Part 1
Lecture 3 AI and Big Data

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Who I am…

Pascal Tyrrell, PhD   *Associate Professor*

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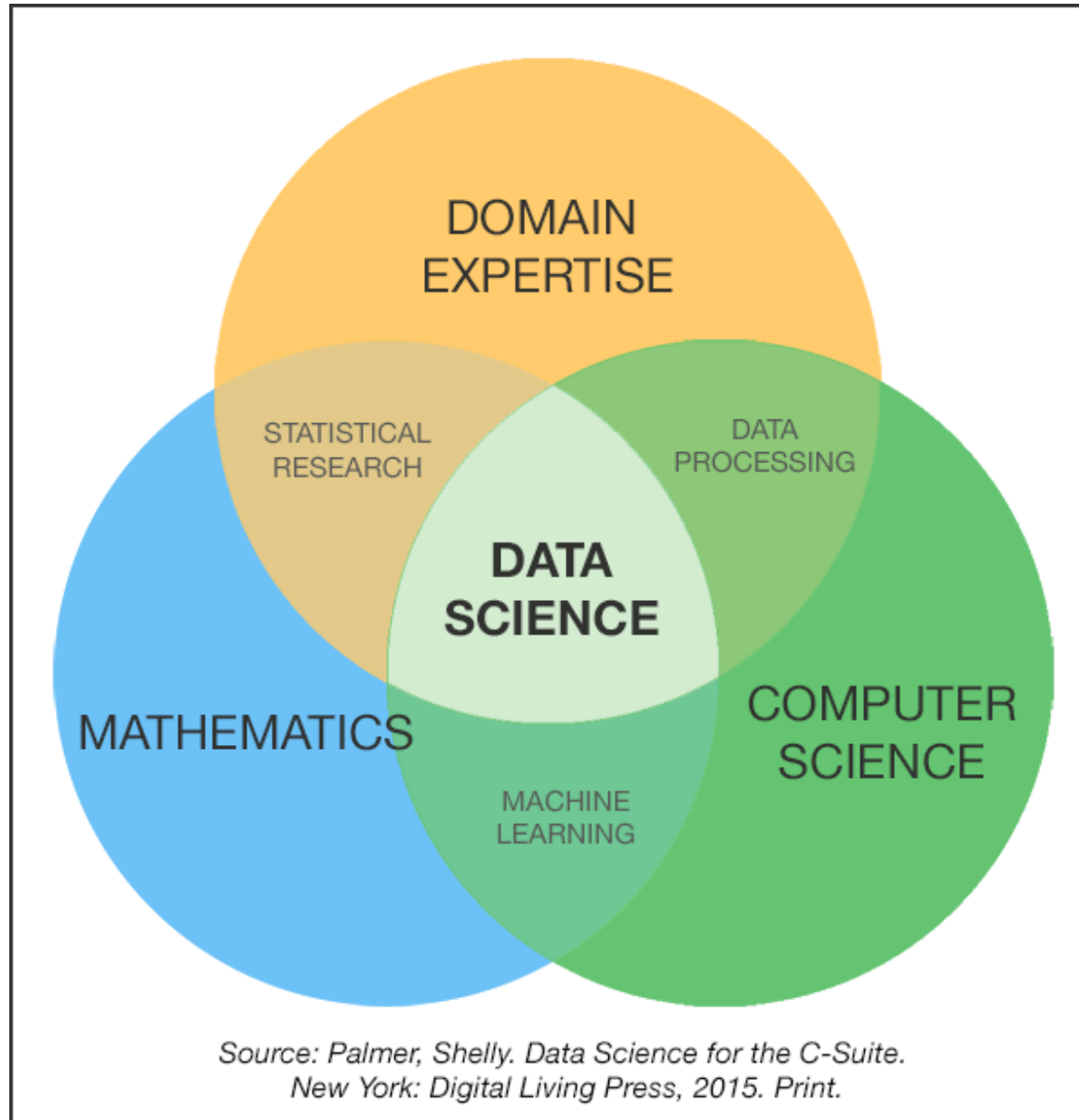
What is Data Science

Data science can be defined as:

