Learning Agent

Introduction

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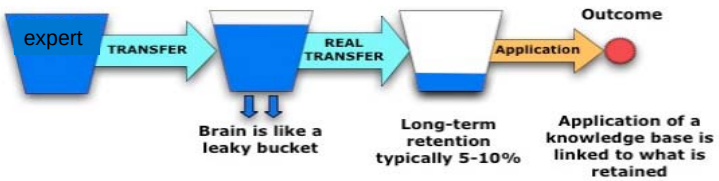
http://mmp.kaist.ac.kr/ra_machine_learning.html

Kuliah Sebelumnya

- Percepts used to get solution (acting)
  - Problem Solving Agent
    - Design: formulate problem → search solution → execute
  - Knowledge-based Agent
    - Design: knowledge base + inference engine
    - Manual knowledge acquisition: elicitation + representation

Knowledge Acquisition Bottleneck

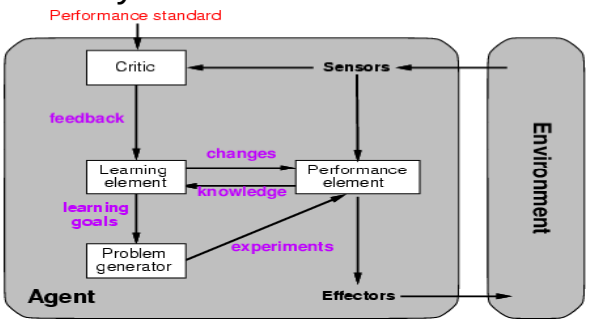
- Knowledge elicitation:
  - slow speed
  - Inability of expert to express the knowledge they posses
- Knowledge representation: knowledge mismatch
  - Perbedaan struktur pengetahuan pakar dan struktur pengetahuan program



http://www.profoundlearning.com/Content/EducationSolutions/educationKnowledgeTransfer.html

Automatic Knowledge Acquisition

- Learning from observations
- Percepts also used for improving the agent's ability to act in the future



- Performance element: selecting external actions (general agent)
- Learning element: making improvements
- Critic: how well the agent is doing
- Problem Generator: suggest the exploratory actions

Learning from observations

- Learning: **changes** in the system that are **adaptive** in the sense that they enable the system to do the task or tasks drawn from the same population **more efficiently** and **more effectively** the next time.
  - Kemampuan yang penting agar dapat beroperasi pada lingkungan yang tidak diketahui → **lazy designers**
  - Berguna sebagai metode pembangunan sistem
  - Mengubah mekanisme pengambilan keputusan untuk memperbaiki performansi

Design of A Learning Element

- Which components of the performance element are to be learned
  - Type of performance element: reflex agent, logical agent, knowledge-based agent, …
  - Component to be learned → learning goal
- What feedback is available to learn these components → supervised, unsupervised, reinforcement
- What representation is used for the components → learning algorithm
- Availability of prior knowledge

Learning Type

- Supervised learning:
  - Diberikan: set of example, correct answers for each example (example label) → I/O pairs
  - Prediksi output dari input baru
- Unsupervised learning:
  - Diberikan: set of example, no labeling
  - Kelompokkan example ke “natural” clusters
- Reinforcement learning:
  - Agen: observasi → aksi {rewarded/punished}
  - Pilih aksi dgn memaksimalkan reward

Taxi Driver Agent

http://www.gettyimages.com/detail/83988175/Stone

- Brake decision: mapping condition-action rule
  - f: states → boolean (brake or not brake)
- Buses recognition: Infer the world from percepts
  - f: images → boolean
- Good/bad traffic day recognition
- Desirable/undesirable behavior recognition from tip indication

Taxi Driver Agent: Feedback

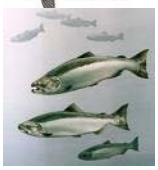
- Brake decision:
  - Direct mapping: states → boolean
  - Feedback: instructor shouts
  - Design: supervised learning
- Buses recognition by seeing many camera images:
  - Infer bus properties: image → boolean
  - Feedback: labeling bus images
  - Design: supervised learning
- Good/bad traffic day recognition
  - Develop own concepts
  - No feedback
  - Design: unsupervised learning
- Behavior recognition by tip indication
  - Feedback: tip from customer at the end of journey
  - Design: reinforcement learning

Supervised vs Unsupervised Learning ?

