# DATA MINING 1
# Classification

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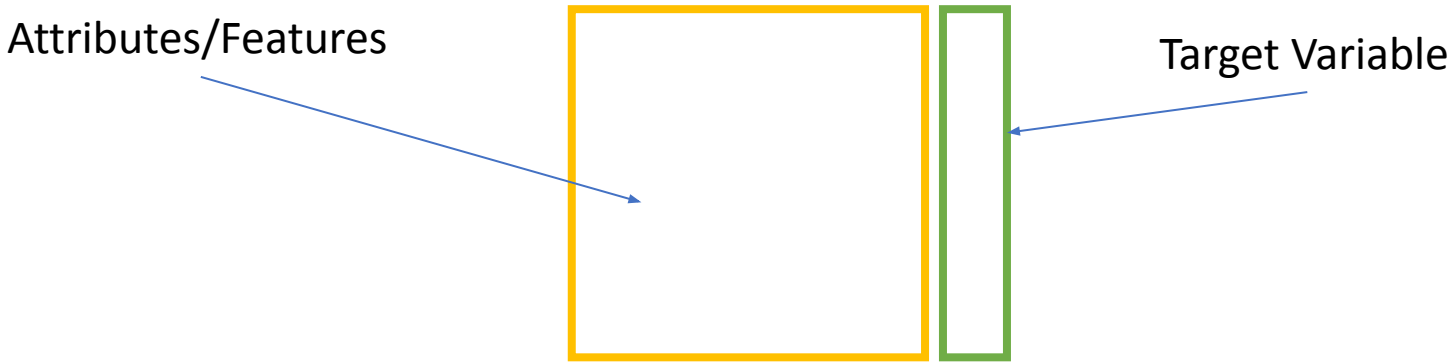
# Supervised Learning

- Cluster analysis and association rules are not concerned with a specific target attribute.
- Supervised learning refers to problems where the value of a target attribute should be predicted based on the values of other attributes.
- Problems with a ***categorical target*** attribute are called **classification**, problems with a ***numerical target*** attribute are called **regression**.



# What is Machine Learning?

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"ML is the field of study that gives computers the ability to learn without being explicitly programmed"
(Arthur Samuel, 1959)

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"A computer program is said to learn from experience E with respect to some task T and some performance measure P, if its performance on T, as measured by P, improves with experience E."
(Tom Mitchell, 1997)

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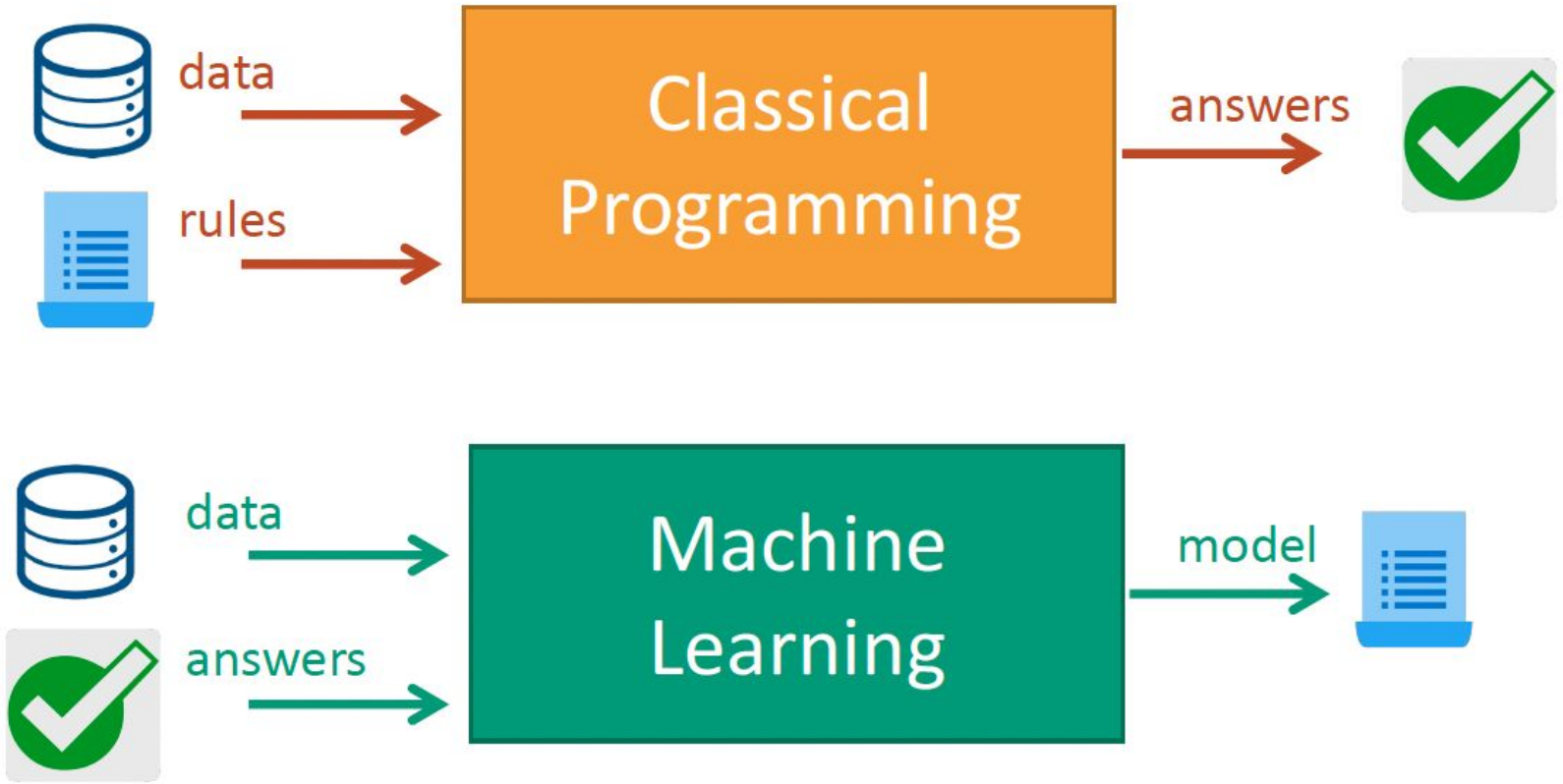

