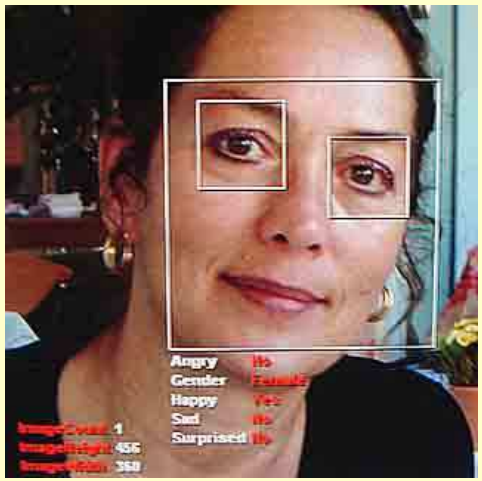
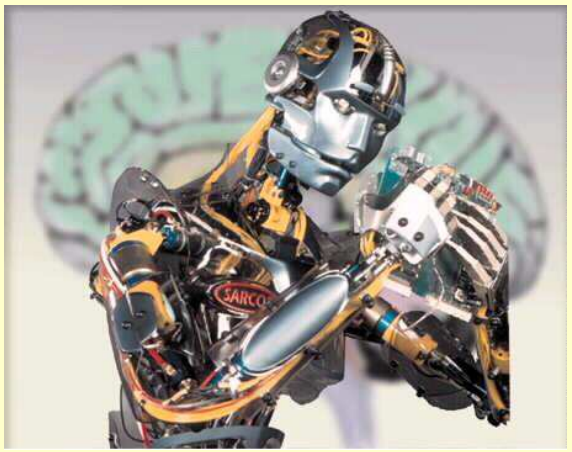
Introduction to Machine Learning

Entin Martiana

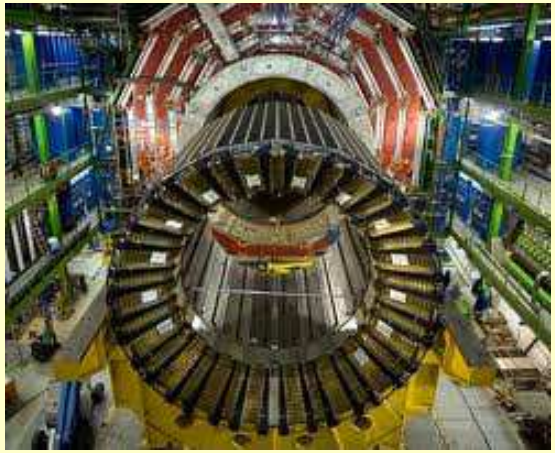


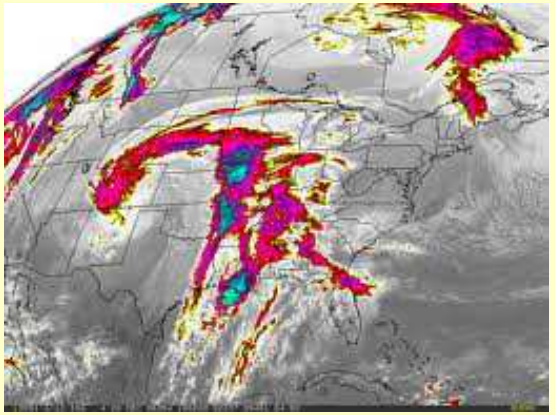


Learning from Data

The world is driven by data.

- Germany's climate research centre generates 10 petabytes per year
- Google processes 24 petabytes per day
- The Large Hadron Collider produces 60 gigabytes per minute (~12 DVDs)
- There are over 50m credit card transactions a day in the US alone.





Learning from Data

Data is recorded from some real-world phenomenon.

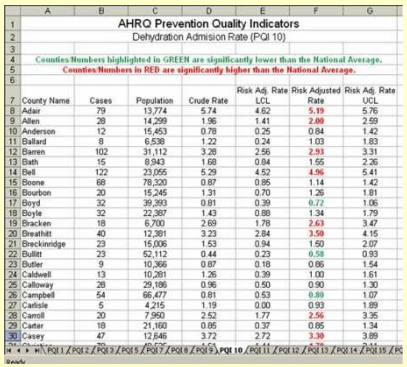
What might we want to do with that data?

Prediction

- what can we **predict** about this phenomenon?

Description

- how can we **describe/understand** this phenomenon in a new way?



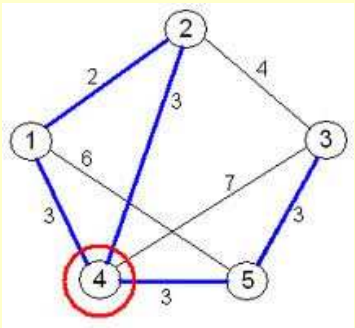
AHRQ Prevention Quality Indicators

Dehydration Admision Rate (PQI 10)

Counties Numbers highlighted in GREEN are significantly lower than the National Average.

Counties Numbers in RED are significantly higher than the National Average.

County Name	Cases	Population	Crude Rate	Risk Adj. Rate LCL	Risk Adjusted Rate	Risk Adj. Rate UCL
Adair	79	13,774	5.74	4.62	5.19	5.76
Allen	28	14,299	1.96	1.41	2.00	2.59
Anderson	12	15,453	0.78	0.25	0.84	1.42
Ballard	8	6,538	1.22	0.24	1.03	1.83
Barren	102	31,112	3.28	2.56	2.93	3.31
Bath	15	8,943	1.68	0.84	1.55	2.26
Bell	122	23,055	5.29	4.52	4.96	5.41
Boone	68	78,320	0.87	0.86	1.14	1.42
Bourbon	20	15,245	1.31	0.70	1.26	1.81
Boyd	32	39,393	0.81	0.39	0.72	1.06
Boyle	32	22,387	1.43	0.88	1.34	1.79
Bracken	18	8,700	2.69	1.78	2.63	3.47
Breathitt	40	12,381	3.23	2.84	3.50	4.15
Breckinridge	23	15,006	1.53	0.94	1.50	2.07
Bullitt	23	52,112	0.44	0.23	0.58	0.93
Butler	9	10,366	0.87	0.18	0.86	1.54
Caldwell	13	10,281	1.26	0.39	1.00	1.61
Calloway	28	29,186	0.96	0.50	0.90	1.30
Campbell	54	88,477	0.81	0.53	0.80	1.07
Carlisle	5	4,215	1.19	0.00	0.93	1.89
Carroll	20	7,950	2.52	1.77	2.56	3.35
Carter	18	21,160	0.85	0.37	0.85	1.34
Casey	47	12,646	3.72	2.72	3.30	3.89



Learning from Data

How can we extract knowledge from data to help humans take decisions?

How can we automate decisions from data?

How can we adapt systems dynamically to enable better user experiences?