" the set of fundamental principles that support and guide the principled extraction of information and knowledge from data"
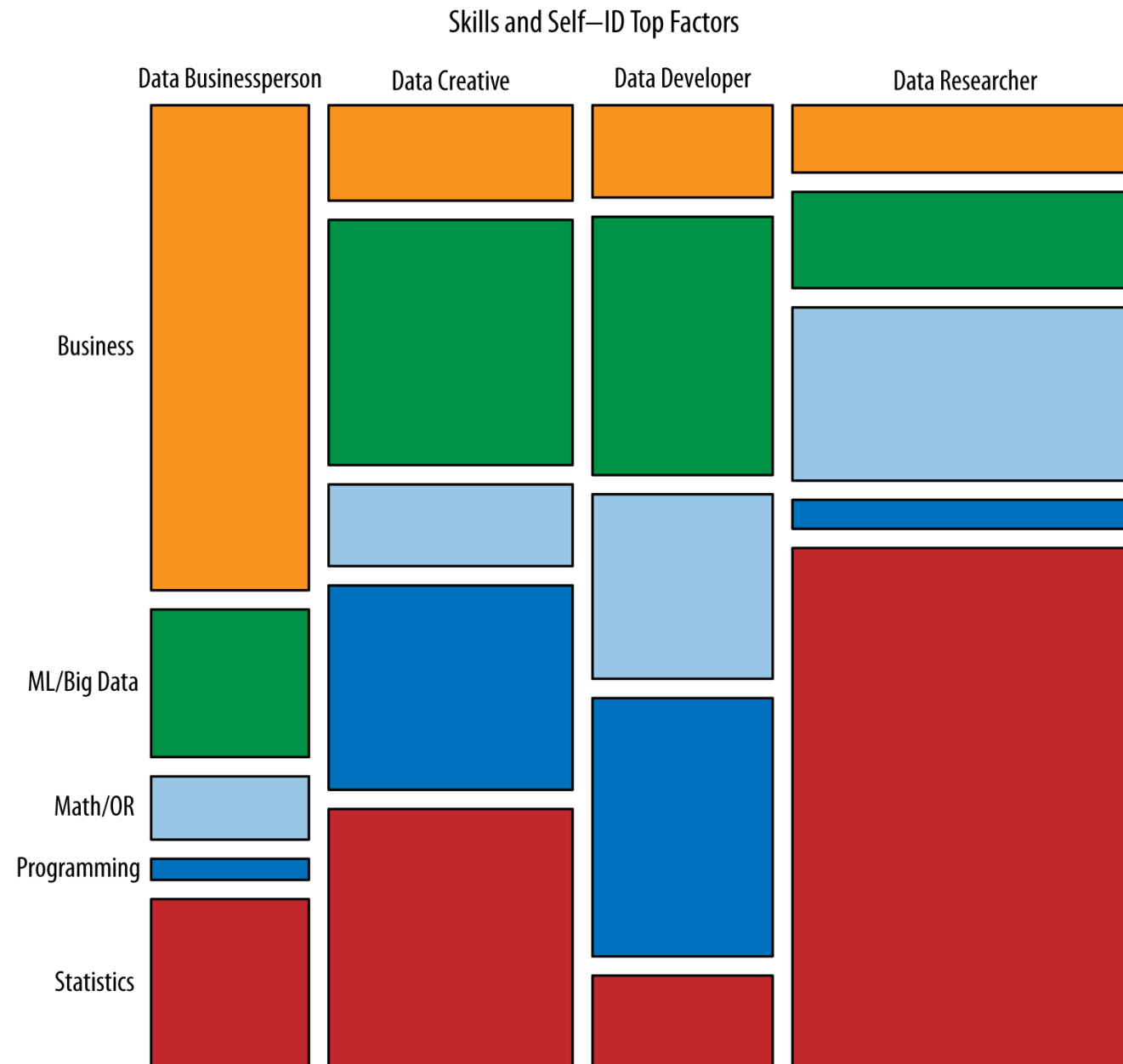