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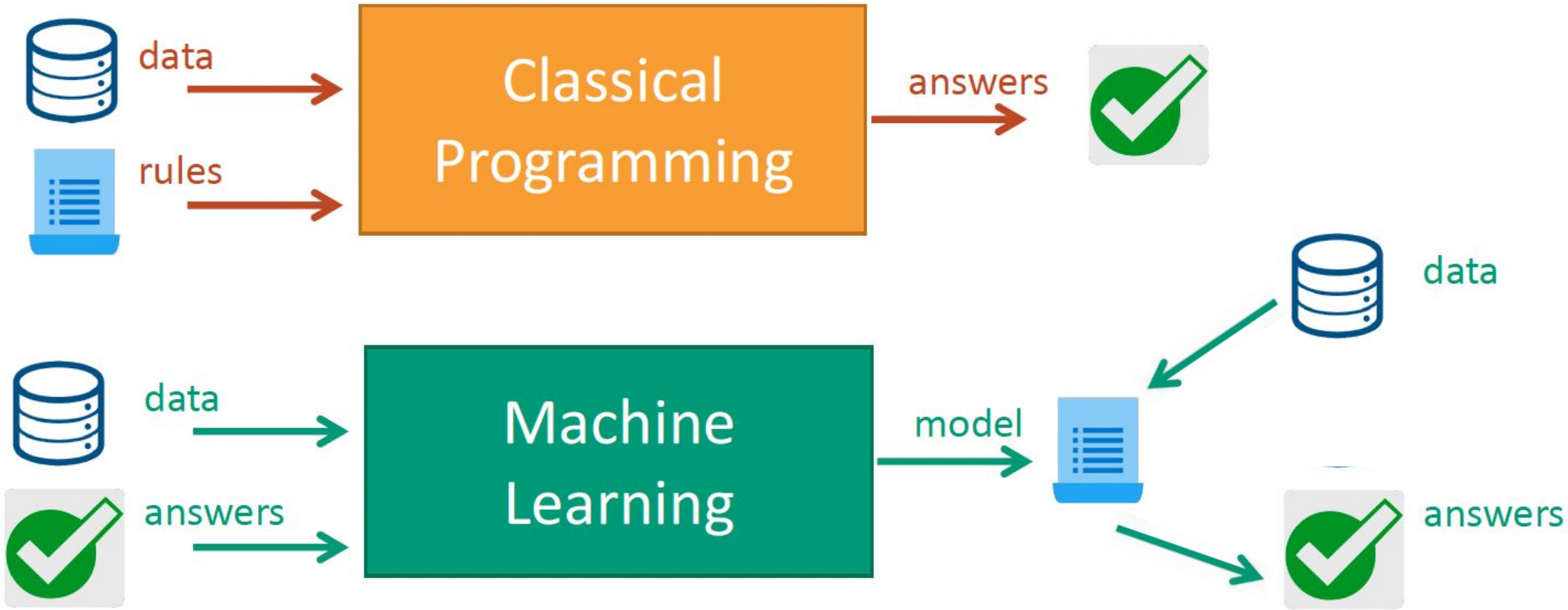
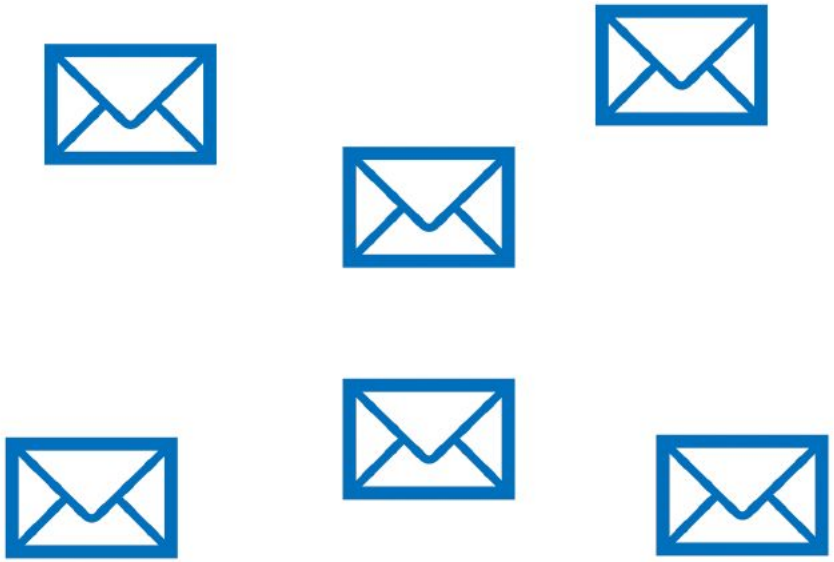


