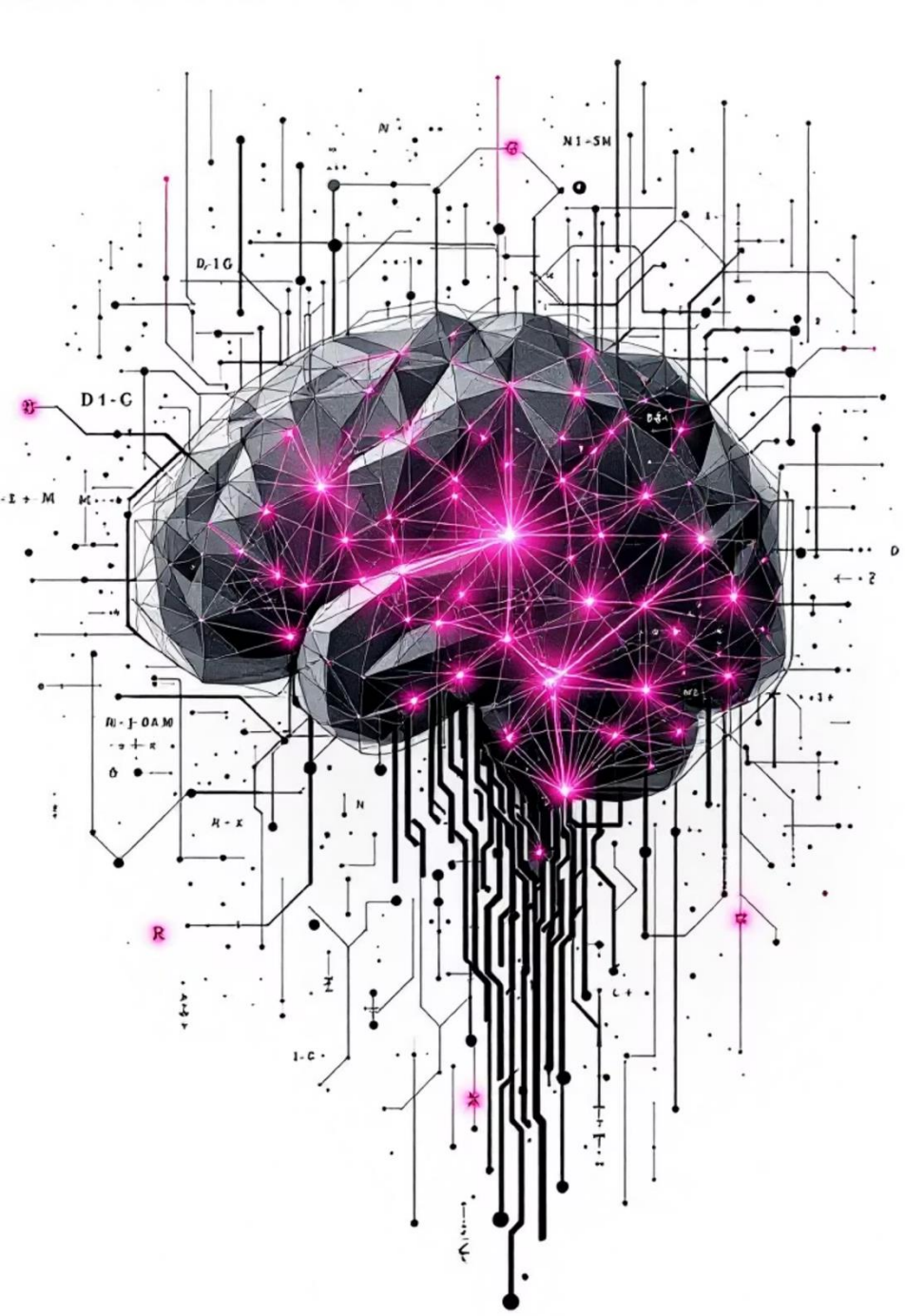

Machine Learning

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Let's Discuss Learning

Scope, Terminology, Prediction, and Data

Putting the Machine in Machine Learning

Examples of Learning Systems

Evaluating Learning Systems

A Process for Building Learning Systems

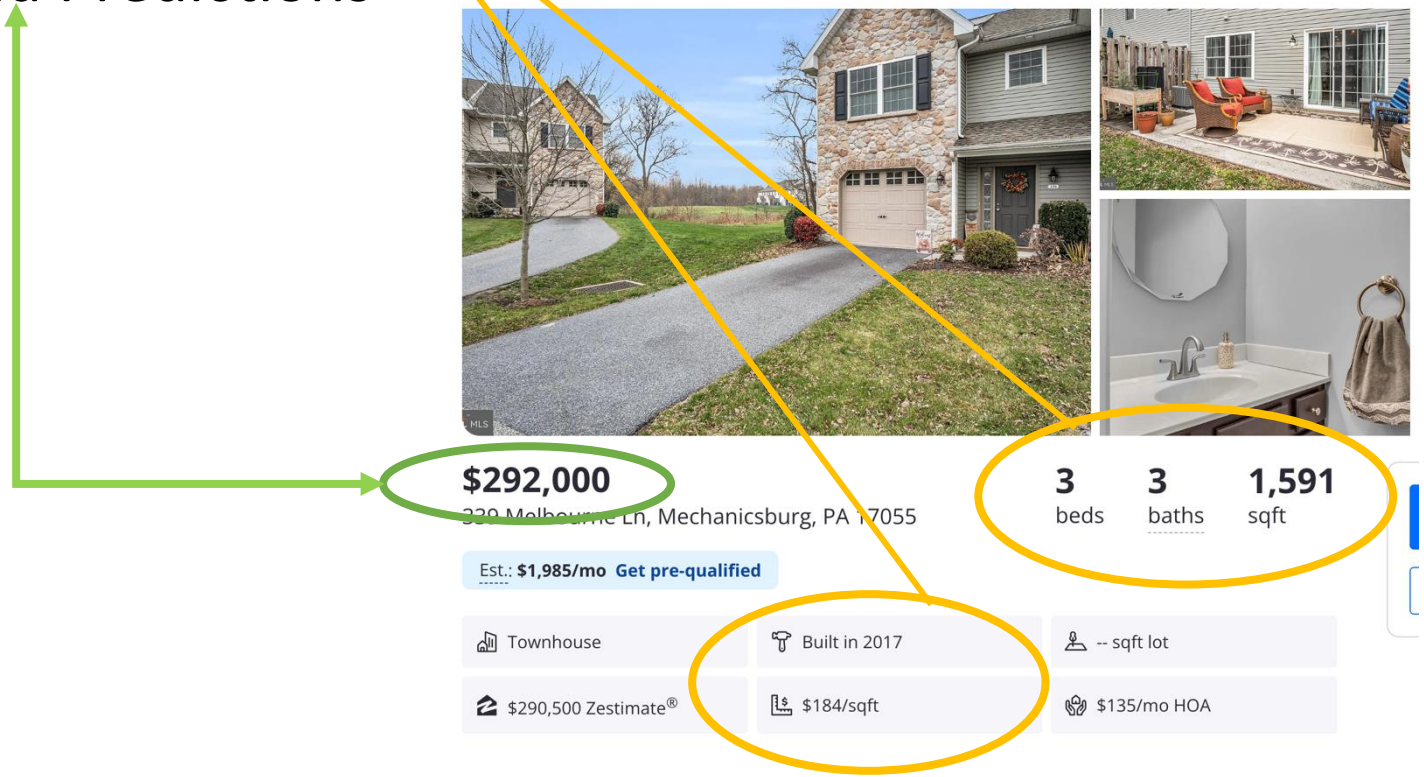
Assumptions and Reality of Learning

The Old & New paradox

- Computers can only do what their programmers know how to do and can explain to the computer.
- Computers can’t solve tasks that their programmers do not understand.
- The above paradox is broken with an example of a computer program that learns.
- In 1950, Arthur Samuel made a computer to play checkers by providing meta-information.
- Computers do what they are told, but they can be told to develop a capability.
- Computers can be told to learn.

