

Introduction to Machine Learning

Image recognition in Python and Tensorflow

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Introduction



Esten H. Leonardsen
(UiO and Biometrical AS)

Interests:

- Talking about esoteric theory
- Making deep learning tutorials



Martin Hovin
(Biometrical AS)

Interests:

- Installing tensorflow
- Debugging Estens code

Introduction

Theory session:

- What is a statistical learning model?
- What is a loss function?
- How do we train a statistical learning model?
- How does a (deep) neural network work?
- What operations does a convolutional neural network use?
- What is transfer learning?
- What is overfitting?
- How do we combat it?

Practical session:

1. Set up a Python-environment containing Tensorflow
2. Use a pretrained convolutional neural network to predict
3. Fit a flower classifier using transfer learning
4. Improve the flower classifier

Introduction

Introduction

Introduction

Introduction

Introduction



Statistical learning models

Muligheten markeds

Venskaper Ny annonse Meldinger Min profil

Søgesstatus
 Til salgs (910)
 Søgt siden 3 dager (9)
 Kommer for salg (1)

Nyhetsbrett
 Ønsket bolig (22)
 Nyheng (33)

Prisprøving
Pris
Pris per kvadratmeter
Søk

Tidspunkt
Tid
Tid per kvadratmeter
Søk

Feltprøving per måned
Måned
Måned per kvadratmeter
Søk

Størrelse
Sjette
Sjette per kvadratmeter
Søk

Antall soverom
1+ 2+ 3+ 4+ 5+

Happar
Happar
Happar per kvadratmeter
Søk

Boligtype
 Leilighet (5144)
 Garage/Parkeringsplass (11)
 Rekkehus (2)
 Ertsgård (1)
 Tverrstrøms (1)
 Flate/Flatehus (1)
 Andre (2)

Vis alle

Interne
 Akjøp (5)
 Andre (104)
 Eier/Leilighetsdrevet (22)

Leren - Titallende 3-roms med god planløsning og flott beliggenhet - Solrik...
73 m² • 6 400 000 kr
Til salgs i 072 201 m² • 4 316 kr./m² (Pris/kvadratmeter) • Lengde: 2
Vomring - 22 januar kl 13:00
Lærveien 41 G, Oslo



SP Schalit & Partner Grunnen
Roderslekk / Grunerløkka - Lys, luftig 3-roms hjemmet med innre gård ...
67 m² • 5 500 000 kr
Til salgs i 048 127 m² • 64 530 kr./m² (Pris/kvadratmeter) • Lengde: 2
Vomring - 22 januar kl 15:30
Rødtvet gate 6, Oslo



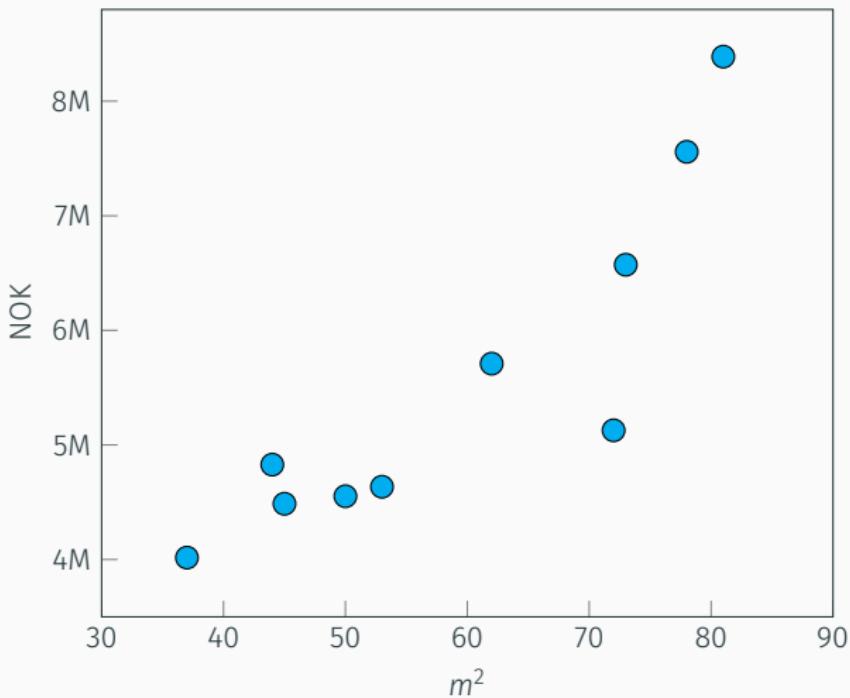
Hansens Bolig
Grunnerløkka - Lys 2-roms med stor potensial! Nordvest balkong - Heis -...
44 m² • 4 100 000 kr
Til salgs i 023 762 m² • 934 540 kr./m² (Pris/kvadratmeter) • Lengde: 1
Vomring - 22 januar kl 15:30
Rødtvet gate 6, Oslo



