

# AI and Healthcare

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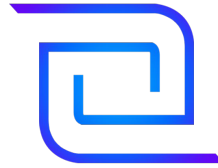
And making responsible Impact

# Ally Jr Salim

Inspired Ideas LLC  
CEO & Founder



**Inspired Ideas**  
Consulting



**Dr. Elsa**  
Artificial Intelligence in Healthcare



**Mary**  
Artificial General Intelligence Research

# 0. Structure & Goals

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# 1. Introduction & background

- Understand the current state of healthcare
- Understand intelligence and its role in healthcare

# 2. Getting technical

- Data & its importance
- Algorithms & Models walkthrough

# 3. Beyond the technical

- Data
- Policies
- Market
- Challenges

# House cleaning items

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# Quick Survey



# What I expect from you

- Please ask questions
- Please make suggestions
- Interruptions are allowed
- Let's have some fun!





# Green light session

What are your expectations from this presentation?



# 1. Background

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# Background & Significance

- High-quality healthcare is crucial to achieving national health objectives & for the development of a country and its people
- There is a precedence for using technology to improve healthcare infrastructure and delivery systems
  - Artificial intelligence is one of these technologies
- Use of technology in healthcare is having massive impact on health outcomes

# Machine Learning & Artificial Intelligence

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An overview

# Machine Learning

**Machine learning is a subset of artificial intelligence in the field of computer science that often uses statistical techniques to give computers the ability to "learn" with data, without being explicitly programmed.**

In other terms...

This is a way of using mathematics and probabilities to understand data and later make decisions based on what we have seen from the data

# Artificial Intelligence

**Artificial intelligence is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans and other animals.**

In other terms:

When a machine can think and reason like you and I do.\*

Soooo....

What's The difference?

Simply put:

*“Machine learning is simply a way of achieving AI.”*

# Current State of Healthcare in Tanzania

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What do you think is the current state of  
healthcare in Tanzania?



# Healthcare in Tanzania

- Massive increase in low-cadre healthcare workers (Community Healthcare Workers) and improvements in medical training over the past decade
- Measurable national and international plans
- Coordinated efforts to improve healthcare outcomes (govt., NGO, private institutions, researchers)
- Increased access to testing services for HIV, malaria, TB, and other infectious diseases

# Health Challenges in Tanzania

- Health spending per capita is low
  - \$137 (USD, 2014)
- Infant mortality rate is 47/1,000 live births
- High causes of death: diarrheal disease, neonatal disorders, HIV/AIDS, malaria, cardiovascular disease, NCDs
- Shortage of specialty doctors

# Health Challenges in Tanzania

- Low physician-patient ratio (**1:20,000**)
  - One of the lowest in the world
- Challenges in healthcare delivery at the “last mile” (especially in rural areas)
- Limited diagnostics in rural areas
- Misdiagnoses and high rates of antibiotic prescriptions

# An Overview of Health Technologies

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# Health, Innovation & Technology

- **Health innovation** responds to unmet public health needs by creating new ways of thinking and working with a focus on the needs of the vulnerable populations.
- Focuses on **efficiency, effectiveness, quality, sustainability (scalability), safety and affordability.**
- Requires collaboration with many different stakeholders

# Technology Use in Tanzania

- **40 million mobile network users in Tanzania**
- **19 million internet users (2016)**
- Technology is a powerful tool for solving problems
- Technology provides a platform to collaborate and solve problems
- Uptake of technology in Tanzania (and across the continent) is impressive
  - Technology penetration rates in TZ are some of the highest in Africa

# Tech-Based Solutions in Health

## Artificial Intelligence (AI)

- One of the most promising approaches to addressing challenges in healthcare is the use of Intelligent Systems at key points in the health delivery chain.
- With Artificially Intelligent systems, we can do new things like empower poorly trained healthcare workers to improve health outcomes, and forecast disease outbreaks for better resource allocation.

## 2. Getting technical

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What can AI achieve in healthcare?

# Case Studies

- **Disease Detection**
  - SkinVision - patient app to detect skin cancer
  - IBM Watson Genomics - Targeting cancer cells with genetic mutations
- **Treatment Recommendations**
  - Berg - AI to research & develop diagnostics and therapeutic treatments in oncology
- **Virtual Nursing Assistants**
  - Care Angel - 24/7 assistant that can answer questions, monitor patients and provide quick answers

# Case Studies Cont.

- **Radiology and Imaging**
  - Google's DeepMind Health - detects differences in healthy and cancerous tissue for radiation treatment
  - Classify and detect abnormalities in imaging
- **Surgery**
  - Analyze data from pre-op medical records to guide a surgeon's instruments during surgery (the Da Vinci)





Computer vision is dominating the healthcare space, why do you think so?

