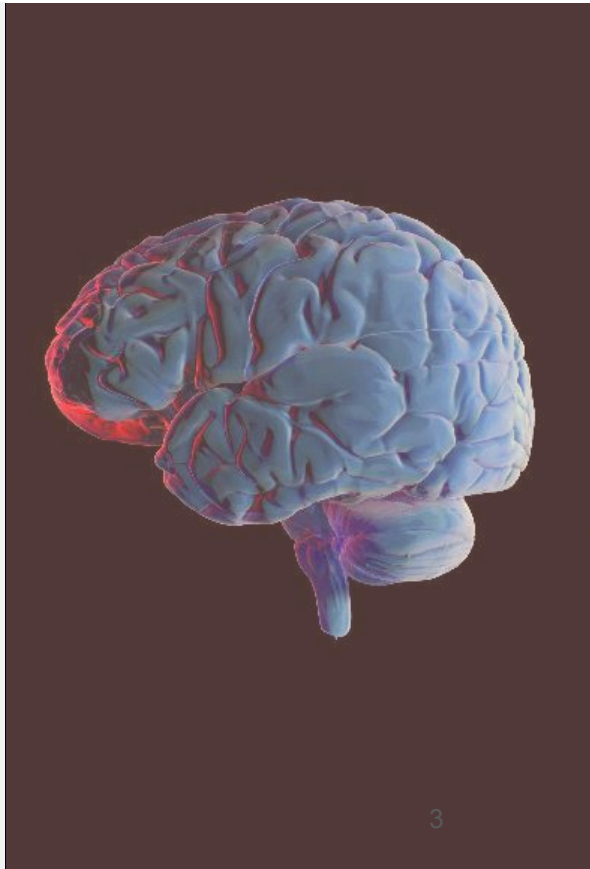
# Artificial Intelligence and Machine Learning

Ivan Yamshchikov

# What is intelligence?

Intelligence — ability to **perceive** or **infer information**, and to **retain it as knowledge** to be **applied towards adaptive behaviors** within an environment or context.

- Logic
- Learning
- Reasoning
- Problem solving
- Planning
- Self-awareness
- Emotional knowledge
- Understanding
- Creativity
- Critical thinking



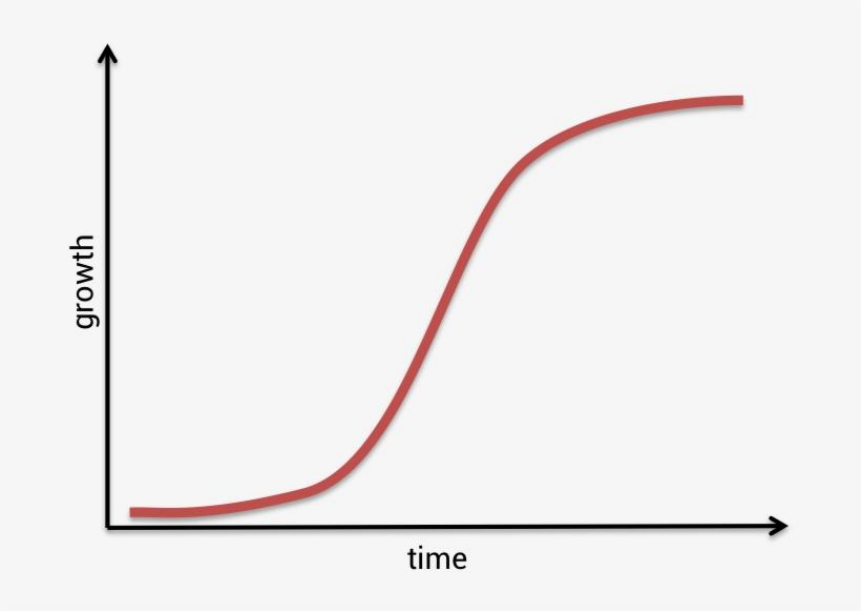
# What is artificial intelligence?

Artificial intelligence (AI) is an **area of computer science** about the design of artificial machines and algorithms that **work and react like humans**.

- Visual perception
- Text and speech recognition
- Natural language processing
- Decision making

# S-curve

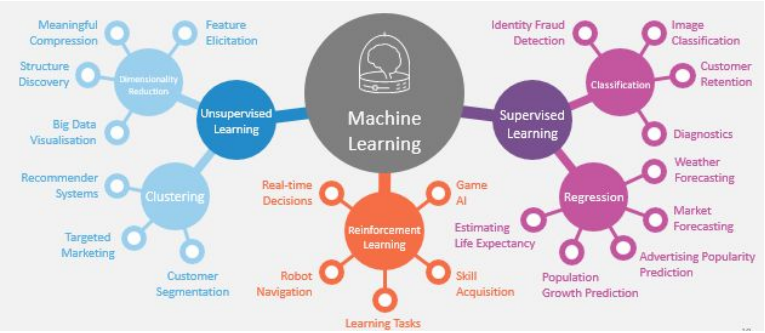
## Mass adoption takes time



# What is artificial intelligence. «Weak AI» versus «Strong AI»

## Weak/Narrow AI

- One **specific task**.
-

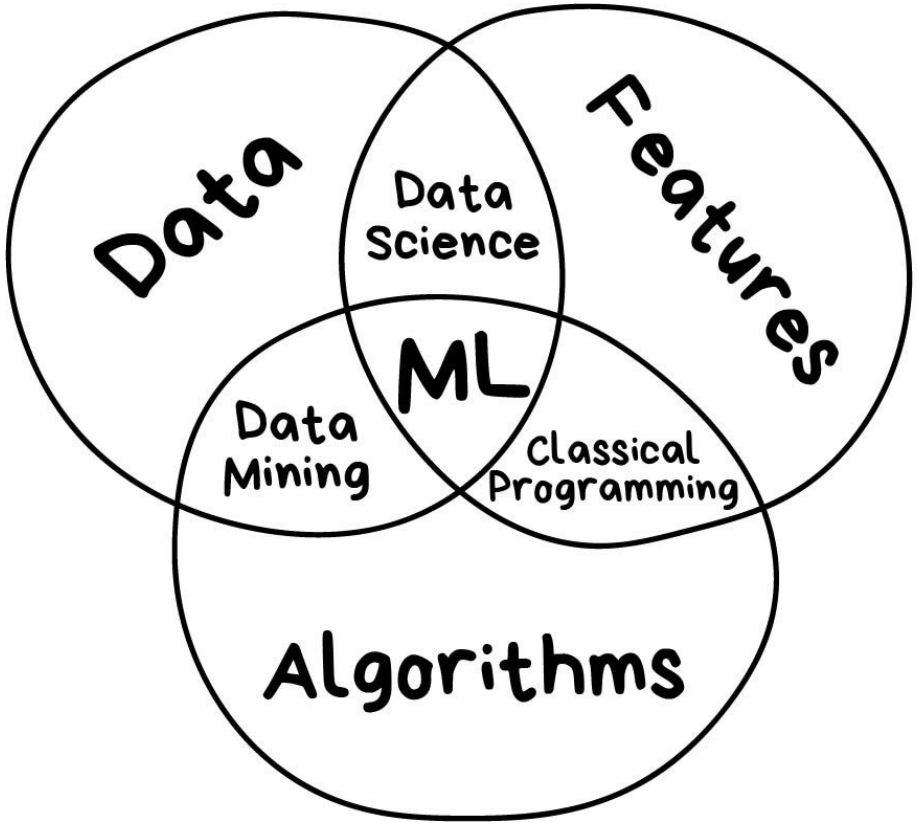



- Solution of **practical problems** by **imitating** human perception and reasoning

## Strong/General AI

- **Any task** that a human being can.

- **Science fiction** and inspiration for philosophers




https://vas3k.ru/blog/machine_learning/

# Deductive vs. inductive learning

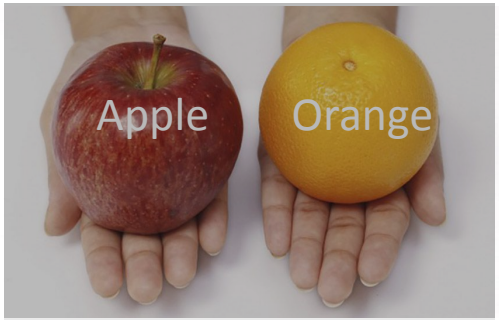
**Deductive**

- Teacher-centered
- From generalisation (rules) to specifics (examples or activities)

**Inductive**

- Student-centered
- From specifics (examples or activities) to generalisations (rules)

# Machine learning paradigms. Supervised, reinforcement and unsupervised learning. (Inductive)




**Supervised learning** infers a function from labeled training data.

**Unsupervised learning** infers the patterns within unlabeled datasets.

**Reinforcement learning** allows intelligent agents to automatically determine the optimal behavior within a specific environment.

