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# CSCI 101
# Connecting with Computer Science
# Lecture 4: Applications of CS I

Jetic Gū

2023 Fall Semester (S3)

# Overview

- Focus: Computing Science in Production
- Architecture: von Neumann
- Readings: 4, 5
- Core Ideas:
    1. Basic Introduction
    2. BioInformatics

# Applications of CS

Where CS is essential

P1
Intro

# What we are NOT talking about

- How information can be stored/accessed in computers instead of in the library/bookkeeper’s closet
- How much faster computers are, comparing to manual computation
- How much convenient it is to use a computer to communicate
- The products made possible through computers
- etc.

P1
Intro

# What we ARE talking about

- How computers are pushing forward human boundaries
- I especially want to discuss a few highly complex fields:
  - Medical Science
  - Automated Research / Experiments, Physical Simulations
  - Robotics, 3D printing

# Computers are making our lives easier

- but not just easier. It is slowly changing what it means to be human.
- CS is one of the few technologies in human history that revolutionises everything else
- CS is essential for all professions, even philosophy!

P1
Intro

# The Digital Revolution

Education

Transport

Manufacture

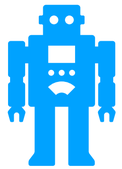
Entertainment

Food

Fashion

Medicine

Research



Robotics

Concept

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# Bioinformatics

Where Medical Advancement is Aided by CS

Summary

# Definition

Medicine

- BioInformatics: the use of computers and computer science to study biological questions (also called computational biology)
  - It is an interdisciplinary field
    - **Medical Science**
      - Biology, Psychology
      - Chemistry and Physics
    - **Computer Science**

Concept

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# Bioinformatics

Medicine

- What you can do (with data)

  1. Using computers to store/access patient records
     All data are stored in the cloud and protected. Your doctors will have your full health history, no matter which hospital you go

  2. Analysing Biometric data

     - Patient Data: records and examination outcome

     - Human Genome Project

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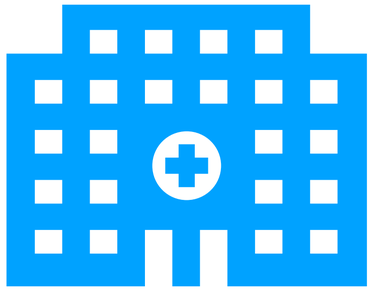
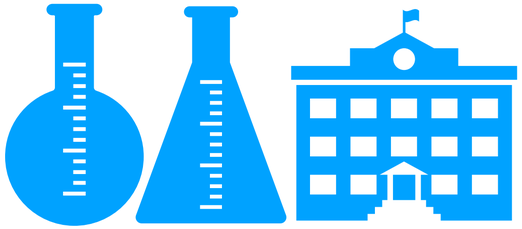
# What is currently being done?

Medicine



**Hospitals**

**Patient Oriented**



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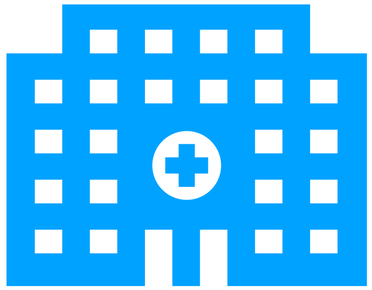
Medicine



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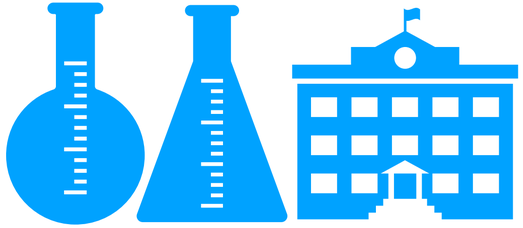

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- Digitisation of Patient Records database optimisation
- Computer analysis of Individual Examination Reports
- Quantitative Analysis including HGP
- Study biology, develop new treatments

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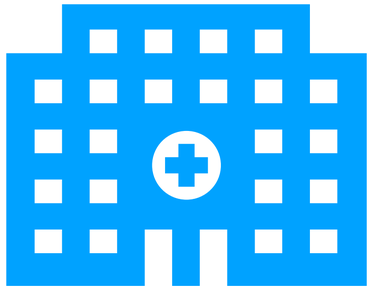
# What is currently being done?

