Defining AI Hypothesis

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Humanly and Rationally (Thinking and Acting)

Definition of AI

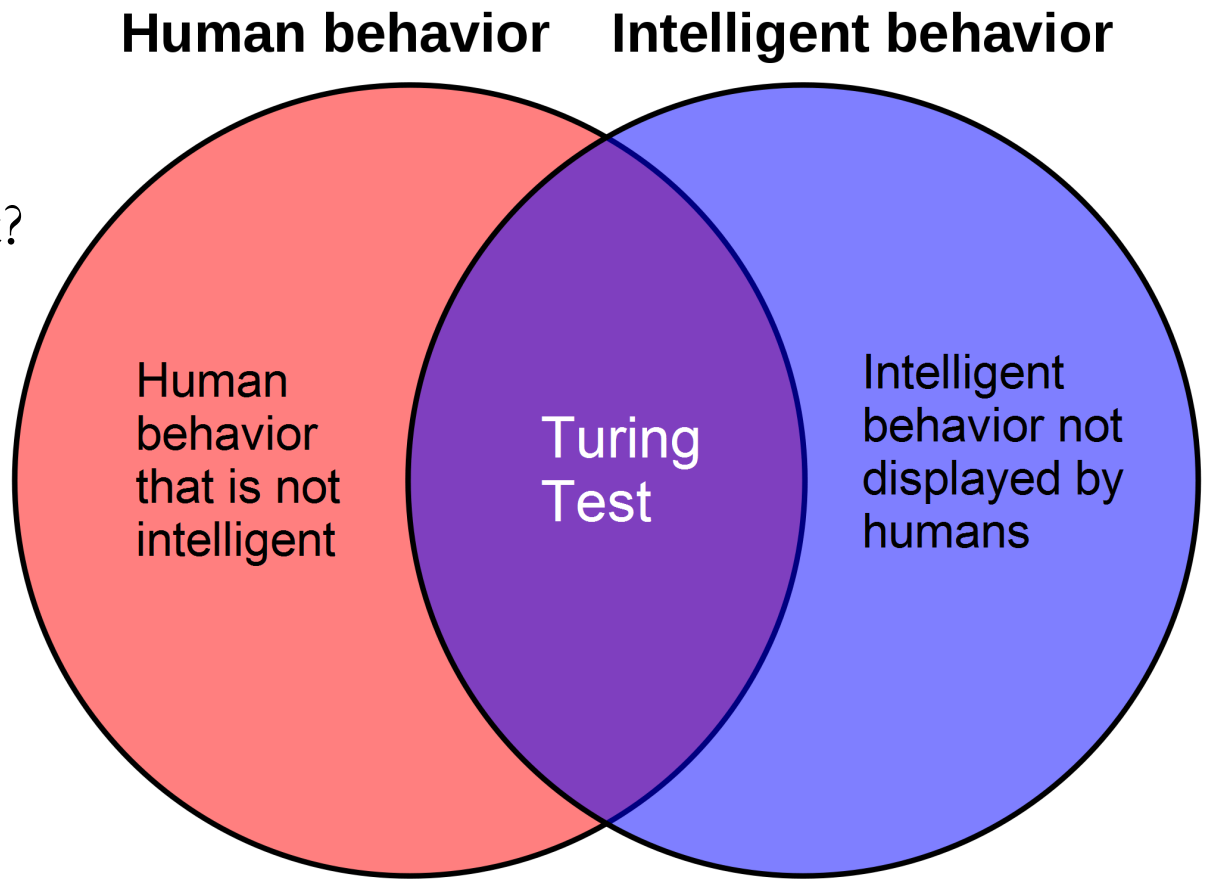
- Physics:
  - Where did the ***physical universe*** come from?
  - What are **physical laws**?
- Biology:
  - Does the ***biological life*** evolved?
  - How does organs in **living organisms** works together?
- AI:
  - What is ***intelligence*** *of a living being and non-living being?*
  - capacity for learning, reasoning, understanding, and similar forms of mental activity

What is Intelligence of Living being

- Ability to perceive and act in the world
- Reasoning: proving theorems, medical diagnosis
- Planning: take decisions
- Learning and Adaptation: recommend movies, learn traffic patterns
- Understanding: text, speech, visual scene