Supervised Learning

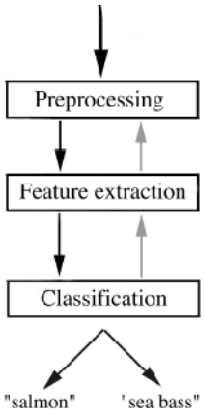
Fish Packing Plant

- Input:
  - sea bass:
  - Salmon



- Goal: automate sorting incoming fish on conveyor belt

Agent Pemisah Ikan



- Comp. of PE: fish classification
- Feedback: labeling fish
- Klasifikasi: model klasifikasi
  - Hasil supervised learning

Supervised Learning

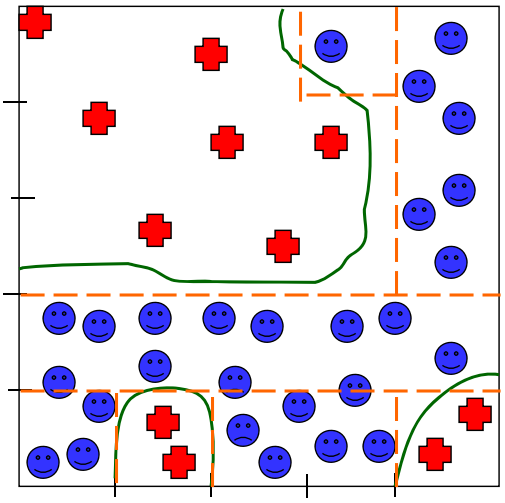
- Learn a function from training data
- Input: training-set <data, label> → <x,f(x)>
- Fungsi target learning: f
- Problem: find a hypothesis *h* s.t *h* ≈ *f*
- Process: inductive learning
- Output: h (class description)
- Usage: classify unseen data based on class description

Data Set (Examples)

- Attribute-based representations
- Examples described by attribute values

Case	Age	Prescription	Astigmatism	Tear Production	Lens
1	young	myope	not astigmatic	reduced	none
2	young	myope	not astigmatic	normal	soft
3	young	myope	astigmatic	reduced	none
4	young	myope	astigmatic	normal	hard
5	young	hypermetrope	not astigmatic	reduced	none
6	young	hypermetrope	not astigmatic	normal	soft
7	young	hypermetrope	astigmatic	reduced	none
8	young	hypermetrope	astigmatic	normal	hard
9	pre-presbyopic	myope	not astigmatic	reduced	none
10	pre-presbyopic	myope	not astigmatic	normal	soft
11	pre-presbyopic	myope	astigmatic	reduced	none
12	pre-presbyopic	myope	astigmatic	normal	hard
13	pre-presbyopic	hypermetrope	not astigmatic	reduced	none
14	pre-presbyopic	hypermetrope	not astigmatic	normal	soft
15	pre-presbyopic	hypermetrope	astigmatic	reduced	none
16	pre-presbyopic	hypermetrope	astigmatic	normal	none
17	presbyopic	myope	not astigmatic	reduced	none
18	presbyopic	myope	not astigmatic	normal	none
19	presbyopic	myope	astigmatic	reduced	none
20	presbyopic	myope	astigmatic	normal	hard
21	presbyopic	hypermetrope	not astigmatic	reduced	none
22	presbyopic	hypermetrope	not astigmatic	normal	soft
23	presbyopic	hypermetrope	astigmatic	reduced	none
24	presbyopic	hypermetrope	astigmatic	normal	none