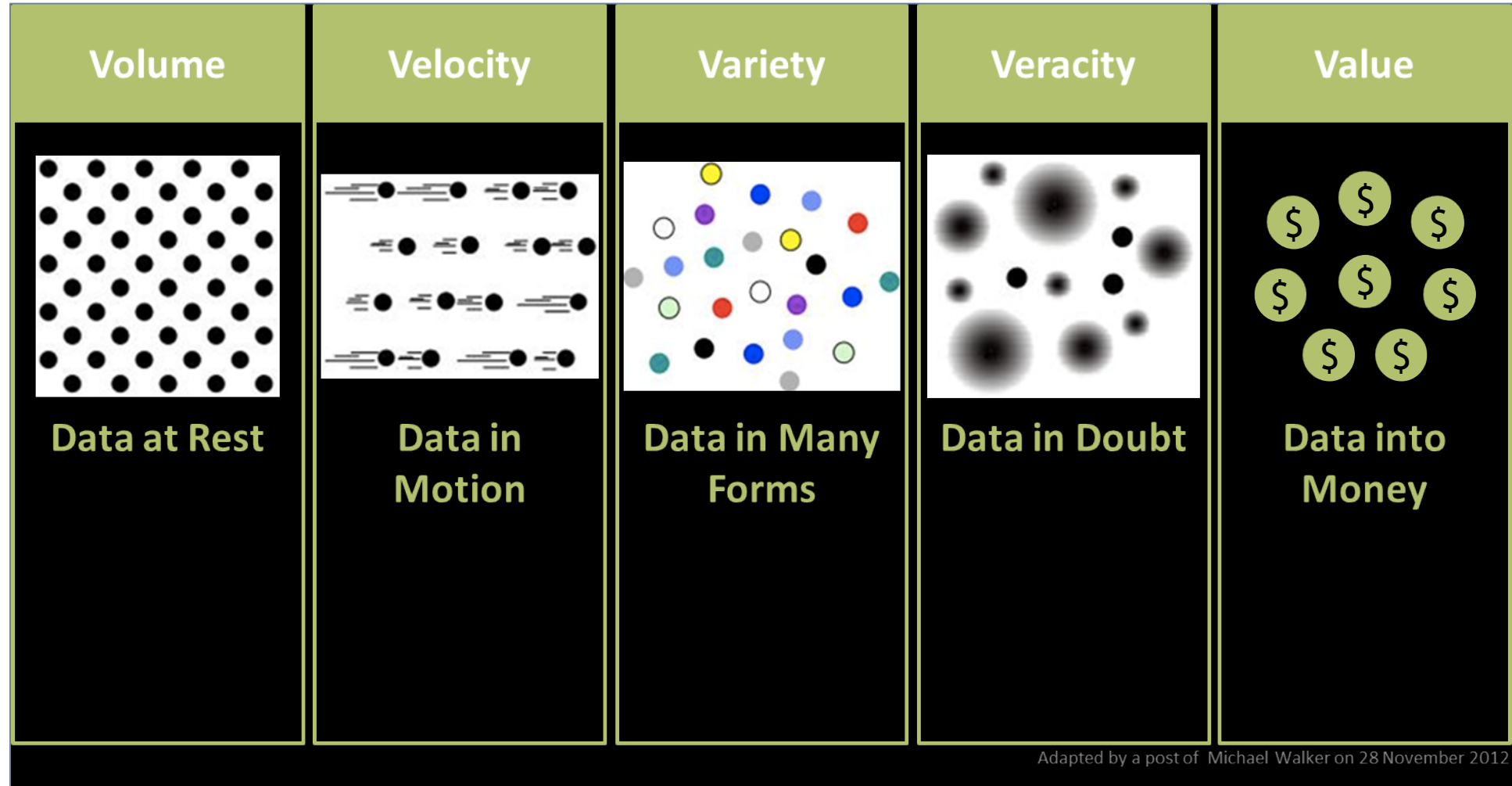Data mining is the "extraction of knowledge from data via ML algorithms that incorporate data science principles"