Statistical learning models

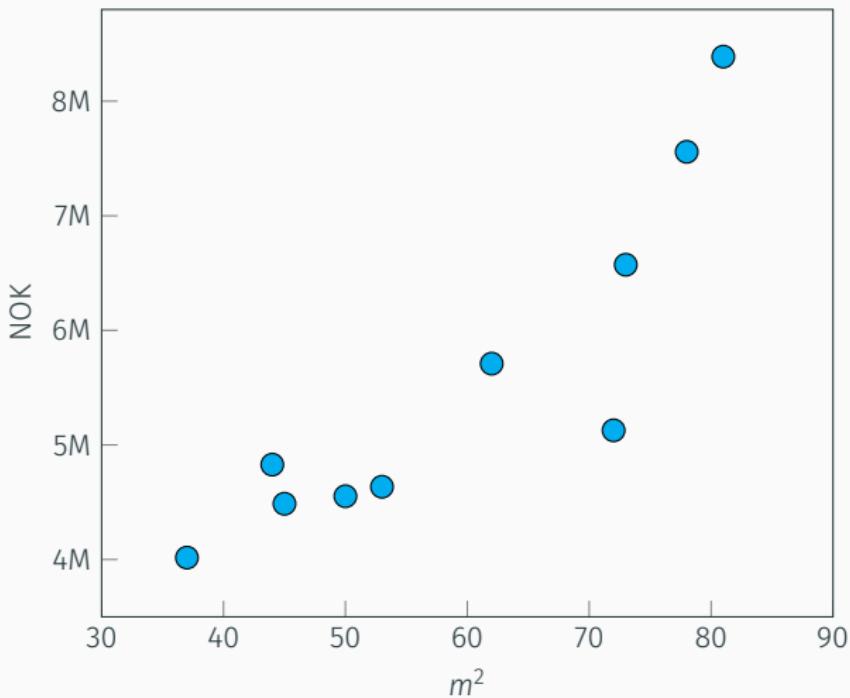
m^2	Price
72	5.127.379
50	4.552.170
45	4.486.654
62	5.709.276
53	4.634.912
81	8.388.570
44	4.828.170
78	7.557.770
37	4.016.520
73	6.572.351