Teknik DM: Machine Learning

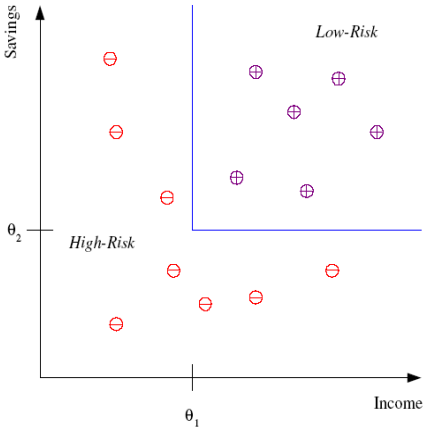


Learning: mencari pola
Pola: pendekatan fungsi

17 MLK/Churn Prediction

Credit Scoring

- Differentiating between low-risk and high-risk customers from their *income* and *savings*



Discriminant: IF *income* > θ_1 AND *savings* > θ_2

THEN low-risk ELSE high-risk

Based on Lecture Notes for E Alpaydın
2004 Introduction to Machine Learning
© The MIT Press (V1.1)

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Inductive learning

Learn suatu fungsi dari contoh

An example is a pair (*x*, *f(x)*); *f* is the target function

Case	Age	Prescription	Astigmatism	Tear Production	Lens
1	young	myope	not astigmatic	reduced	none

x f(x)

Problem: find a hypothesis *h* such that ***h ≈ f***

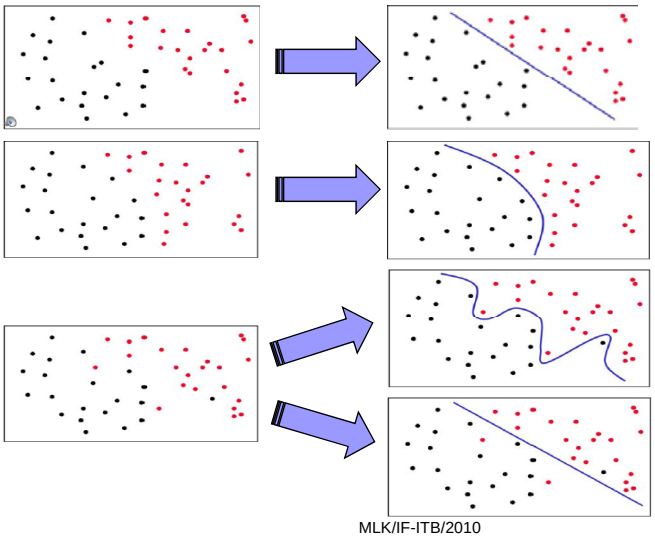
This is a highly simplified model of real learning:

- Ignores prior knowledge
- Assumes examples are given)

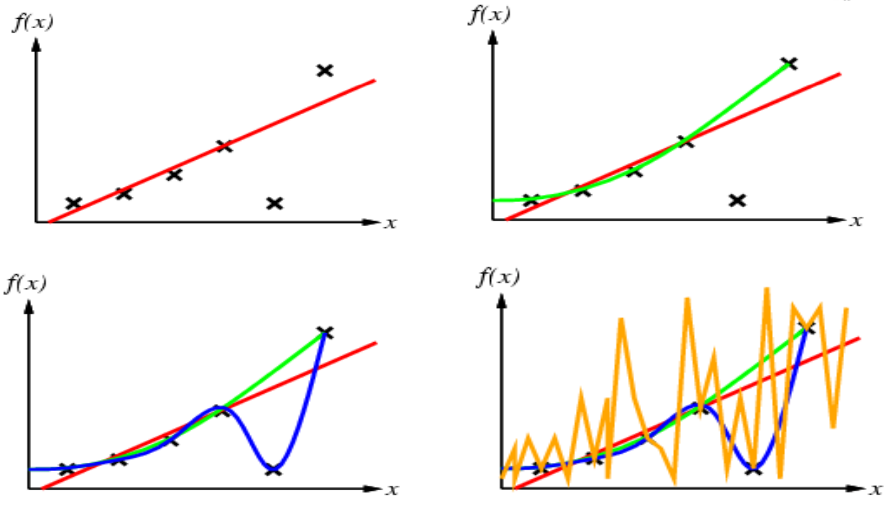
Inductive learning method

- Construct/adjust *h* to agree with *f* on training set
- (*h* is consistent if it agrees with *f* on all examples)
- Contoh: **curve fitting**