# Knowledge engineering pros and cons

Pros:

- Ability to represent high-level knowledge in a structured form without large labeled datasets.

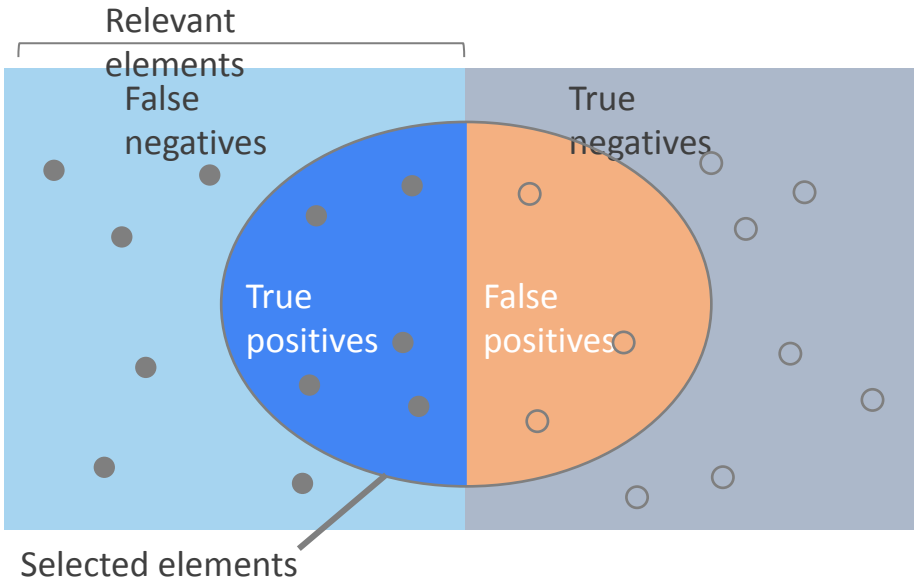
Cons:

- High cost of development and support of large knowledge bases.
- Inability of human experts to correctly estimate probabilities.

# Machine learning. Most important ML algorithms. (Inductive)

- Naïve Bayes
- Support Vector Machines
- Gradient boosting
- Evolutionary algorithm
- Deep Learning

# Key terms definition



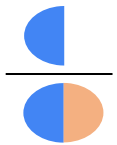

$$\text{Precision} = \frac{tp}{tp + fp}$$

$$\text{Recall} = \frac{tp}{tp + fn}$$

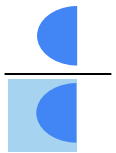
$$F = 2 \cdot \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}}$$

$$\text{Accuracy} = \frac{tp + tn}{tp + tn + fp + fn}$$

How many selected items are relevant?

Precision = 

How many relevant items are selected?

Recall = 

https://en.wikipedia.org/wiki/Precision_and_recall

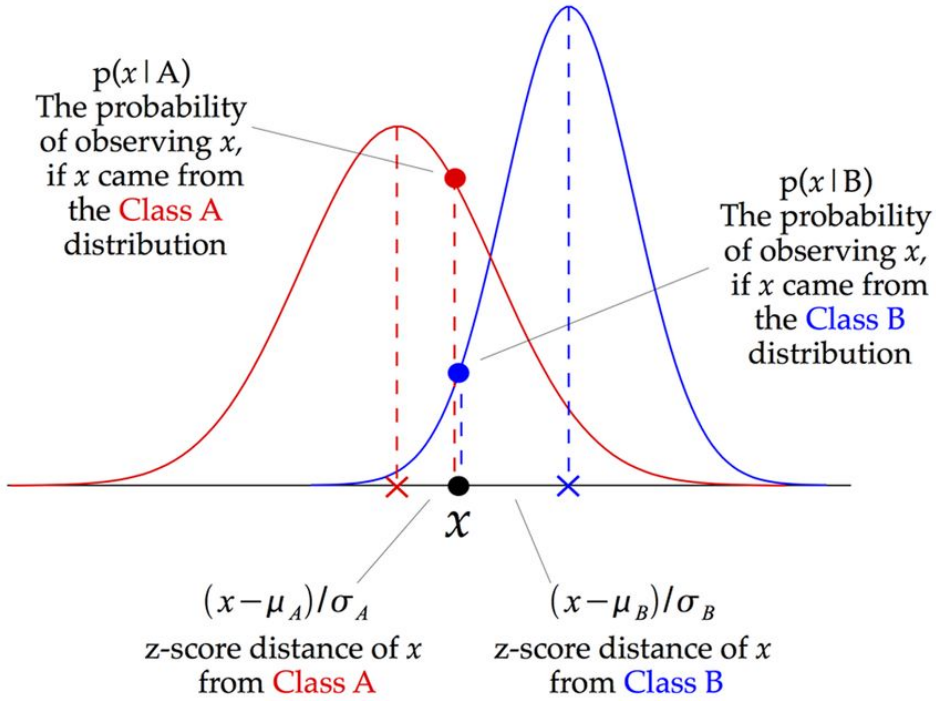
# Naïve Bayes

**Main idea**

- Strong (naive) independence assumptions between the features

**Area of application**

- **Text and image categorization** (such as spam or legitimate, sports or politics, type of document etc.)



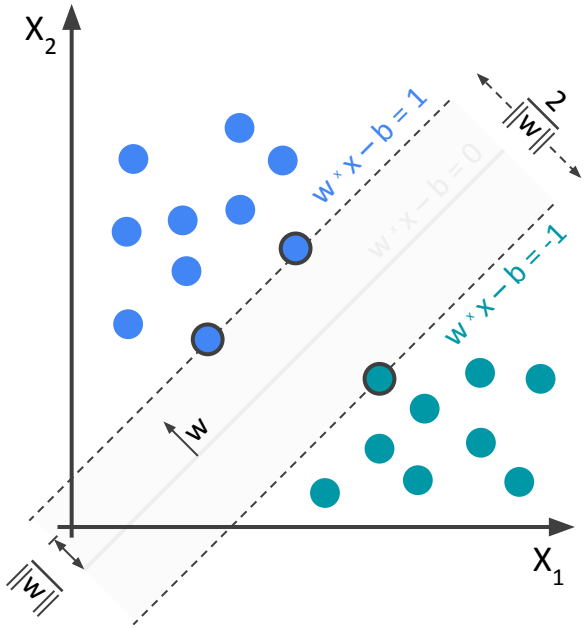
# Support Vector Machines

**Main idea**

- Searching for a clear **gap** that is **as wide as possible**.