# Example Spam Filter



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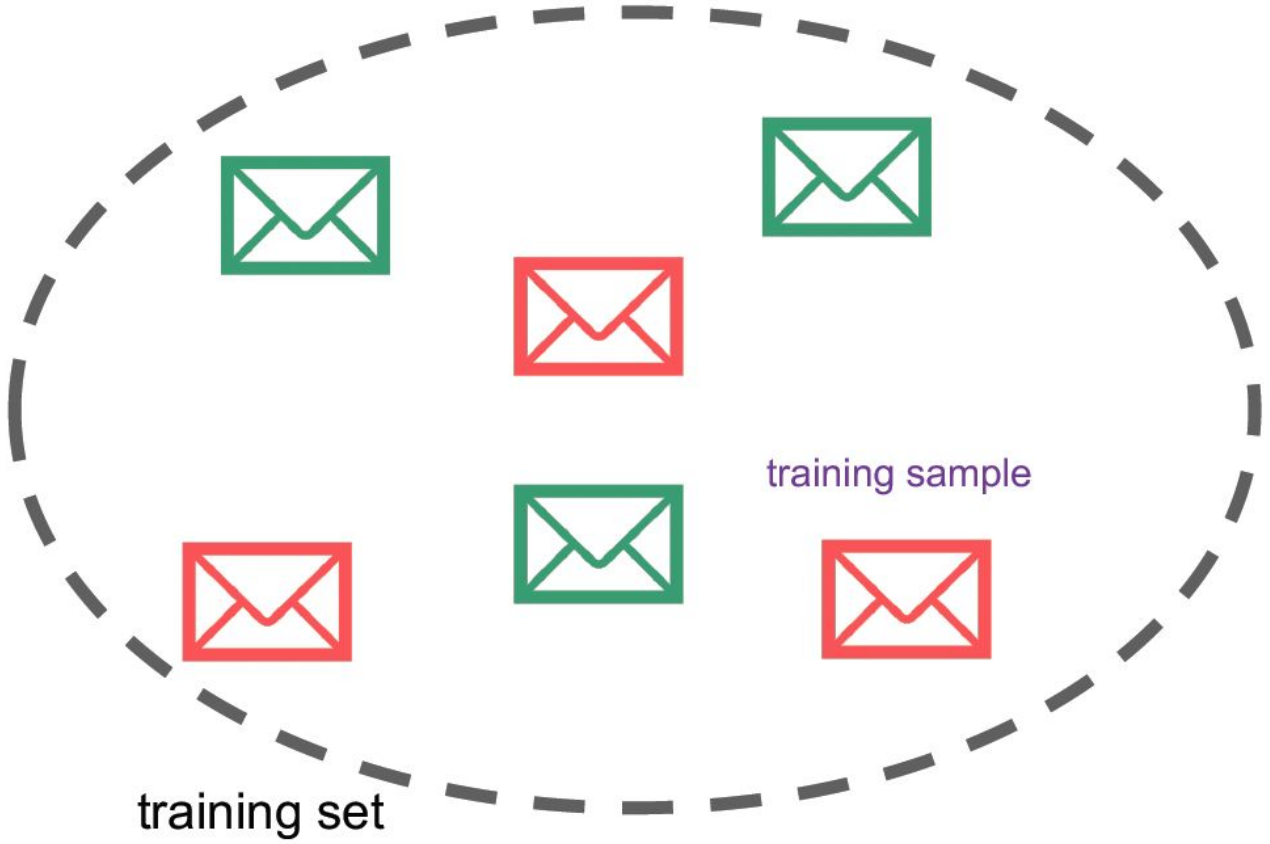