Statistical learning models



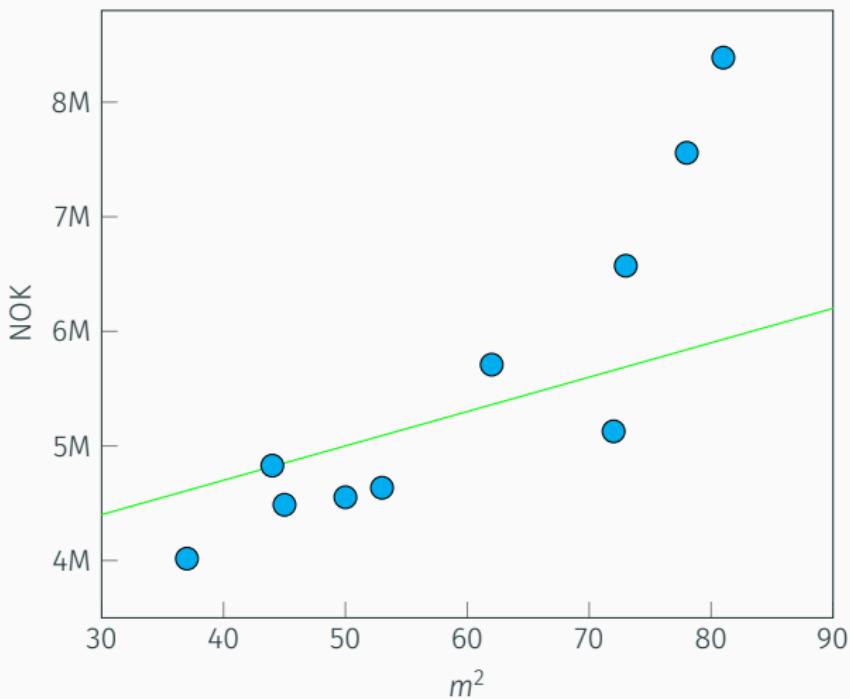
$$\hat{y} = f(x)$$

Statistical learning models



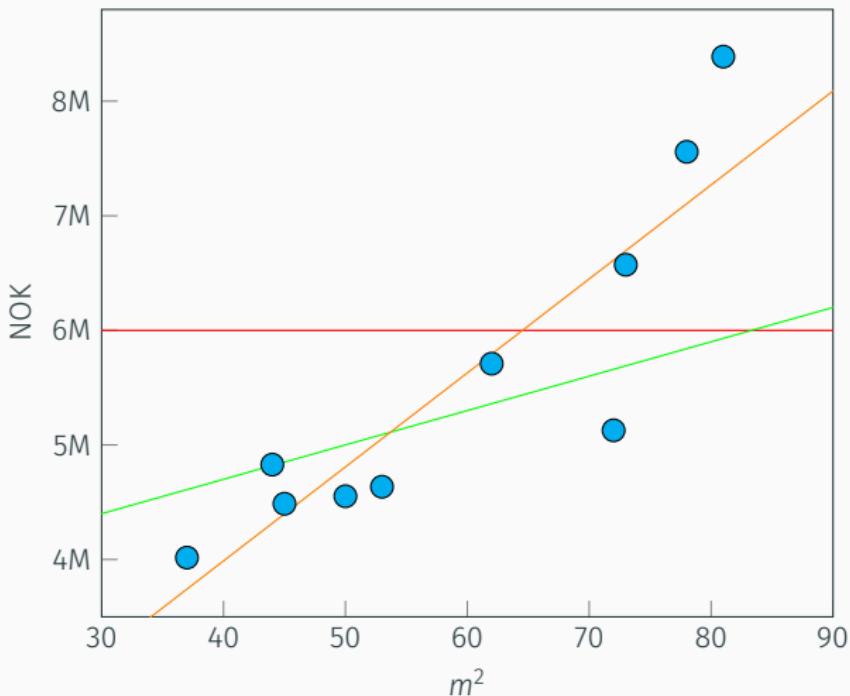
$$\hat{y} = Wx + b$$

Statistical learning models