Intelligence vs. humans

- Are humans intelligent?
  - replicating human behavior early hallmark of intelligence
- Are humans ~~always~~ intelligent?
  - not necessary ☺
- Can non-human behavior be intelligent?
  - possible ☺



Rationally vs Humanly

- The study of how to make computers (learn/do/act/survive/adapt etc.) things as compared to existing humans/machines/algorithm
- **AI important elements:**

1. Systems that think like humans
2. Systems that act like humans
3. Systems that think rationally
4. Systems that act rationally

Human-like vs Rational
Thought vs Behavior

Human-like vs Rational

Thought vs Behavior	Human-like	Rational
Thought	``The exciting new effort to make **computers think** … *machines with minds*, in the full and literal sense" (Haugeland, 1985)``The automation of activities that we associate with **human thinking**, activities such as decision-making, problem solving, learning …" (Bellman, 1978)	``The study of **mental faculties** through the use of **computational models**" (Charniak and McDermott, 1985)``The study of the computations that make it possible to **perceive, reason, and act**" (Winston, 1992)
Behavior	``The art of creating machines that perform functions that require **intelligence when performed by people**" (Kurzweil, 1990)``The study of how to make computers do things at which, at the moment, **people are better**" (Rich and Knight, 1991)	``A field of study that seeks to **explain and emulate intelligent behavior** in terms of computational processes" (Schalkoff, 1990)``The branch of computer science that is concerned with the **automation of intelligent behavior**" (Luger and Stubblefield, 1993)

Thought vs Behavior	Human-like	Rational
Thought	Systems that think like humans.	Systems that think rationally.
Behavior	Systems that act like humans	Systems that act rationally

Intelligent Computer

- Possess the following capabilities:
  - **Natural Language Processing** to enable it to communicate successfully in English (or some other human language);
  - **Knowledge Representation** to store information provided before or during the interrogation;
  - **Automated Reasoning** to use the stored information to answer questions and to draw new conclusions;
  - **Machine Learning** to adapt to new circumstances and to detect and extrapolate patterns.
  - **Computer vision** to perceive objects, and
  - **Robotics** to move them about.

Thinking and Acting

- Two thoughts
- Humanly: concerned with reasoning steps of human subjects solving the same problems.
  - Do we want a machine that beats humans in chess or a machine that thinks like humans while beating humans in chess?
    - Deep Blue supposedly DOESN'T think like humans..
  - Express the theory as a computer program behavior matches human behavior
- Rationally: concerned with getting the right answers regardless of how humans might do it.
  - Power of the representation and reasoning systems

Thinking humanly

- Cognitive Science and Modelling:
  - Determining how humans think and workings of human minds
  - Hard to understand how humans think
  - Two ways
    - Introspection --trying to catch our own thoughts
    - Psychological experiments
- Thinking like humans important in Cognitive Science applications
  - Intelligent tutoring
  - Expressing emotions in interfaces… HCI

Thinking Rationally

- **Right Thinking:** "arguments structures that always gave correct conclusions given correct premises"
- **Syllogism:** "Socrates is a man; all men are mortal therefore Socrates is mortal."
- **Field of Logic:** Laws of thought were supposed to govern the operation of the mind.
  - Logical notation to find solution to a problem.
  - Finding solution to all kinds of things in the world and the relations between them.
- **Issue 1:** Not easy to take informal knowledge and state it in the formal terms required by Logical notation, particularly when the knowledge is less than 100% certain.
- **Issue 2:** There is a big difference between being able to solve a problem "in principle'" and doing so in practice. Means proposing algorithm and it's coding are different problems.

Acting Humanly

- Loebner Prize
  - Every year in Boston
  - an annual contest based on the Turing Test
  - an annual competition in artificial intelligence that awards prizes to the computer programs considered by the judges to be the most human-like.
- Problems
  - Not reproducible, constructive, or mathematically analyzable
  - Make human-like errors

Acting Rationally

- Acting to achieve one's goals, given one's beliefs.
- Rational behavior: doing the right thing
- Need not always be deliberative
  - Reflexive
- Every art and every inquiry, and similarly every action and every pursuit is thought to aim at some good.
  - By Aristotle (Nicomachean ethics)

Hypothesis space:
Problem and Solution domain formulations

Machine Acting V/S Thinking?

