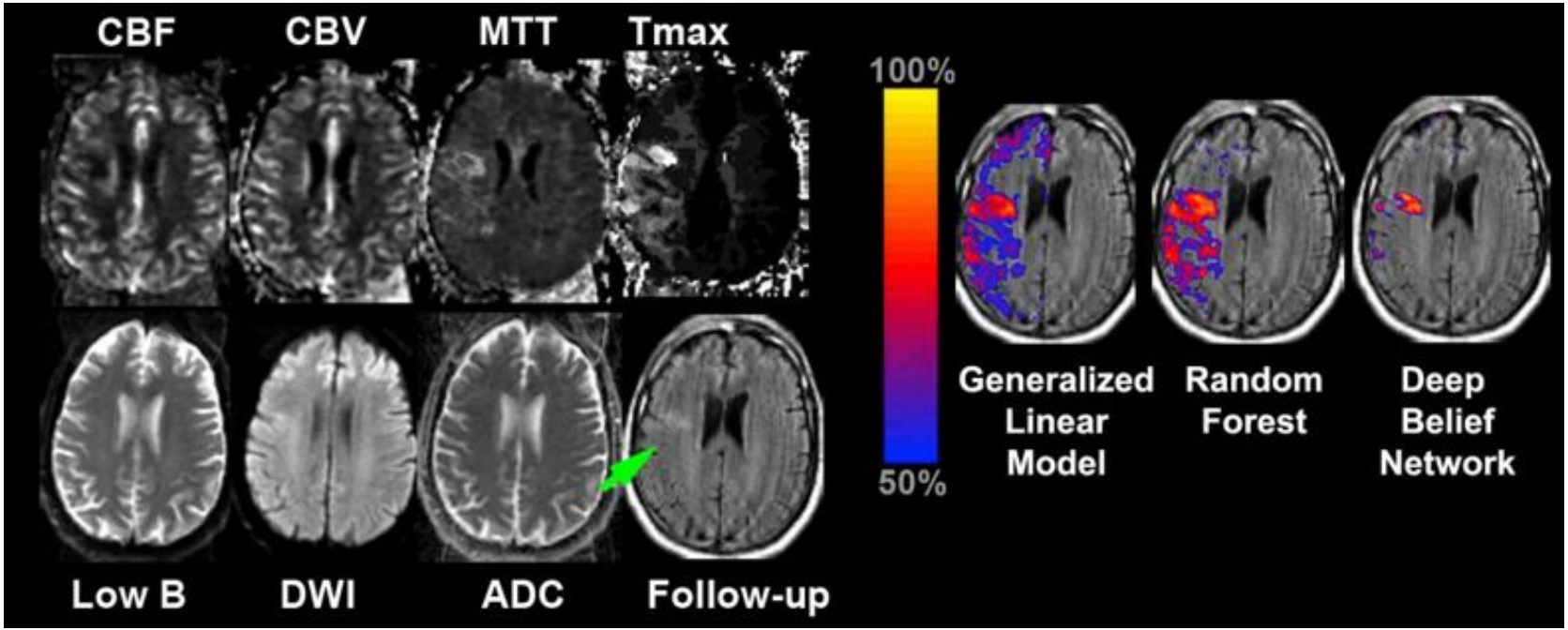


BPM Core

CLINICALLY VALIDATED

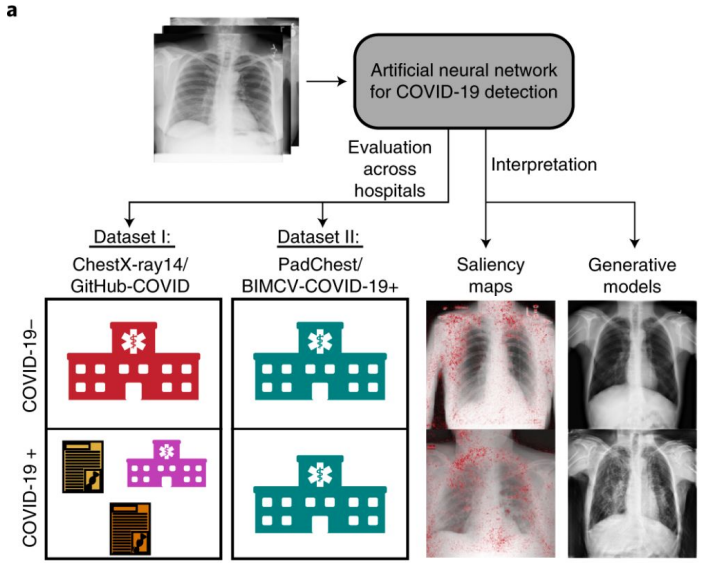
Smart blood pressure monitor with ECG & digital stethoscope

How about images and videos?