Medicine

- Digitisation of Patient Records
  - Mostly a database project
  - privacy, efficiency, bureaucracy
- Computer analysis of individual examination reports
  - Statistical analysis
  - Artificial intelligence



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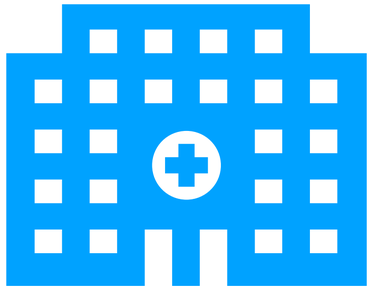
# What is currently being done?

Medicine

- Digitisation of Patient Records (challenges)
  - Data structure
    How is the data stored
  - Privacy
    How can the data be accessed
  - Efficiency
    How can the database handle hundreds of requests
  - Bureaucracy
    What are the legal requirements? What about universal healthcare?



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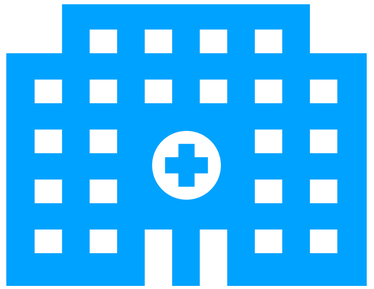
# What is currently being done?

Medicine

- Computer analysis of individual examination reports
  - Basic statistic analysis
    Spotting abnormal indices
  - Using AI to spot possible problems
    e.g. cancer detection



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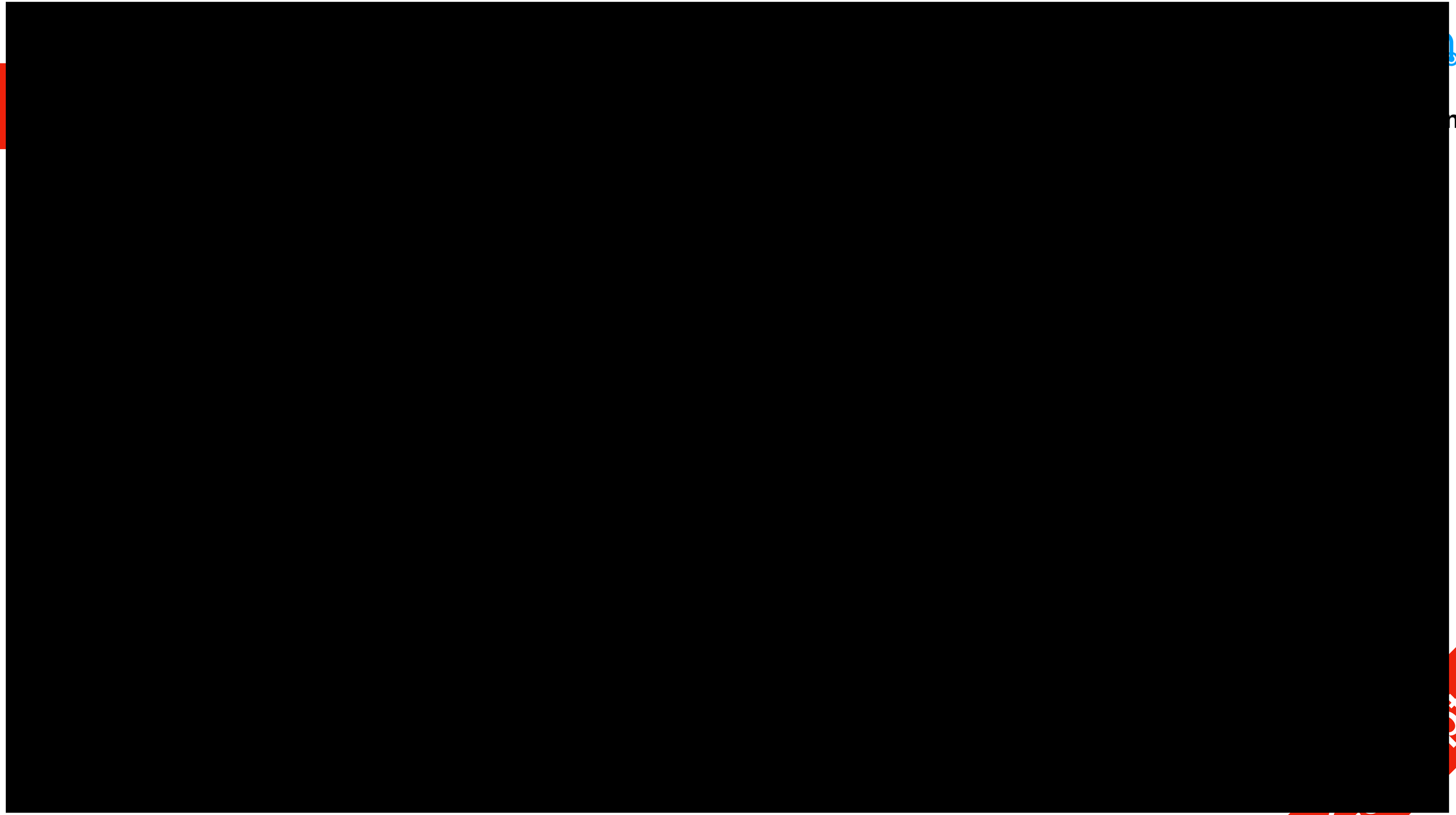