Write code to explicitly
do the above tasks

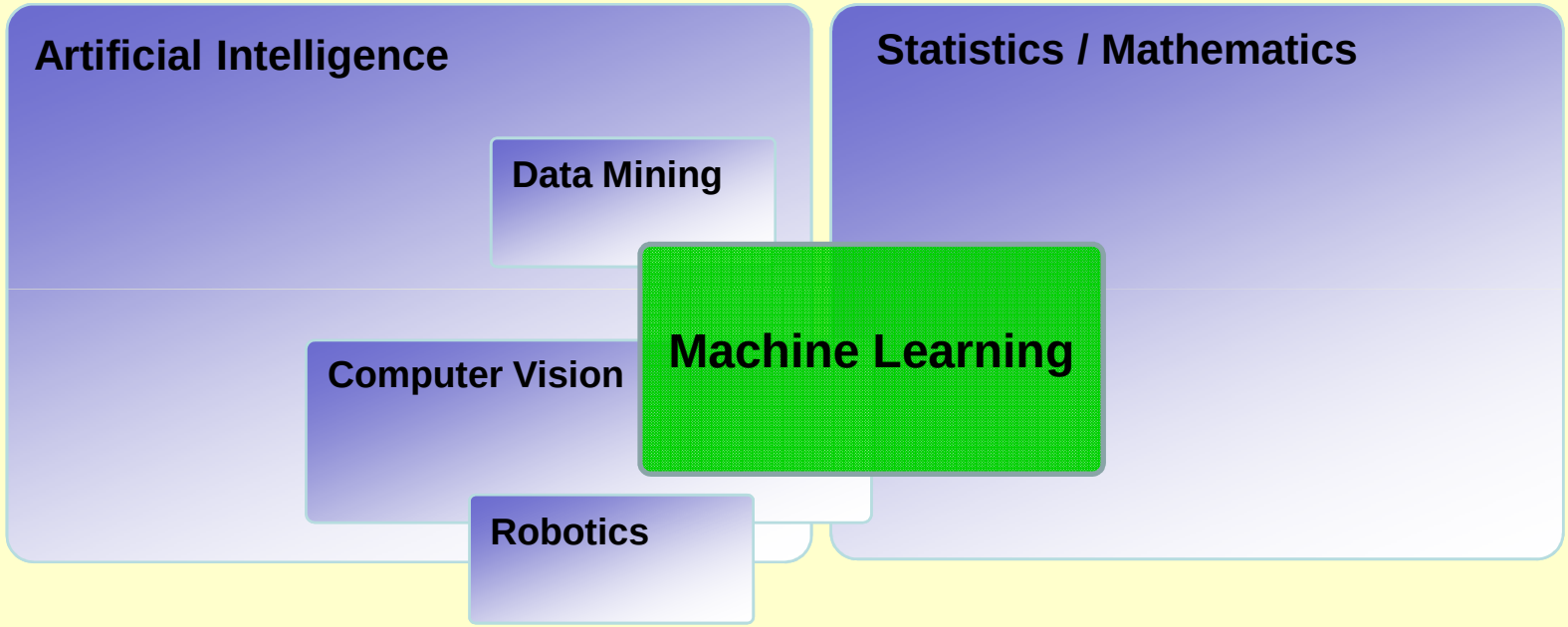
Write code to make the computer
learn how to do the tasks

Apa itu Machine Learning?

- Machine Learning adalah salah satu disiplin ilmu dari Computer Science yang mempelajari bagaimana membuat komputer/mesin itu mempunyai suatu kecerdasan
- Agar mempunyai suatu kecerdasan, komputer/mesin harus dapat belajar.
- Dengan kata lain, Machine Learning adalah suatu bidang keilmuan yang berisi tentang pembelajaran komputer/mesin untuk menjadi cerdas

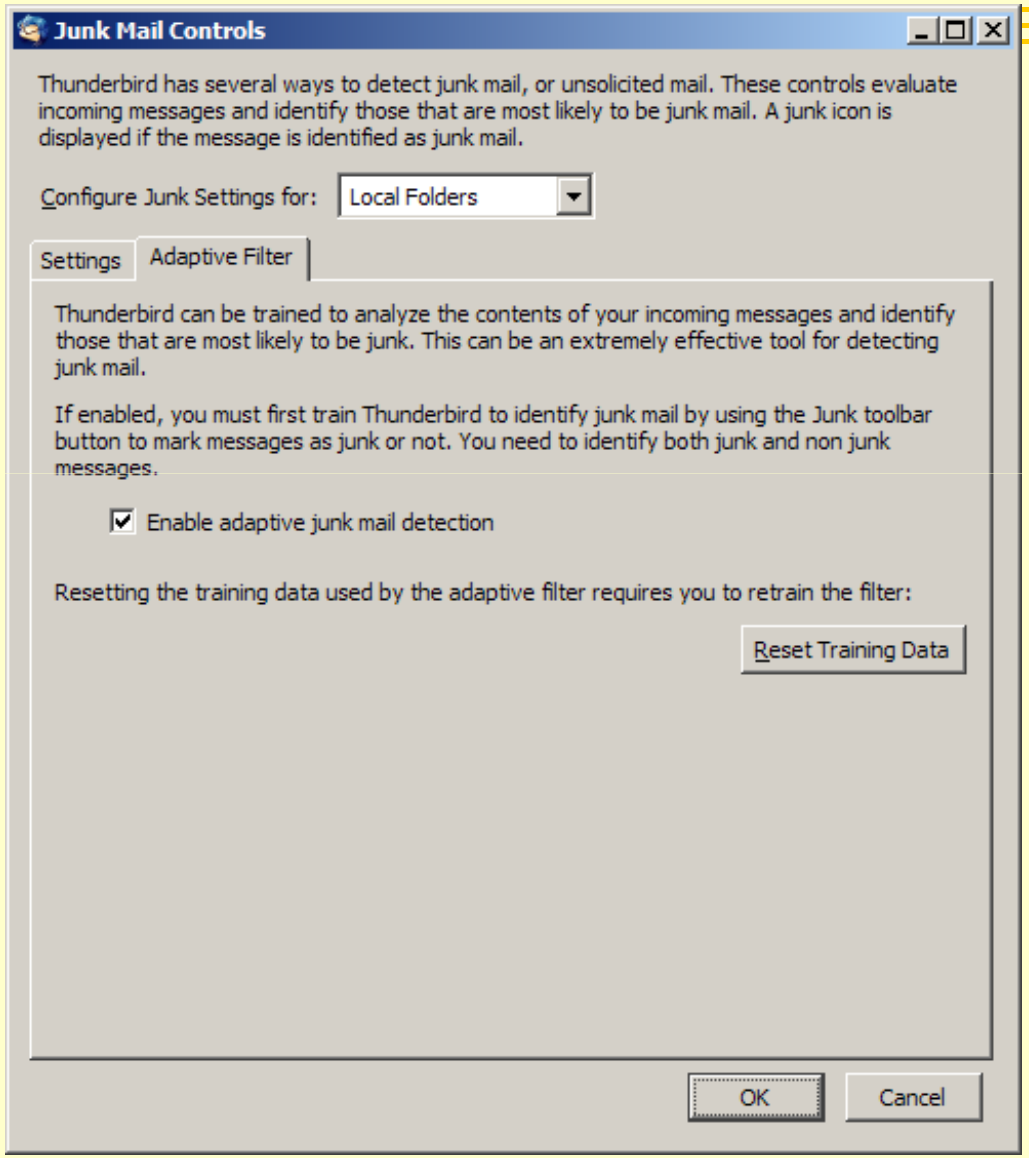
Machine Learning

*Where does it fit? What is it **not**?*



(No definition of a field is perfect – the diagram above is just one interpretation, mine ;-)

- Using machine learning to detect spam emails.