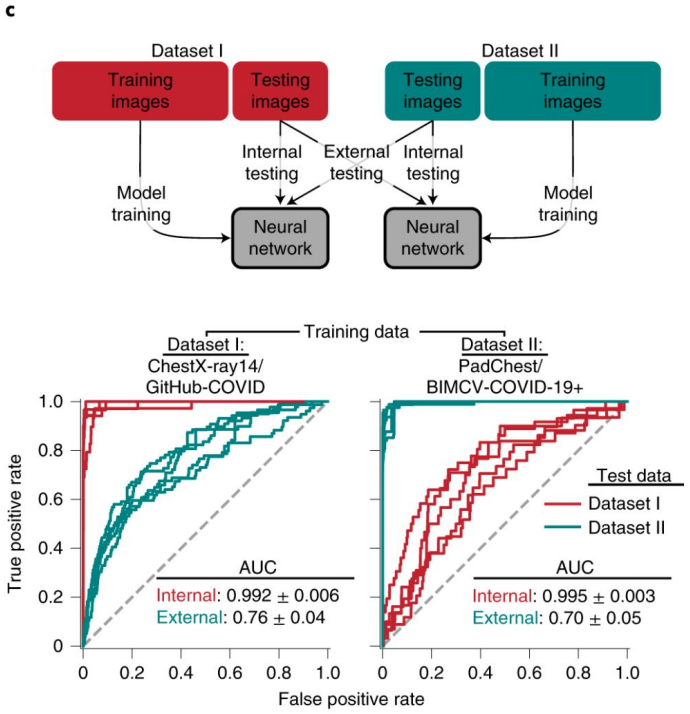
https://www.martinos.org/lab/clinical-computational-neuroimaging-group/research

How about images and videos?



b

	Dataset I			Dataset II		
	Combined	Chest-X-ray14	GitHub-COVID	Combined	PadChest	BIMCV-COVID-19+
No. radiographs	112,528	112,120	408	97,866	96,270	1,596
No. patients	31,067	30,805	262	64,954	63,939	1,105
% COVID-19+	0.2	0	76.5	1.6	0	100
% AP images	39.9	40	26	5.6	4.7	58.1



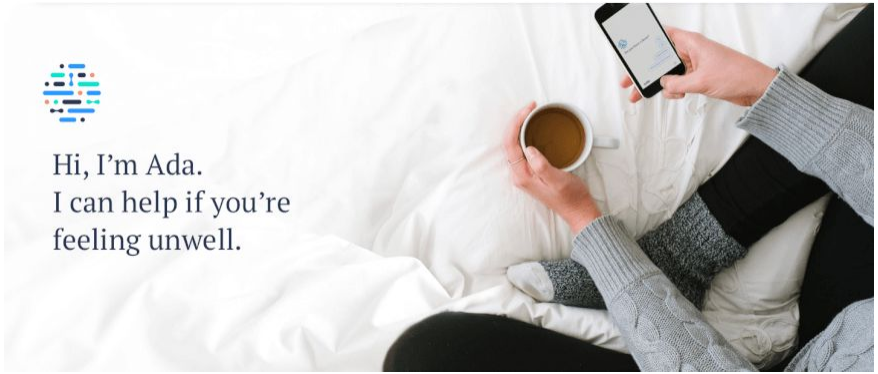
https://www.nature.com/articles/s42256-021-00338-7

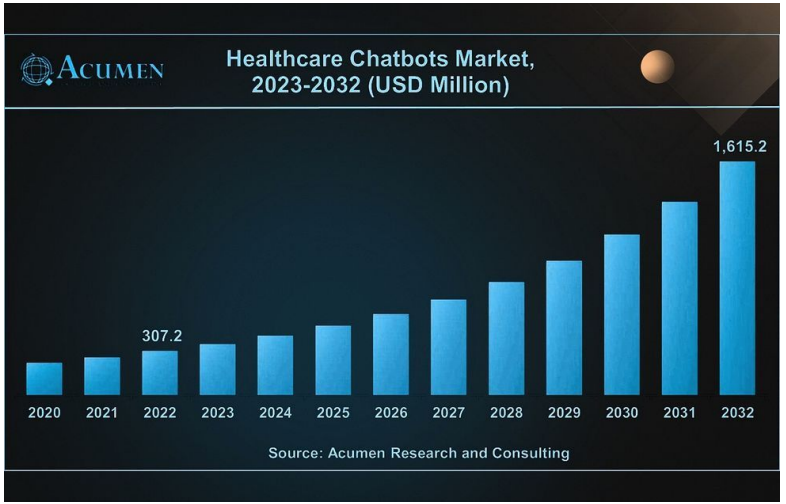
Audio?

https://www.snorelab.com/how-snorelab-works/

Texts

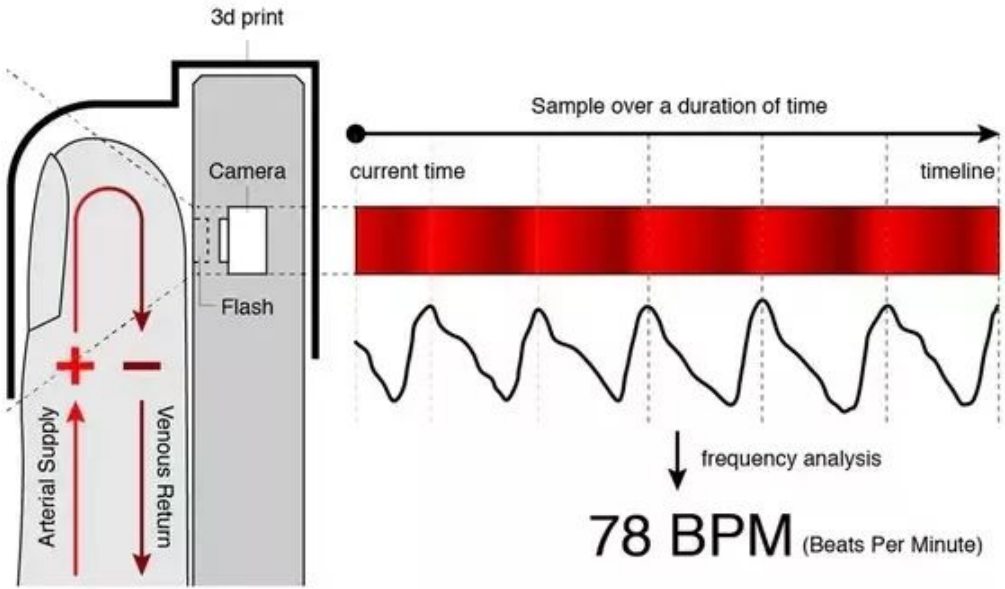
- Medical chat bots: both standalone (Ada) and integrated