1. https://www.youtube.com/watch?v=Mur70YjlnmI

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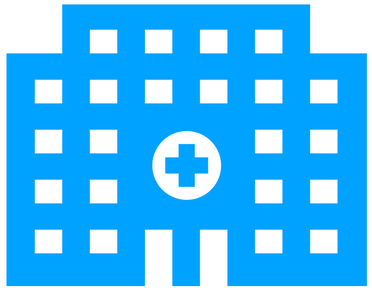
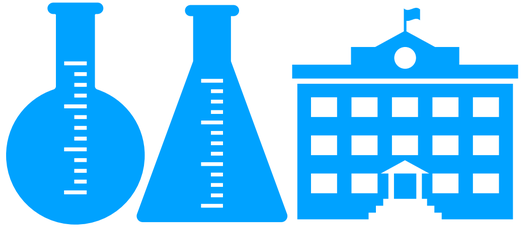
# What is currently being done?

Medicine



**Hospitals**

**Patient Oriented**



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**Knowledge Oriented**

- Digitisation of Patient Records database optimisation
- Computer analysis of Individual Examination Reports
- Quantitative Analysis including HGP
- Study biology, develop new treatments

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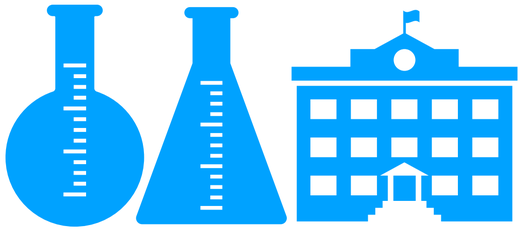
# What is currently being done?

Medicine

- Quantitative Analysis
  - Patient records are very valuable resources
  - Discover patterns between medications and symptoms
  - Long-term assessment of health conditions
- Study biology, develop new treatments
  - Prosthetic Arms and BCI
  - Human Genome Project



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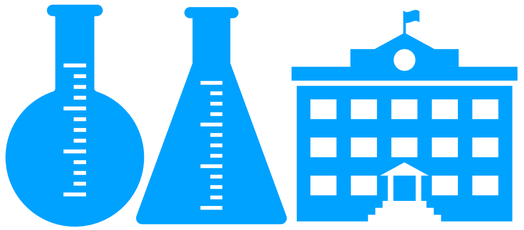
# What is currently being done?

Medicine

- Quantitative Analysis
  - Patient Records comes in natural language (human language)
  - Information Extraction
  - Data analysis



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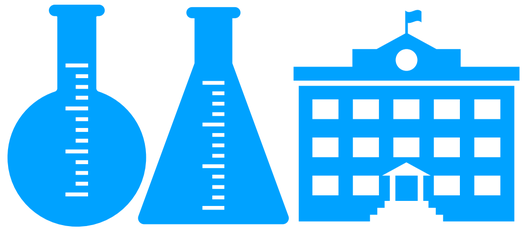

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adj. n. adj. n.