$$\hat{y} = 30000x + 3500000$$

Statistical learning models

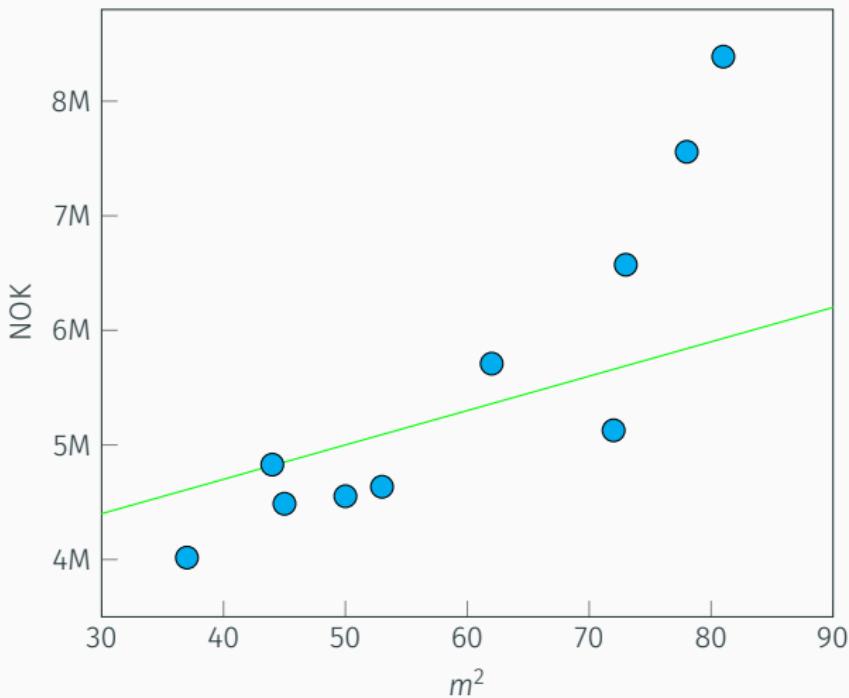


$$\hat{y} = 0x + 6000000$$

$$\hat{y} = 30000x + 3500000$$

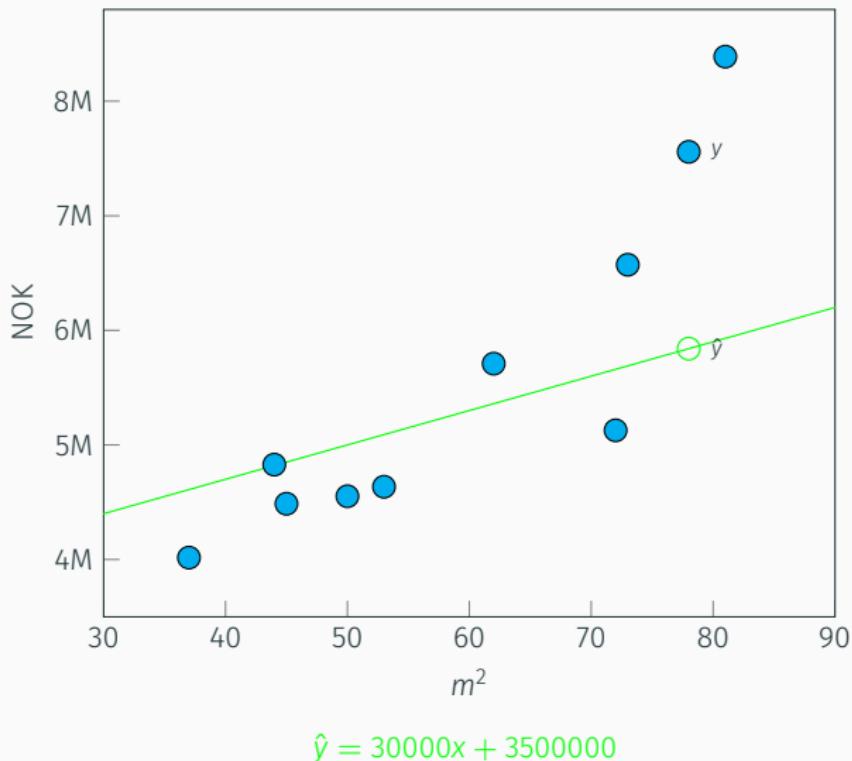
$$\hat{y} = 82031x + 706495$$