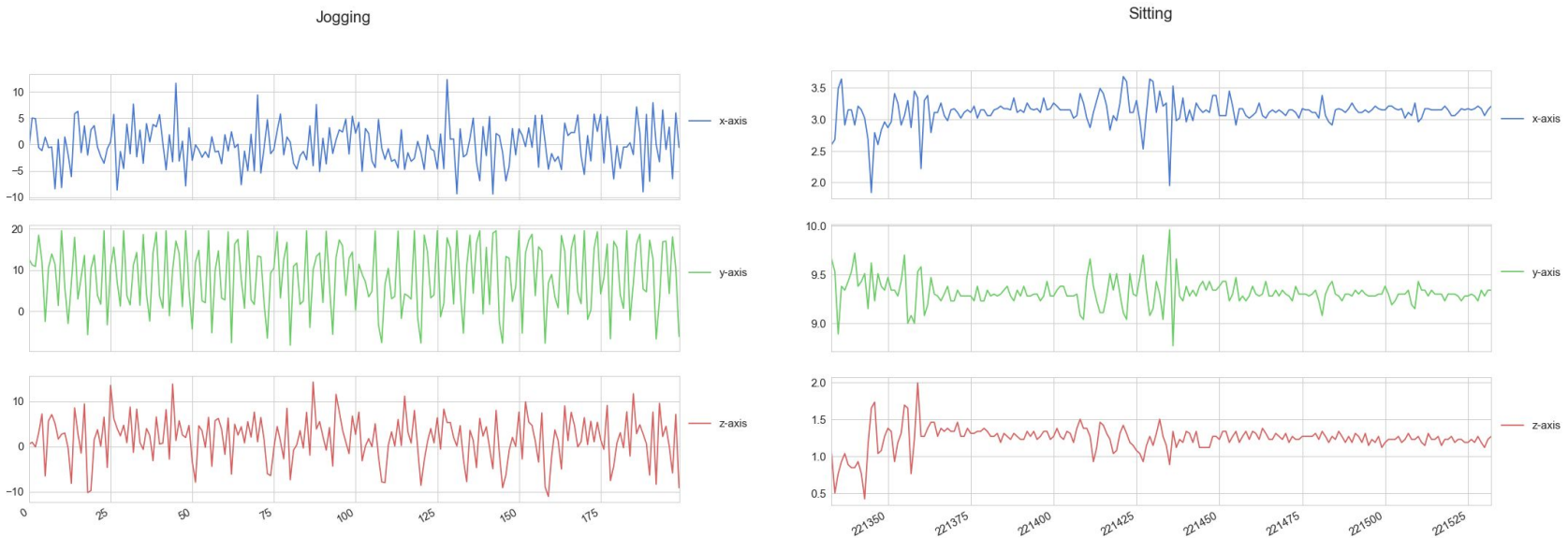
Continuous sensors data: wearables

- LED (light-emitting diode) -> PPG (photoplethysmography) -> HR/HRV/SpO2/..



Continuous sensors data: wearables

- ACM (accelerometer) -> Motion detection -> Activity recognition/Fall detection/Parkinson’s diagnostics and mitigation/…



Continuous sensors data: wearables

- Liftware Steady

Continuous sensors data: wearables

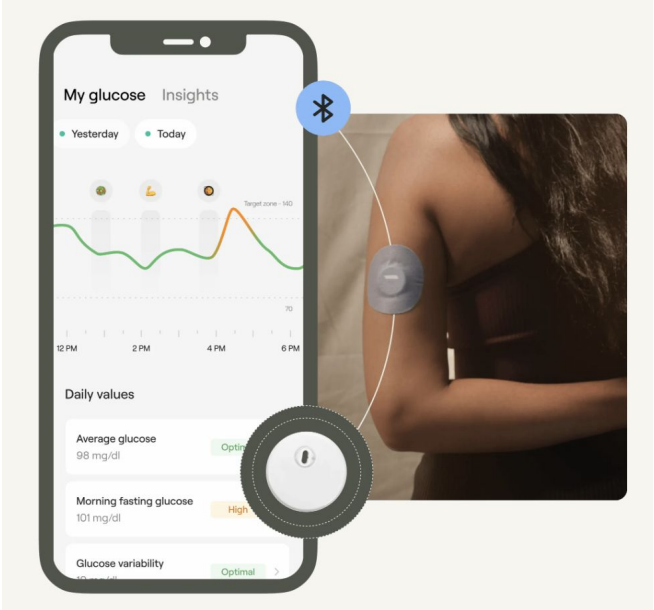
- Electrodes outside -> EEG (electroencephalography)
- Electrodes inside -> iEEG (intracranial electroencephalography)

https://choosemuse.com/

https://neuralink.com/

Continuous sensors data: wearables

- Sticking a needle into bloodstream -> CGM (continuous glucose monitoring)



https://www.veri.co/

Continuous healthcare

- Wearables allow us to continuously collect data that was earlier only available in medical studies with special equipment
- “Non medical grade” data quality is largely compensated by volumes and frequency of data and enables long-term pattern discoveries
- With wearables we can collect health data at scales that were earlier unimaginable
- This leads to new population level discoveries