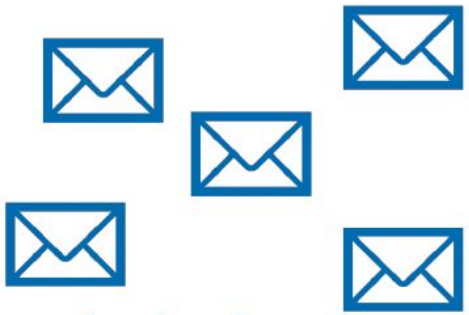


T = flag spam for new emails

E = training set

P = accuracy

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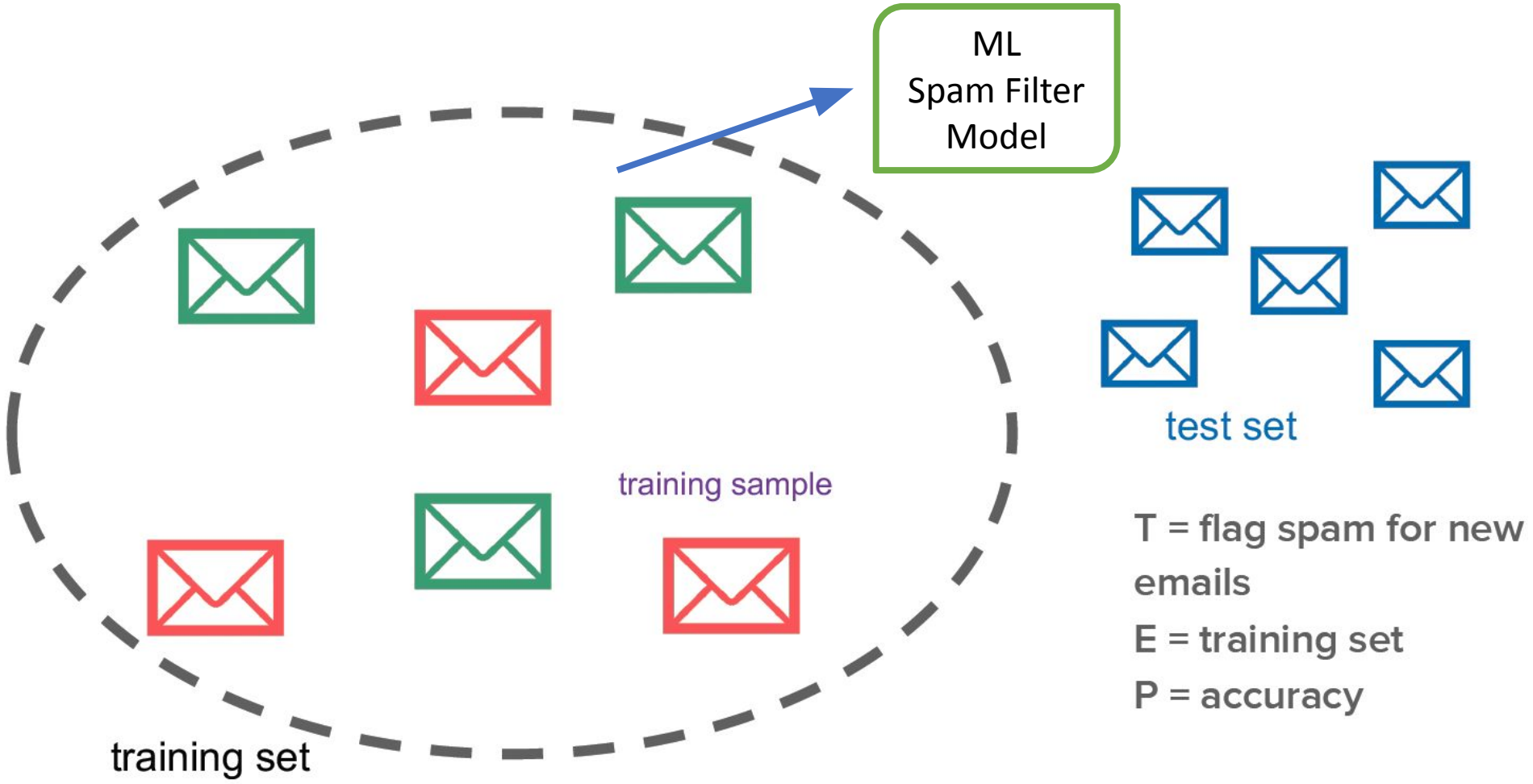