Loss functions

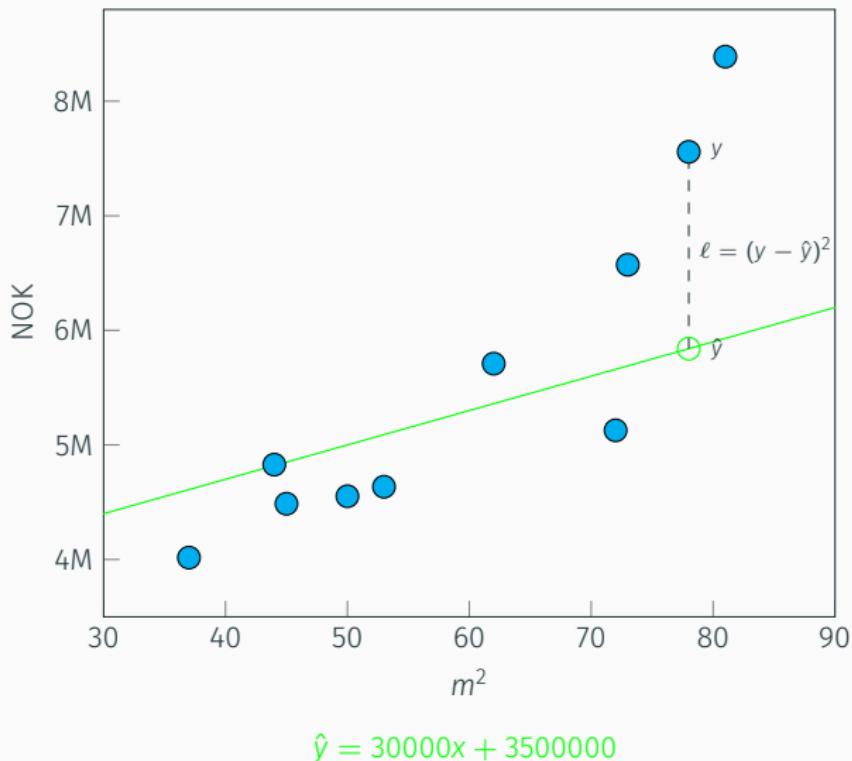


$$\hat{y} = 30000x + 3500000$$

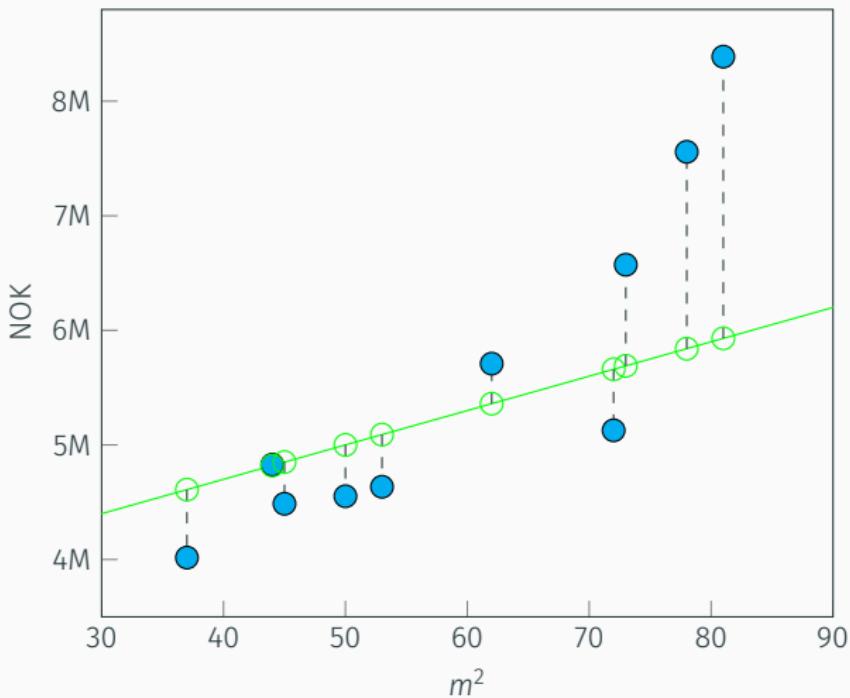
Loss functions



Loss functions



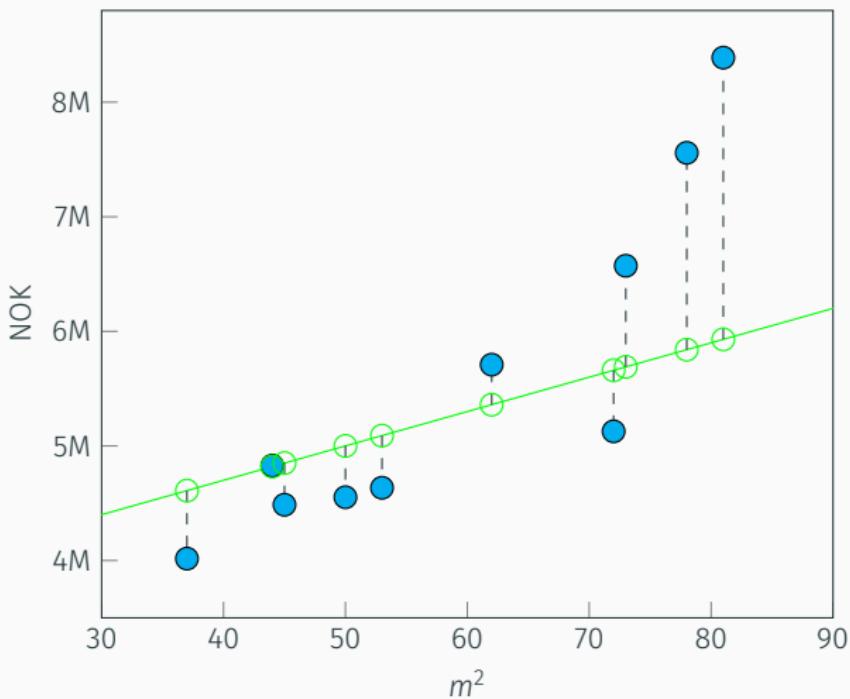
Loss functions