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ALGORITHM

Naïve Bayes

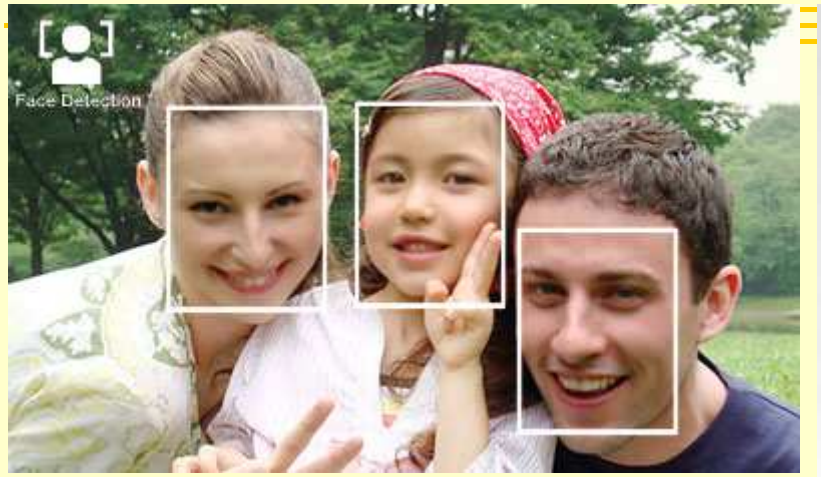
Rule mining

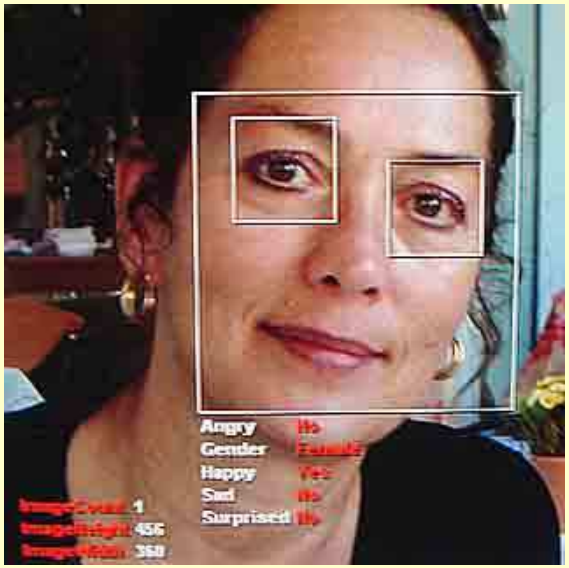
- Using machine learning to recommend books.

ALGORITHMS

Collaborative Filtering
Nearest Neighbour
Clustering

- Using machine learning to identify faces and expressions.