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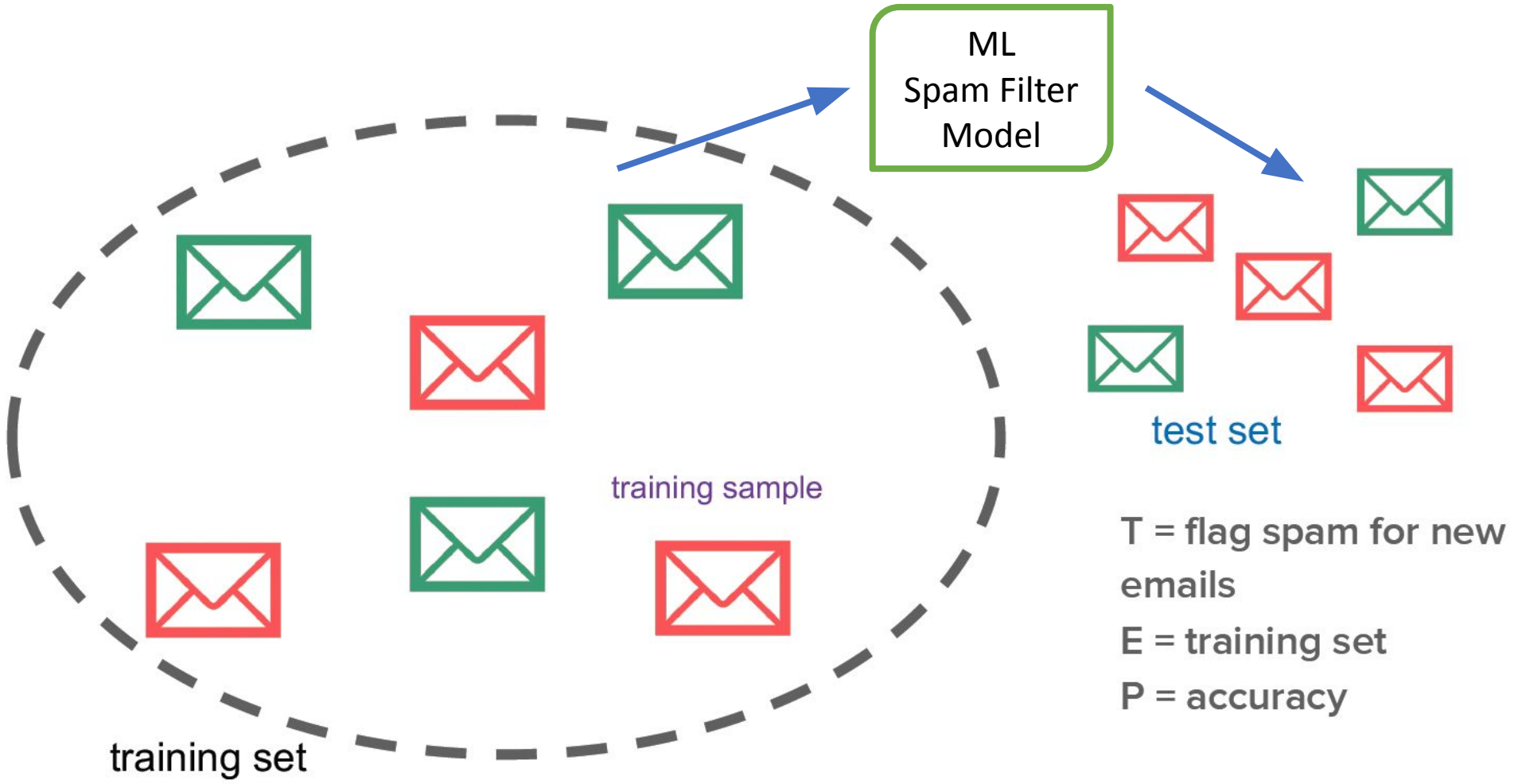
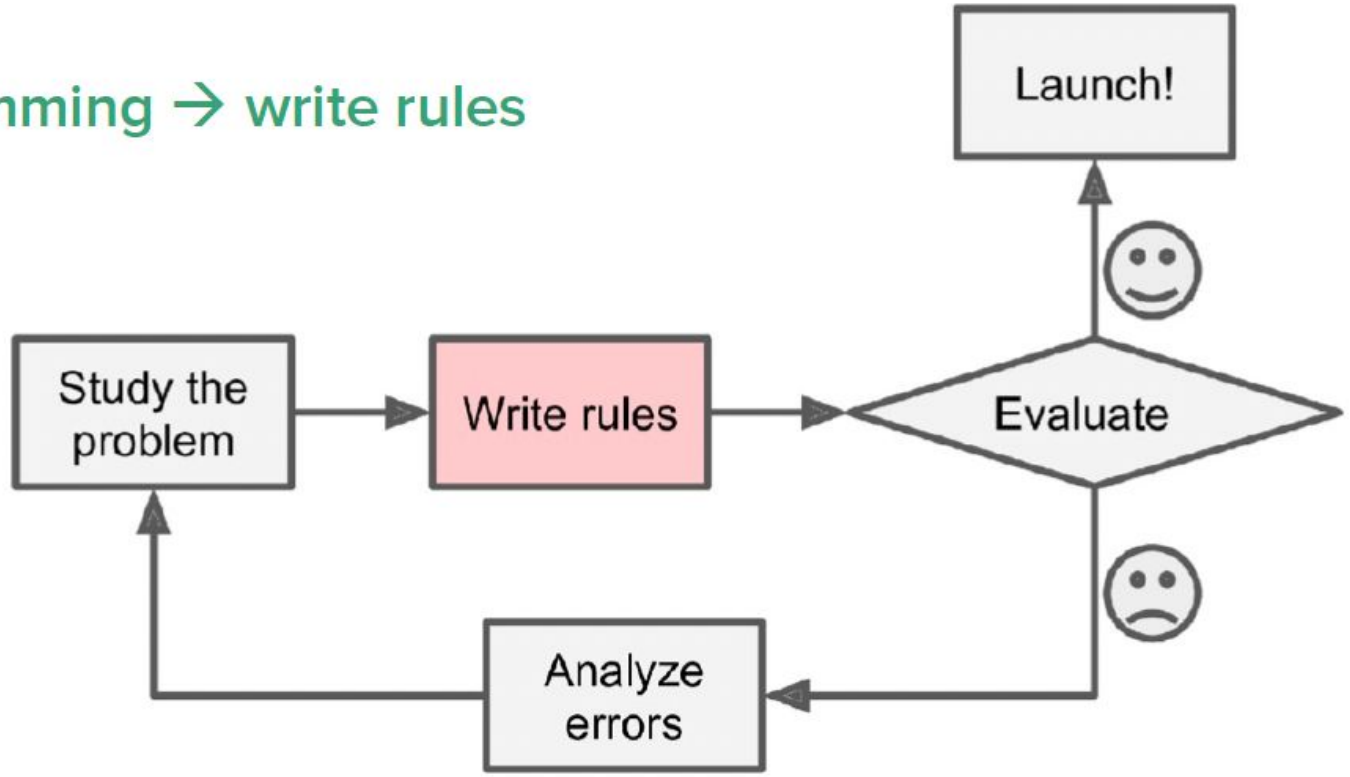