- Weak AI Hypothesis vs. Strong AI Hypothesis
  - Weak Hyp: machines could act as if they are intelligent
  - Strong Hyp: machines that act intelligent have to think intelligently too
- Hypothesis:
  - “a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation”
  - “a proposition made as a basis for reasoning, without any assumption of its truth”
- What is Machine learning Hypothesis?
  - “algorithms to build model using data for training, which makes machine capable enough to make predictions or decisions without being explicitly programmed”

Machine Learning

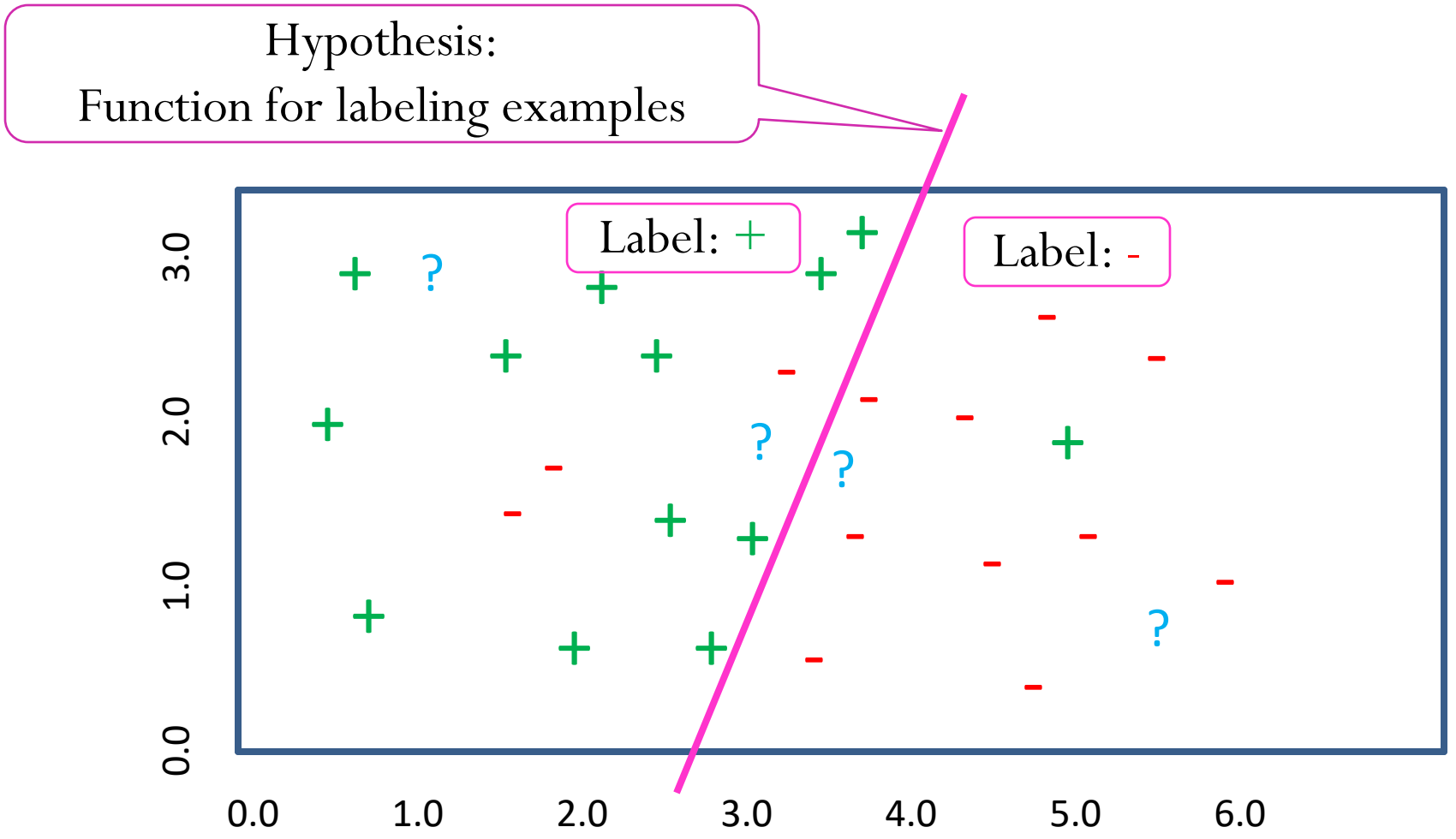
- **Machine Learning do Prediction or Recommendation**:
  - **Given** examples of a function *(X, F(X))*
  - **Predict** function *F(X)* for new examples *X*
- Classification