$$\hat{y} = 30000x + 3500000$$

$$\ell = \sum(y - \hat{y})^2$$

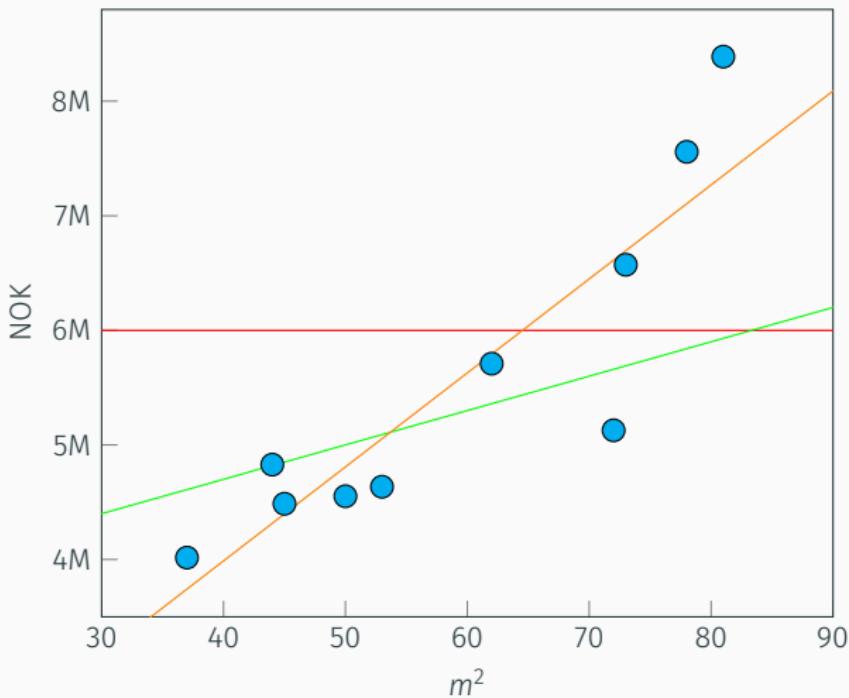
Loss functions



$$\hat{y} = 30000x + 3500000$$

$$\ell = 1.10 \times 10^{13}$$

Loss functions

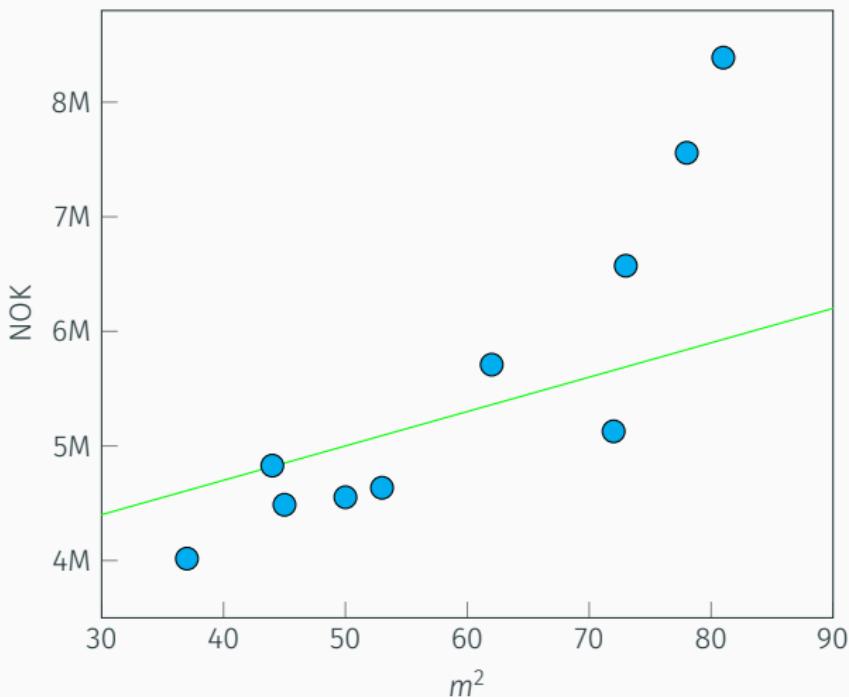