# Examples of Classification Task

| Task | Attribute set, $x$ | Class label, $y$ |
|---|---|---|
| Categorizing email messages | Features extracted from email message header and content | spam or non-spam |
| Identifying tumor cells | Features extracted from MRI scans | malignant or benign cells |
| Cataloging galaxies | Features extracted from telescope images | Elliptical, spiral, or irregular-shaped galaxies |

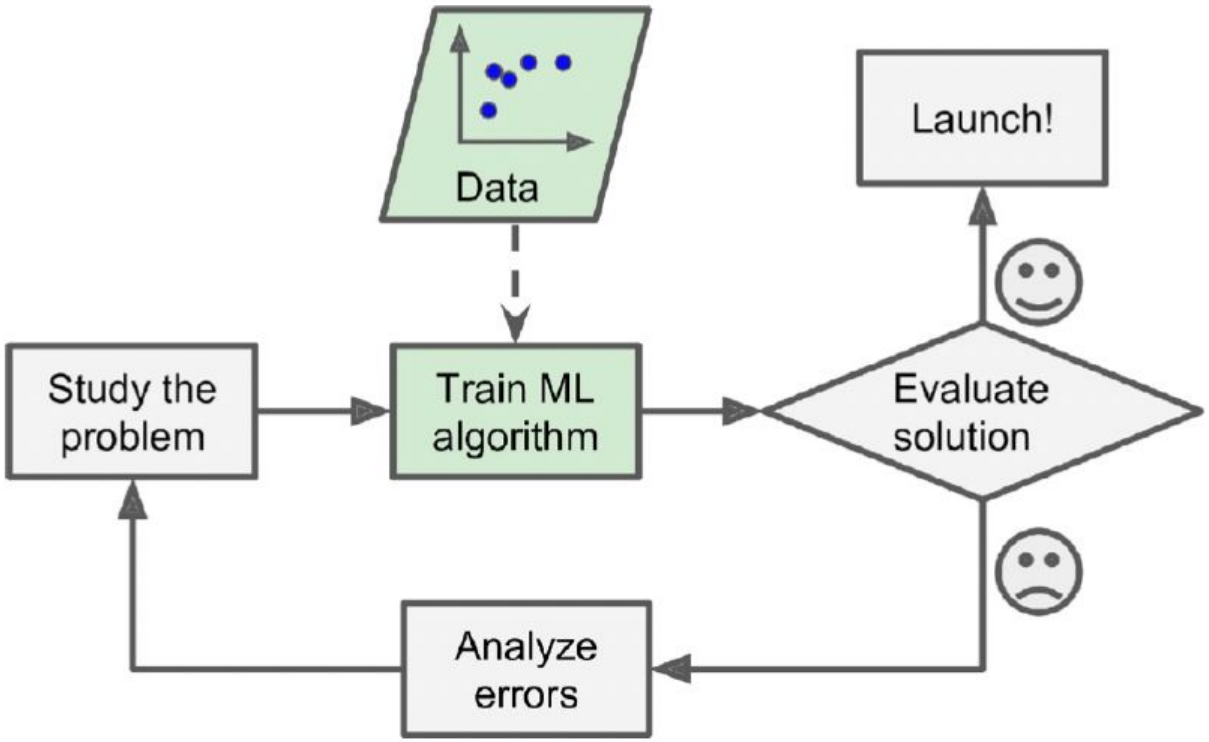
# Why do we want to use Machine Learning?