**Record: Patient suffering major knee injury, under excessive pain.**

**Extracted information:**

- **Location: "knee"**
- **Degree: "major"**
- **Condition: external injury**
- **Patient feeling: pain, level 0.7**

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# What is currently being done?

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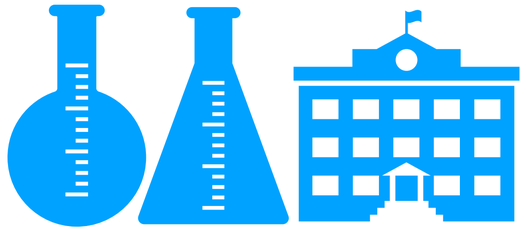
  - Patient Records comes in natural language (human language)
  - Information Extraction
  - **Data analysis**



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**100 patients with knee injury**

- **Location: "knee"**
- **Degree: "substantial" -> "major"**
- **Condition: external injury**
- **Patient feeling: pain, level 0.5-0.7**

- **Treatment A: recovery in 30 days**
- **Treatment B: recovery in 15 days**

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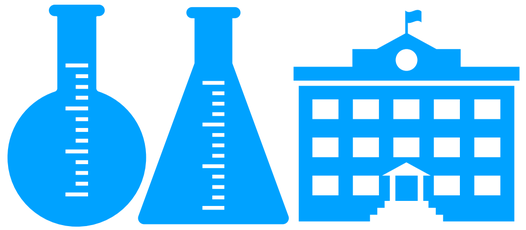
# What is currently being done?

Medicine

- Quantitative Analysis
  - Patient Records comes in natural language (human language)
  - Information Extraction
  - **Data analysis**



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**100 patients with knee injury**
- **Location: "knee"**
- **Degree: "substantial" -> "major"**
- **Condition: external injury**
- **Patient feeling: pain, level 0.5-0.7**

- **Age 30 and under:**
  - **Treatment A: recovery in 30 days**
  - **Treatment B: recovery in 15 days**
- **Age 50 and over:**
  - **Treatment A: recovery in 45 days**
  - **Treatment B: recovery in 30 days**

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Medicine

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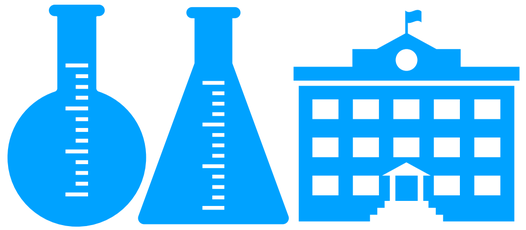
  - **Data analysis**



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**100 patients with knee injury**
- **Location: "knee"**
- **Degree: "substantial" -> "major"**
- **Condition: external injury**
- **Patient feeling: pain, level 0.5-0.7**

→

- **Age, Occupation, Gender, ....:**
  - **Treatment A: recovery in ... days**
  - **Treatment B: recovery in ... days**
  - **...**
  - **Treatment Z: recovery in ... days**

→ **...**

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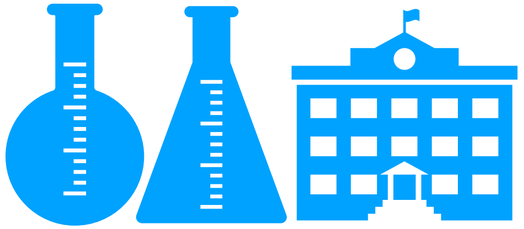
# What is currently being done?

Medicine

- Data analysis: Intelligent Diagnostic System
  - IBM Watson
    - Input: patient info and examination records
    - Output: treatment options
    - This is a failed project



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Medicine


1. https://www.youtube.com/watch?v=lRhg6yxenY4

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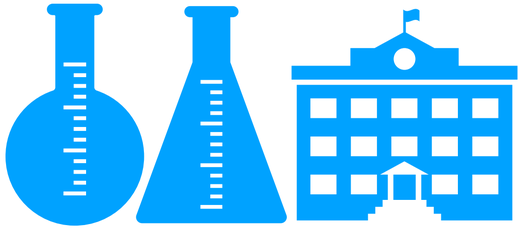
# What is currently being done?