Personal examples

Some cool stuff

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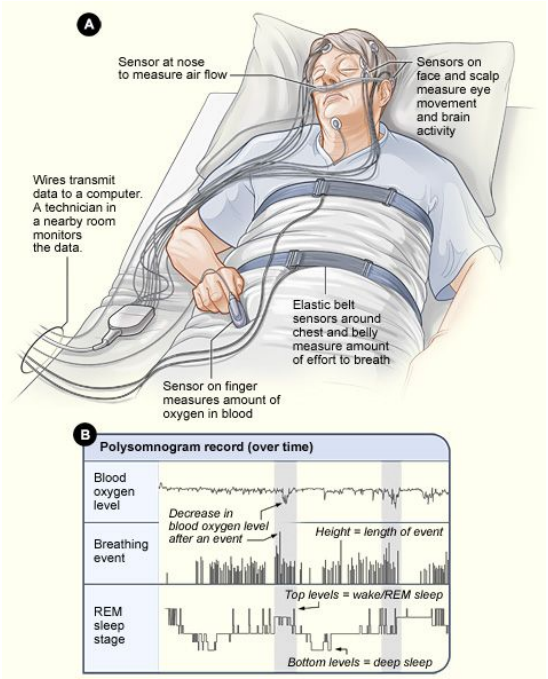
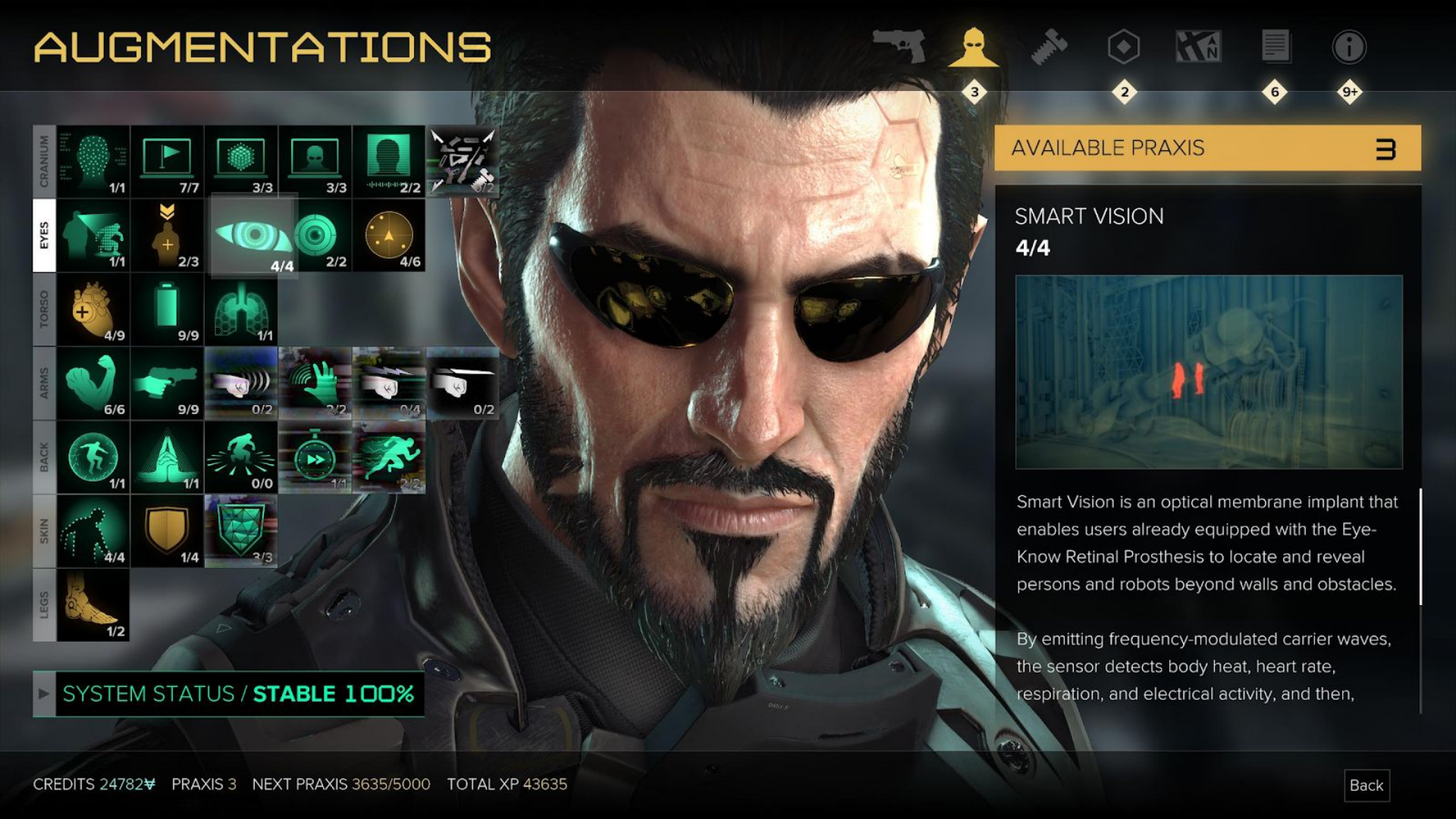
Sleep – originally done with Polysomnography