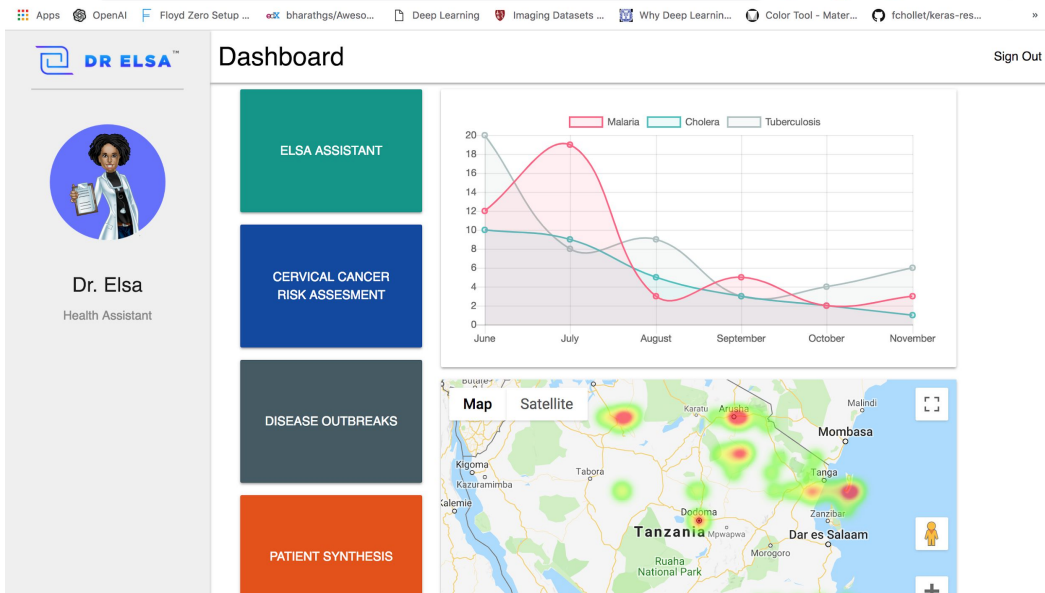
# Dr. Elsa - Intelligent Healthcare

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# Dr. Elsa's Health Assistant is an AI-powered tool for health workers

Supports the knowledge and capacity of health workers in rural settings by using AI and trends of disease patterns to come up with diagnosis and course of treatment in absence of diagnostic equipment and tests.

# Intelligent Healthcare Assistant



- Prediction
  - Infectious Disease
  - General Medical Cases
  - Medical Triage
  - Next Steps Recommendations
- Forecasting
  - Individual Disease
  - Multiple Disease
  - Disease interaction research

# Applications of an AI-Powered Health Assistant

## Diagnosis Prediction

Predicting Differential Diagnoses for patients based on symptoms and patient demographics and lab test results if available.

## Lab Test & Prescription Recommendations

Recommending next steps like test to take and prescriptions based on patient symptoms, diagnoses and demographics

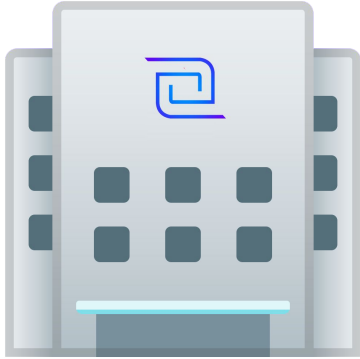
## Disease Outbreaks

Using predictive algorithms to predict the trending diseases and outbreaks months before they happen