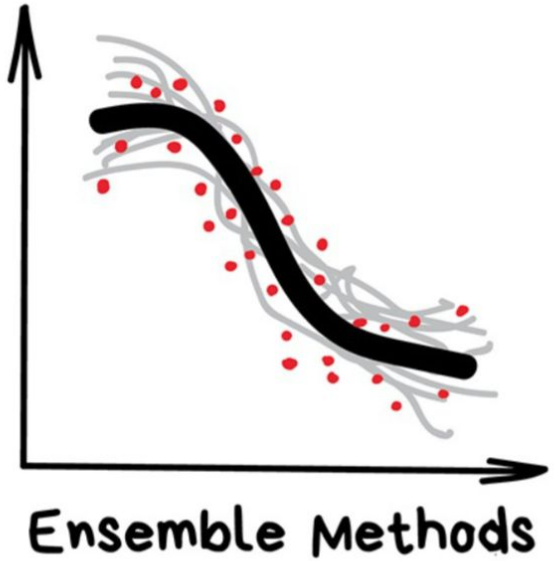
**Area of application**

- Text and Image classification

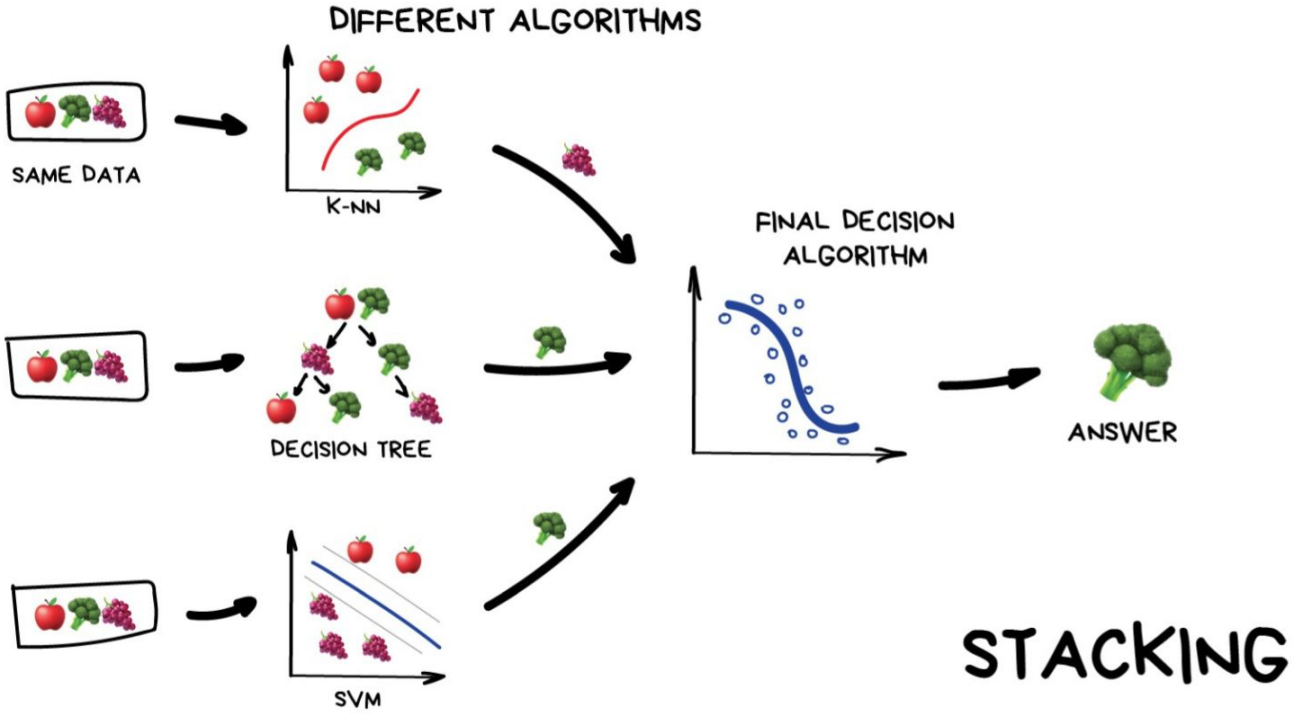


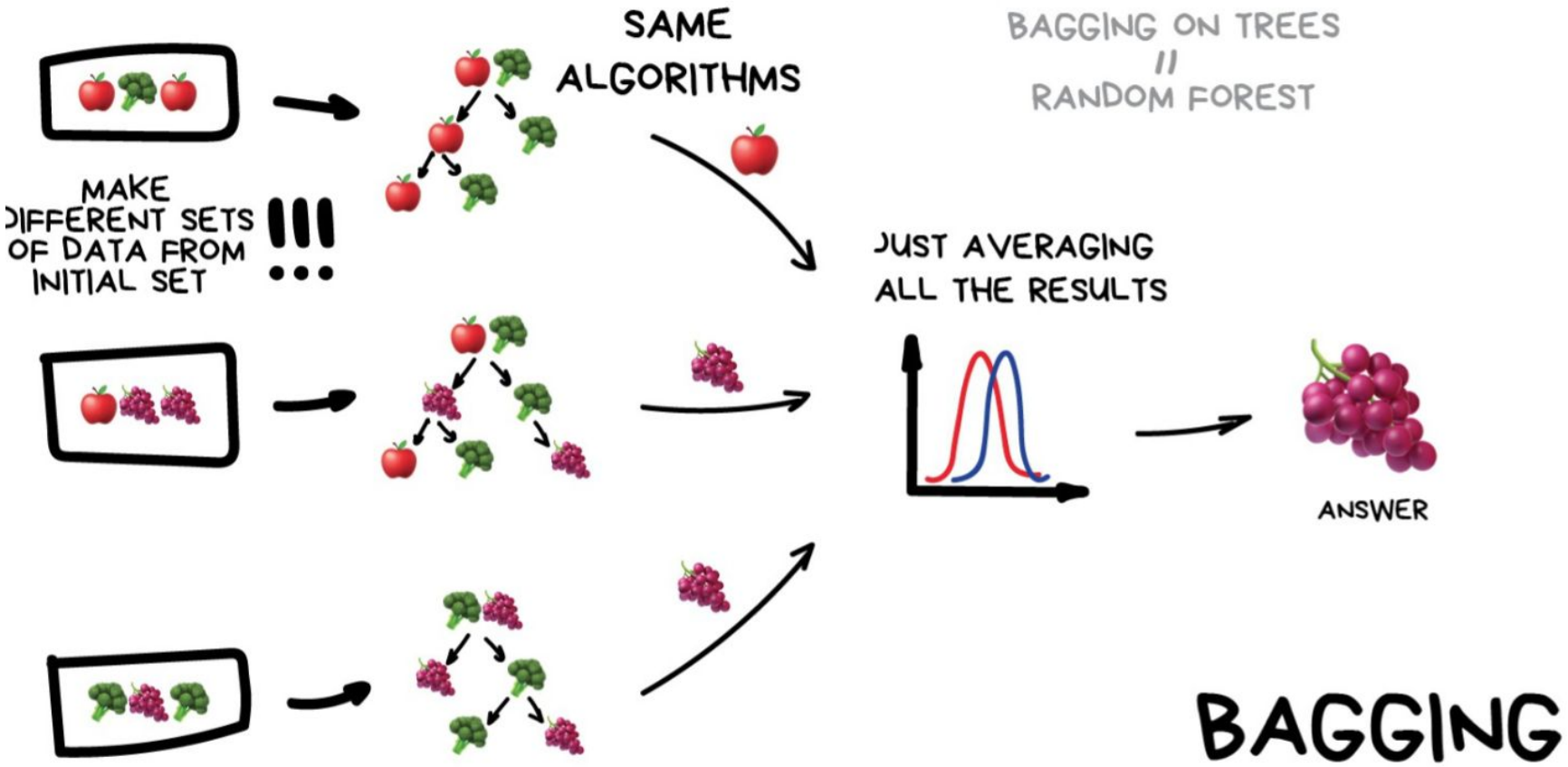
# Trees and ensembles

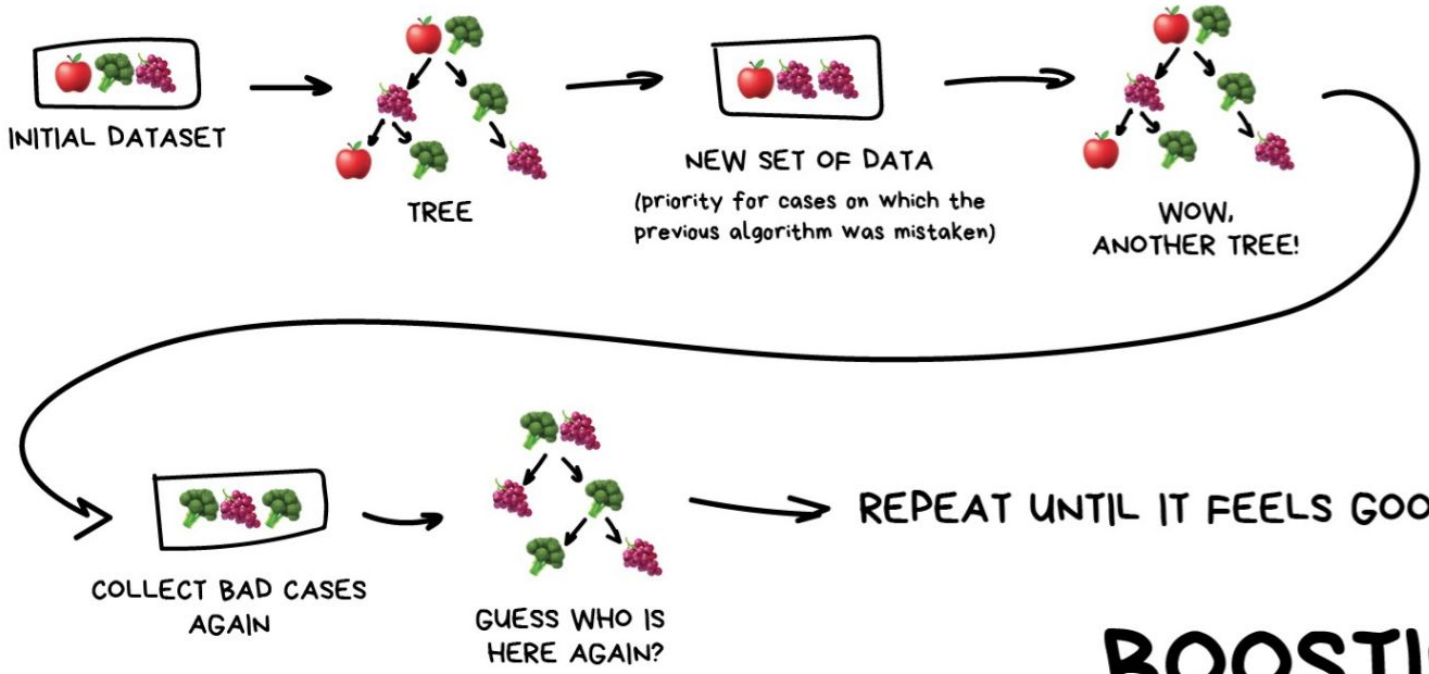
# Ensembles



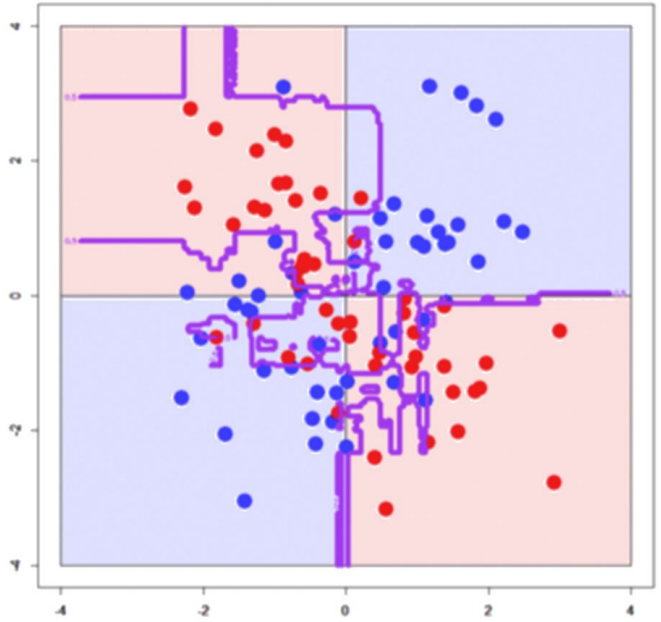

https://vas3k.ru/blog/machine_learning/

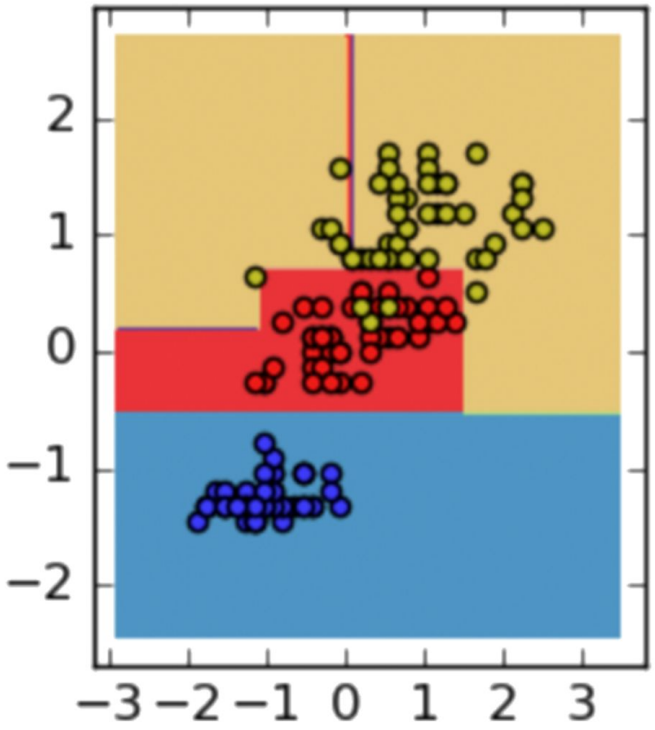

DIFFERENT ALGORITHMS
SAME DATA
K-NN
DECISION TREE
SVM
FINAL DECISION ALGORITHM
ANSWER
STACKING


SAME ALGORITHMS
BAGGING ON TREES
//
RANDOM FOREST