Curve Fitting: Contoh 1



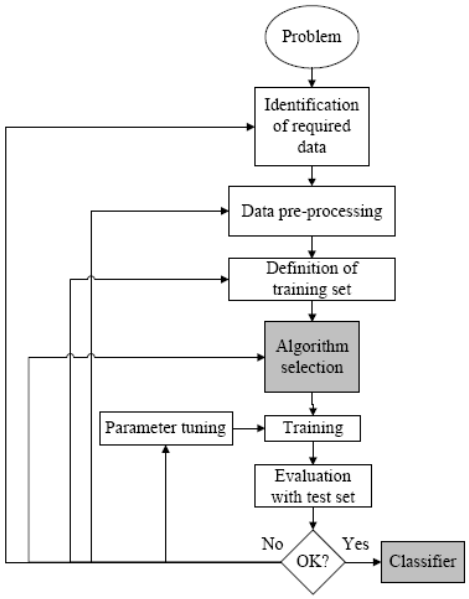
Curve Fitting: Contoh 2



Inductive learning method

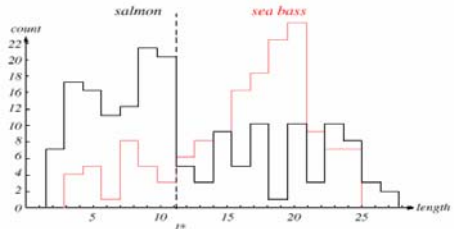
- Construct/adjust *h* to agree with *f* on training set
- (*h* is consistent if it agrees with *f* on all examples)
- **Ockham's razor:**
  - Pilih hipotesis yang paling sederhana yang konsisten dengan data

Supervised Learning Process



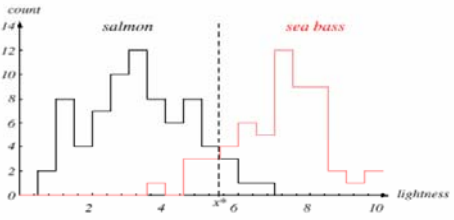
1 feature: Threshold Value

A sea bass is generally longer than a salmon.

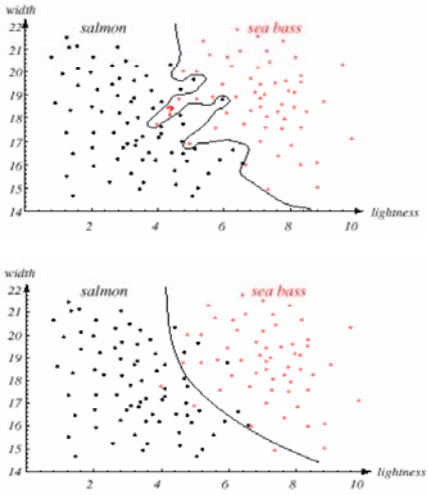


Poor performance
→ length is a poor feature

Lightness is better feature to classify the fish.



>1 Features: Decision Boundary



- Features: width, lightness
- Ideal decision boundary: 100% training accuracy
- Aim of classifier designing is to correctly classify novel input
- Need good generalization for future patterns
- Testing accuracy vs training accuracy