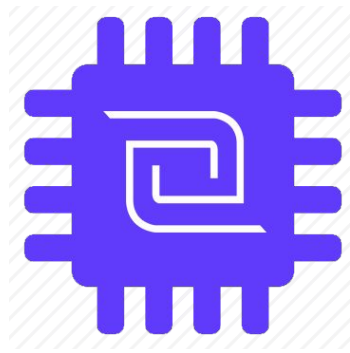
Step 1

Patient goes to a  
healthcare facility



Step 2

Doctor enters patient details

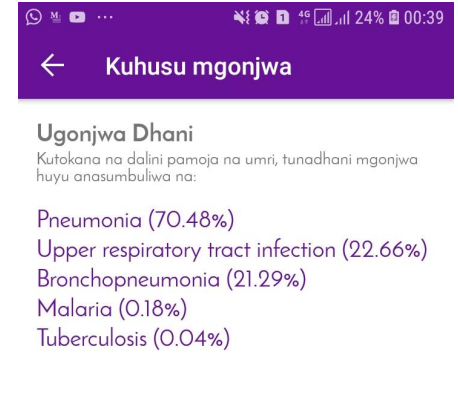


Step 3

AI makes calculations in  
background

Step 4

Evidence Based Decisions



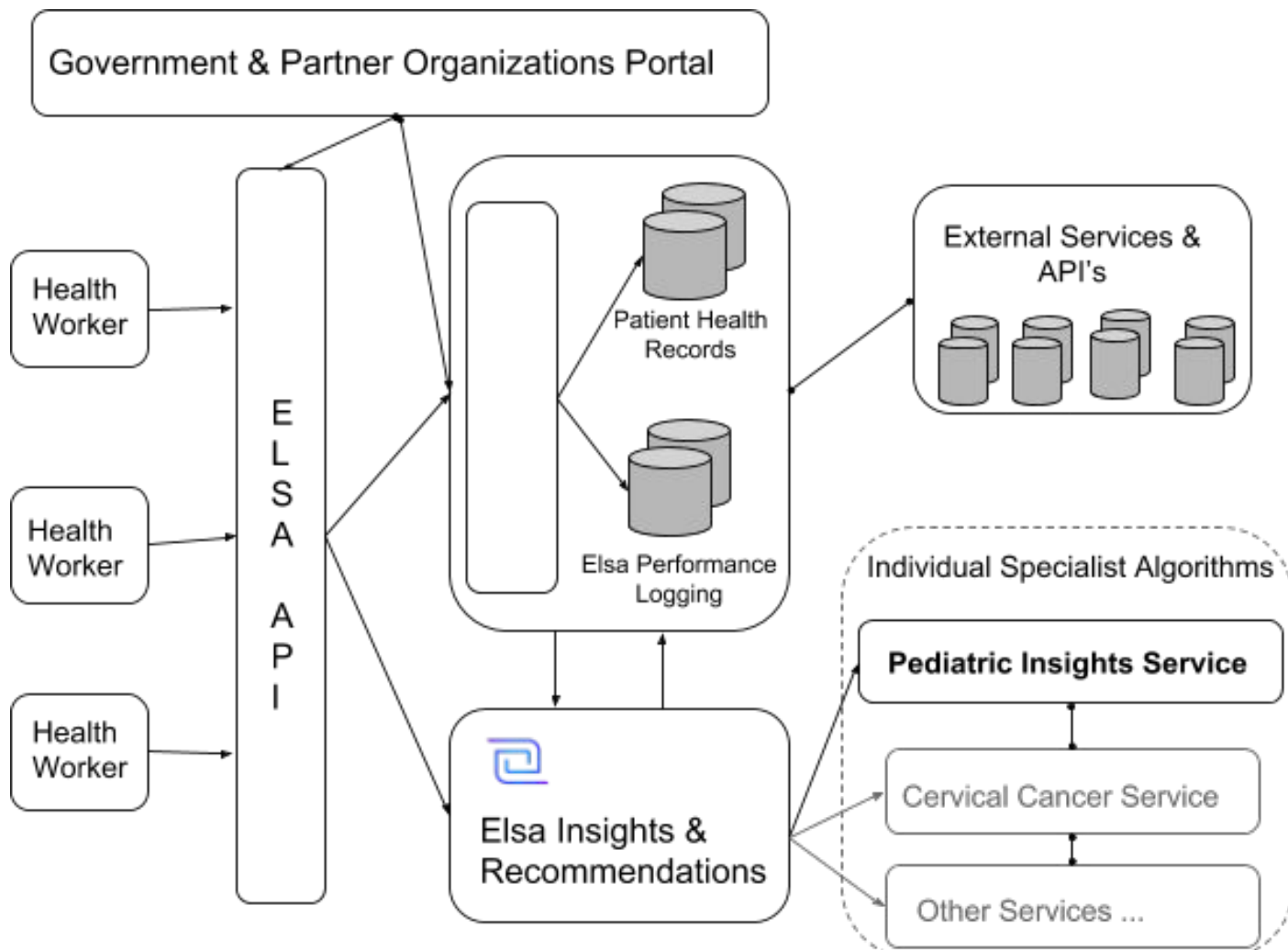
# Dr. Elsa - System Architecture

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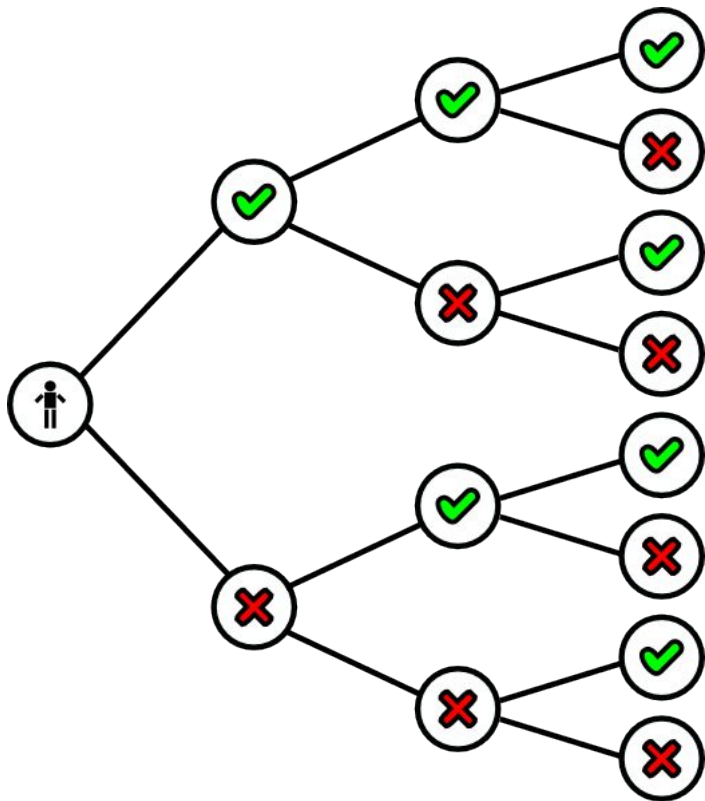
