

# Computational Communication Science 2

## Week 7 - Lecture

### »Rule-based vs. Automated Text Classification«

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# Today

Rule-based Text Classification

Automated Text Classification: SML

The principles behind SML

SML step by step

Some classical ML models

Validating models

## **Rule-based Text Classification**

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# Text Classification

Text classification: To assign a label to a text.

For example, to distinguish between:

- newspaper articles about sports vs. economics.
- reliable vs. unreliable information about vaccination.
- webpages about holding companies vs. financing companies.
- positive vs. negative movie reviews.

## Studying Flaming (Example)

RQ: How problematic is flaming on Twitter?

Bag-of-words approach:

1. Create a list with all the swearwords that exist.
2. For each tweet in the dataset, use the list to count the number of swearwords

## Sentiment Analysis

We can add nuance by creating more rules.

For example, in sentiment analyses, we can include a rule telling the machine what to do in case of negation or modifiers.

"This movie is really not good."

"This movie is really good."

## Rule-based Text Classification

Advantages of rule-based text classification:

- Simple and therefore transparent
- Cheap

Challenges of rule-based text classification:

- Not a suitable way to analyze latent or abstract variables
- You must know all the categories beforehand

## From Rule-based to Automated

When it is easy for humans to decide to what class a text belongs, but we struggle to translate our decision process into straight-forward rules, we are likely to be better off using a form of automated text classification: Supervised Machine Learning.



# **Automated Text Classification: SML**

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# What is SML?

Select all images with cats



Reset

Submit

Yu, J., Ma, X., & Han, T. (2016). Four-Dimensional Usability Investigation of Image CAPTCHA. *arXiv preprint arXiv:1612.01067*.

# What is SML?



Read more about this project in: Sermanet, P., Eigen, D., Zhang, X., Mathieu, M., Fergus, R., & LeCun, Y.

(2014). OverFeat: Integrated recognition, localization and detection using convolutional networks. *arXiv:1312.6229*

[cs]. Retrieved December 23, 2021, from <http://arxiv.org/abs/1312.6229>

# What is SML?

Machine Learning: A process whereby a machine learns how to predict a variable.

# What is SML?

Supervised Machine Learning (SML): “A form of machine learning, where we aim to predict a variable that, for a least part of our data is known.”

“The goal of Supervised Machine Learning: estimate a model based on some data, and then use the model to predict the expected outcome for some new cases, for which we do not know the outcome yet.”

Van Atteveldt, W., Trilling, D., & Calderon, C. A. (2022). *Computational analysis of communication*.

Wiley-Blackwell

# What is SML?

Machine Learning has a lot of similarities to regression analysis!

# The principles behind SML

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# The principles behind SML

$$y = \text{constant} + b_1 * x_1 + b_2 * x_2$$

$x_1$  = bark? (0 = no, 1 = yes)

$x_2$  = tail? (0 = no, 1 = yes)

$y$  = Is this a dog? ( 0 = definitely no, 1 = definitely yes)



# The principles behind SML

$$y = \text{constant} + b_1 * x_1 + b_2 * x_2$$

$$y = 0 + 0.8 * x_1 + 0.2 * x_2$$

$$y = 0 + 0.8 * 1 + 0.2 * 0$$

# The principles behind SML

$$y = 0 + 0.8 * 1 + 0.2 * 0$$

$$0.8 = 0 + 0.8 * 1 + 0.2 * 0$$

# The principles behind SML

$$0.8 = 0 + 0.8 * 1 + 0.2 * 0$$

Classification: a predictive modeling problem where a class label is predicted for a given example of input data.

# The principles behind SML

Machine Learning Lingo	Statistics Lingo
Feature	Independent variable
Label	Dependent variable
Labeled dataset	Dataset with both independent and dependent variables
To train a model	To estimate
Classifier	Model to predict nominal outcomes
To annotate	To (manually) code

Adapted from: Van Atteveldt, Trilling, & Arcilla (2021)

## The principles behind SML

Machine Learning: using a (regression) formula to predict a label.