$$\hat{y} = 0x + 6000000$$
$$\ell = 2.08 \times 10^{13}$$

$$\hat{y} = 30000x + 3500000$$
$$\ell = 1.10 \times 10^{13}$$

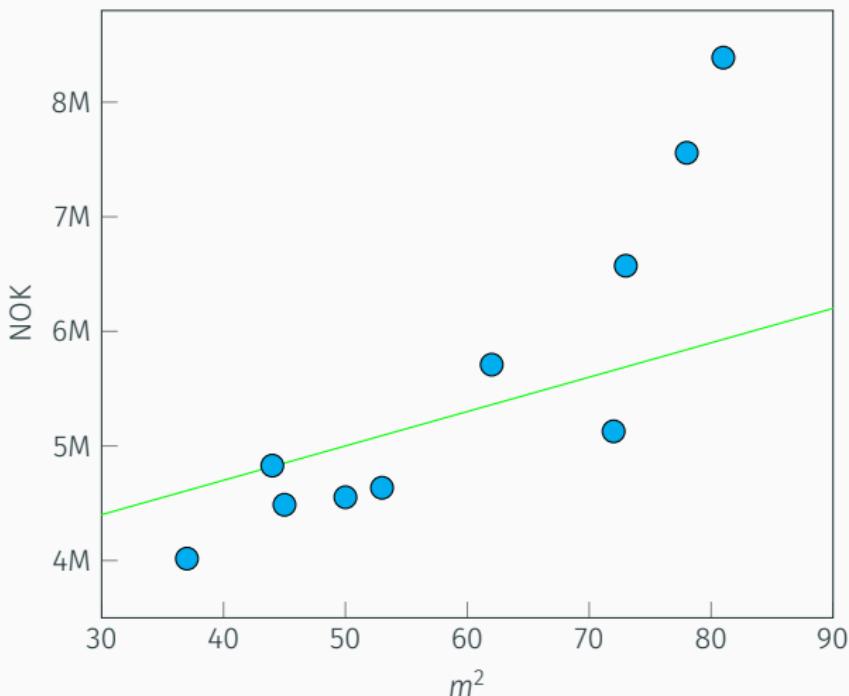
$$\hat{y} = 82031x + 706495$$
$$\ell = 4.09 \times 10^{12}$$