Scope, Terminology, Prediction, and Data

- Features
- Target Values and Predictions



Scope, Terminology, Prediction, and Data

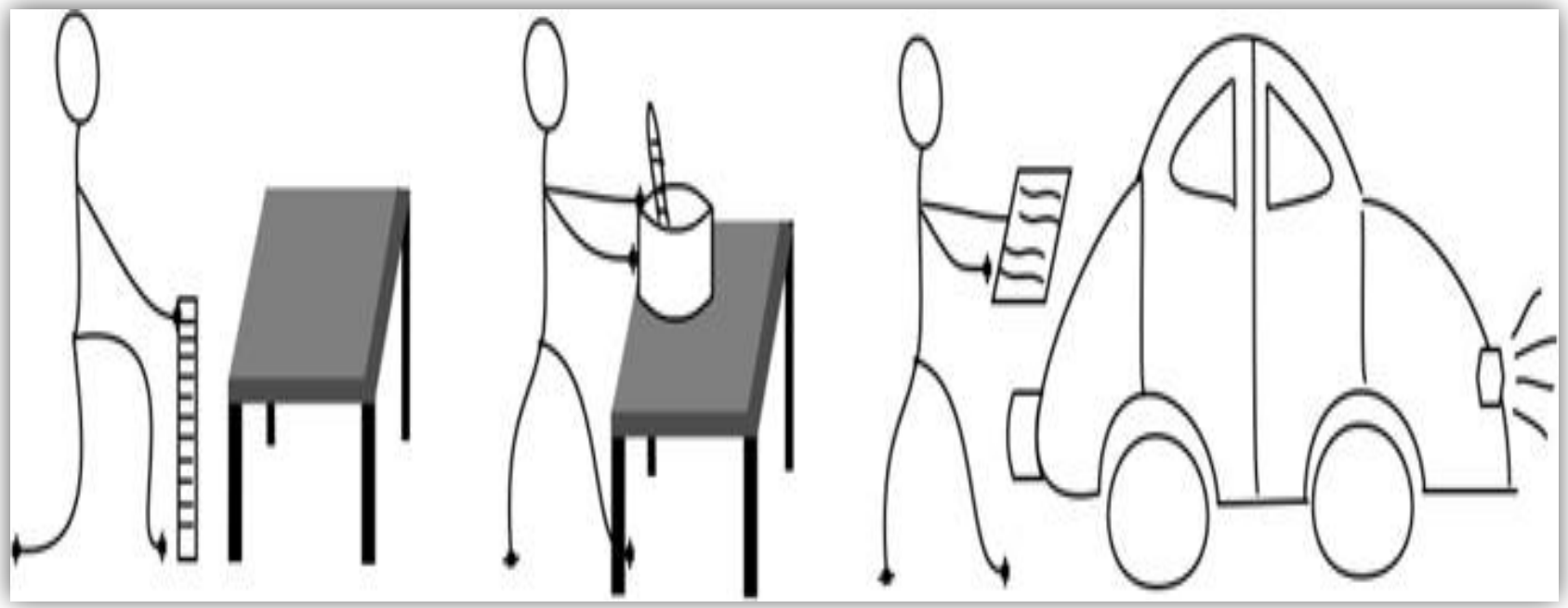
- The academic field that studies computational learning system is called machine learning.
- Machine learning is a method of data analysis that automates analytical model building.
- The current wunderkind of learning systems focuses on "learning from examples".
- There are three types of learning:
  - ✓Supervised
  - ✓Unsupervised
  - ✓Reinforcement

Scope, Terminology, Prediction, and Data

- Supervised learning is the machine learning task of learning a function that maps an input to an output based on example input-output pairs.
- Unsupervised learning refers to the use of artificial intelligence algorithms to identify patterns in datasets that are neither classified nor labeled.
- Reinforcement learning is the training of machine learning models to make a sequence of decisions.
- In learning system, each example is measured on a common group of attributes.
- The value is measured and recorded for each attribute on each example.