Traditional usage of formulas in CS: to explain

Usage of formulas in ML: to predict

## Zooming out

We talked about:

- Rule-based Text Classification
- Automated Text Classification: SML
- The principles behind SML

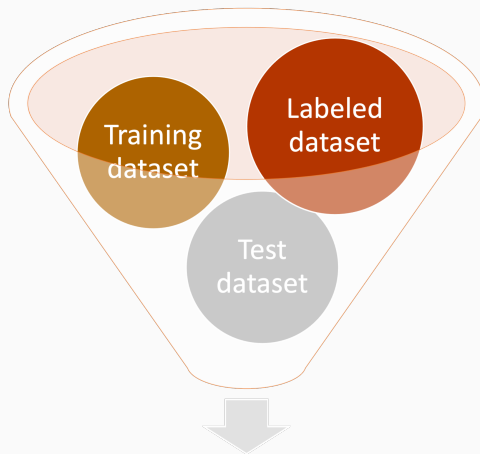
Next, we will talk about:

- The steps of SML

## SML step by step

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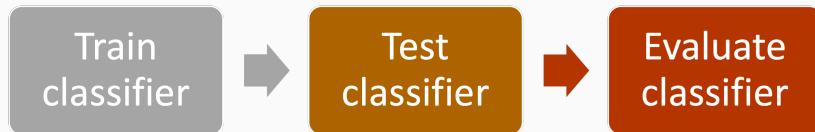
## SML step by step



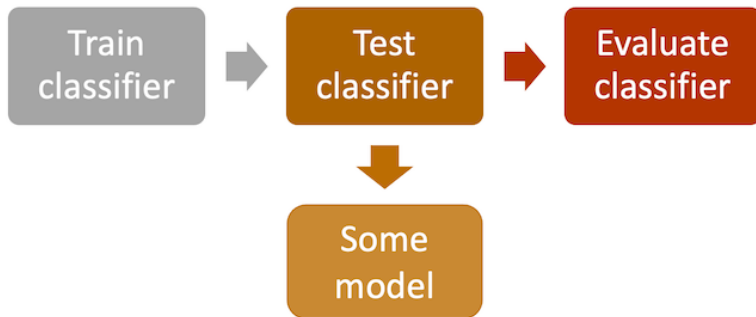
Machine Learning Process



## SML step by step



## SML step by step



Next class, we look at some commonly used ML models and at the process of evaluating classifiers.

## Zooming out

We talked about:

- Rule-based Text Classification
- Automated Text Classification: SML
- The principles behind SML
- The steps of SML

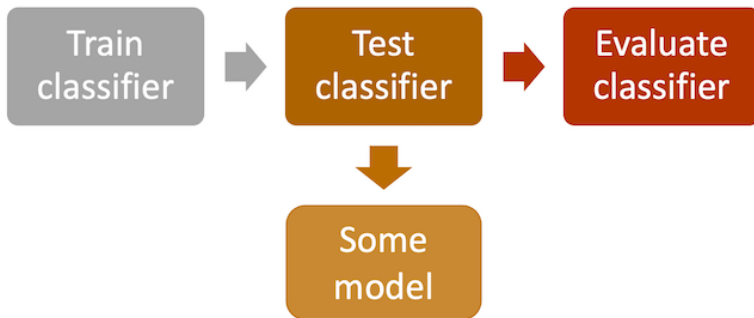
Next, we will talk about:

- Some commonly used ML models

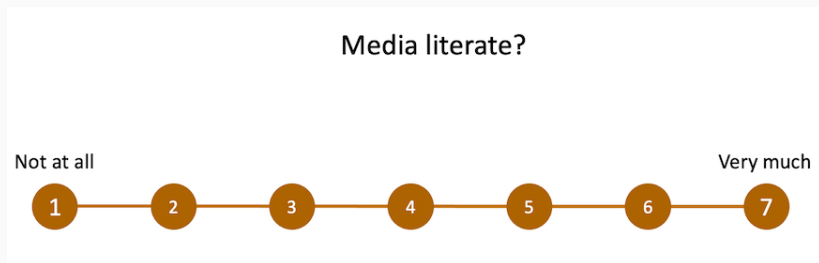
## **Some classical ML models**

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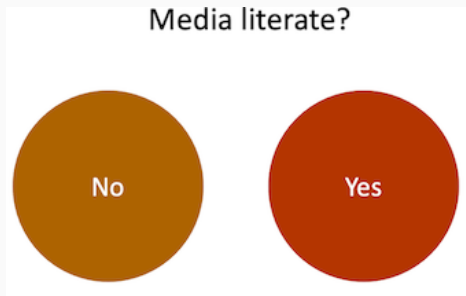
# Regression



# Regression



# Regression



# Regression

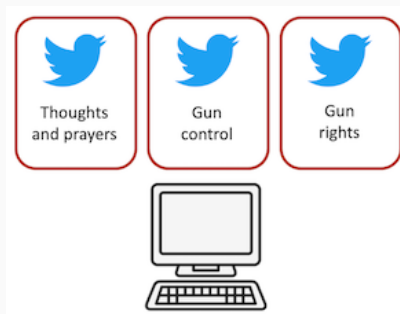


Zhang, Y., Shah, D., Foley, J., Abhishek, A., Lukito, J., Suk, J., Kim, S. J., Sun, Z., Pevehouse, J., & Garlough, C. (2019). Whose lives matter? mass shootings and social media discourses of sympathy and policy, 2012–2014.