Applications for Supervised Learning

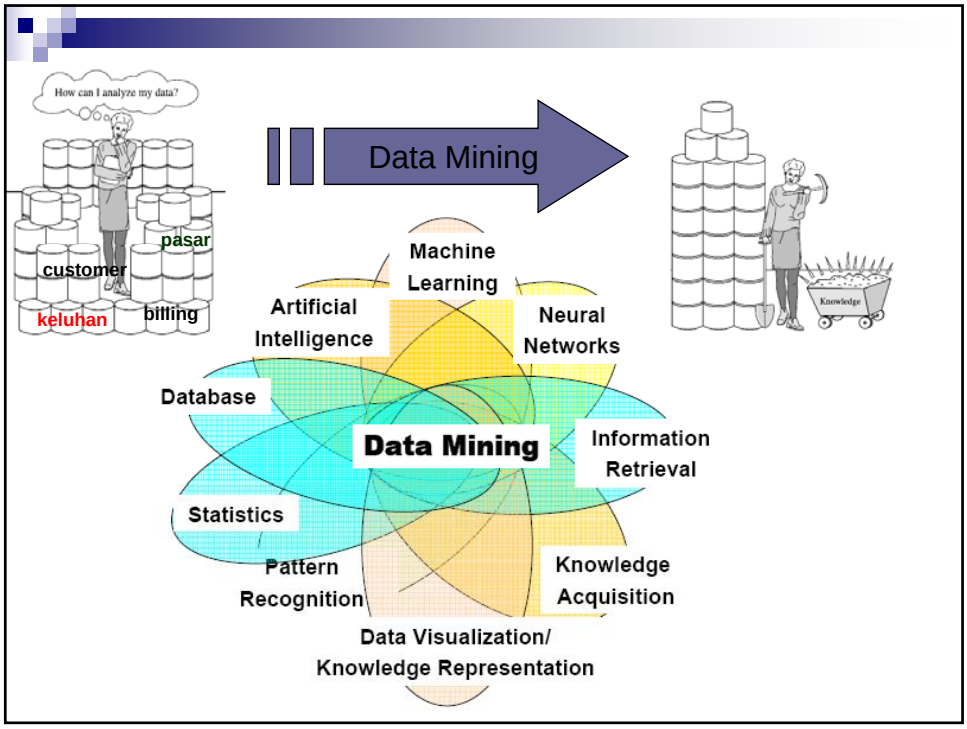
Given: Training examples (**x**, *f*(**x**)) for some unknown function *f*
Find: A good approximation to *f*.

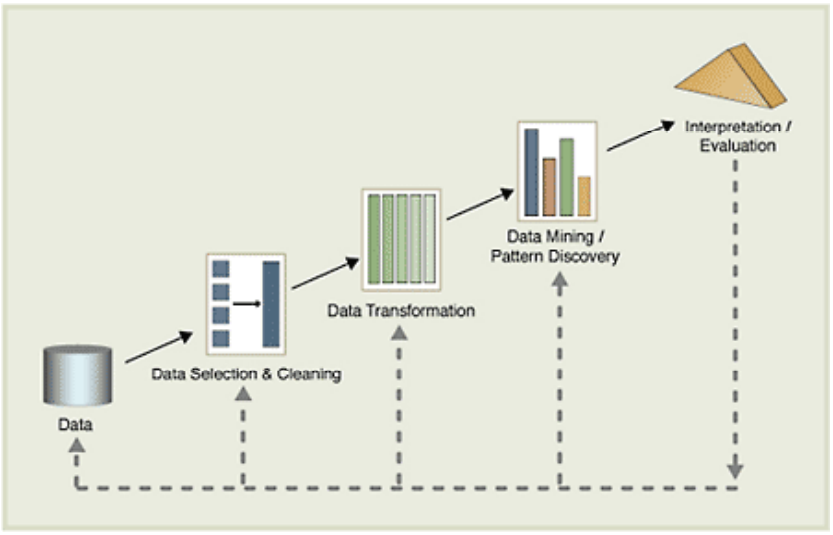
Example Applications

- **Handwriting Recognition**
  - **x**: Data from pen motion.
  - *f*(**x**): Letter of the alphabet.
- **Disease diagnosis**
  - **x**: Properties of patient (symptoms, lab tests)
  - *f*(**x**): Disease (or maybe, recommended therapy)
- **Face recognition**
  - **x**: Bitmap picture of person's face
  - *f*(**x**): Name of the person.
- **Spam Detection**
  - **x**: Email message
  - *f*(**x**): Spam or not spam.