MAKE DIFFERENT SETS OF DATA FROM INITIAL SET
!!!
JUST AVERAGING ALL THE RESULTS
ANSWER
BAGGING


INITIAL DATASET
TREE
NEW SET OF DATA
(priority for cases on which the previous algorithm was mistaken)
WOW, ANOTHER TREE!
REPEAT UNTIL IT FEELS GOOD
GUESS WHO IS HERE AGAIN?
COLLECT BAD CASES AGAIN
BOOSTING

# Which tree is overfitted?



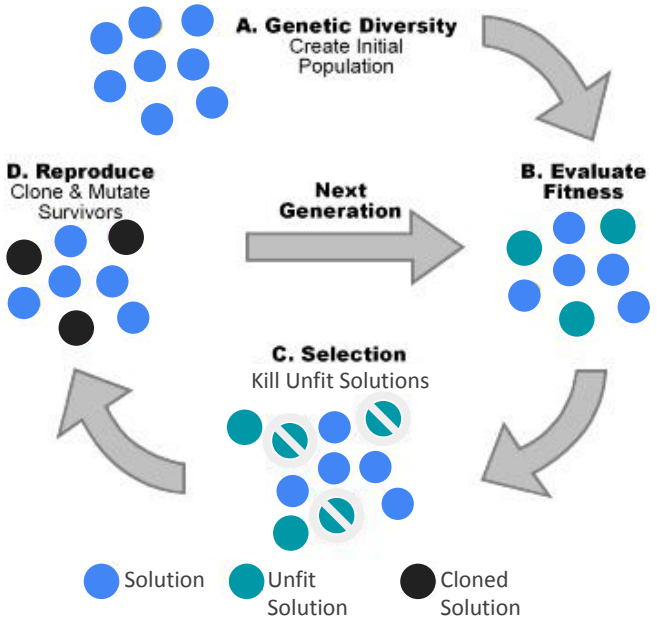
# Evolutionary algorithm

## Main idea

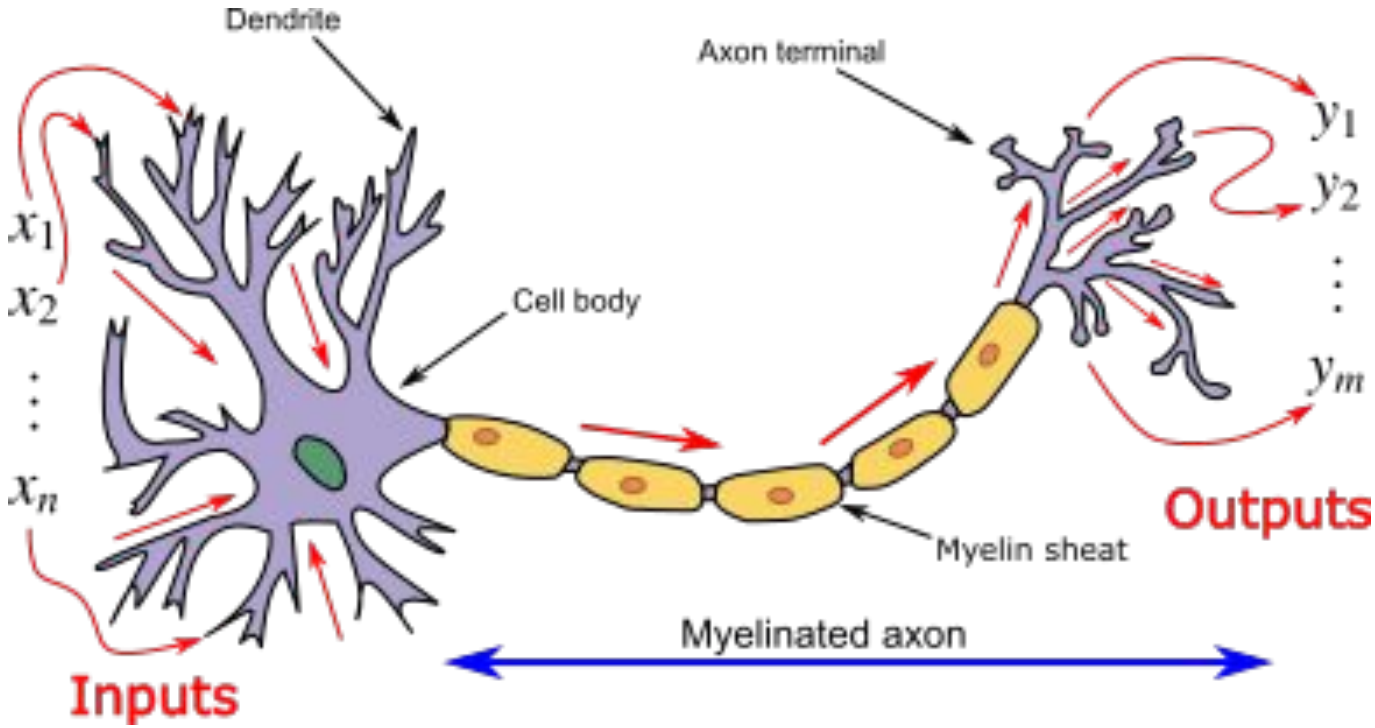
- Mechanisms inspired by biological evolution, such as reproduction, mutation, recombination, and selection.