*Journal of Computer-Mediated Communication*, 24(4), 182–202. <https://doi.org/10.1093/jcmc/zmz009>



# Regression

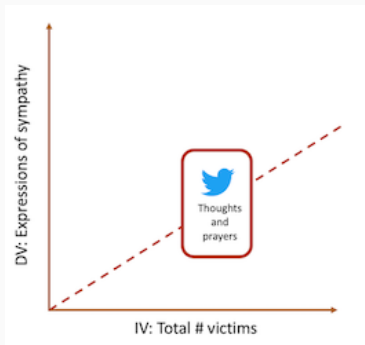


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(2019). Whose lives matter? mass shootings and social media discourses of sympathy and policy, 2012–2014.

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# Regression

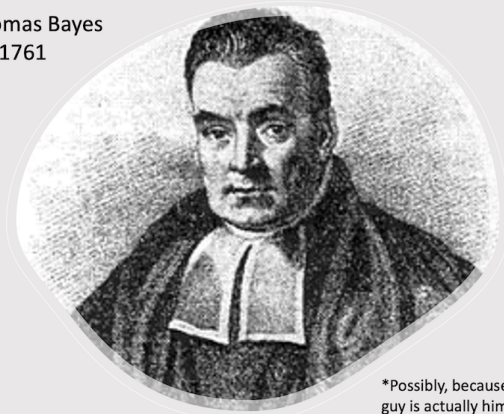


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*Journal of Computer-Mediated Communication*, 24(4), 182–202. <https://doi.org/10.1093/jcmc/zmz009>

# Naïve Bayes

Possibly\* Thomas Bayes  
1702 – 1761



\*Possibly, because it is unclear if this guy is actually him, but there is no other (claimed) portrait of him.

# Naïve Bayes

$$P(A | B) = \frac{P(B|A) \cdot P(A)}{P(B)}$$

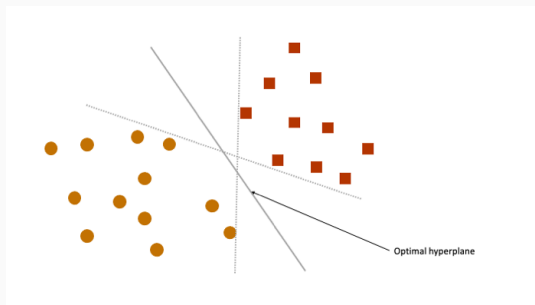
Mathematicians' language for: the probability of A is B is the case/present/true.

$$P(\text{label} | \text{features}) = \frac{P(\text{features}|\text{label}) \cdot P(\text{label})}{P(\text{features})}$$

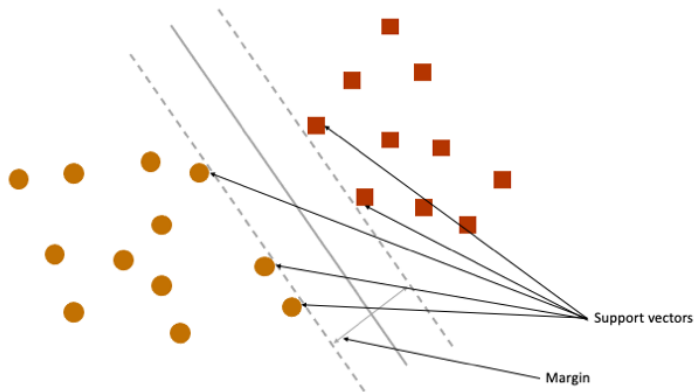
# Support Vector Machines

SVMs aim to find a hyperplane in an  $N$ -dimensional space that distinctly classifies the datapoints.