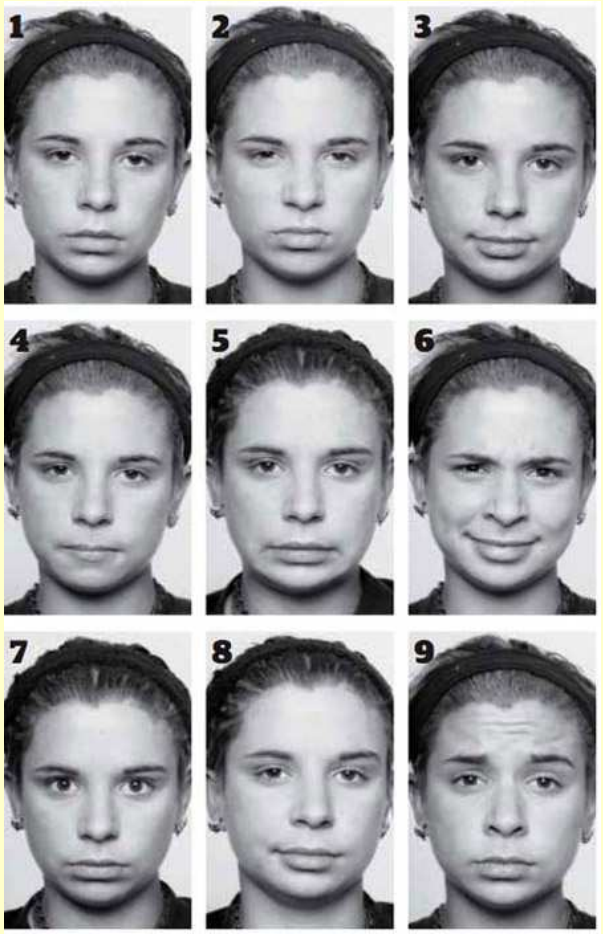


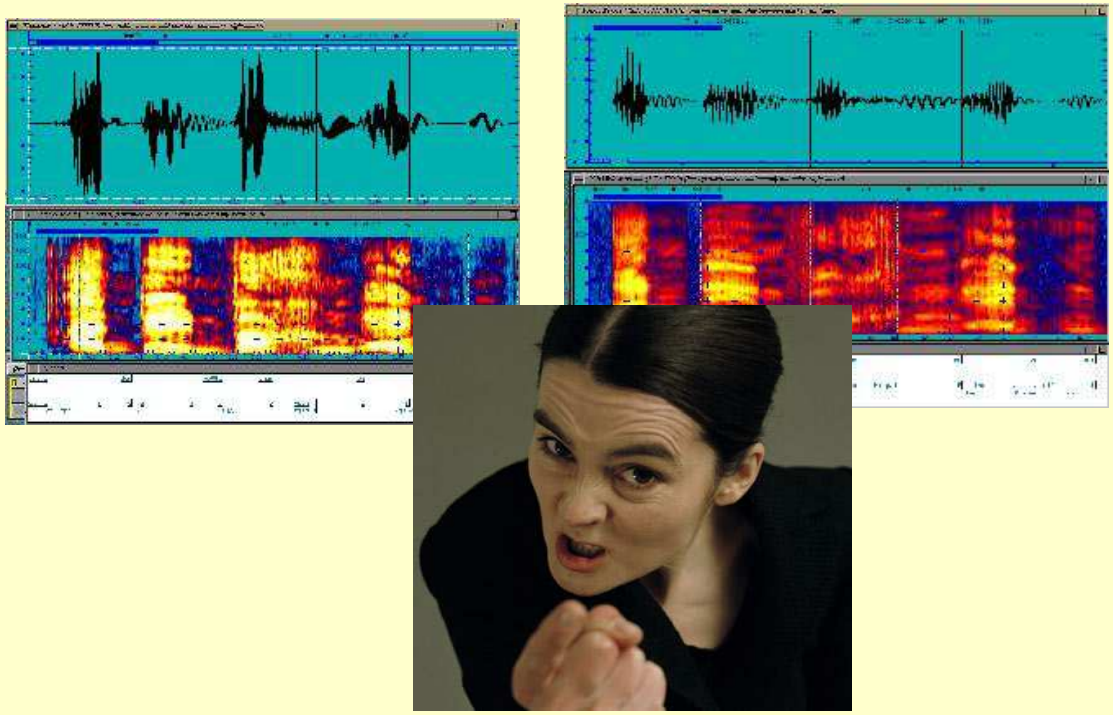
ALGORITHMS

Decision Trees

Adaboost

- Using machine learning to identify vocal patterns





ALGORITHMS

Feature Extraction
Probabilistic Classifiers
Support Vector Machines
+ many more….

- ML for working with social network data: detecting fraud, predicting click-thru patterns, targeted advertising, etc etc etc .

facebook

amazon.com

ebay

Lloyds TSB

ALGORITHMS

Support Vector Machines
Collaborative filtering
Rule mining algorithms
Many many more….

Driving a car

Recognising spam emails

Recommending books

Reading handwriting

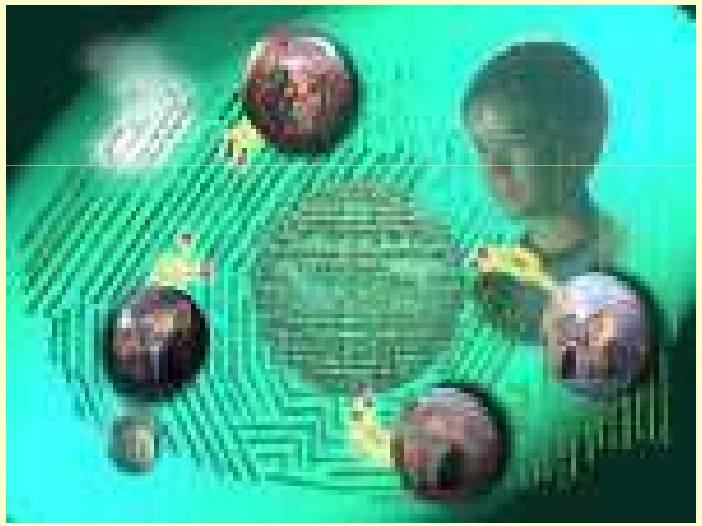
Recognising speech, faces, etc

How would you write these programs?

Would you want to?!?!?!?

Learning process

- Supervised learning
- Unsupervised learning
- Reinforcement learning



Pembahasan di dalam ML

- Concept learning
- Bayesian learning
- Instance based learning (clustering)
- Neural Networks
- Genetic Algorithm
- Reinforcement Learning
- Dan lain-lain

Concept learning

- Learning from examples
- General to specific ordering of hypotheses
- Uses only the positive data → Find-S
- Uses both positive and negative data → Candidate-Elimination
- Data harus konsisten
- Jawaban berada dalam 2 kemungkinan, ada atau tidak ada

Contoh kasus

Data	Sky	AirTemp	Humidity	Wind	Water	Forecast	EnjoySport
1	Sunny	Warm	Normal	Strong	Warm	Same	Yes
2	Sunny	Warm	High	Strong	Warm	Same	Yes
3	Rainy	Cold	High	Strong	Warm	Change	No
4	Sunny	Warm	High	Strong	Cool	Change	Yes

Bayesian Learning

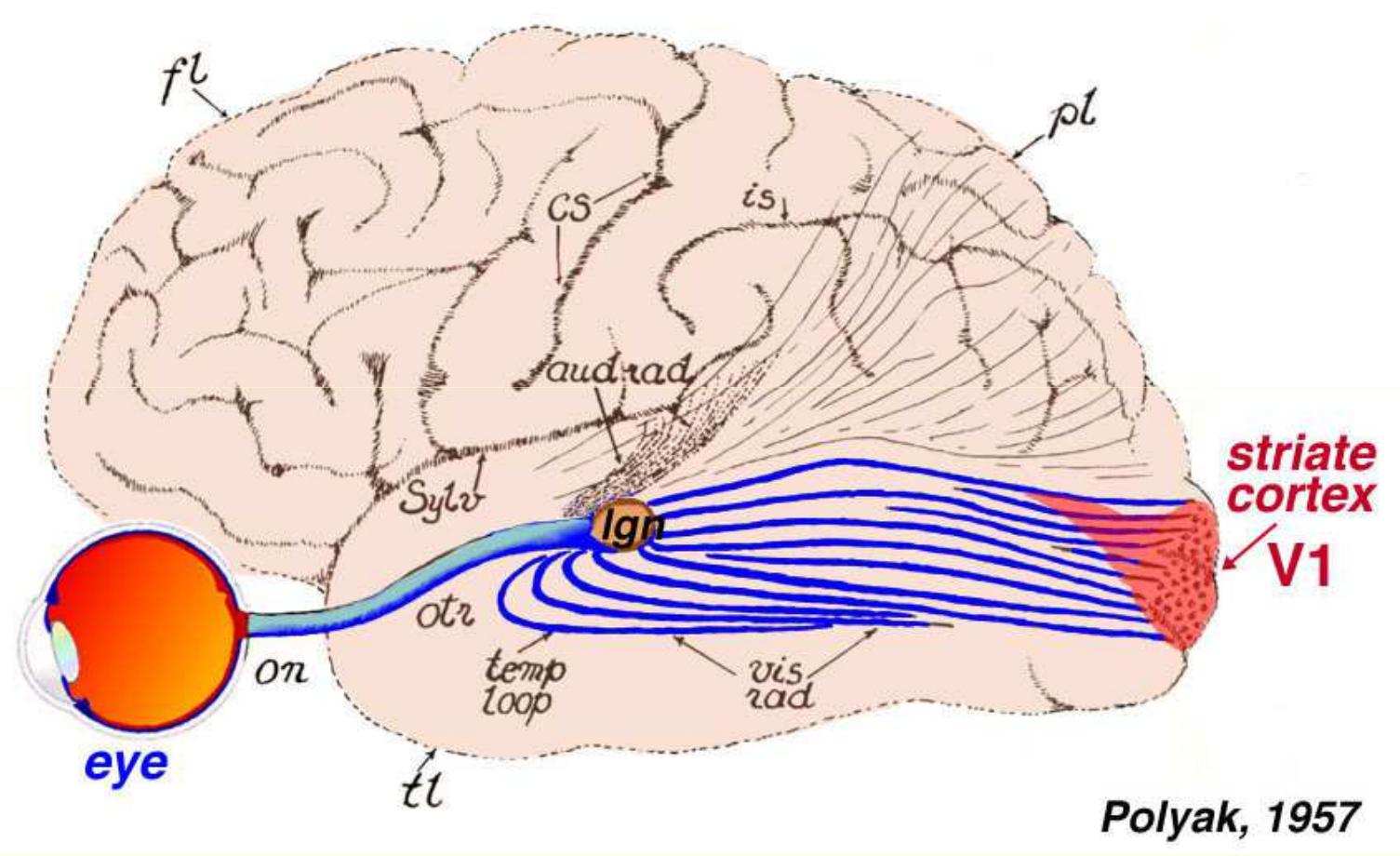
- Learning from examples
- Termasuk ke dalam supervised learning
- Didasari pada Bayes Theorem
- Uses both positive and negative data
- Tidak mengharuskan data harus konsisten
- Jawaban ditunjukkan oleh nilai probabilitas
- Biasanya dipakai untuk fungsi-fungsi klasifikasi