## Area of application

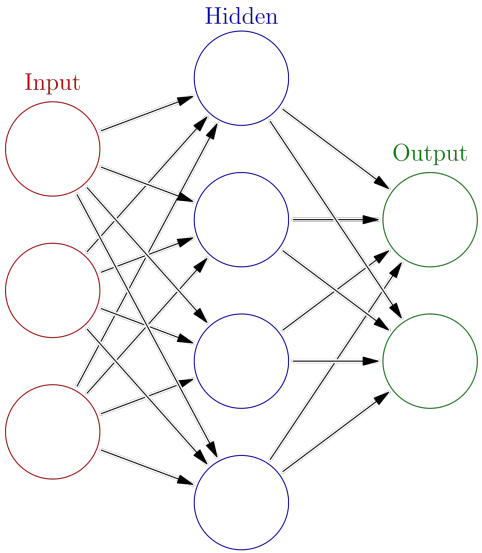
- Learning of hyperparameters



# Neuron


Dendrite
Axon terminal
$x_1$
$x_2$
$x_n$
Cell body
$y_1$
$y_2$
$y_m$
Outputs
Myelin sheat
Myelinated axon
Inputs

# ANN



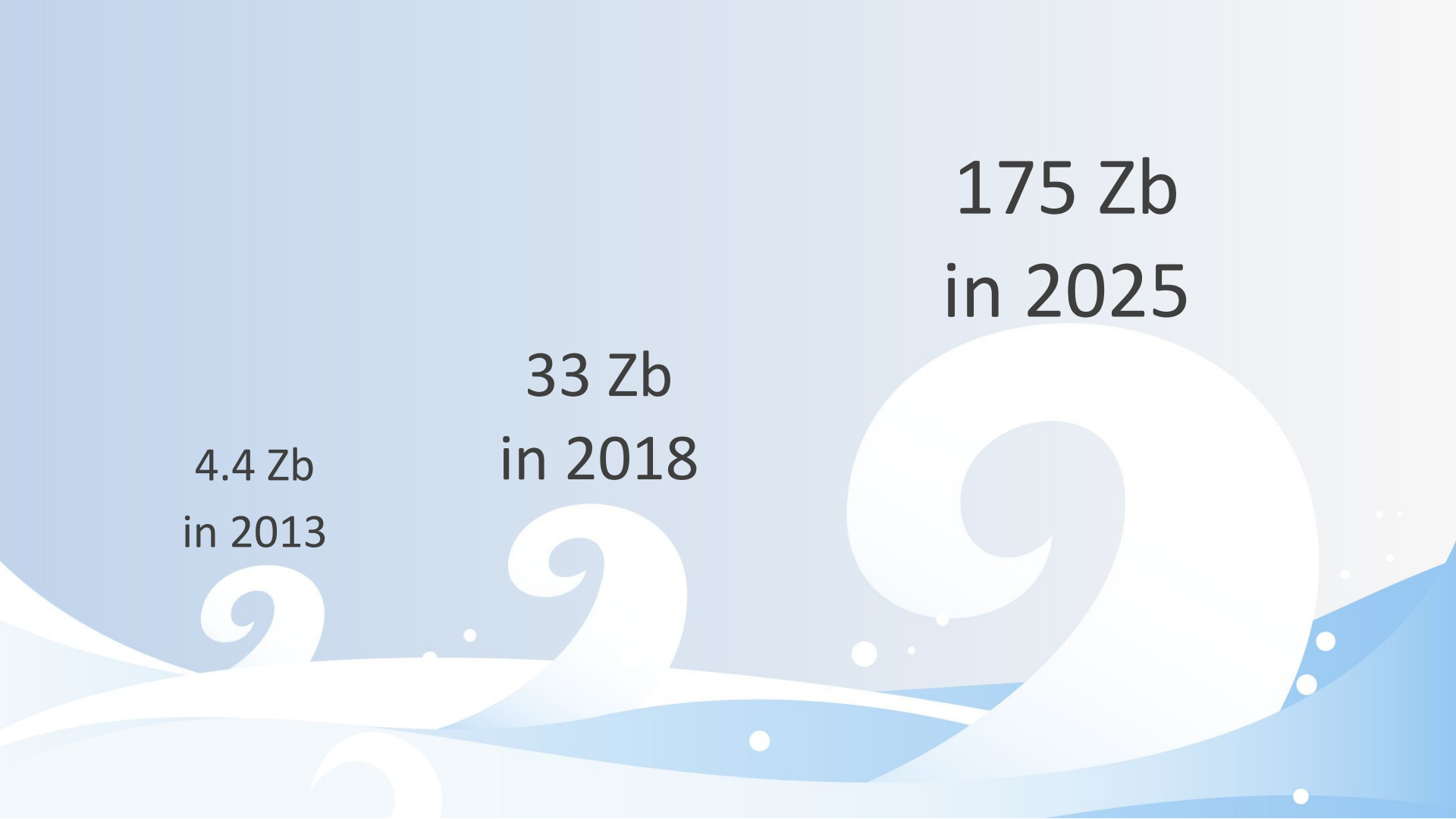
# Deep learning

**Deep learning** — a class of machine learning algorithms that use a graph of multiple **layers of nonlinear processing units** for **feature extraction and transformation.** Each successive layer uses the output from the previous layer as input.

# Deep Learning: Convolutional Neural Network

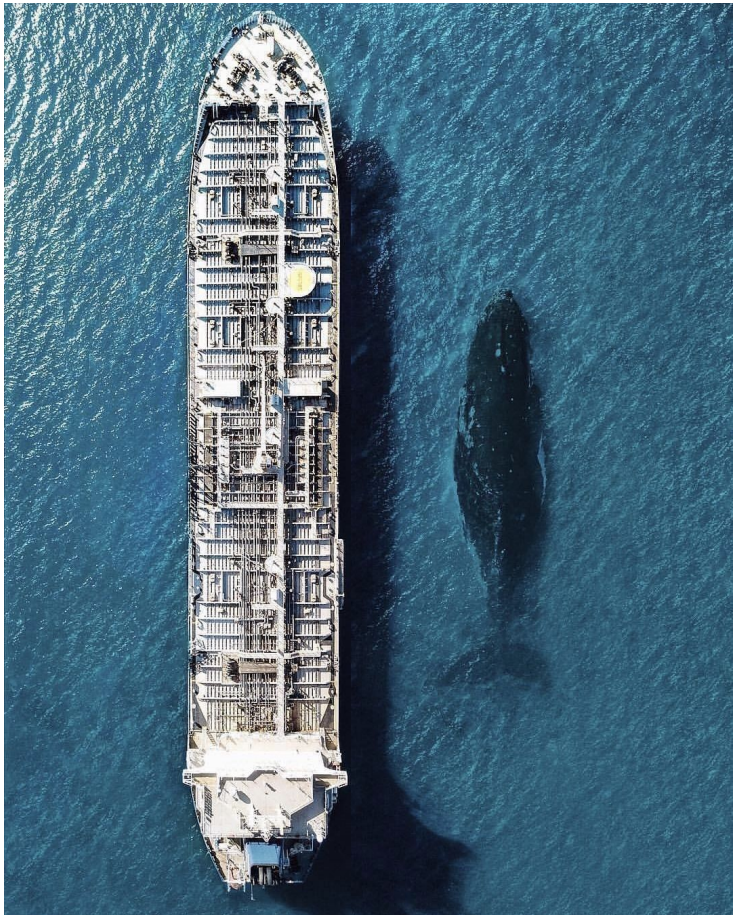

| Input Patch Data 28x28 | Conv 5x5 (1) 20 feature maps (FM) | Max Pool 2x2 (2) 20 FM | Conv 5x5 (1) 50 FM | Max Pool 2x2 (2) 50 FM | Fully Connected 1 500 FM | Fully Connected 2 2 FM (classes) |
|---|---|---|---|---|---|---|