  F(X) = Discrete
- Regression

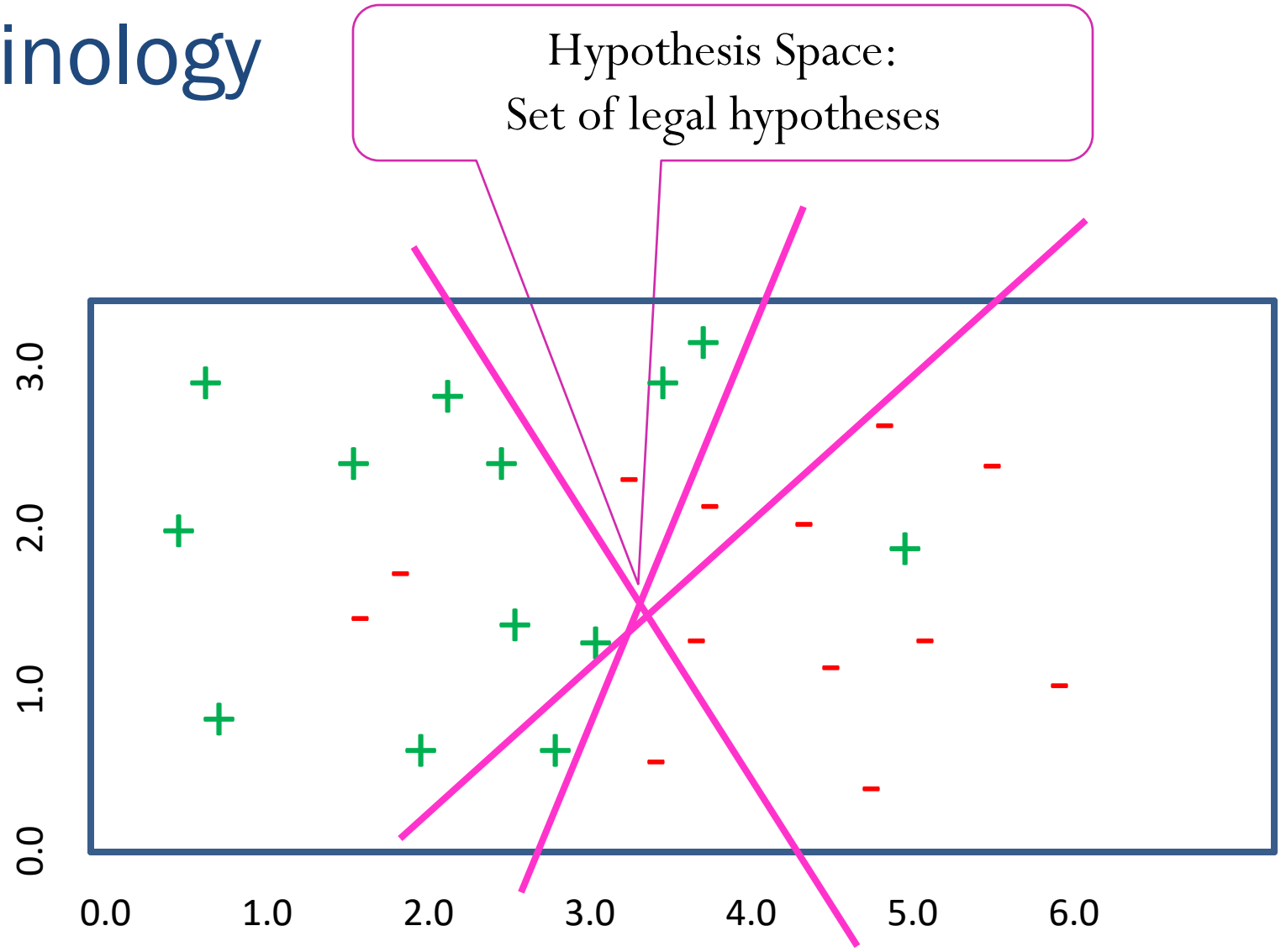
  F(X) = Continuous
- Probability estimation

