DM825 (5 ECTS - 4th Quarter) Introduction to Machine Learning

Introduktion til maskinlœring

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Machine Learning

A computer program is said to **learn** from experience E with respect to some class of tasks T and performance measure P,
if its performance at tasks in T, as measured by P, improves with experience E.

Tom M. Mitchell (1997) Machine Learning p.2

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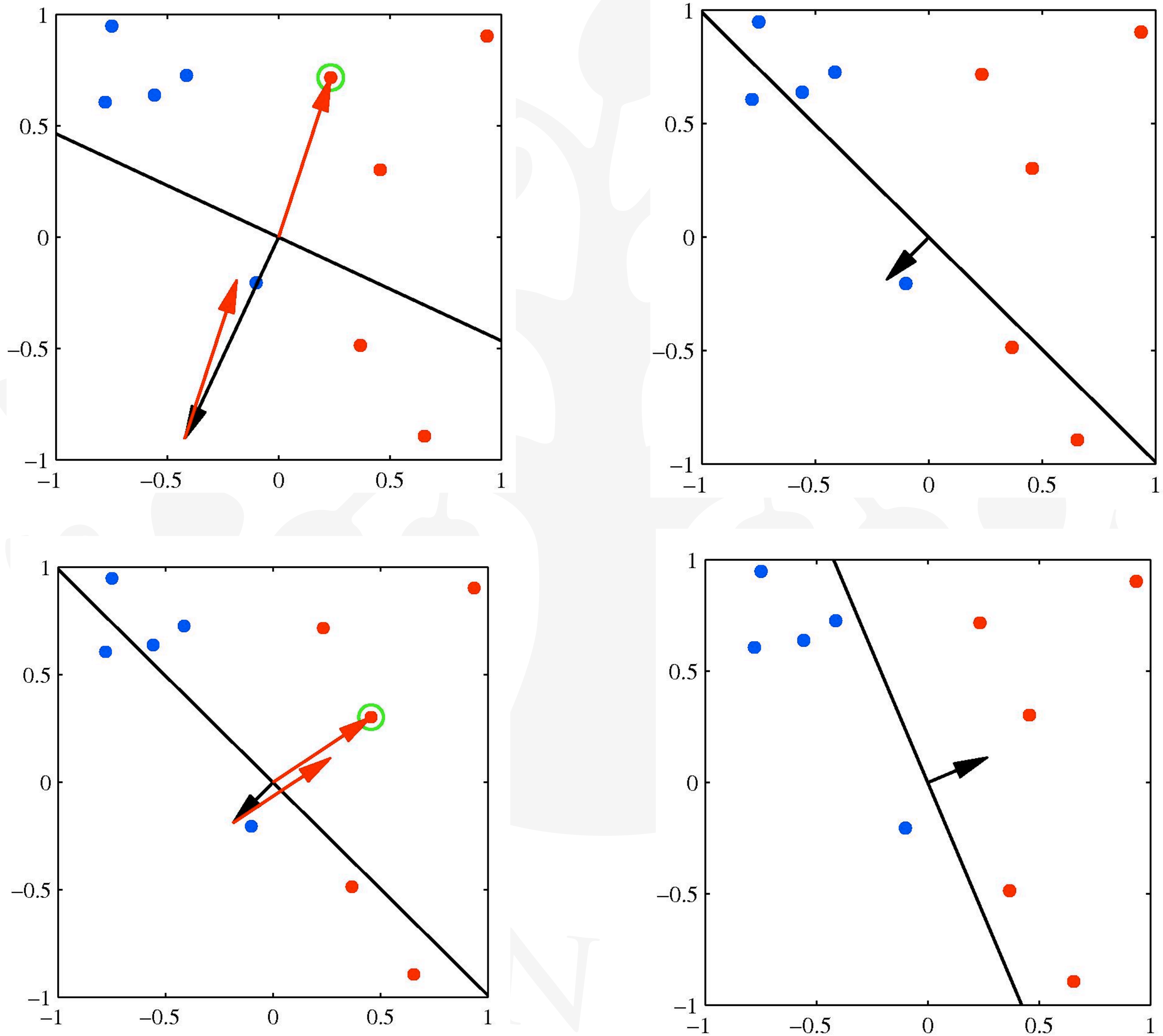
Core objective of a learner: generalize from its experience.