Scope, Terminology, Prediction, and Data

» The figure shows an insatiable desire of humans to measure all sorts of things.



Features

- Features are the measurements or values of our attributes.
- There is a slight difference between what-is-measured, what-the-value-is, and what-the-measured-value-is.
  - The first is an **attribute**,
  - the second is a **value**, and
  - the last is a **feature**.
- Categorical data is a collection of information that is divided into groups.
- Categorical data take a small, limited number of possibilities that typically represent one of several options.

Features

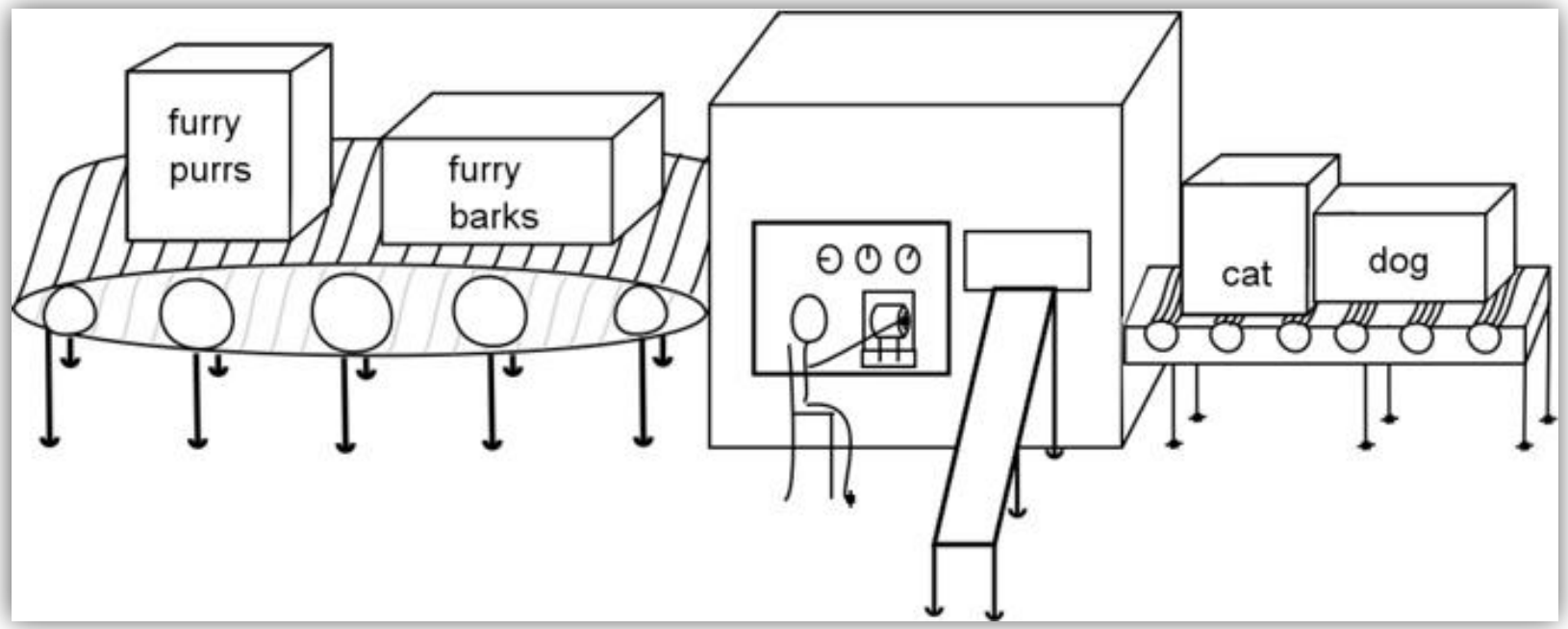
- The information in the categorical data attributes can be recorded in two distinct ways:
  - ✓As a single feature that takes one value for each option.
  - ✓As several features, one per option, where one, and only one, of those features is marked as yes or true and the remainder are marked as no or false.
- Feature values that are recorded and operated on as numbers are called numerical features.
- Values for attributes like height and weight are typically recorded as decimal numbers.
- It is not necessarily possible to perform meaningful numerical calculations directly on categorical data.