What is Data Science?

Source: Palmer, Shelly. *Data Science for the C-Suite.*
New York: Digital Living Press, 2015. Print.

CORE VALUES

Skills and Self—ID Top Factors

Big Data

Volume	Velocity	Variety	Veracity	Value
Data at Rest	**Data in Motion**	**Data in Many Forms**	**Data in Doubt**	**Data into Money**

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Medication Adherence Problem

Findings by TREATMENT AREA

Adherence rate

	3 months	6 months	12 months
Cholesterol	60%	52%*	41%*
Diabetes (Type 2)	53%	43%*	38%
Obesity	48%	34%	8%
Hypertension	47%	43%*	35%
Depression	30%	20%	10%
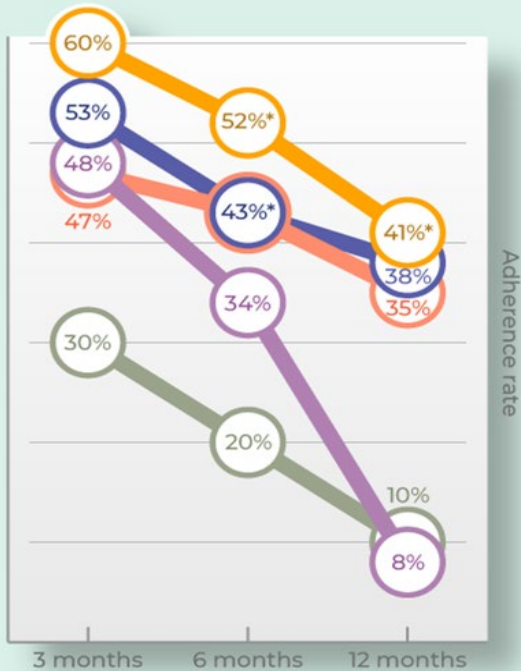
By end of the first year, 50-90% of patients stop taking their prescribed therapies.

* Rates averaged

Source: various sources; A.T. Kearney analysis

Up to 90% of patients do NOT take their medication properly

resulting in

28% of all **Emergency Room Visits**

23% of all **Nursing Home Admissions**

TOTAL Direct & Indirect COSTS due to NON-ADHERENCE

-$ **290 BILLION USD**

ANNUAL LOSSES in DRUG SALES

-$ **188 BILLION USD**

http://www.ncbi.nlm.nih.gov/pubmed/12126224
http://www.mloz.be/files/medias/review%20patient%20adherence.pdf
http://www.nehi.net/writable/publication_files/file/pa_issue_brief_final.pdf
http://www.drugchannels.net/2011/01/owning-pharmacy-still-pretty-profitable.html

https://www.adherence564.com/php/download.php?token=7d8y2a5002fa97E5
http://www.phrma.org/sites/default/files/pdf/PhRMA_Improving%20Medication%20Adherence_Issue%20Brief.pdf
http://www.cognizant.com/InsightsWhitepapers/medication-adherence-in-the-real-world-codex1089.pdf

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Using KARIE
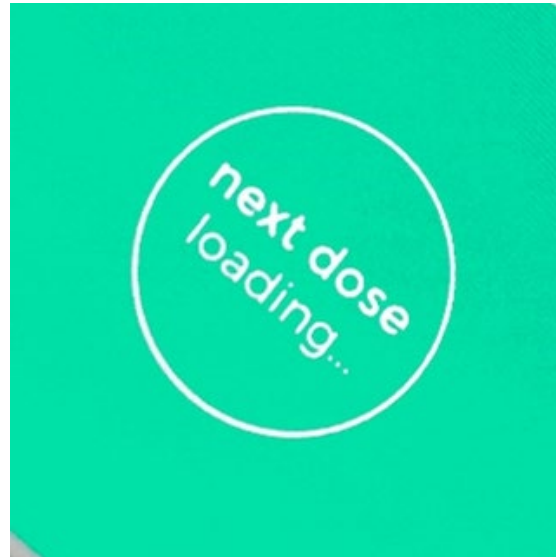## Makes Medication Management Simple

Loading

After receiving your medication pre-organized in a cartridge from your pharmacist, place it in the back of KARIE

Scheduling

KARIE automatically loads your medication schedule when you put in your cartridge

Delivering

When KARIE goes off like an alarm clock when is it time for your next dose, press the button on the front of KARIE

Dose

KARIE will deliver you the medication that you need at that exact point in time, and will be on standby until it's time for your next dose.