Traditional Programming → write rules



# Why do we want to use Machine Learning?

Machine Learning: train based on data (examples)



# Why do we want to use Machine Learning?

- Problems for which existing solutions require a lot of finetuning or a long list of rules
- Complex problems for which a traditional approach yields no good solution
- Changing environments
- Getting insights about complex problems and large amount of data

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- Usually, the given data set is divided into training and test sets, with training set used to build the model and test set used to evaluate it.

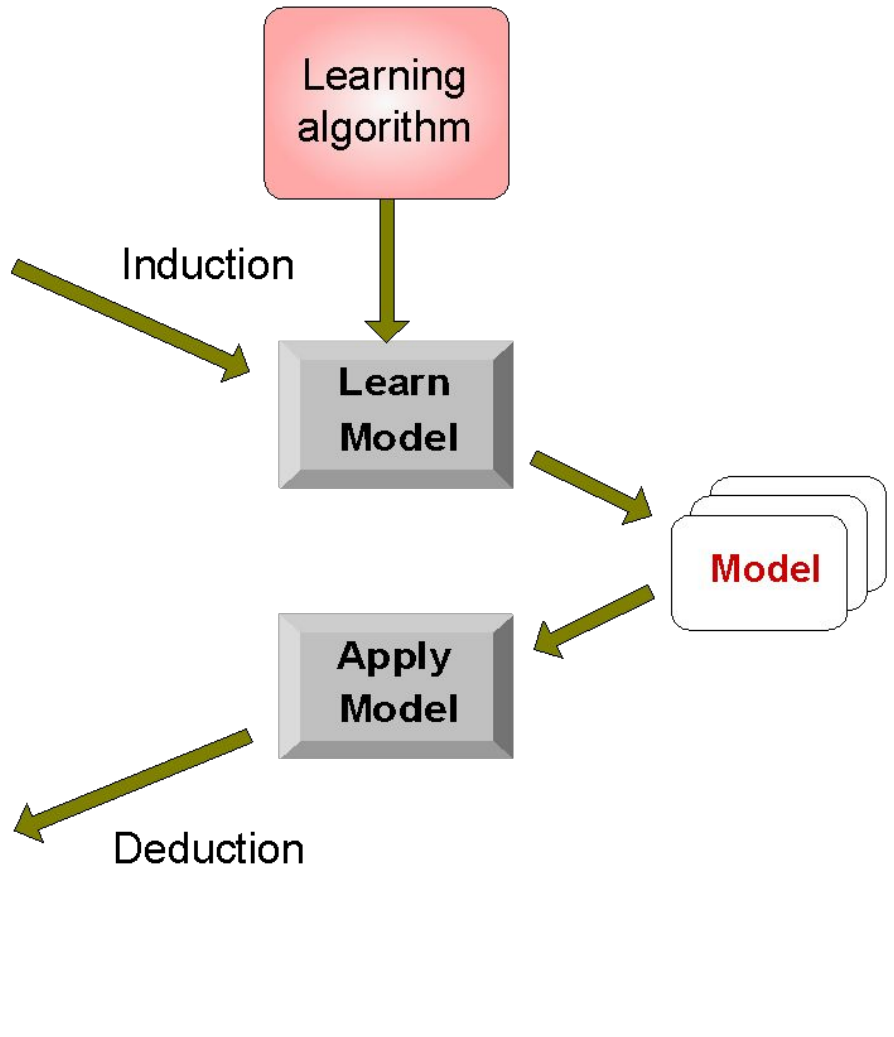
# General Approach for Building Classification Model

| Tid | Attrib1 | Attrib2 | Attrib3 | Class |
|---|---|---|---|---|
| 1 | Yes | Large | 125K | No |
| 2 | No | Medium | 100K | No |
| 3 | No | Small | 70K | No |
| 4 | Yes | Medium | 120K | No |
| 5 | No | Large | 95K | Yes |
| 6 | No | Medium | 60K | No |
| 7 | Yes | Large | 220K | No |
| 8 | No | Small | 85K | Yes |
| 9 | No | Medium | 75K | No |
| 10 | No | Small | 90K | Yes |