What are some important things to keep in mind when building such a system?





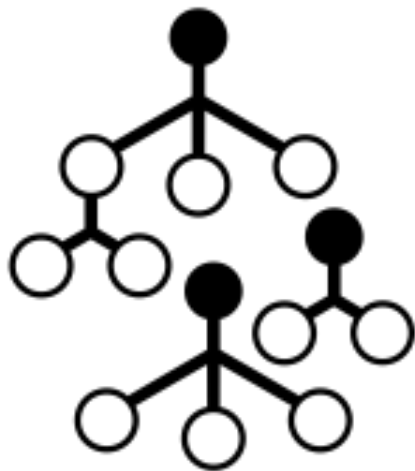
Suggestions for algorithms & models that we  
could use?

# Decision Trees



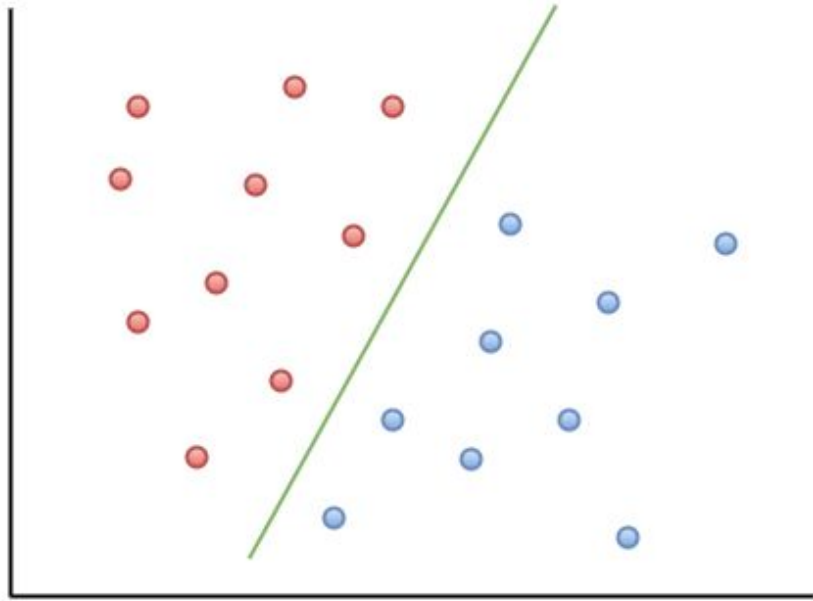
- Black & Grey box interpretation

# Random Forests



- Diagnoses Prediction
- Tests recommendation
- Prescription Recommendation
- Cervical Cancer Risk Analysis
- Skin Cancer (Image) detection