- Manually labelled data
- A huge amount of sensors
- Doesn’t feel comfy tho



AUGMENTATIONS



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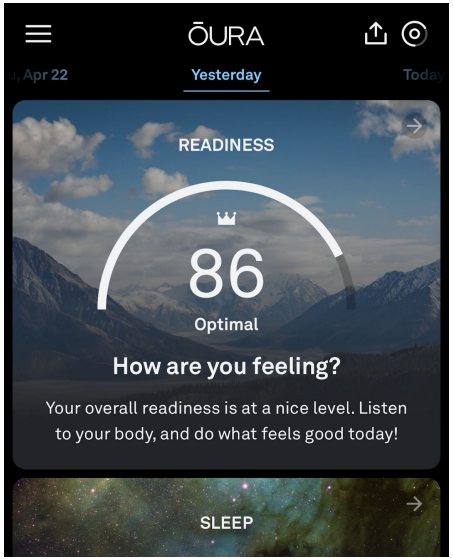
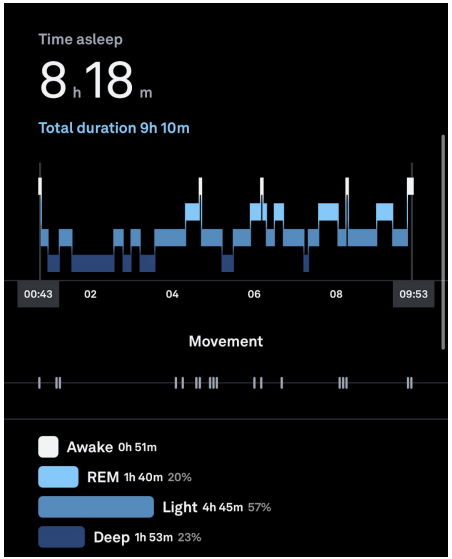
Sleep

- Let’s approximate!
- Multiple sensors
- Complex models
- Profit (84% accuracy)



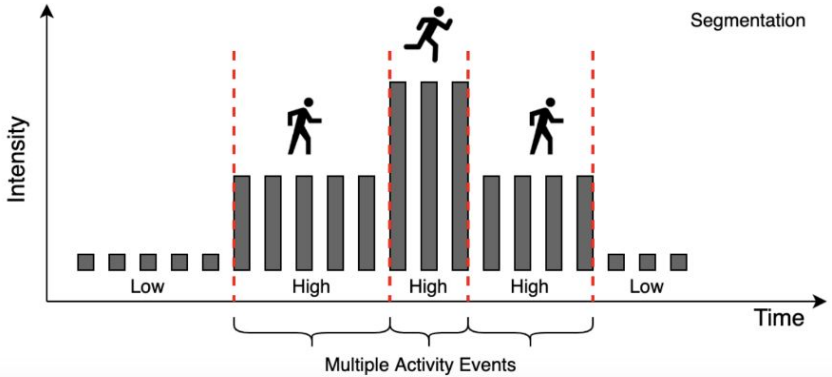


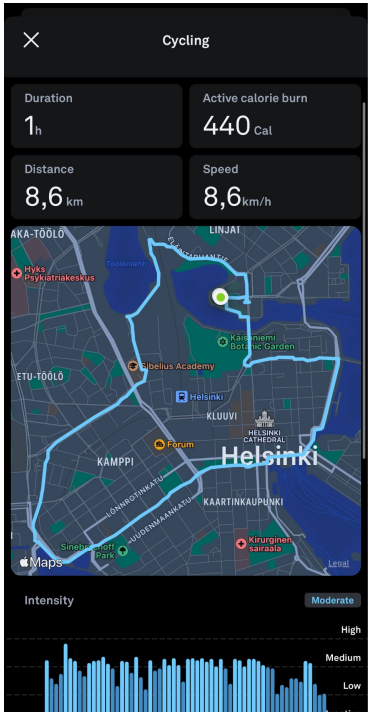
https://ouraring.com/blog/how-does-the-oura-ring-track-my-sleep/

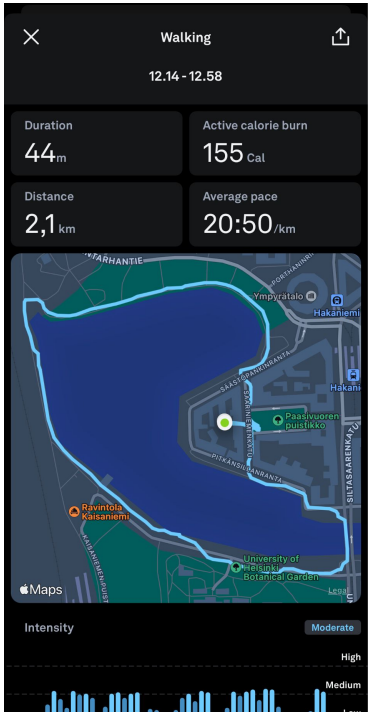
ŌURA

Automatic Activity Detection (AAD)