Applications for Supervised Learning

- **Situations where there is no human expert**
  - **x**: Bond graph for a new molecule.
  - *f*(**x**): Predicted binding strength to AIDS protease molecule.
- **Situations where humans can perform the task but can't describe how they do it.**
  - **x**: Bitmap picture of hand-written character
  - *f*(**x**): Ascii code of the character
- **Situations where the desired function is changing frequently**
  - **x**: Description of stock prices and trades for last 10 days.
  - *f*(**x**): Recommended stock transactions
- **Situations where each user needs a customized function *f***
  - **x**: Incoming email message.
  - *f*(**x**): Importance score for presenting to user (or deleting without presenting).


How can I analyze my data?
pasar
customer
keluhan
billing
Data Mining
Knowledge
Machine Learning
Artificial Intelligence
Neural Networks
Database
Data Mining
Information Retrieval
Statistics
Pattern Recognition
Knowledge Acquisition
Data Visualization/ Knowledge Representation

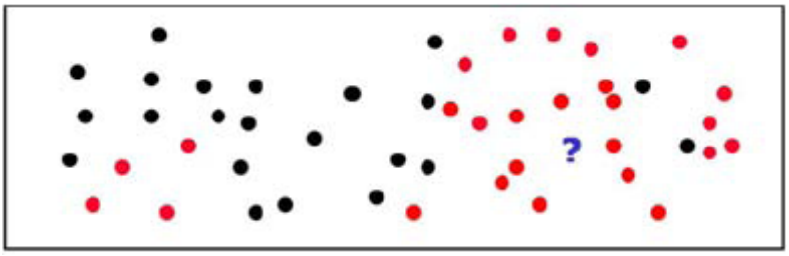

Interpretation / Evaluation
Data Mining / Pattern Discovery
Data Transformation
Data Selection & Cleaning
Data

Learning Method

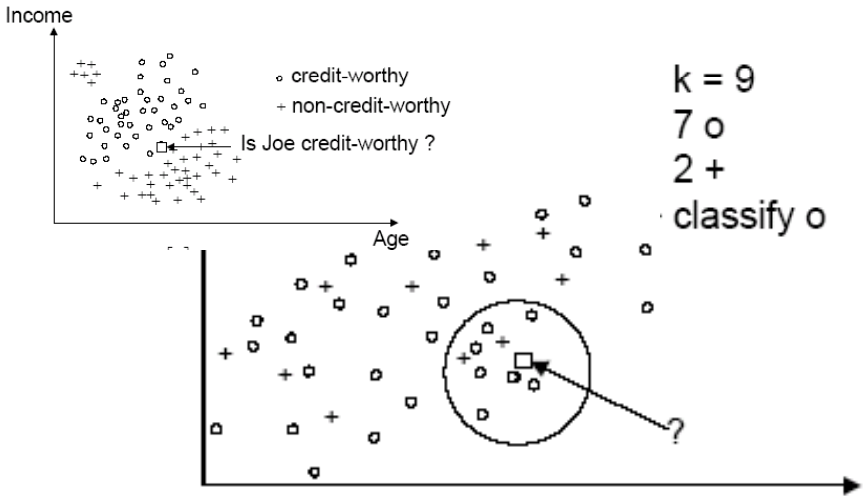
- Numeric/quantitative:
  - probabilistic classifier, linear classifier, SVM, regression, artificial neural network, Naïve Bayes
- Nonnumeric/symbolic:
  - Decision tree learning, decision rule classifier
- Example-based classifier:
  - k-Nearest Neighbor

K-Nearest Neighbor

- Menyimpan semua data
- Input baru → kelas dari data terdekat



Contoh k-NN


Income
credit-worthy
non-credit-worthy
Is Joe credit-worthy ?
Age
k = 9
7 o
2 +
classify o
?