Training Set

| Tid | Attrib1 | Attrib2 | Attrib3 | Class |
|---|---|---|---|---|
| 11 | No | Small | 55K | ? |
| 12 | Yes | Medium | 80K | ? |
| 13 | Yes | Large | 110K | ? |
| 14 | No | Small | 95K | ? |
| 15 | No | Large | 67K | ? |

Test Set



# Classification Techniques

- Base Classifiers
  - Decision Tree based Methods
  - Rule-based Methods
  - Nearest-neighbor
  - Neural Networks
  - Deep Learning
  - Naïve Bayes and Bayesian Belief Networks
  - Support Vector Machines
- Ensemble Classifiers
  - Boosting, Bagging, Random Forests

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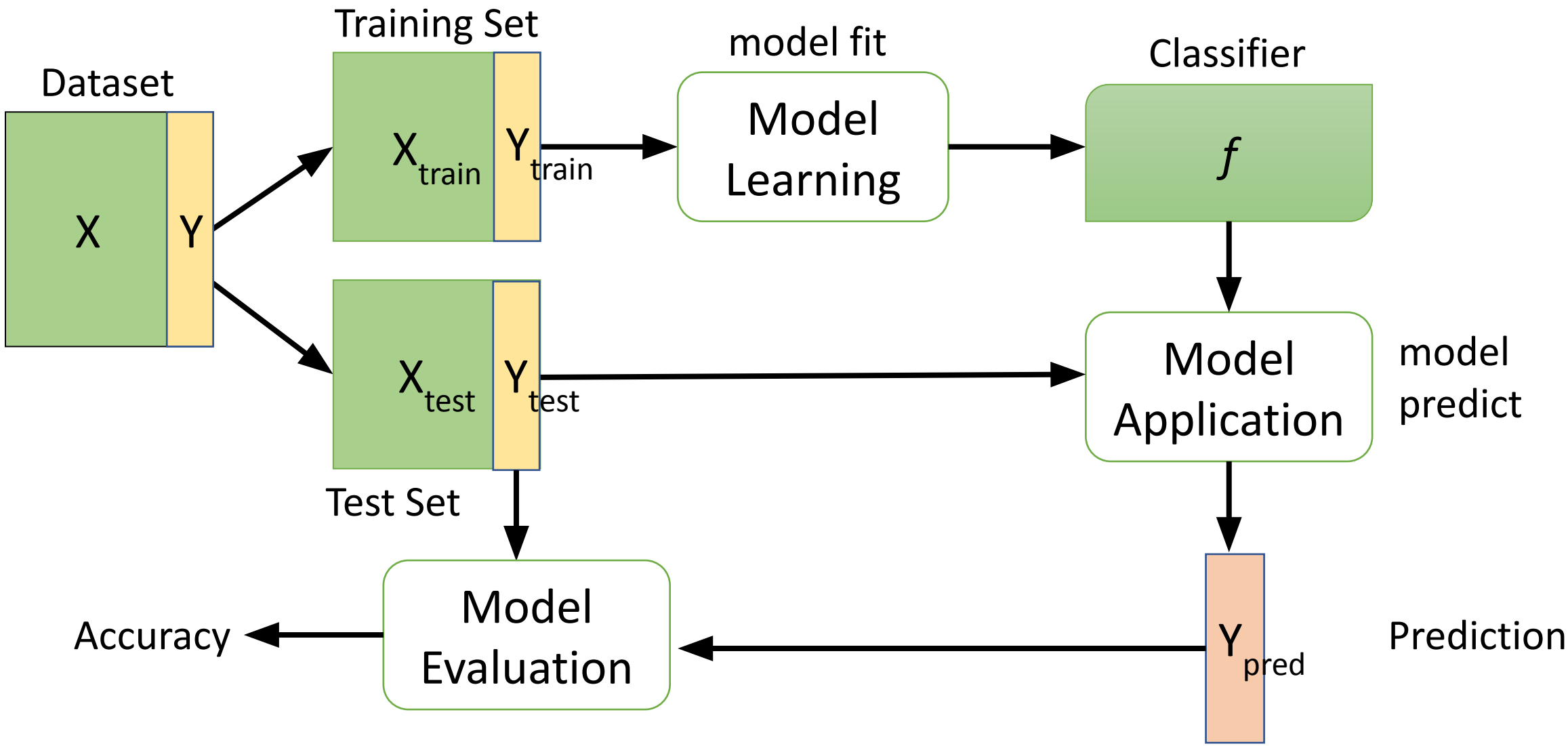

# References

- Chapter 3. Classification: Basic Concepts and Techniques.