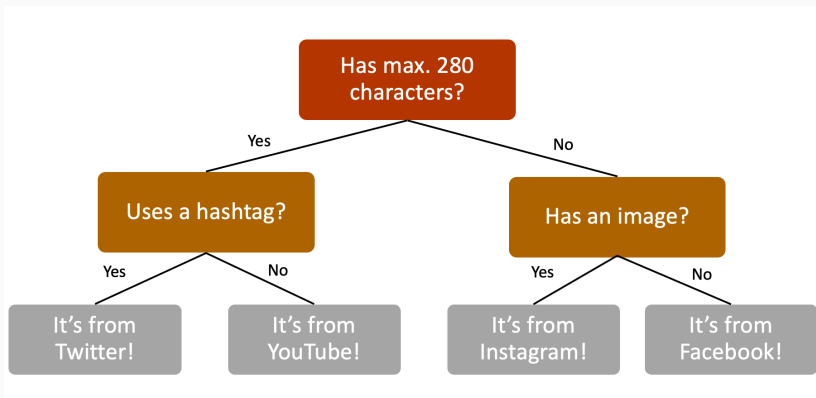
The best hyperplane is the one that has the maximum margin (distance) between the datapoints of both classes.



# Support Vector Machines



# Decision Trees and Random Forests



# Decision Trees and Random Forests

Advantages of decision trees:

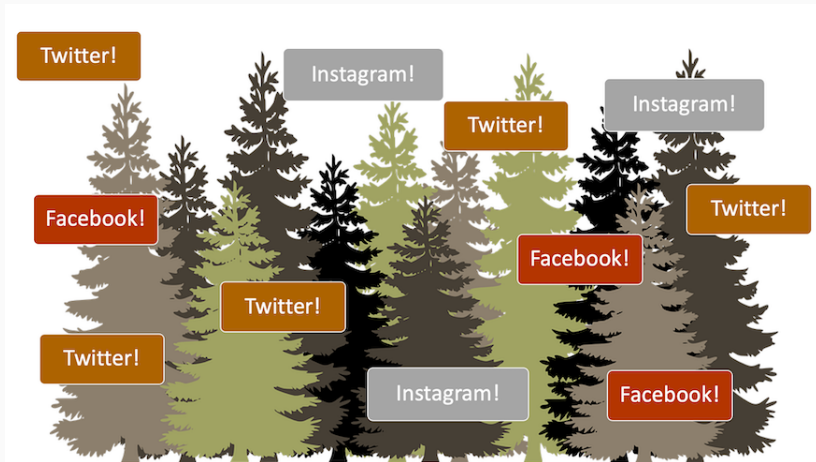
- Transparency
- Suitable for non-linear relationships

Disadvantages of decision trees:

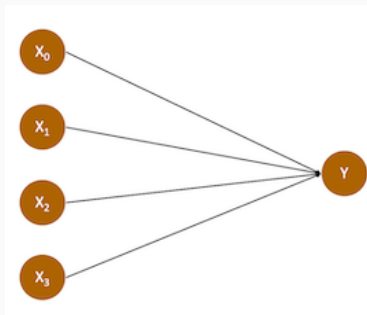
- Loss of nuance due to yes/no-design
- Cannot correct early mistakes
- Prone to overfitting



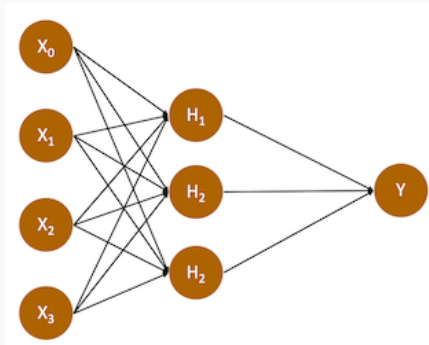
## Decision Trees and Random Forests



# Neural Networks



# Neural Networks



Ha, Y., Park, K., Kim, S. J., Joo, J., & Cha, M. (2021). Automatically detecting image–text mismatch on instagram with deep learning. *Journal of Advertising*, 50(1), 52–62.

<https://doi.org/10.1080/00913367.2020.1843091>

## Recap

Many different models available for machine learning.

How do you know what is the best for your case? Try it out and validate!

## Zooming out

We talked about:

- Rule-based Text Classification
- Automated Text Classification: SML
- The principles behind SML
- The steps of SML
- Some commonly used ML models

Next, we will talk about:

- Validating models

## Validating models

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## Precision and Recall

Precision quantifies the number of positive class predictions that actually belong to the positive cases.

OR: How much of what we found is actually correct?

Recall quantifies the number of positive class prediction made out of all positive examples in the dataset.

OR: How many of the cases that we wanted to find did we actually find?