- Time-series segmentation, feature extraction, classification, smoothing







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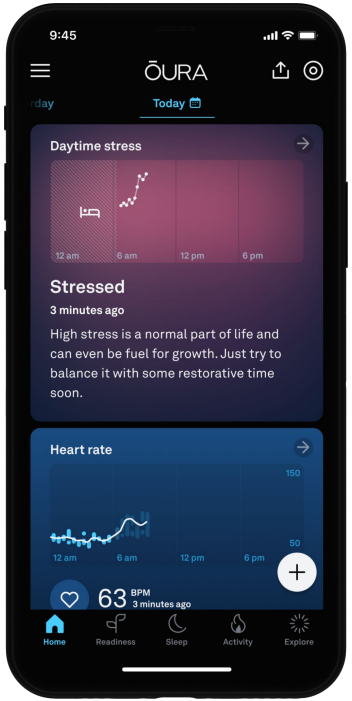
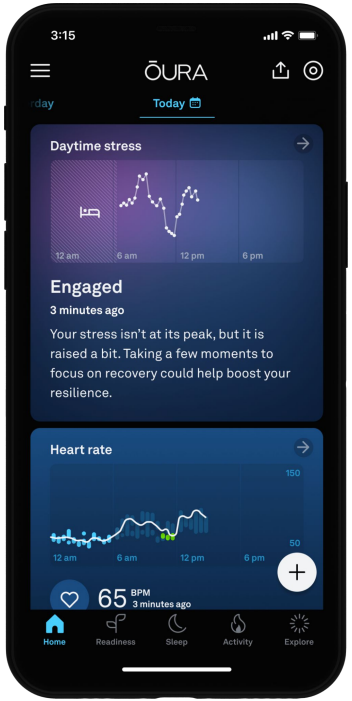
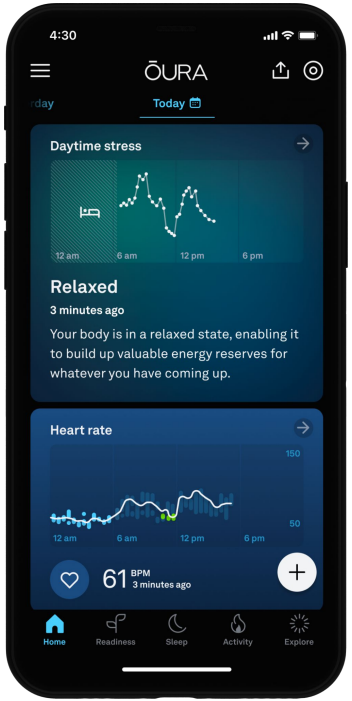
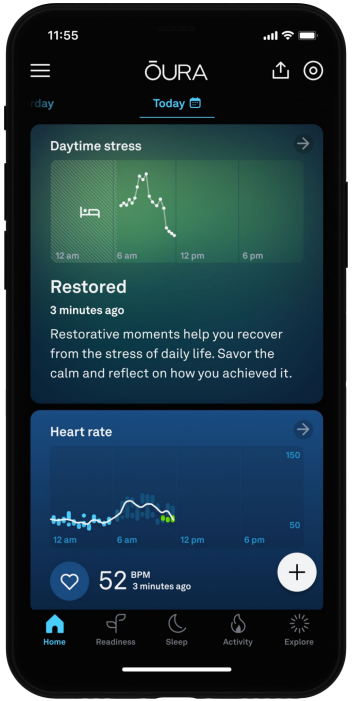
- Stress


9:45
ŌURA
Today
Daytime stress
12 am
6 am
12 pm
6 pm
Stressed
3 minutes ago
High stress is a normal part of life and can even be fuel for growth. Just try to balance it with some restorative time soon.
Heart rate
150
50
63 BPM
3 minutes ago
Home
Readiness
Sleep
Activity
Explore


3:15
ŌURA
Today
Daytime stress
12 am
6 am
12 pm
6 pm
Engaged
3 minutes ago
Your stress isn't at its peak, but it is raised a bit. Taking a few moments to focus on recovery could help boost your resilience.
Heart rate
150
50
65 BPM
3 minutes ago
Home
Readiness
Sleep
Activity
Explore


4:30
ŌURA
Today
Daytime stress
12 am
6 am
12 pm
6 pm
Relaxed
3 minutes ago
Your body is in a relaxed state, enabling it to build up valuable energy reserves for whatever you have coming up.
Heart rate
150
50
61 BPM
3 minutes ago
Home
Readiness
Sleep
Activity
Explore


11:55
ŌURA
Today
Daytime stress
12 am
6 am
12 pm
6 pm
Restored
3 minutes ago
Restorative moments help you recover from the stress of daily life. Savor the calm and reflect on how you achieved it.
Heart rate
150
50
52 BPM
3 minutes ago
Home
Readiness
Sleep
Activity
Explore

WeatherWell

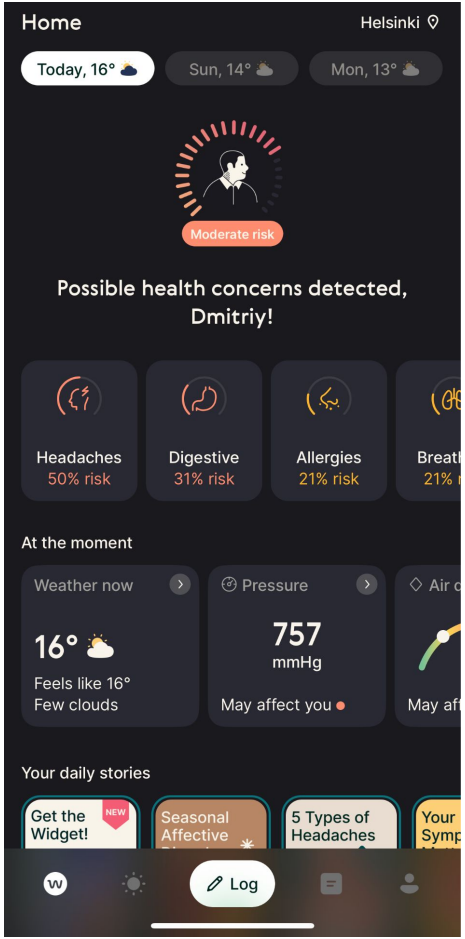
- Does weather affect health? If yes, how?