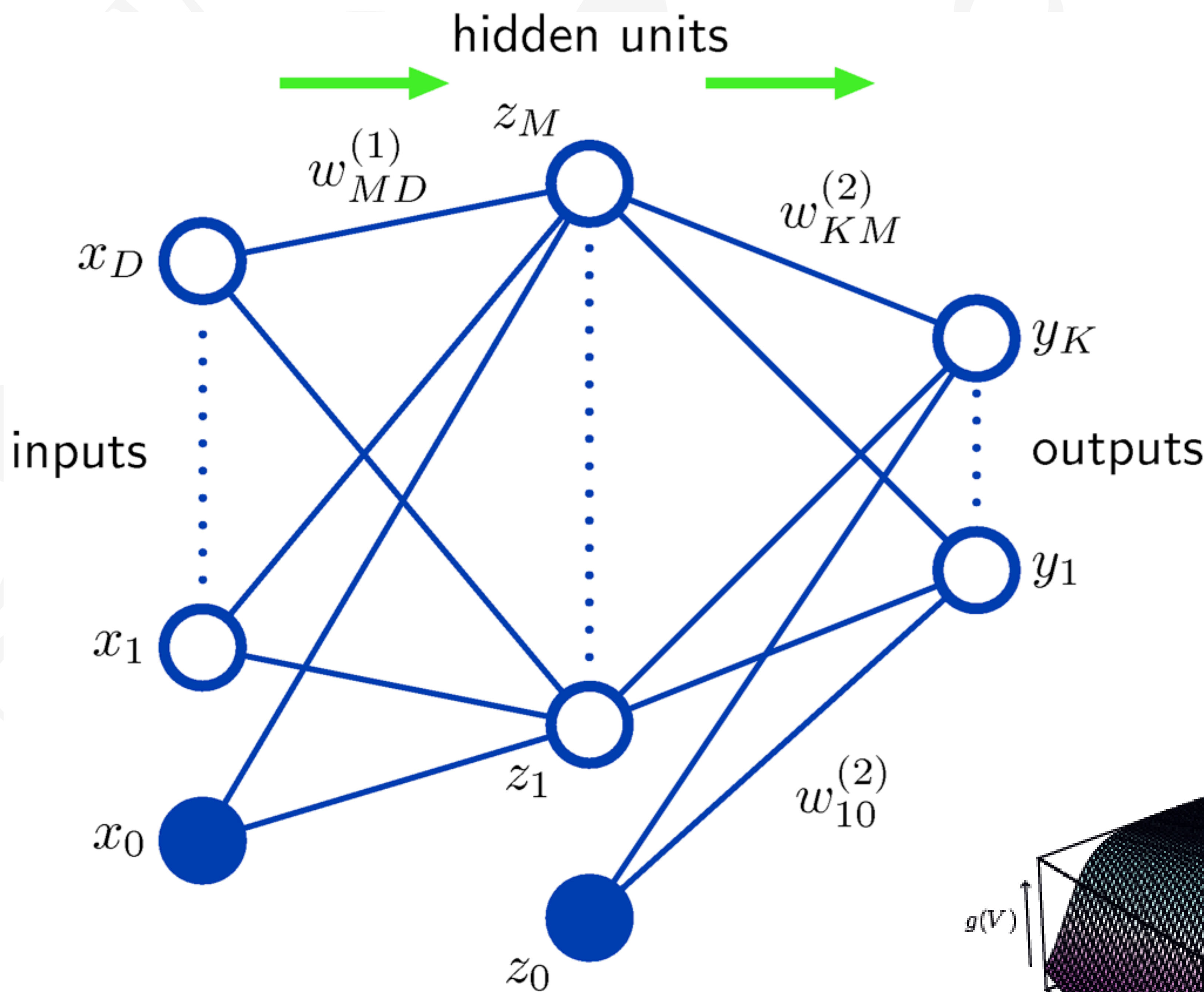
Training examples from experience come from unknown probability distribution. The learner has to extract something to produce a useful answer in new cases.