  F(X) = Probability*(X):*
- Feature Space: Properties that describe the problem
- Given: <x, f(x)> for some unknown function f
- Learn: A hypothesis H, that approximates f

Terminology



Terminology



Inductive Bias

- Need to make assumptions
  - Experience alone doesn't allow us to make conclusions about unseen data instances

- Two types of bias:
  - Restriction: Limit the hypothesis space (e.g., look at rules)
  - Preference: Impose ordering on hypothesis space (e.g., more general, consistent with data)

- Statistical hypothesis test: Comparing and Validating Machine Learning Algorithms

Confusion Matrix

- True Positive (TP):
  - A test result that correctly indicates the presence of a condition or characteristic
- True Negative (TN):
  - A test result that correctly indicates the absence of a condition or characteristic
- False Positive (FP):
  - A test result which wrongly indicates that a particular condition or attribute is present
- False Negative (FN):
  - A test result which wrongly indicates that a particular condition or attribute is absent

Confusion Matrix

$$P = TP + FN$$

$$N = FP + TN$$

		Predicted condition	
	Total population = P + N	**Positive (PP)**	**Negative (PN)**
Actual condition	**Positive (P)**	**True positive (TP)**	**False negative (FN)**
	Negative (N)	**False positive (FP)**	**True negative (TN)**