Health forecast

Moderate risk of headaches due to low atmospheric pressure. Balance caffeine intake to reduce risk.

Daily overview

Good morning! Today is partly cloudy with an avg temp of 8°C. Low risk for sleep, fatigue, and breathing. Moderate risk for headaches.



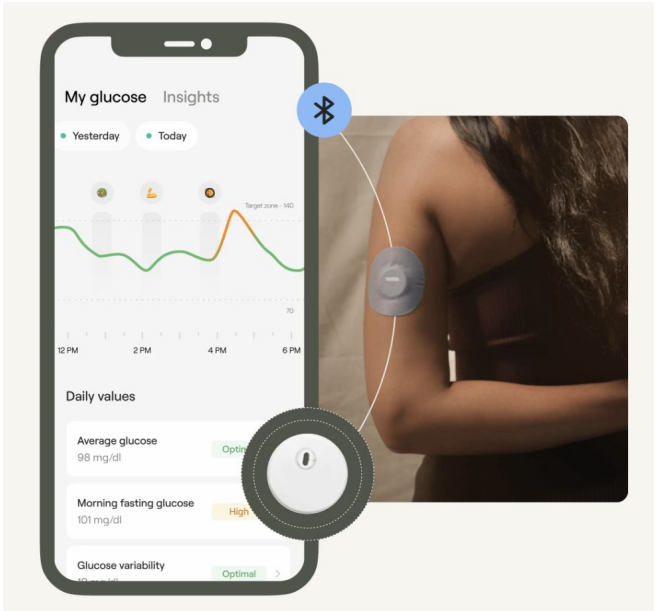
https://palta.com/blog/confirmed-weather-affects-our-wellbeing

Veri

- Goal – understand which meals are healthy and what affects blood glucose

Your Personalized Metabolic Health Program

Find the right foods for you, achieve your health goals, and reach your ideal weight.



Future of HealthTech

“As an AI language model…”

Future of HealthTech

Hyper Personalization

Future of HealthTech

Hyper Personalization

- Tailored medicine based on genome info and all your medical data

Future of HealthTech

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- Tailored medicine based on genome info and all your medical data
- Personalised lifestyle guidance: activity, sleep, nutrition, etc.

Future of HealthTech

Hyper Personalization

- Tailored medicine based on genome info and all your medical data
- Personalised lifestyle guidance: activity, sleep, nutrition, etc.
- Preventive medicine and early disease detection

Future of HealthTech

Sensor and Data Fusion

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Sensor and Data Fusion

- Combining signals from multiple sources

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- Combining signals from multiple sources
- Large Health data aggregations: Apple Health

Future of HealthTech

Sensor and Data Fusion

- Combining signals from multiple sources
- Large Health data aggregations: Apple Health
- (Almost) full context awareness

Future of HealthTech

LLMs and transformers?

Future of HealthTech

LLMs and transformers?

- Already extremely useful in limited applications (Alphafold)

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- Big potential for fine-tuning

Future of HealthTech

LLMs and transformers?

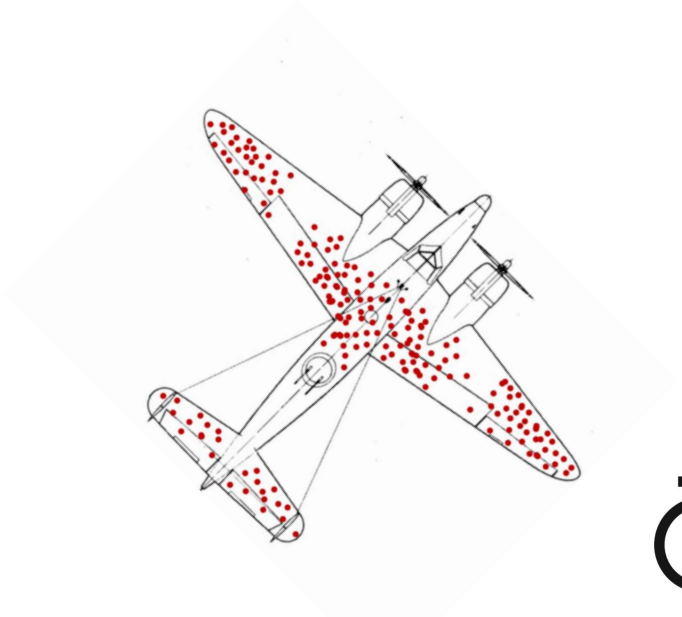
- Already extremely useful in limited applications (Alphafold)
- Big potential for fine-tuning
- Personalized guidance

Challenges

What could possibly go wrong?