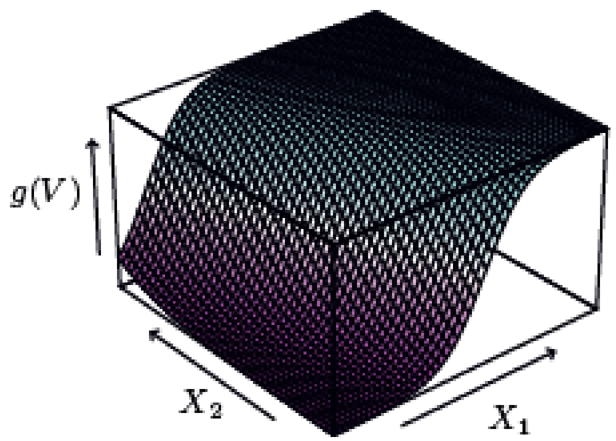
Contents

Perceptron algorithm

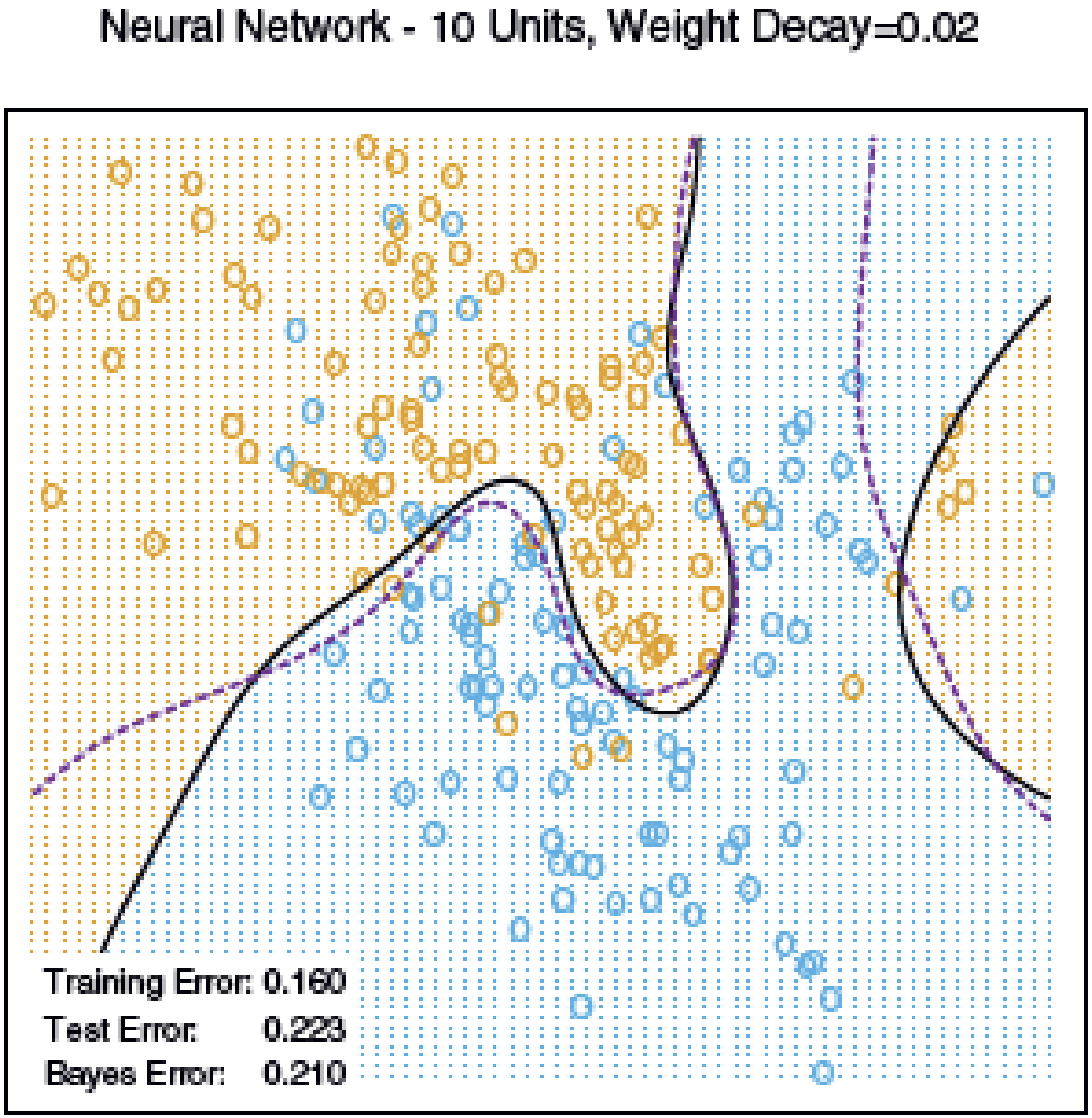


Multilayered Neural Networks



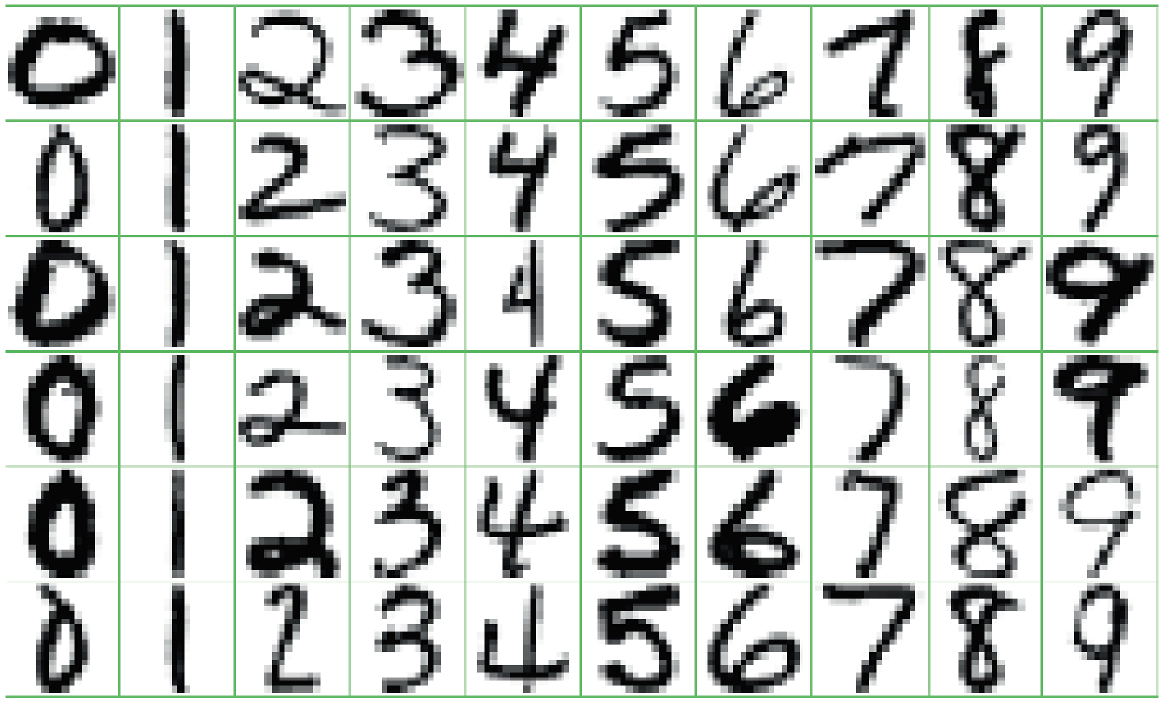


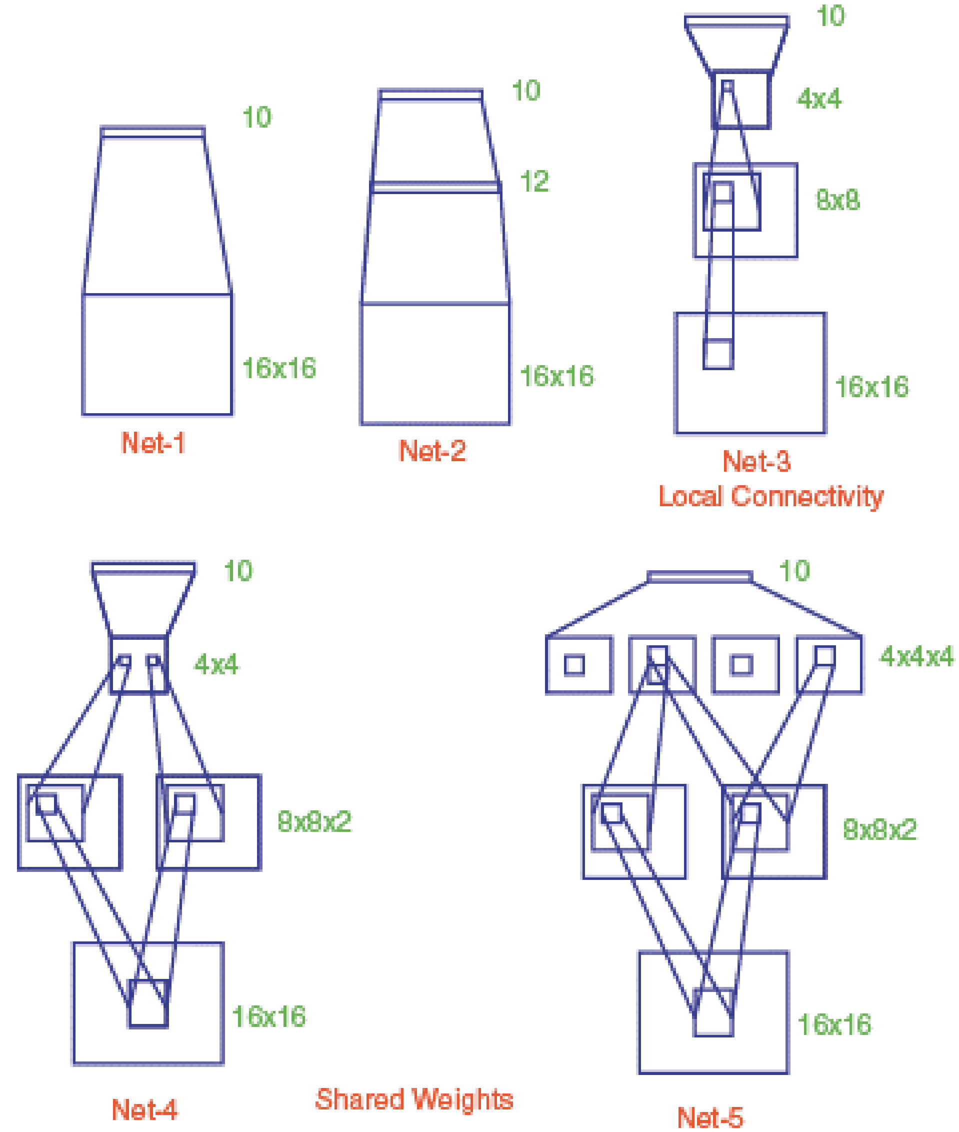
Applications



Applications

Handwritten digit recognition





Humans are at 0.2% – 2.5 % error
400–300–10 unit MLP = 1.6% error
LeNet: 768–192–30–10 unit MLP = 0.9% error

Graphical Models

Allow to represent our prior knoweldge
and to use a general suite of algorithms to make inference and to improve our models for a specific application domain

Complex systems involve uncertainty => Probability framework

interralated aspects of the system are modelled as random variables

Example: Medical diagnosis

- two deases: Fly and Hayfever
- they are not mutually exclusive
- Season might be correlated with them
- symptoms such as Congestion and Muscle Pain