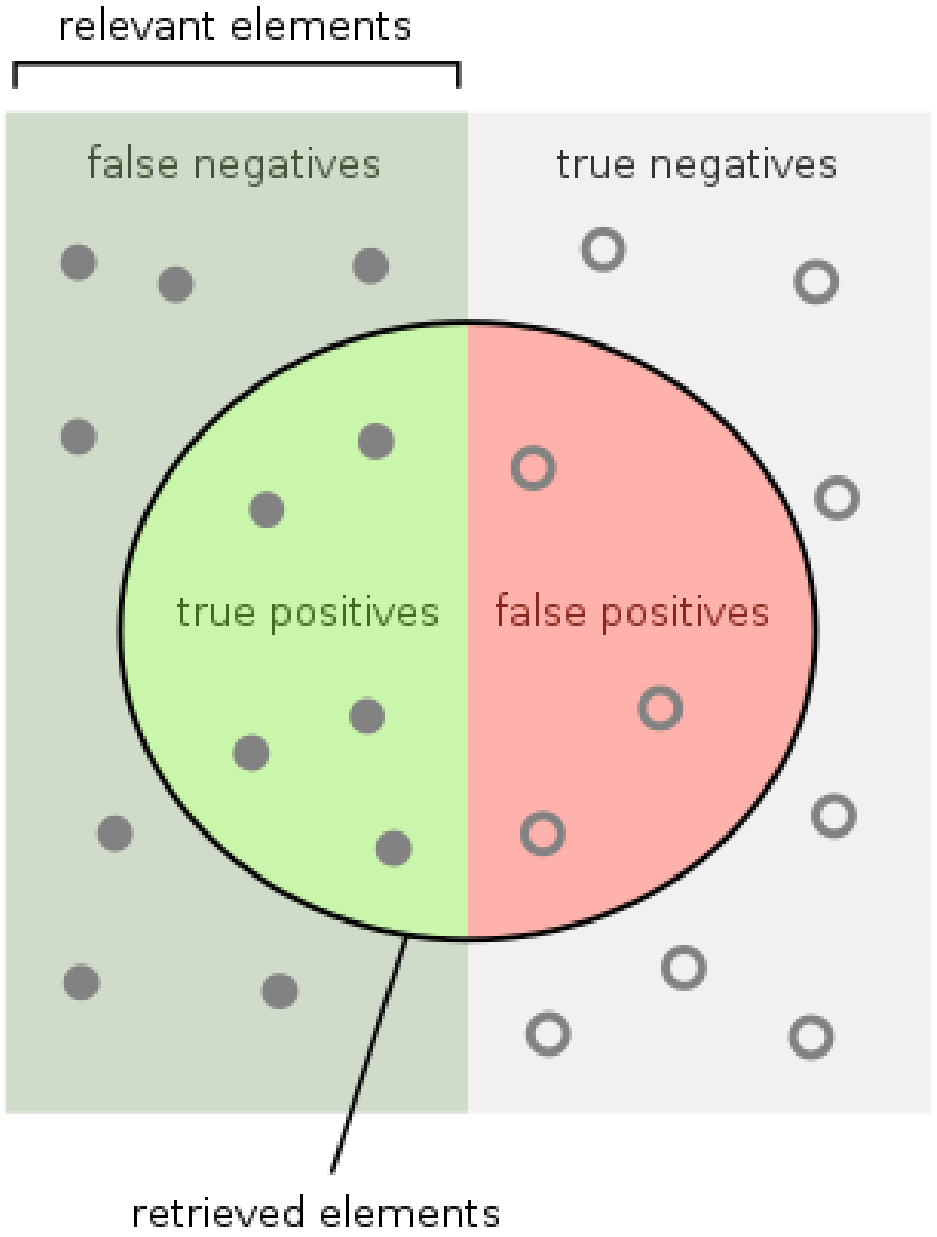
Precision and Recall

How many retrieved items are relevant?

$$\text{Precision} = \frac{\text{retrieved} \cap \text{relevant}}{\text{retrieved}}$$

How many relevant items are retrieved?

$$\text{Recall} = \frac{\text{retrieved} \cap \text{relevant}}{\text{relevant}}$$



Precision and Recall

- A set of retrieved documents
  - (e.g. the list of documents produced by a web search engine for a query)
- A set of relevant documents
  - (e.g. the list of all documents on the internet that are relevant for a certain topic)

$$\text{precision} = \frac{|\{\text{relevant documents}\} \cap \{\text{retrieved documents}\}|}{|\{\text{retrieved documents}\}|}$$

$$\text{recall} = \frac{|\{\text{relevant documents}\} \cap \{\text{retrieved documents}\}|}{|\{\text{relevant documents}\}|}$$

Accuracy and F-score

- $Precision = \frac{TP}{TP + FP}$
- $Recall = \frac{TP}{TP + FN}$
- $Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$
- $F\text{-}Measure = 2 \times \frac{precision \times recall}{precision + recall}$

Sensitivity and Specificity

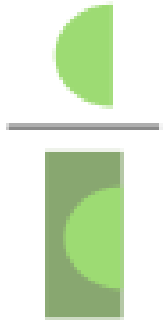
- **Recall** is also referred to as the **True Positive Rate** or **Sensitivity**
- **Precision** is also referred to as **Positive Predictive Value (PPV)**

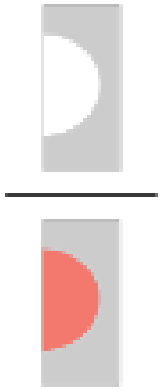
$$\text{PPV} = \frac{\text{Number of true positives}}{\text{Number of true positives} + \text{Number of false positives}} = \frac{\text{Number of true positives}}{\text{Number of positive calls}}$$