# Where is ML a gamechanger?

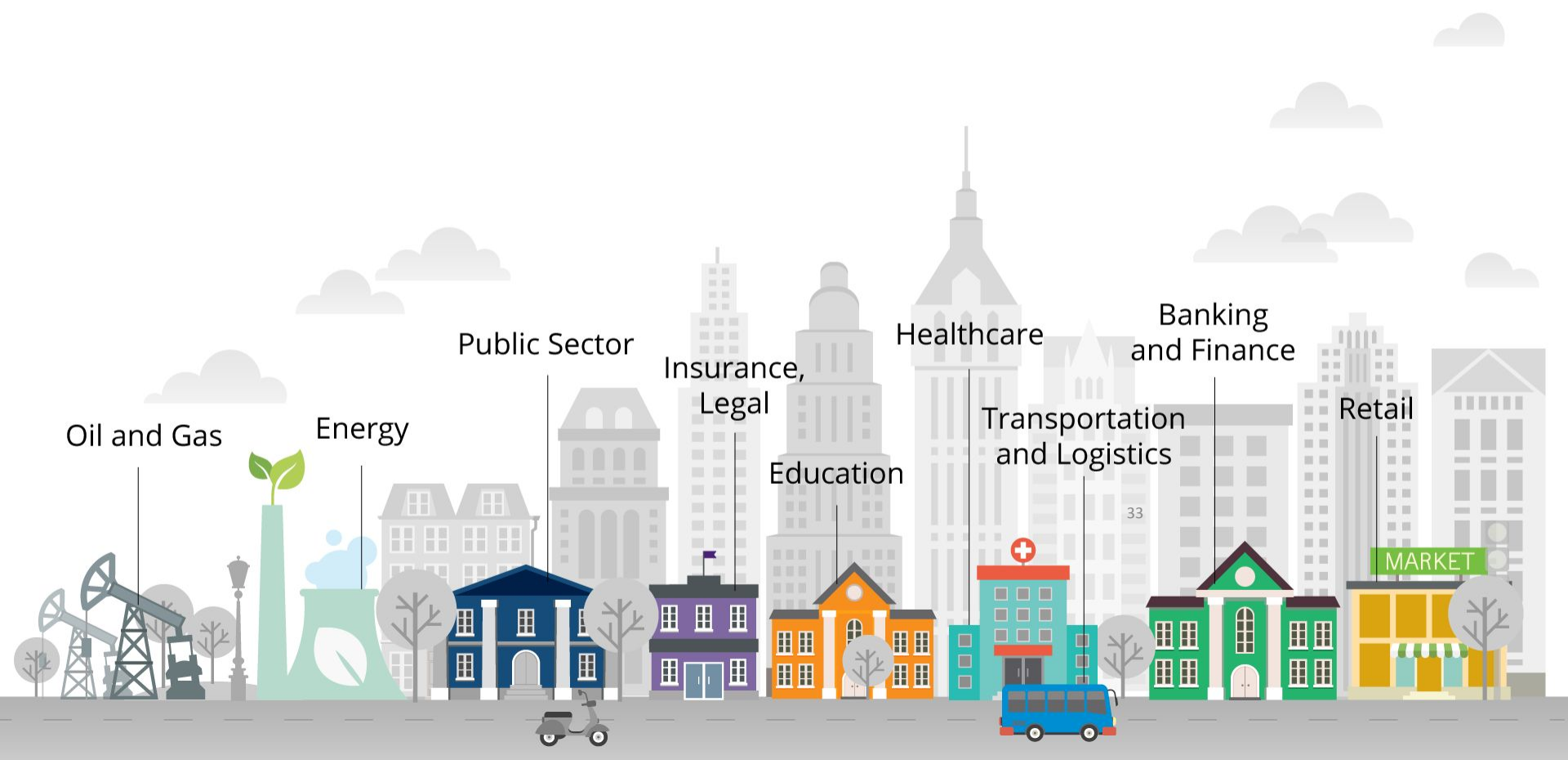

175 Zb
in 2025
33 Zb
in 2018
4.4 Zb
in 2013

# Animalcule to Big Blue Whale

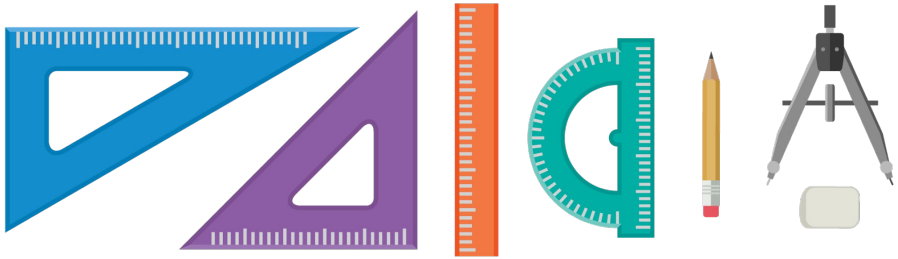
## Is Gb to Zb



# Where do we use AI?



# Future is measurable

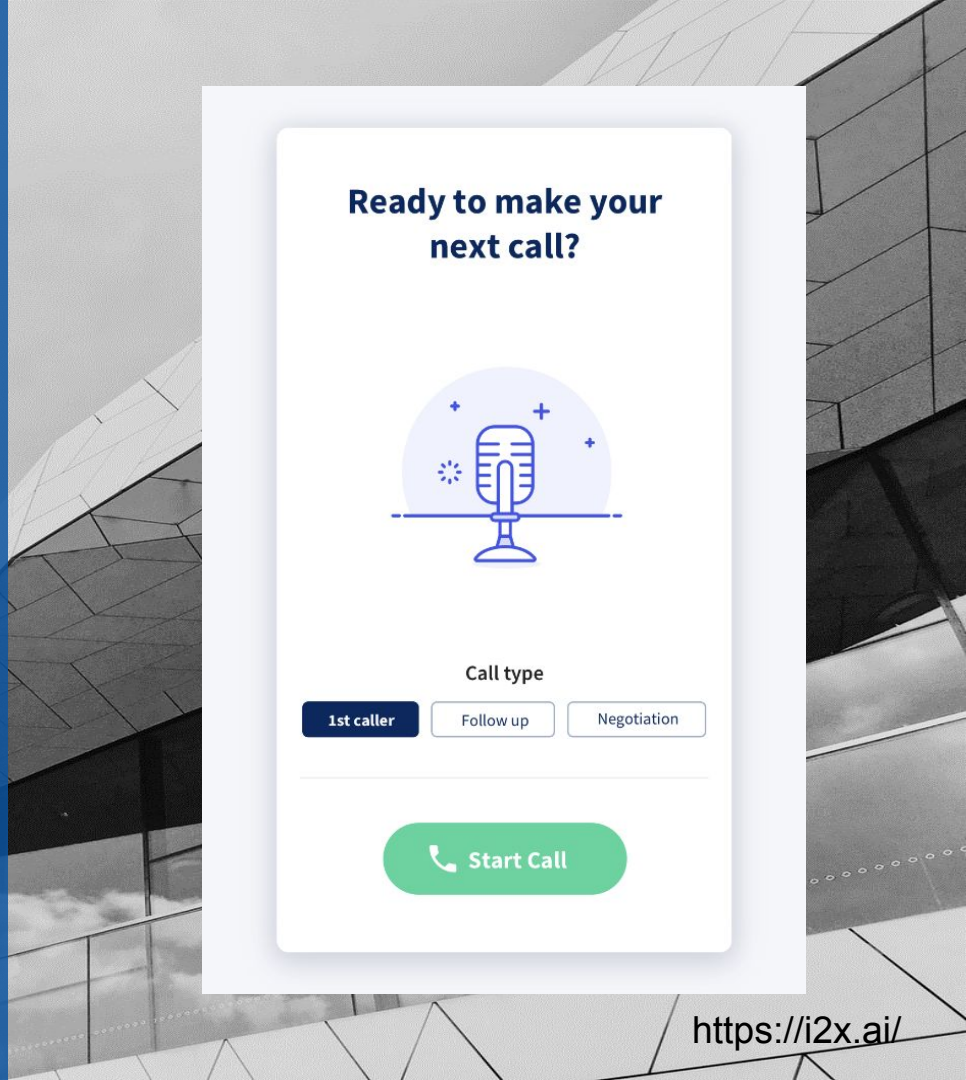


# AUTOMATION

# DEEP DIVE I

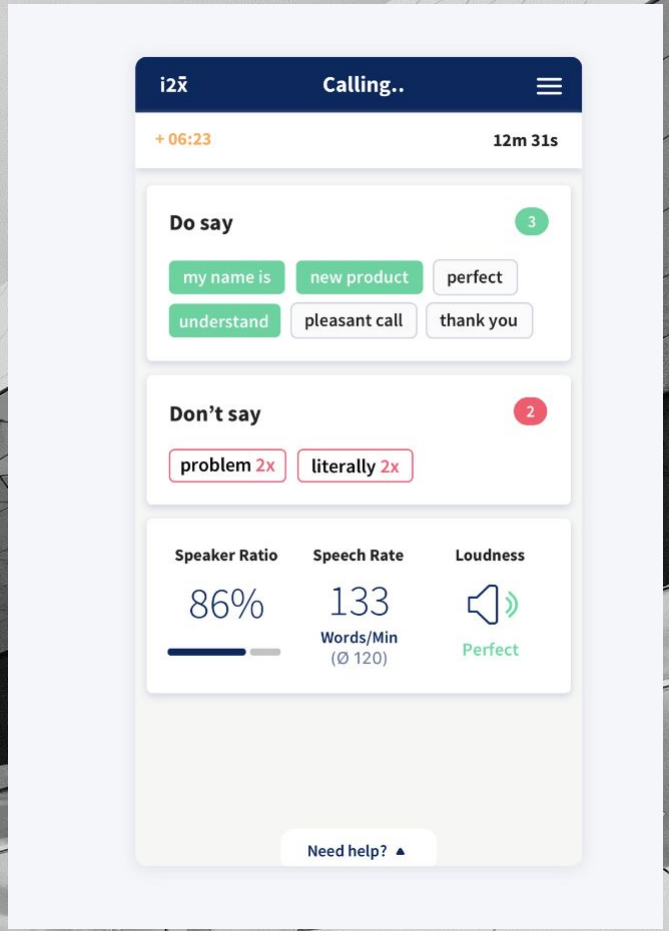
# CALL CENTERS

# I2X



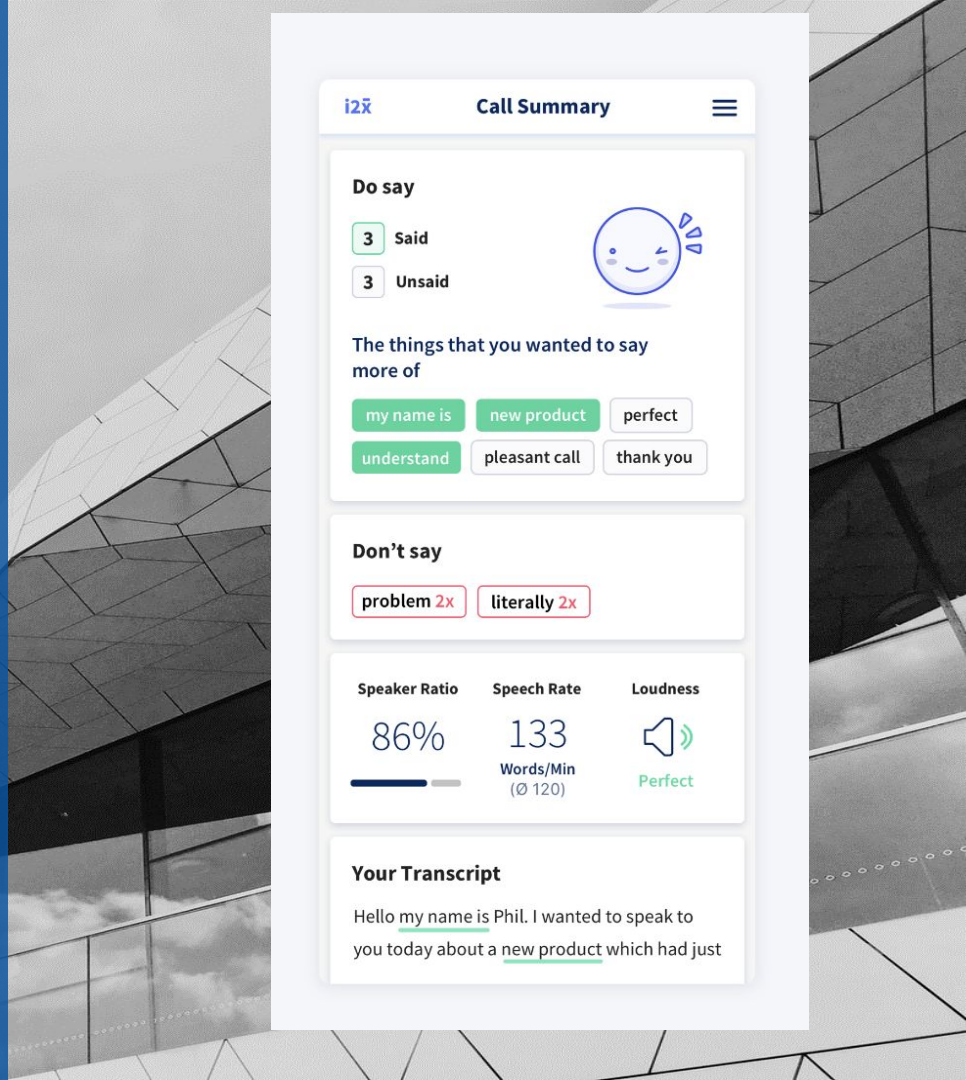