4 random variables:
Flu = {true,false}; Hayfever = {true, false}
Season = {fall, winter, spring, summer}
Congestion = {true, false}
MusclePain = {true, false}

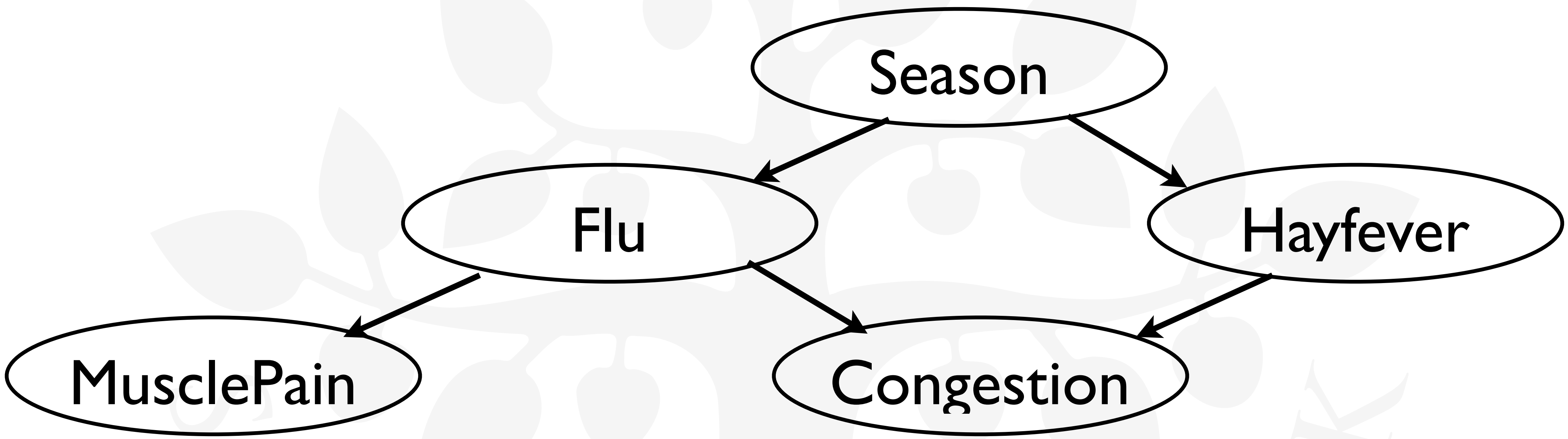
2x2x4x2x2=64
possible prob. values
for joint distribution

P(Flu=true | Season=fall, Congestion=true, MusclePain=false)

If the number of variables grows the problem becomes intractable

Example: continued

Graphical models use graph-based representation to encode independencies



F and H independent given Season
C and S independent given F and H
M and H,C independent given F
M and C independent gien F

We thus only need to define
3+ 4 +4 +4 +2 =17 parameteers

$$P(S,F,H,C,M)=P(S)P(F|S)P(H|S)P(C|F,H)P(M|F)$$

Bayesian Learning

What can we do from here?

- Inference: Complexity issues O(2^n)
- Learning (parameters and structure)

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Flip the thumbtack in the air and observe the number of times it lands with head and tail

We wish to learn how much the probability deviates from 0.5

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Suppose we observe 3 heads in 10 tosses.

- With no prior knowledge we would set p=3/10=0.33
- With a prior of 10 heads over 20 tosses we would set p=(3+10)/(10+20)=13/30=0.43
- However if we obtain more data the effect diminshes: (300+1)/1000+2=0.3 and (300+10)/(1000+20)=0.3

Course Organization

Prerequisites

- ✓ MM501 Calculus I
- ✓ MM505 Linear Algebra
- ✓ Basics of Probability Calculus

Final Assessment (5 ECTS)

- Mandatory assignments, pass/fail, internal evaluation by the teacher. Include programming work in R
- 3 hours written exam, Danish 7 mark scale
- External examiner

Course Material

- Text book
  - C.M. Bishop. Pattern recognition and Machine Learning Springer, 2006
  - Slides
- Source code and data sets
- www.imada.sdu.dk/~marco/DM825