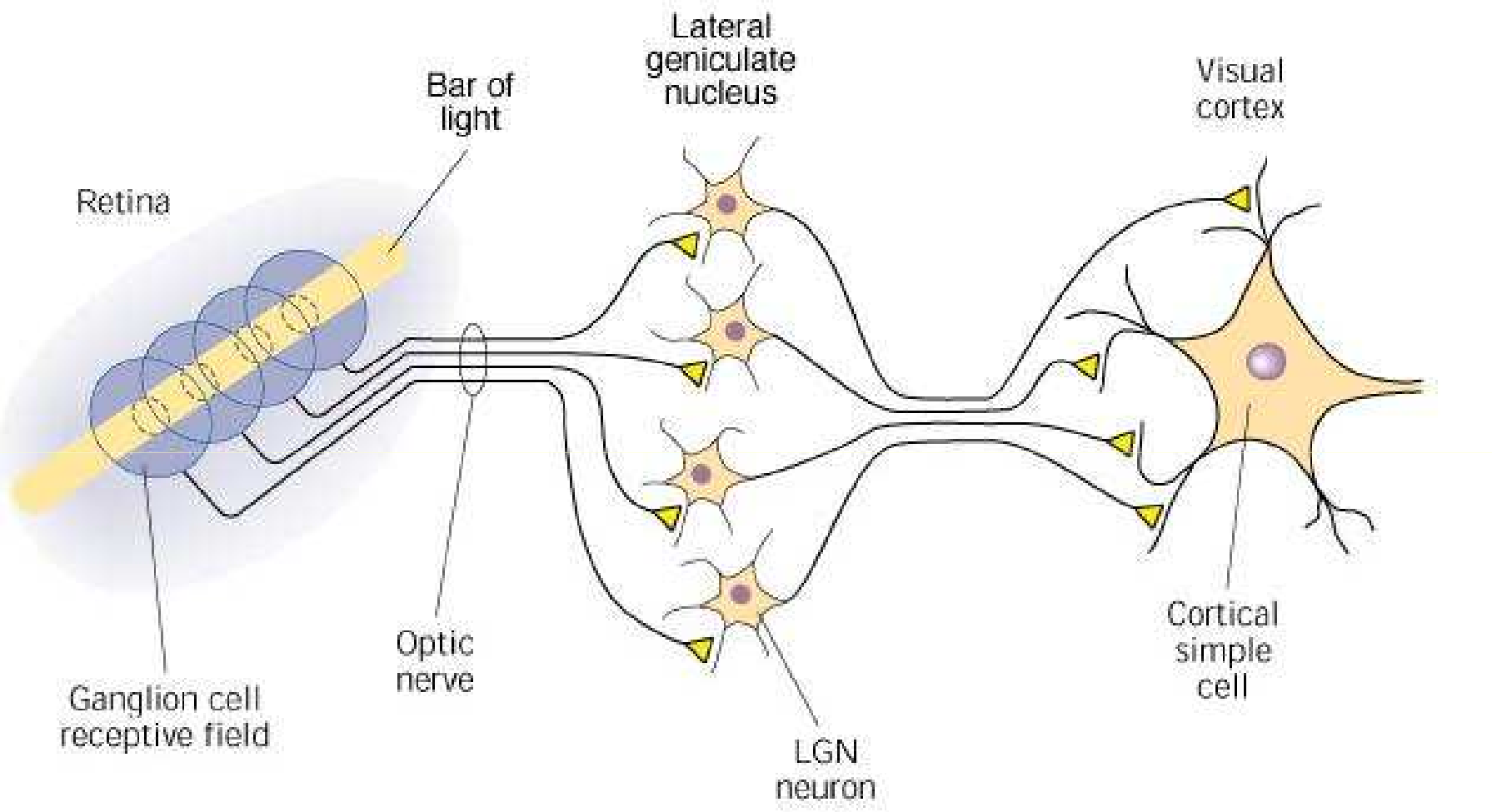
Instance based learning (Clustering)

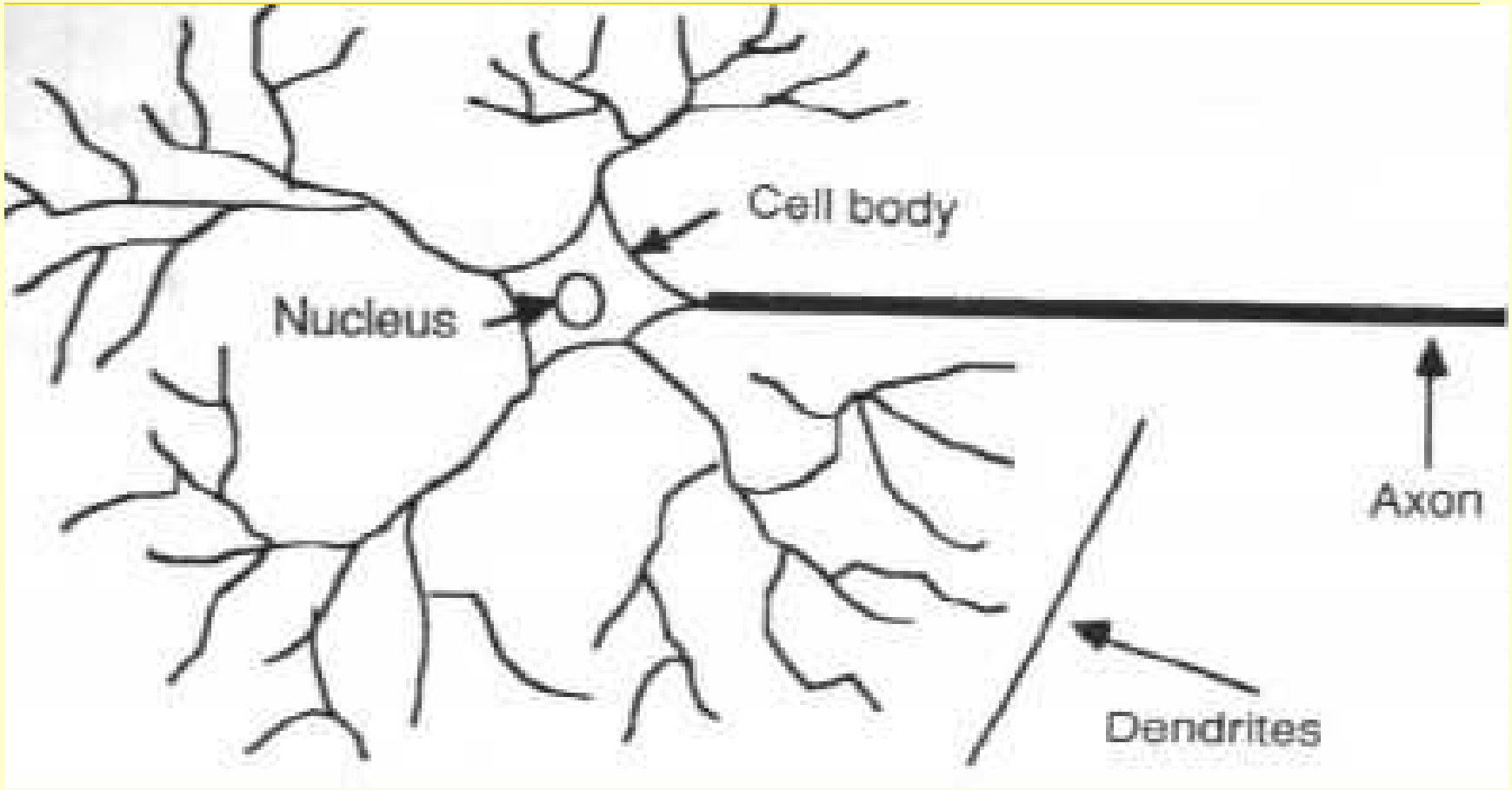
- Tidak melibatkan jawaban dalam data
- Termasuk ke dalam unsupervised learning
- Hanya membuat suatu klasifikasi tanpa label/jawaban
- Labelisasi (pemberian jawaban) menjadi tanggung jawab user