Integrated Solution:
Your Personal Health Companion

Activity Monitors

Fitbit, Garmin, Apple Watch
Cellphone, Cloud DX

Treatment Monitor

Portal for Health Data
Video Conferencing/Tele-monitoring
Touch Screen & Microphone
Face Recognition

Vital Monitors

Blood sugar, e-scale,
pulse oximeter, peak flow,
blood pressure

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Volume

❑ Let's assume 5 million KARIE units deployed across Canada
  ❑ Each patient has a schedule for their 3+ medications a day
    ❑ What medications are delivered when.
    ❑ Medication name, drug type, dosage, unit, frequency
  ❑ Additional medical device data:
    ❑ Weigh scale – once a day
    ❑ Glucometer – twice a day
    ❑ Blood pressure monitor – once a day

VOLUME

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Velocity

❑ If data is sent with every delivery of medication (3-5 times a day) we can expect:

   ❑ 50-100 KB of data per unit per day
      ❑ That's up to 21 GB of data every hour or 500 GB /day or 182,500 GB /year

❑ *When including the schedules(100 KB/ unit), the log data (5 MB /unit), and overhead (1MB/ unit) the total required storage per year is about 213 TB!*

VELOCITY

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Variety

❑ Schedules and log data

❑ Numeric data from measurements

❑ Textual data from questionnaires

❑ Image data? Video recognition of medication ingestion (not included in this sample calculation).

Veracity

❑ The definition of **veracity** is truthfulness or accuracy.

    ❑ In this example veracity is less of a concern as we do not deal as much with unstructured data like social media data.

Value

- Great question! What is the value of this data?

- Potential Costs (Drawbacks)?
  - Karie must store 213 TB of patient data annually

VALUE

20-30% of seniors experience one or more falls each year

❑ Falls cause:
  ❑ 85% of seniors' injury-related hospitalizations
  ❑ 95% of all hip fractures
  ❑ $2 billion a year in direct healthcare costs, and over one third of seniors are admitted to long-term care following hospitalization for a fall.

1. Seniors' Falls in Canada: Second Report - Canada.ca. https://www.canada.ca/en/public-health/services/health-promotion/aging-seniors/publications/publications-general-public/seniors-falls-canada-second-report.html#s3. Accessed February 9, 2019.

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Biological or intrinsic risk factors

- ❏ Acute illness
- ❏ Balance and gait deficits
- ❏ Chronic conditions and disabilities
- ❏ Cognitive impairments
- ❏ Low vision
- ❏ Muscle weakness and reduced physical fitness

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Behavioural risk factors

❑ Assistive devices

❑ Excessive alcohol

❑ Fear of falling

❑ Footwear and clothing

❑ History of previous falls

❑ Inadequate diet

❑ Medications

❑ Risk-taking behaviour

❑ Vitamin D

Evidence

- ❑ Systematic reviews of the evidence have illustrated a strong association between the occurrence of falls and fractures in older people and the use of certain medications.

- ❑ Older adults taking more than three to four medications seem to be at higher risk of falls

- ❑ Furthermore, complications related to diabetes, such as neuropathy, retinopathy and nephropathy, likely contribute to an increased risk of falls

DIABETES IN CANADA

PRE-DIABETES FACTS

29% of Canadians are currently living with pre-diabetes

5.7 million or more are pre-diabetic

OVER 45 recommended age to get blood sugar levels checked

HEART DISEASE and nerve damage may begin during pre-diabetes

DIABETES FACTS

$2500 the annual out of pocket expense for a patient living with diabetes type 2

3.4 million are living with diabetes

14 billion cost of diabetes to the country

HIGH blood sugar may cause diabetes-related complications like kidney disease

INSULIN

6.0

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What If We Could Prevent Falls?

❑ With a "Big Data" AI solution in place we could predict when a patient is at increased risk of falls and notify them.
   ❑ Put in place appropriate measures for prevention (at home monitoring system)

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So What Now...?

Where AI is used

- Virtual Assistant or Chatbots
- Agriculture and Farming
- Autonomous Flying
- Retail, Shopping and Fashion
- Security and Surveillance
- Sports Analytics and Activities
- Manufacturing and Production
- Live Stock and Inventory Management
- Self-driving Cars or Autonomous Vehicles
- Healthcare and Medical Imaging Analysis
- Warehousing and Logistic Supply Chain

AI in medicine

❏ Addressing high medical and medication error rates, as well as high cost and low productivity

AI for medical diagnosis

Can we improve diagnosis of disease?