Medicine

- Data analysis: Disease Prevention Systems
  - Given patient records and life style, can we predict what likely disease this patient can contract?
  - Given above predictions, can we give recommendations that will lower the chance of actual contraction?



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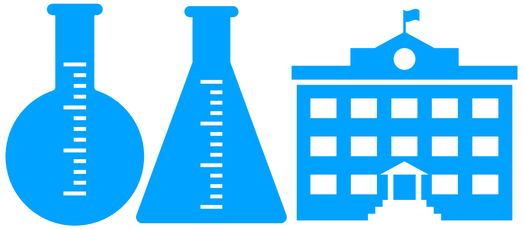
# What is currently being done?

Medicine

- Data analysis: Contact Tracing for Covid-19
  - How does it work?
  - Uses bluetooth technology



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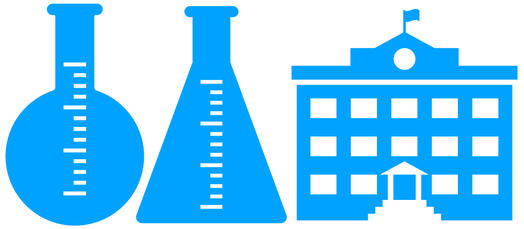
- Study biology, develop new treatments
  - Prosthetic Arms and BCI
  - Human Genome Project



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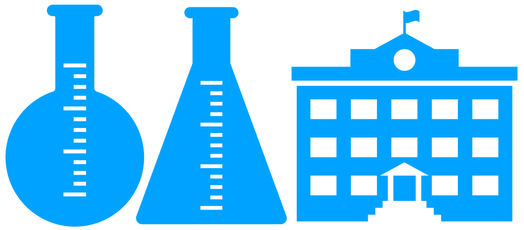
# What is currently being done?

Medicine

- Study biology, develop new treatments
  - Prosthetic Arms and BCI
    - Human bodies are filled with neurones
    - Neurones produce electric signals to each other
      - Motor control: controlled through neurones
      - Sensing: optical neurones, etc.
      - Thinking: Wernicke’s’ region for language etc.



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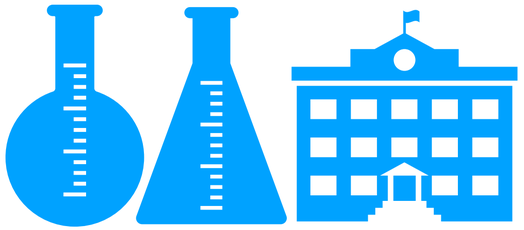

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1. https://www.youtube.com/watch?v=rSQNi5sAwuc

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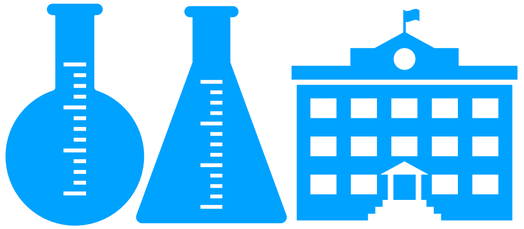
# What is currently being done?

Medicine

- Study biology, develop new treatments
  - Prosthetic Body Parts
    - Detect motor control signals (muscle controlling electric signals)
  - BCI: Brain Computer Interface
    - Interpret human brain signals