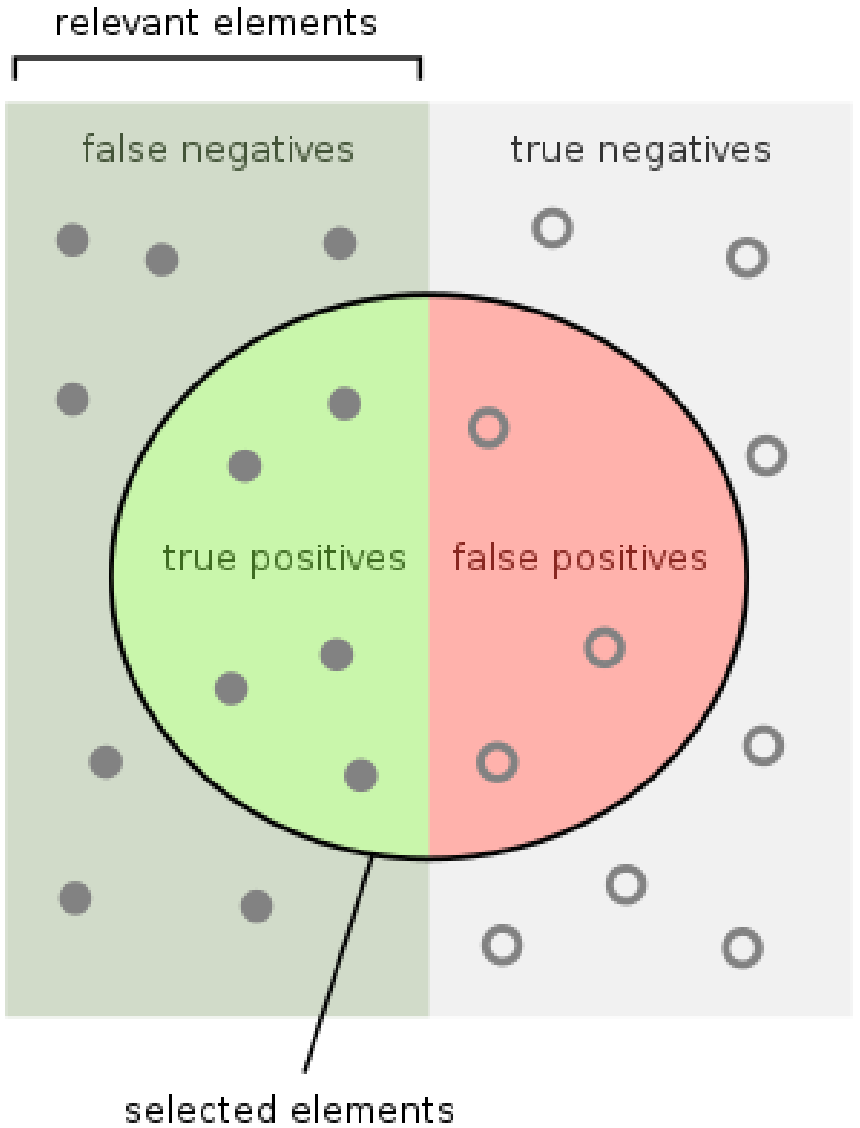
- **True negative rate** is also called **Specificity**

$$\textbf{True negative rate} = \frac{TN}{TN + FP}$$

Sensitivity and Specificity

Sensitivity= 

Specificity = 



How many relevant items are selected? e.g. How many sick people are correctly identified as having the condition.

How many negative selected elements are truly negative? e.g. How many healthy people are identified as not having the condition.

References

- Slides of Artificial Intelligence by Jesse Davis, jdavis@cs.washington.edu https://courses.cs.washington.edu/courses/cse573/08au/slides/
- Stuart Russel, and Peter Norvig. "Artificial intelligence: A modern approach. Third edit." Upper Saddle River, New Jersey 7458 (2015). http://aima.cs.berkeley.edu/
- https://people.eecs.berkeley.edu/~russell/intro.html
- Wikipedia contents
  - https://en.wikipedia.org/wiki/Precision_and_recall
  - https://en.wikipedia.org/wiki/Confusion_matrix
- Images are from several sources e.g. movies, TV serials, internet, miscellaneous links, slides, blogs, etc.
- Artificial Intelligence, Prof. Mausam https://www.cse.iitd.ac.in/~mausam/courses/col333/autumn2019/

תודה רבה
Hebrew

Ευχαριστώ
Greek

Спасибо
Russian

Danke
German

धन्यवादः
Sanskrit

Merci
French

ধন্যবাদ
Bangla

நன்றி
Tamil

شكراً
Arabic

ಧನ್ಯವಾದಗಳು
Kannada

Thank You
English

നന്ദി
Malayalam

多謝
Traditional Chinese

Grazie
Italian

ధన్యవాదాలు
Telugu

આભાર
Gujarati

ਧੰਨਵਾਦ
Punjabi

धन्यवाद
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多谢
Simplified Chinese

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Obrigado
Portuguese

ありがとうございました
Japanese

ขอบคุณ
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