CAD in Third World Countries

❏ The study shows that combining CAD (Computer-Aided Diagnosis) with low-cost ultrasound improves the accuracy of identifying palpable breast lumps.
❏ CAD aids minimally trained operators in interpreting ultrasound images, enhancing diagnostic accuracy.
❏ The research underscores the value of CAD and affordable ultrasound in resource-limited settings like Mexico for better breast cancer screening and efficient triage.

AI for prognosis

Collect information, organize it and provide insights to improve clinical decision making.

CADx used in Disease Prognosis

❑ The article by Wang et al. explores the use of 2D hand photographs to predict postoperative biochemical remission in patients with acromegaly, using a transfer learning approach.

❑ The study demonstrates that 2D hand photographs can be a valuable tool in predicting outcomes, especially when interpreted through transfer learning algorithms.

❑ Published in "Quantitative Imaging in Medicine and Surgery," the research offers a novel, non-invasive method for assessing the likelihood of postoperative remission in acromegaly patients.

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AI for treatment

Allows doctors recommend better treatments to patient with the help of data
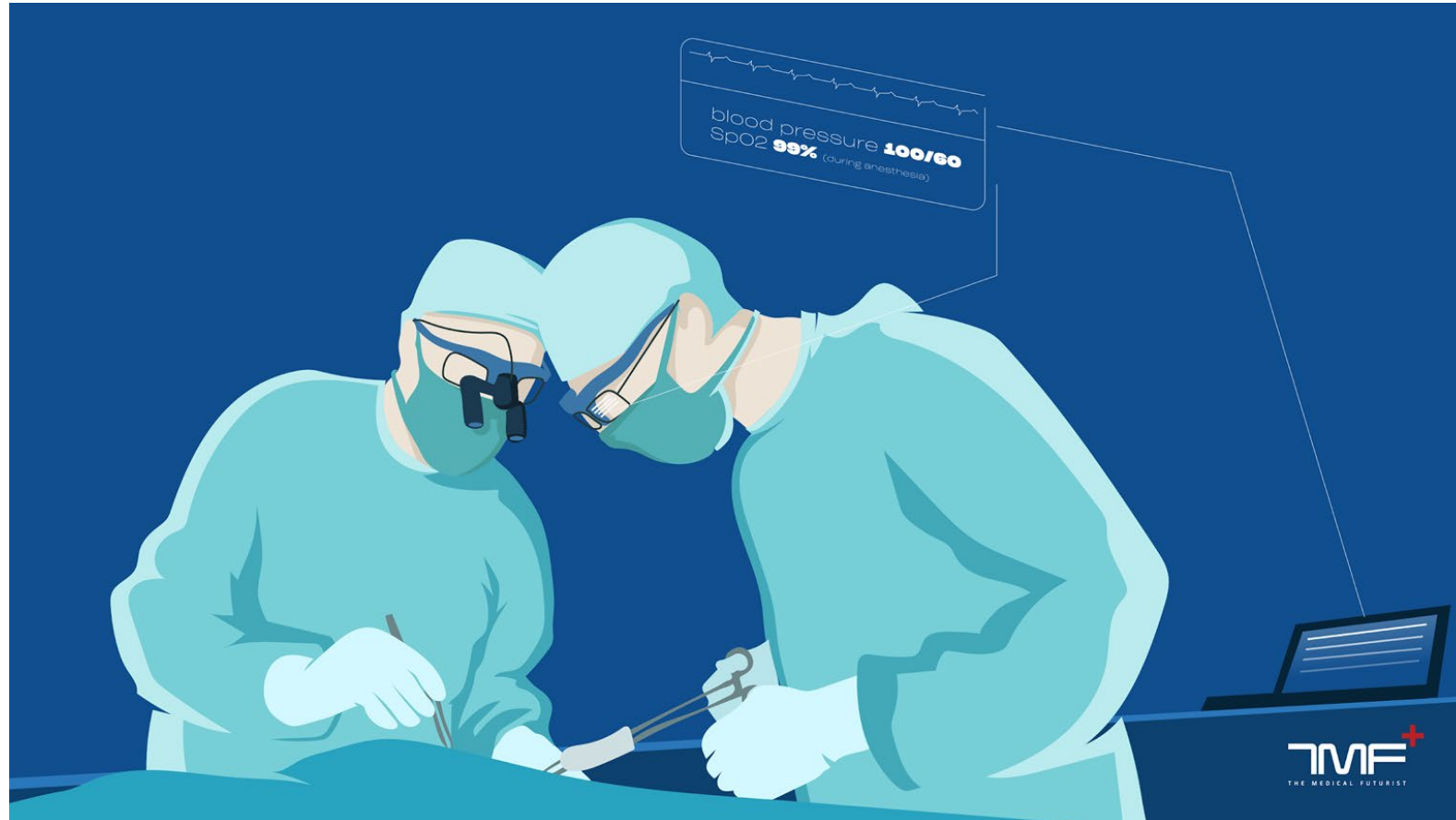
AI for precision