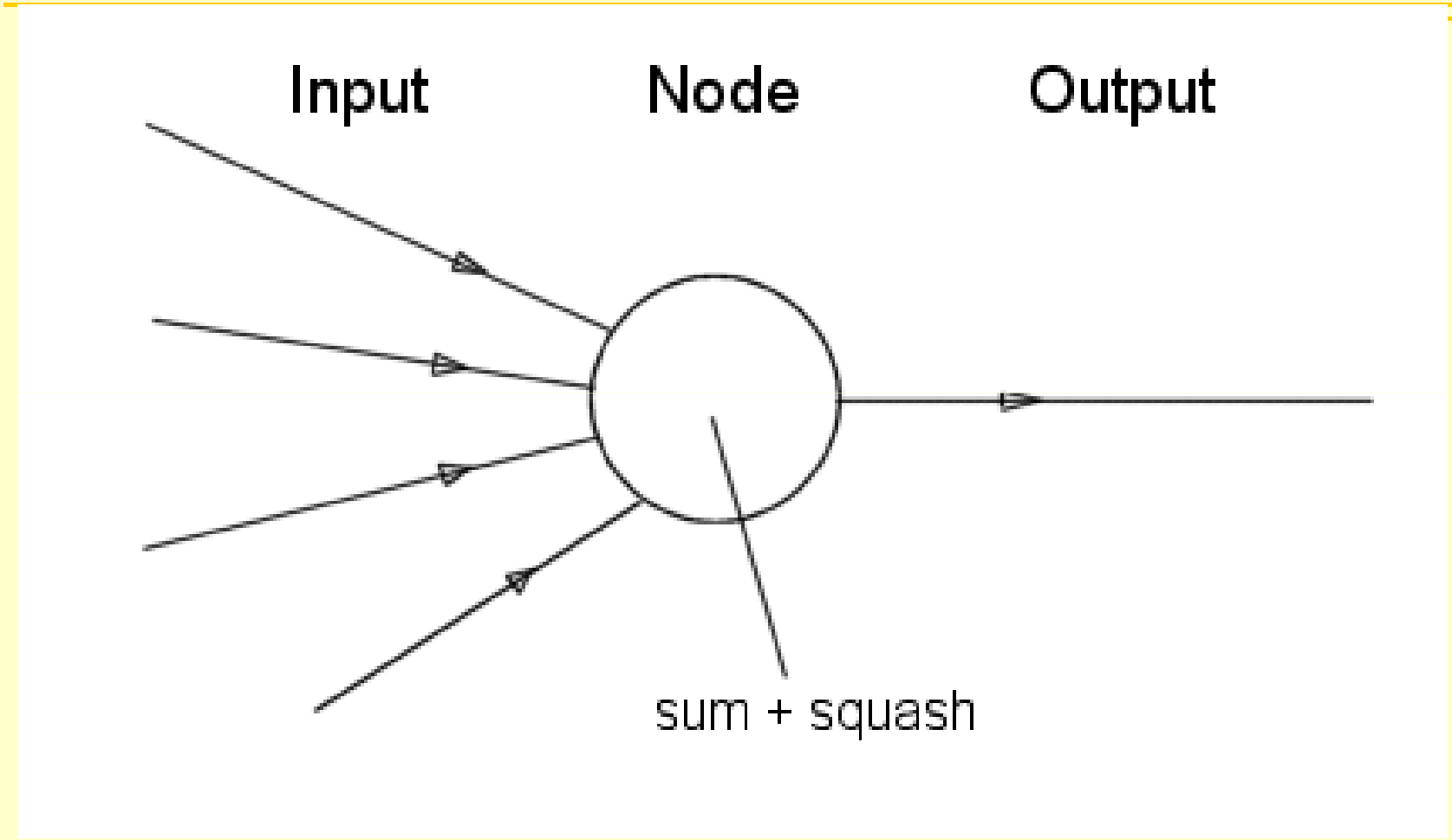
Neural networks

- Mensimulasikan kerja otak manusia
- *Neuron* adalah satuan unit pemroses terkecil pada otak
- Bentuk standard ini mungkin dikemudian hari akan berubah
- Jaringan otak manusia tersusun tidak kurang dari 10^{13} buah neuron yang masing-masing terhubung oleh sekitar 10^{15} buah *dendrite*
- Fungsi dendrite adalah sebagai penyampai sinyal dari neuron tersebut ke neuron yang terhubung dengannya
- Sebagai keluaran, setiap neuron memiliki *axon,* sedangkan bagian penerima sinyal disebut *synapse*
- Penjelasan lebih rinci tentang hal ini dapat diperoleh pada disiplin ilmu *biology molecular*
- Secara umum jaringan saraf terbentuk dari jutaan (bahkan lebih) struktur dasar neuron yang terinterkoneksi dan terintegrasi antara satu dengan yang lain sehingga dapat melaksanakan aktifitas secara teratur dan terus menerus sesuai dengan kebutuhan