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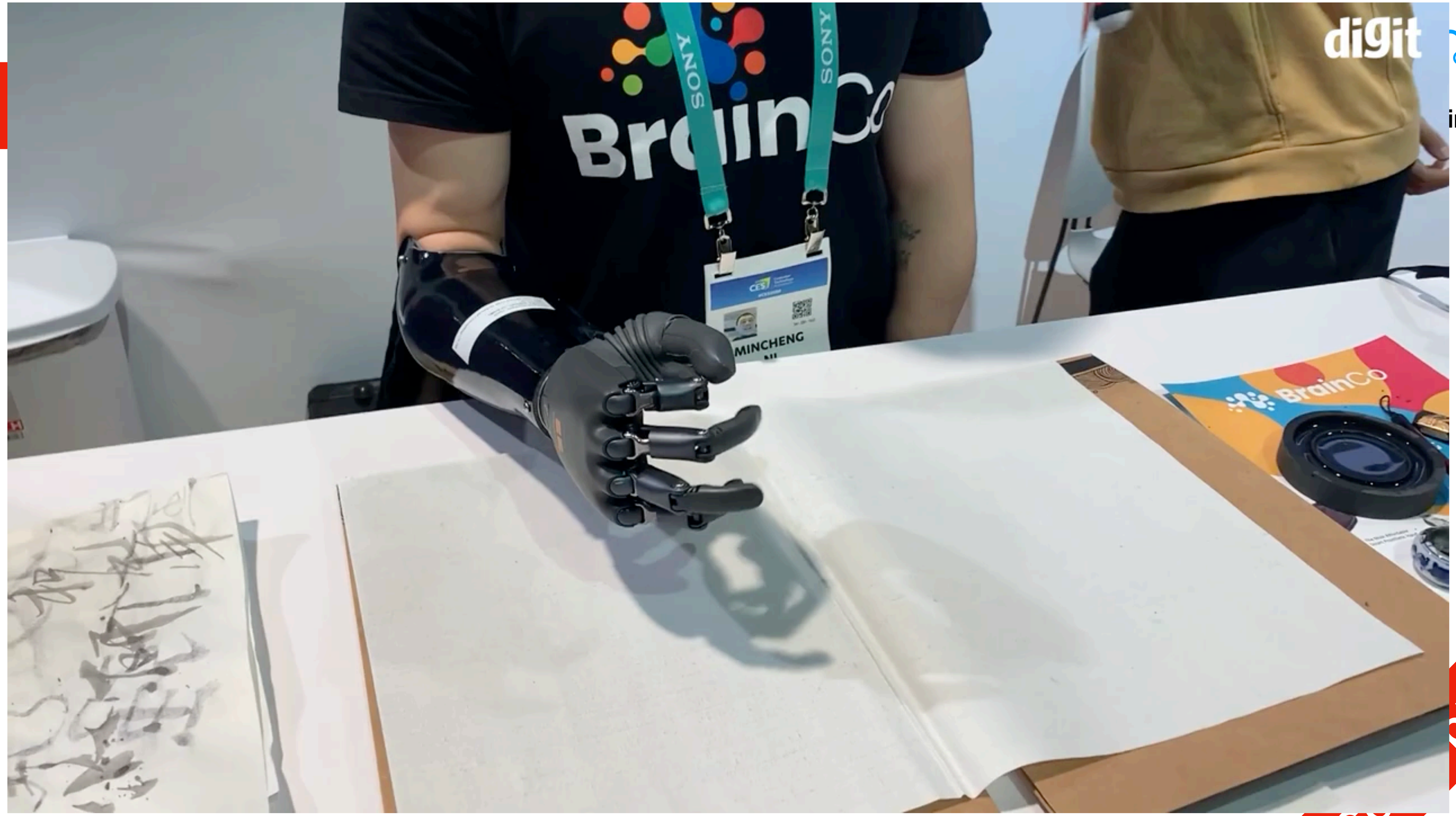


1. https://www.youtube.com/watch?v=rSQNi5sAwuc

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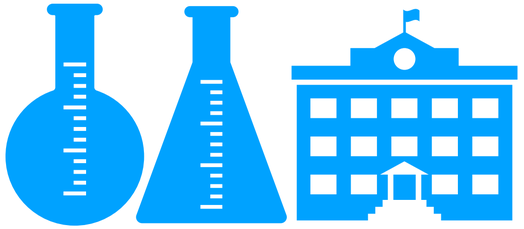
# What is currently being done?

Medicine

- Current Advancement in BCI
  - Binary Sentiment Analysis from EEG
  - Reconstruct (some) Acoustics from EEG/ECogG
  - Controlling robotic arms using Brain signals



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