The ambition of precision medicine is to design and optimize the pathway for diagnosis, therapeutic intervention, and prognosis by using large multidimensional biological datasets that capture individual variability in genes, function and environment.

Where is AI used in medicine

- Three DL systems (CAD4TB, Lunit INSIGHT, and qXR) for detecting TB-associated abnormalities in chest radiographs from outpatients in Nepal and Cameroon

Qin, Z.Z., Sander, M.S., Rai, B. et al. Using artificial intelligence to read chest radiographs for tuberculosis detection: A multi-site evaluation of the diagnostic accuracy of three deep learning systems. Sci Rep 9, 15000 (2019). https://doi.org/10.1038/s41598-019-51503-3

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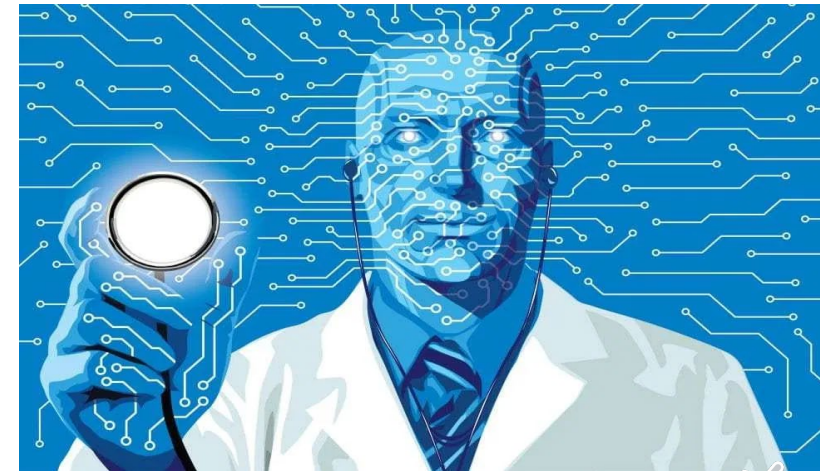
Interesting application

MEDO.ai received FDA approval to automatically detect hip dysplasia, preventing the leading cause of early hip osteoarthritis and hip replacement surgery

Ultrasound

Butterfly network Inc. (2017)

A window into the human body for less than $2,000 enabled by breakthrough Ultrasound-on- a-Chip technology.

Butterfly Network has developed deep learning-based artificial intelligence applications that are tightly coupled to the hardware and assist clinician

Urology for prostate cancer diagnosis

❑ A patch-based Deep-CNN model is proposed to classify prostate cancer (PC) and non-cancer (NC) image patches from multiparametric MR images.

Saba L, Biswas M, Kuppili V, et al. The present and future of deep learning in radiology. Eur J Radiol. 2019;114:14-24. doi:10.1016/j.ejrad.2019.02.038

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ALS

- Amyotrophic lateral sclerosis (ALS) is a devastating neurodegenerative disease with no effective treatments. Numerous RNA-binding proteins (RBPs) have been shown to be altered in ALS.

- Used IBM Watson® to go through all RBPs in the genome and identify new RBPs linked to ALS

Bakkar N *et al*. Artificial intelligence in neurodegenerative disease research: use of IBM Watson to identify additional RNA-binding proteins altered in amyotrophic lateral sclerosis. Acta Neuropathol. 2018; 135: 227-247.

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End of Lecture 3

Next up Part 2 Lecture 1: How can AI help me?

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