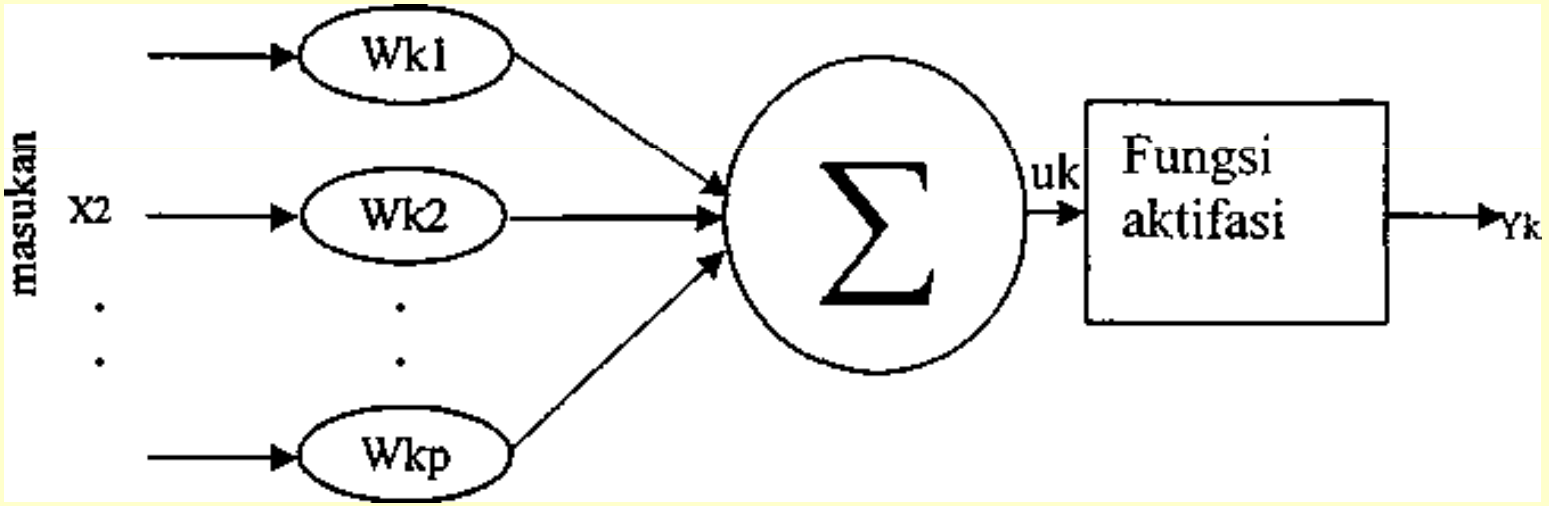

fl
pl
cs
is
aud rad
Sylv
lgn
striate
cortex
V1
otr
on
temp
loop
vis
rad
eye
tl
Polyak, 1957


Lateral
geniculate
nucleus
Bar of
light
Visual
cortex
Retina
Optic
nerve
Ganglion cell
receptive field
LGN
neuron
Cortical
simple
cell