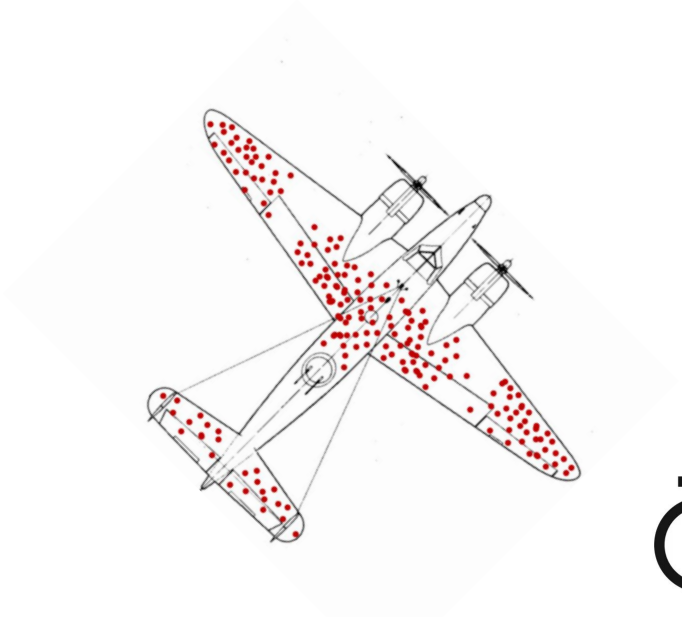
Challenges

- Data Quality:
  - How do we get enough labelled data?



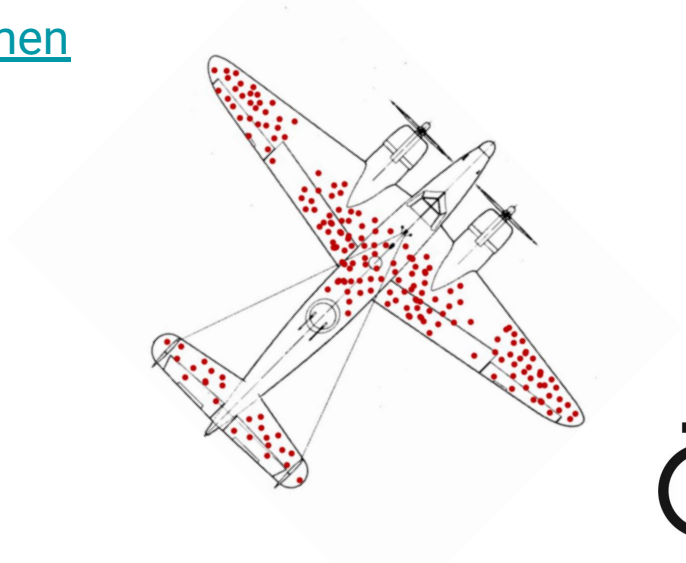
Challenges

- Data Quality:
  - How do we get enough labelled data?
  - Are there intrinsic biases in our data?



Challenges

- Data Quality:
  - How do we get enough labelled data?
  - Are there intrinsic biases in our data?
  - Invisible Women: Exposing Data Bias In A World Designed For Men
  - This Won't Hurt: How Medicine Fails Women



Challenges

- Data Privacy:

Challenges

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  - How we can ensure that our data is safe?

Challenges

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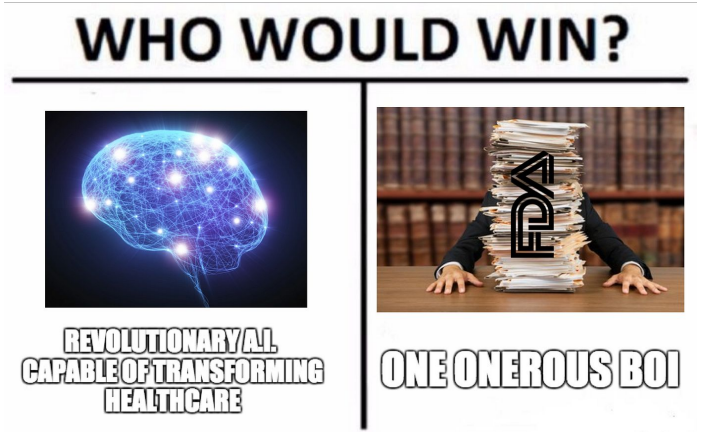
  - Data can be stolen, sold, used against you

Challenges

- Data Privacy:
  - How we can ensure that our data is safe?
  - Data can be stolen, sold, used against you
  - General Data Protection Regulation (GDPR)
  - Health Insurance Portability and Accountability Act (HIPAA)



Who works in HealthTech

Who works in HealthTech

If you are interested – there’s always a way

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- Profiles are super different

Who works in HealthTech

If you are interested – there’s always a way

- Profiles are super different
- PhDs in relevant domains (both medical and technical)
  - Signal processing
  - Physiology
  - Neuroscience
  - Behaviourism
  - …

Who works in HealthTech

If you are interested – there’s always a way

- Profiles are super different
- PhDs in relevant domains (both medical and technical)
- But health education is not a must!

Who works in HealthTech

If you are interested – there’s always a way

- Profiles are super different
- PhDs in relevant domains (both medical and technical)
- But health education is not a must!
- Data profiles:
  - Data Scientists
  - Data Analysts
  - BI Analysts
  - ML engineers
  - Statisticians
  - Data Engineers

Q&A

When your FitBit registers your panic attack as exercise

Keep in touch

- Mail: dmitryserg.consultancy@gmail.com
- Telegram: @dmitryserg
- GitHub: https://github.com/dmitryserg
- LinkedIn: https://www.linkedin.com/in/sergeyevdmitry/