# Support Vector Machines

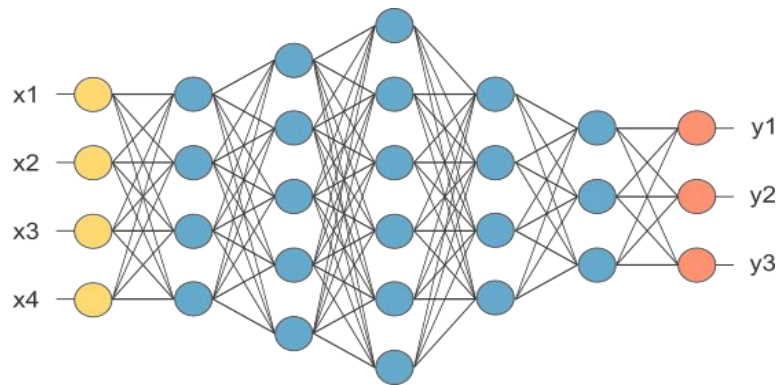


- Diagnoses Prediction
- Cervical Cancer Classification

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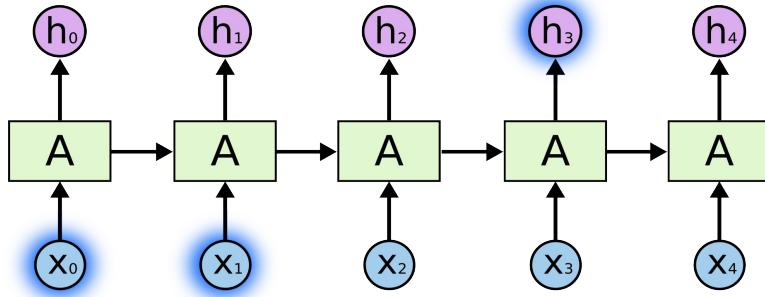


# Deep Neural Networks



- Diagnoses Prediction
  - Tests recommendation
  - Prescription Recommendation
  - Cervical Cancer Risk Analysis
  - Skin Cancer (Image) detection
-

# LSTM Neural Networks & ARIMA



$$z_t = x_{t-100} = \sum_{j=0}^{\infty} (0.6)^j w_{t-j}$$

- Forecasting & Outbreak risk predictions

# Importance of data

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How important is data?  
What can we do to mitigate this challenge?

Rule of thumb

The **more high quality** data  
you can collect, the better off  
you are.

# How do we mitigate the data challenge?

- Feature Engineering - Domain knowledge to select relevant features as well
- Hybrid intelligent solutions - Using expert systems together with AI solutions to curb the lack of data
- Synthetic data generation - Simply create your own dataset :)

# 3. Beyond the technical

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80% of the work





What else can be beyond the technology?



# Interpretability & Explanations of our models

- In healthcare, it is very important to have explainable models are easy to understand
- Simpler models are easier to interpret

# Challenges

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- **Data**

- Digital Data is scarce - Government collects summaries
- Acquiring data is very expensive and time consuming
- DOCTORS' HANDWRITINGS ARE IMPOSSIBLE!

- **Policies & Legislation**

- Too broad and cover literally “everything”
- Bureaucracies & gatekeepers keep innovation from being implemented
- Poor exposure among policy makers
- “Stealing jobs” accusations

- **Uptake of Technology**

- People are often wary of using new technologies in their practice - low trust factor
- Learning curve to using new technologies

- **Infrastructure**

- Availability of internet/ access to cloud servers
- Health infrastructure is often fragmented, making it challenging to tracking patients throughout their care

# Impact

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# Why does all of this matter?

- Support for decision making & next steps recommendations
- Better understanding and tracking of health related issues
- More access to health information
- Scalability in a growing population
- Using technology to engage young people
- Supporting the Sustainable Development Goals



# Next Steps / The Future

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What can we do moving forward?



# Ways Forward - What Can We Do?

- Embrace innovation and technology
- Encourage national policy that supports innovation and entrepreneurship
- Support in building smart cities
- Collaborate within our communities to develop our own solutions
- Utilize human centered design thinking
- Do good!