https://i2x.ai/

# CALL CENTERS

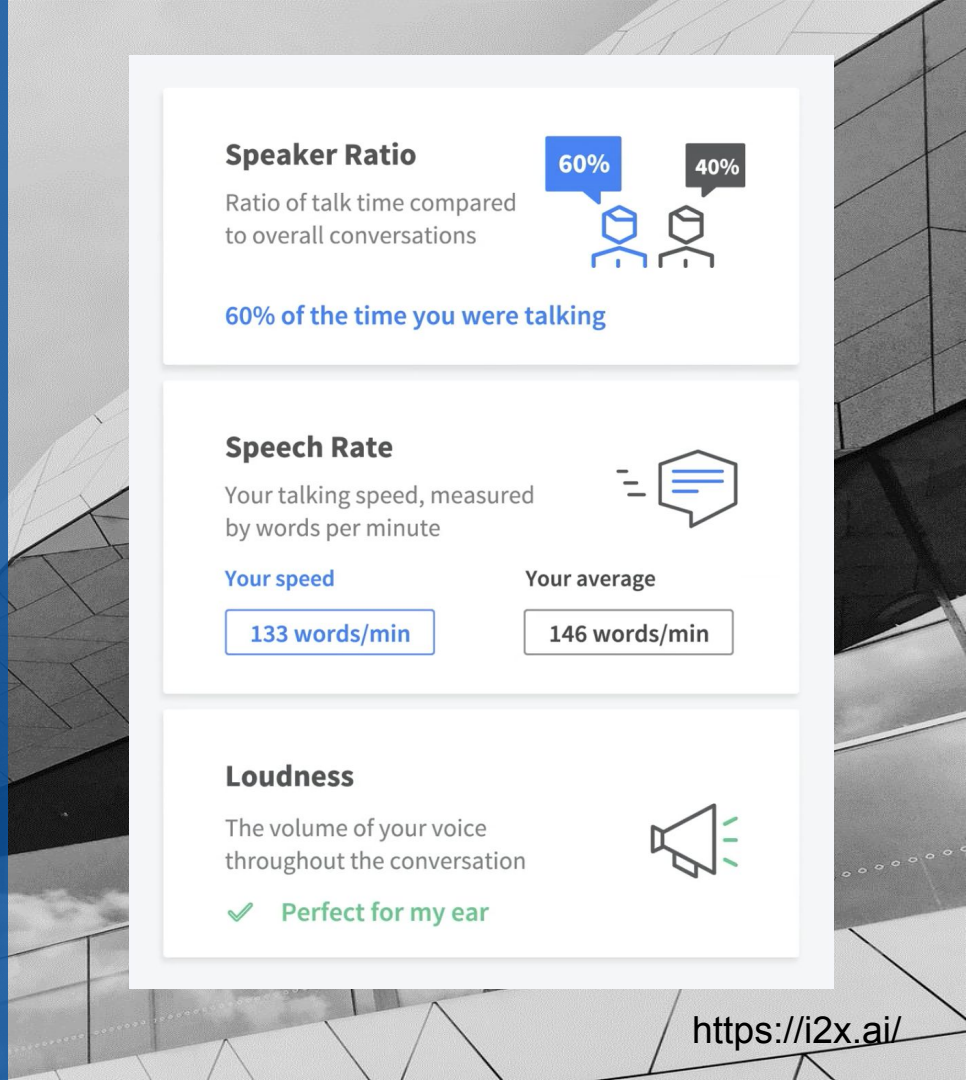



https://i2x.ai/

# CALL CENTERS



# CALL CENTERS

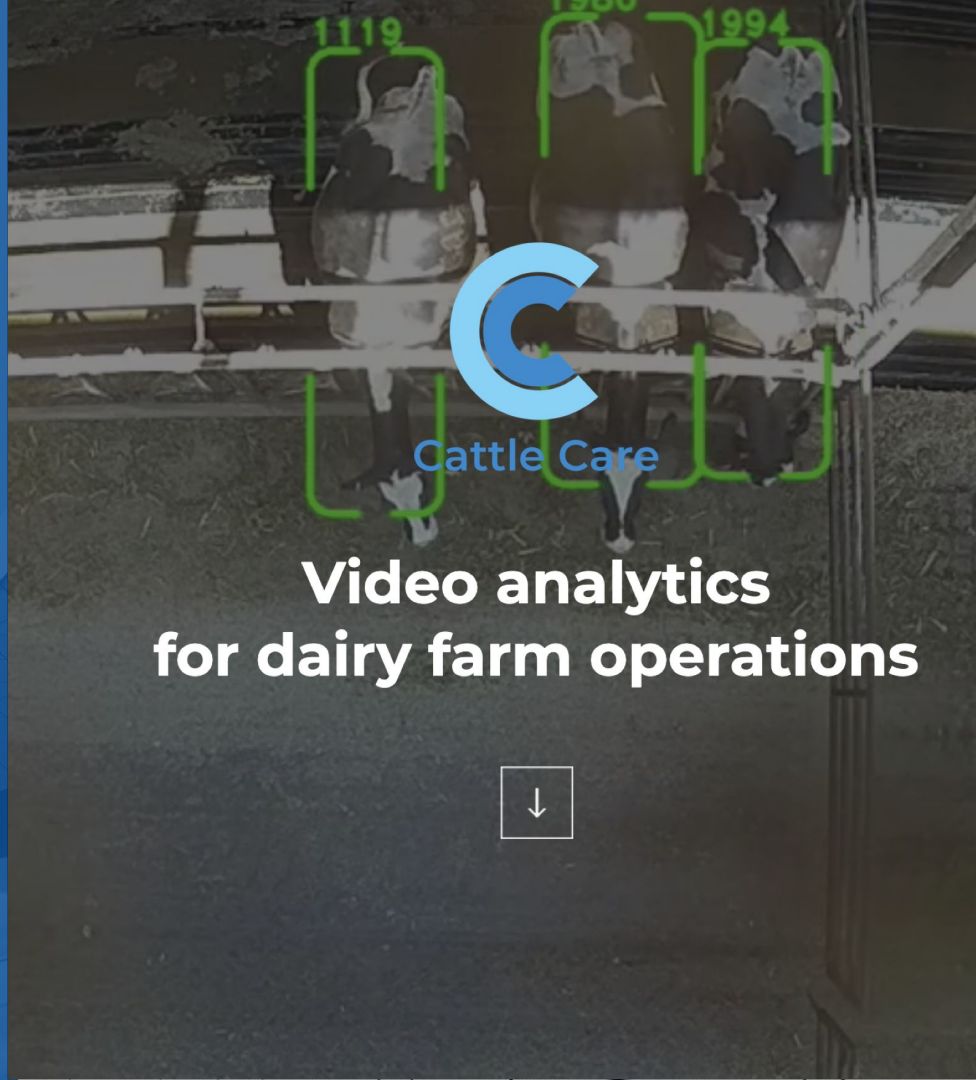


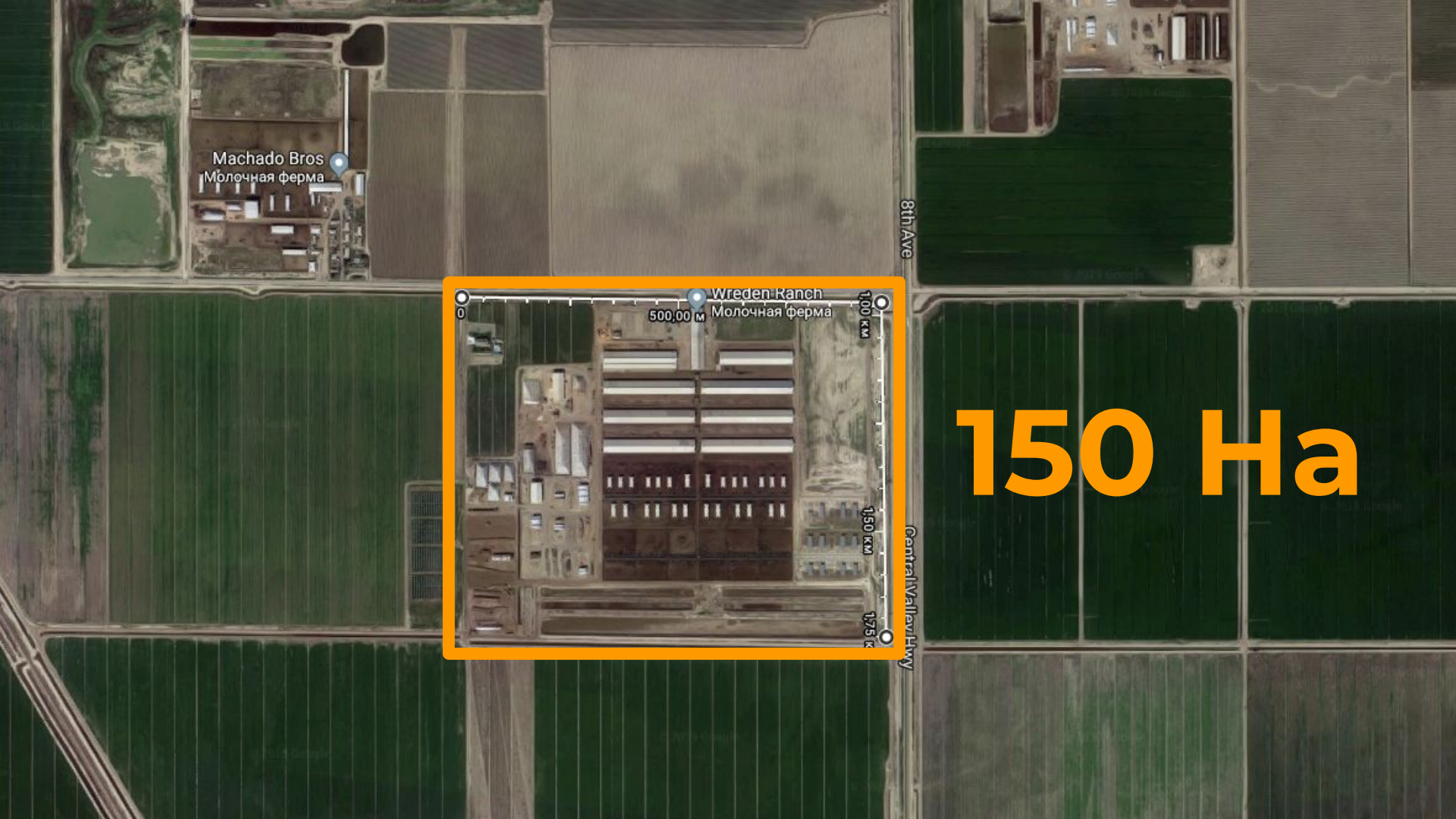

https://i2x.ai/

# DEEP DIVE II

# AGRICULTURE

# CATTLE CARE


1119
1994
Cattle Care
Video analytics
for dairy farm operations


Machado Bros
Молочная ферма
8th Ave
Wreden Ranch
Молочная ферма
0
500,00 м
1,00 км
1,50 км
1,75 км
Central Valley Hwy
150 Ha

## Group Management

- $19.4 mln for food
- 5,500 cow-hours a day in a headlock
- 200 robo-hours a day

# Problems

- 3 to 6 hours a day the cow has no food
- $0.6 mln a year of food waste
- Robots break and there is not alert systems

# Solution

- Web-camera feeding control
- Head-lock notification
- Robot-breaks notifications