Cell body
Nucleus
Axon
Dendrites


Input
Node
Output
sum + squash

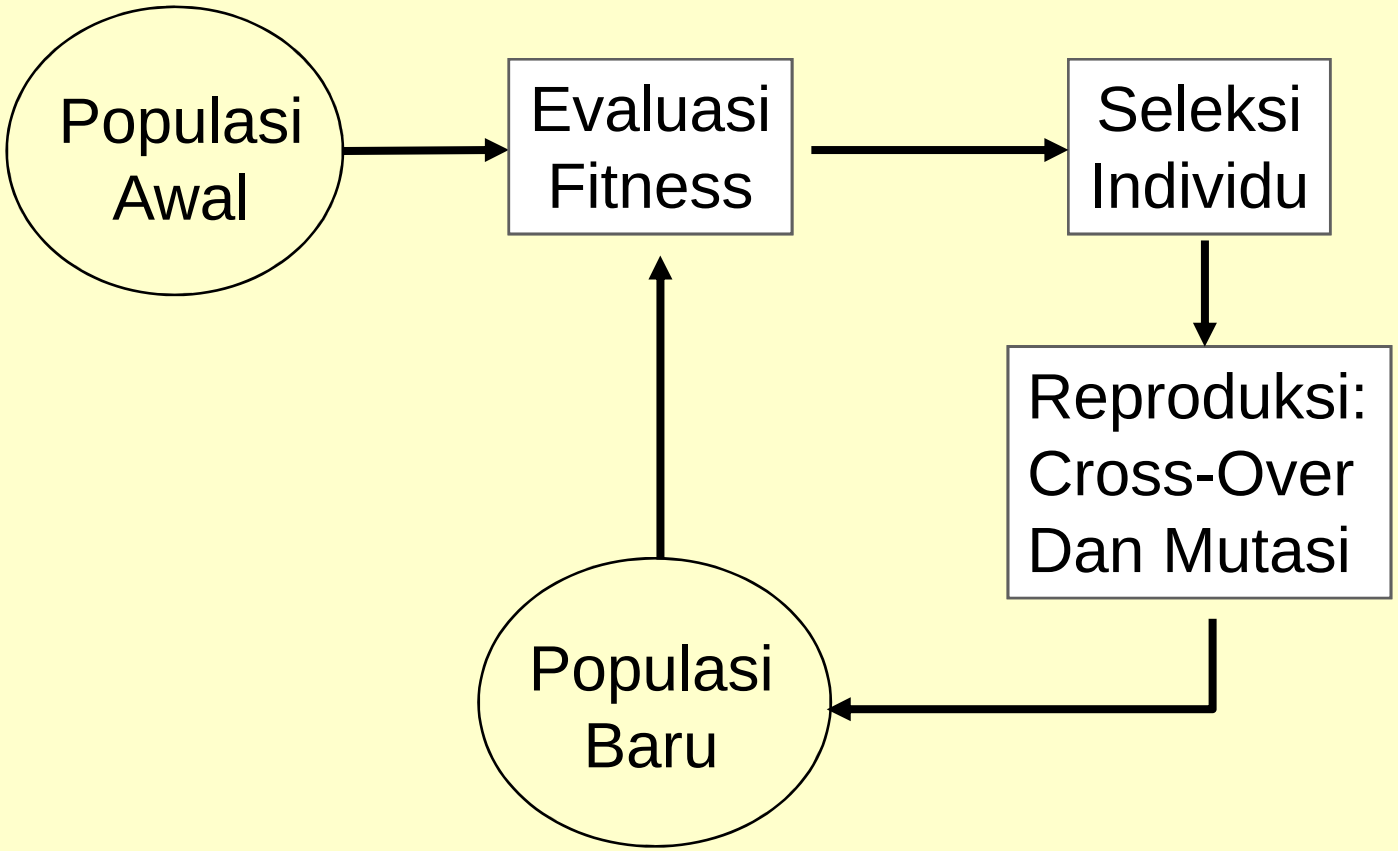
Penimbang **penjumlahan** **Keluaran**



Genetic Algorithm

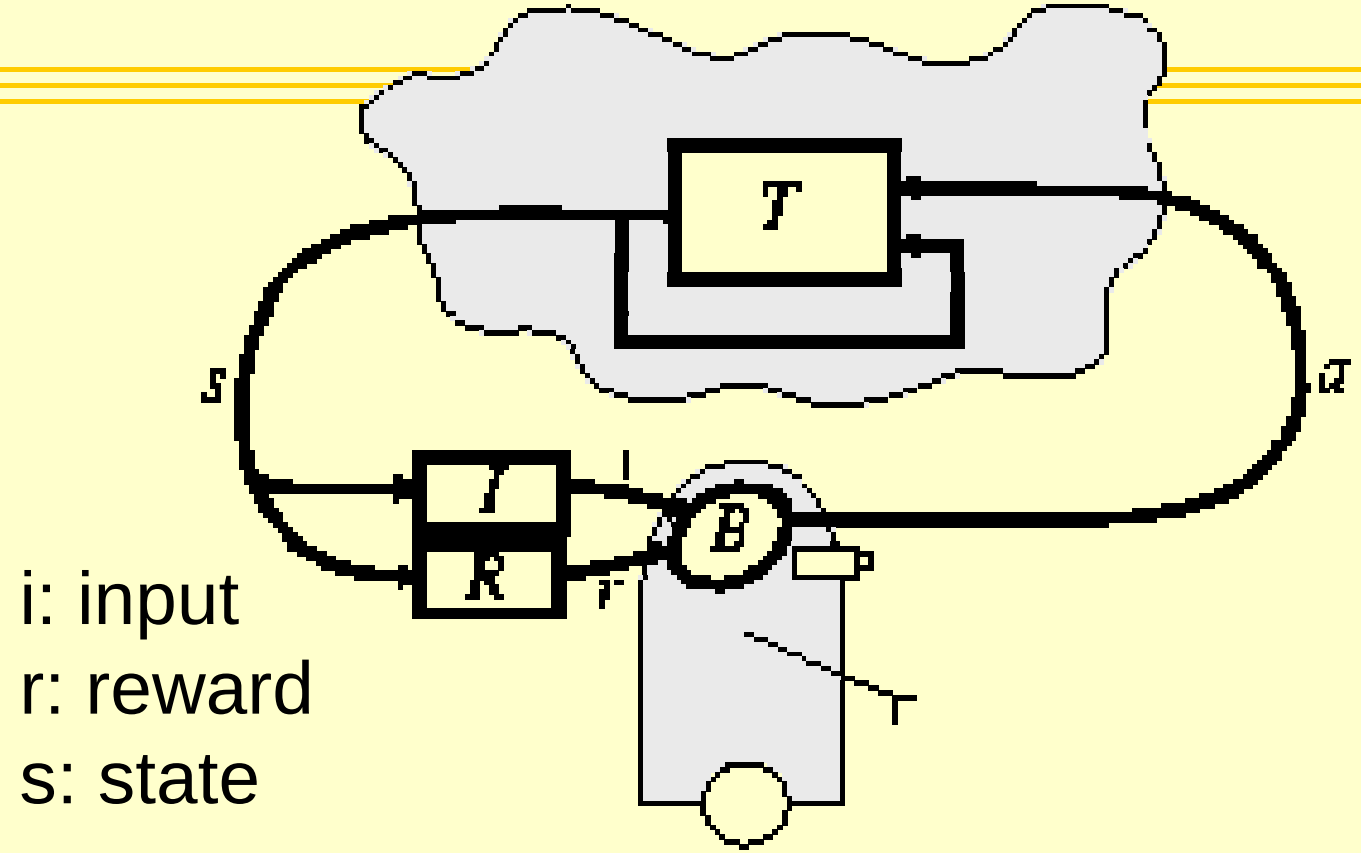
- **Algoritma Genetika adalah algoritma yang memanfaatkan proses seleksi alamiah yang dikenal dengan proses evolusi.**
- **Dalam proses evolusi, individu secara terus-menerus mengalami perubahan gen untuk menyesuaikan dengan lingkungan hidupnya. "Hanya individu-individu yang kuat yang mampu bertahan".**
- **Proses seleksi alamiah ini melibatkan perubahan gen yang terjadi pada individu melalui proses perkembang-biakan. Dalam algoritma genetika ini, proses perkembang-biakan ini menjadi proses dasar yang menjadi perhatian utama, dengan dasar berpikir: "Bagaimana mendapatkan keturunan yang lebih baik".**

Siklus Genetic Algorithm



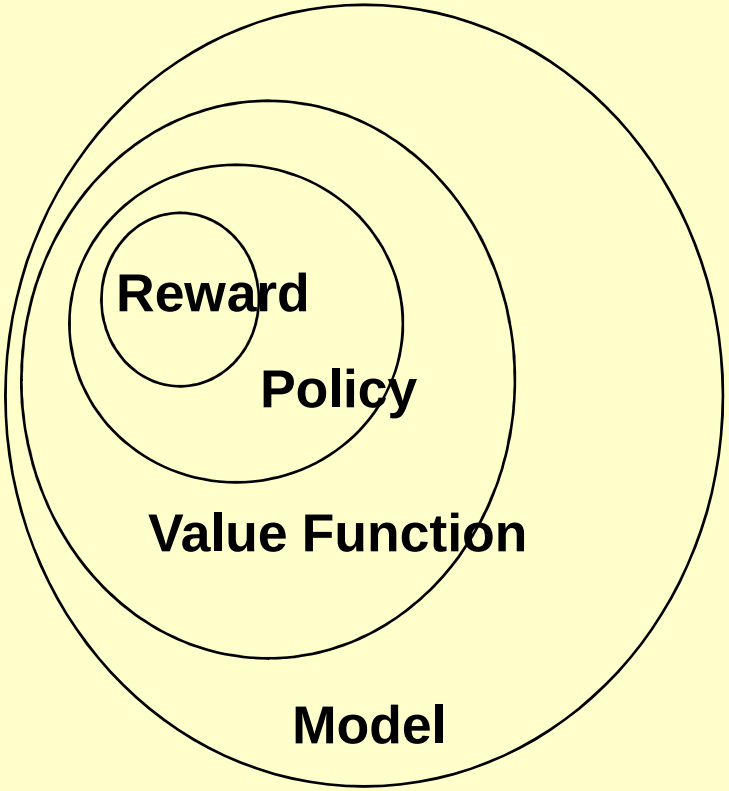
Reinforcement Learning

- Learning from experiences
- Memakai konsep reward dan punishment dalam proses learning



The standard reinforcement-learning model

Components of Reinforcement Learning



Reward: How good is this action?

Policy: what do I do now?

Value function: how good is this state?

Model: what happens if I do this action?

Referensi

1. ***Introduction to Machine Learning*** http://www.cs.manchester.ac.uk/ugt/COMP24111
2. ***Machine Learning***, Tom Mitchell, McGraw-Hill. 2008.