# Thank you!

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@3210jr

@doctor\_elsa

# Extras

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Step 01

# Data Collection

- 80% of time is spent doing this
- Hard and challenging, both collecting and ensuring quality
- More is (almost) always Better!
- Privacy is important, do not disclose personally identifying information

Our options for getting data are:

01 Build data collection tools & start collecting data at a hospital

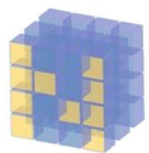
02 Look for already collected data. Through partnerships or Open source



# Clean & Prepare Date

- Very time consuming and delicate process
- **Visualize** the data for better understanding
- Ask questions about the data

Here we use open source tools:

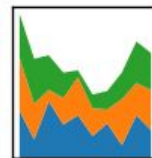
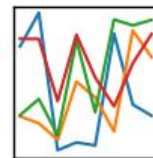


NumPy

matplotlib

pandas

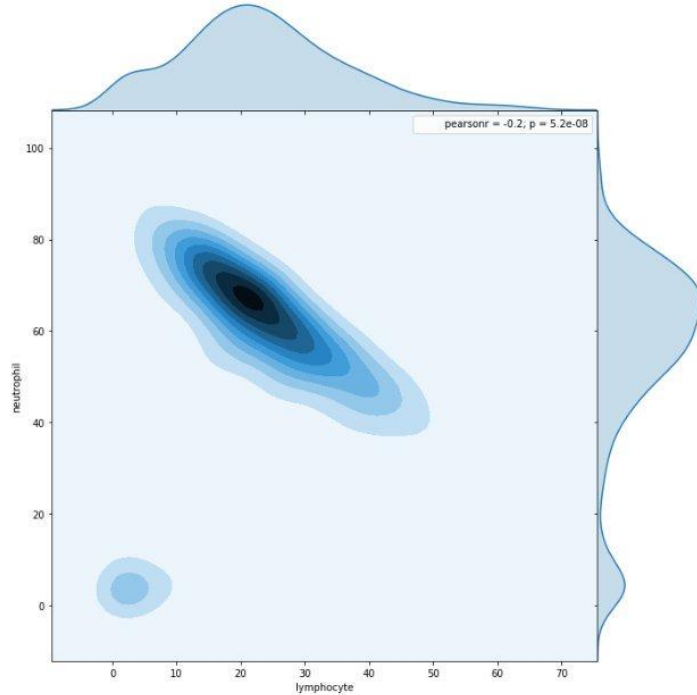
$$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$$



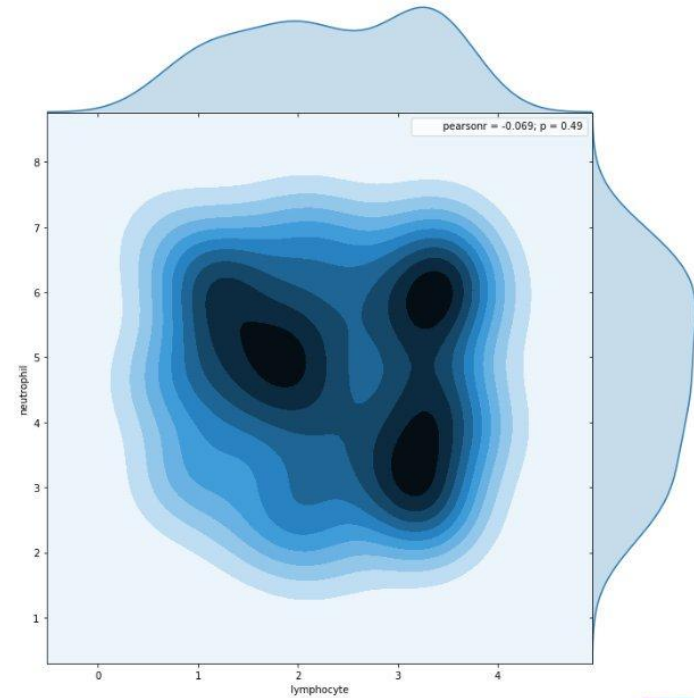
# Useful Open Source Libraries

- 01 **Numpy** : Fast and Convenient tools for Numerical computing
- 02 **Matplotlib** : Data visualization tools / Makes it possible to draw charts and graphs
- 03 **Pandas** : Data manipulation and cleaning
- 04 **Jupyter** : Interactive coding environments to simplify the process
- 05 **Scipy** : An ecosystem of open-source software for mathematics, science, and engineering

# Visualization makes things easier to understand.



Cervical Cancer Patient



Perfectly healthy person





Step 03

## Train Model

- Here we teach the computer
- We use the data acquired as examples
- Experiment with Different models and learning algorithms
- At this point we know that we are solving a **Classification** and not a **Regression** problem.

\*There are many options of what algorithms and models we can use, but, we will use Support Vector Machines for classification!