Target Values and Predictions

- Target value is the feature of a dataset about which you want to gain a deeper understanding.
- A prediction is a forecast or a statement about the future.
- Features that are used to predict the future unknown outcome are called input features or predictive features.

Putting the Machine in Machine Learning

- Machine learning algorithms are formal rules for how to manipulate our controls.
- The figure shows a factory machine.



Putting the Machine in Machine Learning

- Target value is the feature of a dataset about which you want to gain a deeper understanding.
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Examples of Learning Systems

- Predicting Categories: Examples of Classifiers
- Predicting Values: Examples of Regressors

Examples of Learning Systems

- Under the umbrella of supervised learning from examples, there is a major distinction between two things:
  - ✓Predicting values
  - ✓Predicting categories
- Predicting a category is called classification.
- Predicting a numerical value is called regression.

Predicting Categories: Examples of Classifiers

- Classifiers are models that take input examples and produce an output that is one of a small number of possible groups or classes.
- Here are some examples of classifiers:
  - ✓Image classification
  - ✓Stock action
  - ✓Medical diagnosis

Predicting Values: Examples of Regressors

- A regressor is the name given to any variable in a regression model that is used to predict a response variable.
- Here are some examples of regressors:
  - ✓Student success
  - ✓Stock pricing
  - ✓Web browsing behavior

Evaluating Learning Systems

- Correctness
- Resource Consumption

Evaluating Learning Systems

- Learning system is evaluated on the basis of the following criteria:
  - ✓How correct are the predictions?
  - ✓What computational resources did it need to get those predictions?

Correctness

- The key criteria for evaluating learning systems is that they give us correct predictive answers.
- Correctness checks whether the learning system performs better than random guessing.
- It requires two steps:
  - ✓Quantify how well the learner is doing.

$$\text{Accuracy} = \frac{\text{Number of Correct Predictions}}{\text{Total Number of Predictions}}$$

  - ✓Compare that level of success or failure with other systems.

Resource Consumption

- Resource consumption is about the consumption of non-renewable, or less often, renewable resources.
- Learning algorithms compress data in a way that is suitable for predicting new examples.
- At each level of increased complexity of a computational system, the following privileges are required:
  - ✓More software support
  - ✓More specialized human capital
  - ✓More complicated off-the-shelf libraries

Example: A weather app that uses a simple historical average (Low Resource) vs. one that uses a global satellite-fed AI model (High Resource). The AI model likely has better **Correctness**, but its **Resource Consumption** is massive.

A Process for Building Learning Systems

» The following options describe a learning system:

- ✓There are different domains where we might apply learning, such as business, medicine, and science.
- ✓There are different tasks within a domain, such as animal image recognition, medical diagnosis, web browsing behavior, and stock market prediction.
- ✓There are different types of data.
- ✓There are different models relating features to a target.

A Process for Building Learning Systems

» Here are the high-level steps of building a learning system:

- ✓Task understanding
- ✓Data collection
- ✓Data preparation
- ✓Modeling
- ✓Evaluation
- ✓Deployment

A Process for Building Learning Systems

- These steps are taken from the CRISP-DM flow chart that organizes the high-level steps of building a learning system.
- CRISP-DM stands for a cross-industry process for data mining.
- The CRISP-DM methodology provides a structured approach to planning a data mining project.

Assumptions and Reality of Learning

- Computational learning theory is devoted to the details of telling us how many examples are required to learn relationships under certain mathematically idealized conditions.
- Data is greater than (more important than) algorithms: data > algorithms.
- If the data is excessively noisy whether due to errors or randomness—it might not be useful.

Summary

» In this presentation, we have learned about:

- ✓Features
- ✓Target values and predictions
- ✓Machine learning
- ✓Types of machine learning
- ✓Features, target values, and predictions
- ✓Examples of learning systems
- ✓Evaluating learning systems
- ✓Building learning systems
- ✓Assumptions and reality of learning