# Precision and Recall

		Predicted Class	
		Positive	Negative
Actual Class	Positive	True Positive (TP)	False Negative (FN)
	Negative	False Positive (FP)	True Negative (TN)



# Precision and Recall

		Predicted Class	
		Positive	Negative
Actual Class	Positive	150 (TP)	20 (FN)
	Negative	50 (FP)	180 (TN)

Precision is calculated as:  $\frac{TP}{TP+FP}$

In our case  $\frac{150}{150+50}$  which is 0.75

Recall is calculated as  $\frac{TP}{TP+FN}$

In our case  $\frac{150}{150+20}$  which is 0.88

# Precision and Recall

**Table 2**  
Relationship classification performance and number of training tweets, random sampling approach.

		100	200	500	1000	2000	3000	4000
Linear support vector machine classifier	AC	0.63	0.65	0.70	0.73	0.80	0.84	0.91
	PC	0.45	0.48	0.59	0.62	0.76	0.80	0.90
	RC	0.38	0.43	0.51	0.59	0.71	0.79	0.86
	AUC	0.41	0.45	0.59	0.61	0.69	0.76	0.85
Naïve Bayes classifier	KA	0.09	0.10	0.39	0.41	0.54	0.65	0.79
	AC	0.63	0.65	0.71	0.75	0.82	0.86	0.91
	PC	0.42	0.46	0.62	0.68	0.81	0.86	0.92
	RC	0.27	0.33	0.47	0.49	0.61	0.69	0.79
Logistic regression classifier	AUC	0.33	0.38	0.60	0.62	0.69	0.77	0.84
	KA	0.08	0.13	0.39	0.40	0.56	0.67	0.78
	AC	0.66	0.67	0.71	0.74	0.79	0.85	0.89
	PC	0.48	0.51	0.63	0.70	0.78	0.89	0.93
	RC	0.04	0.22	0.35	0.39	0.53	0.64	0.73
	AUC	0.08	0.31	0.51	0.55	0.62	0.74	0.82
	KA	0.01	0.09	0.21	0.32	0.48	0.64	0.74

Van Zoonen, W., & Van der Meer, T. G. (2016). Social media research: The application of supervised machine learning in organizational communication research.. *Computers in Human Behavior*, 63, 132–141.

<https://doi.org/10.1016/j.chb.2016.05.028>

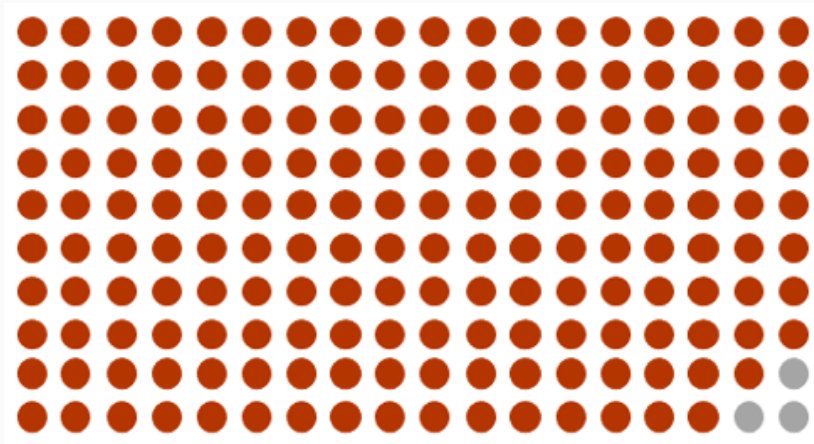
# Accuracy

Accuracy: In which percentage of all cases was our classifier right?

Class distribution: The number of examples that belong to each class.

Imbalanced classification: A classification predictive modeling problem where the distribution of examples across the classes within a training dataset is not equal.

# Accuracy



Majority class (red dots) vs. minority class (grey dots)

# $F_1$ -score

$F_1$ -score: The harmonic mean of precision and recall.

$$F_1\text{-score} = 2 \cdot \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}}$$

## Validating Models

Many more metrics to validate models.

Learn more using, for example, the scikit-learn documentation.

## Zooming out

Today, we talked about:

- Rule-based Text Classification
- Automated Text Classification: SML
- The principles behind SML
- The steps of SML
- Some commonly used ML models
- Validating models

In this week's tutorial, you will:

- Present your group projects

To do before next meeting:

- Make the homework assignments for week 8: Complete the first six questions of next week's tutorial exercises
- The exercises are available on Github