Training



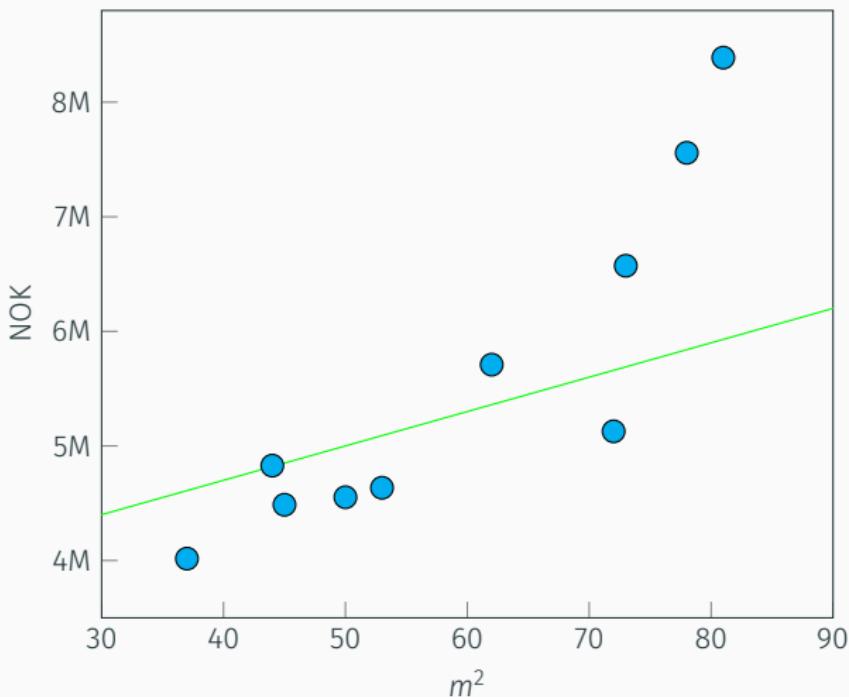
$$\hat{y} = Wx + b$$
$$\ell = \sum(y - \hat{y})^2$$

Training



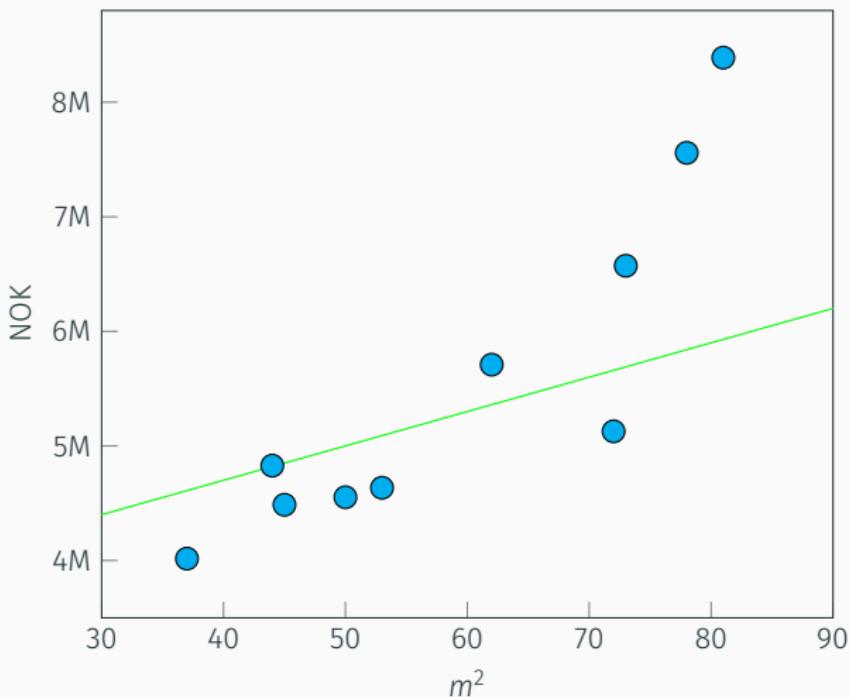
$$\hat{y} = Wx + b$$
$$\ell = \sum(y - \hat{y})^2$$

Training



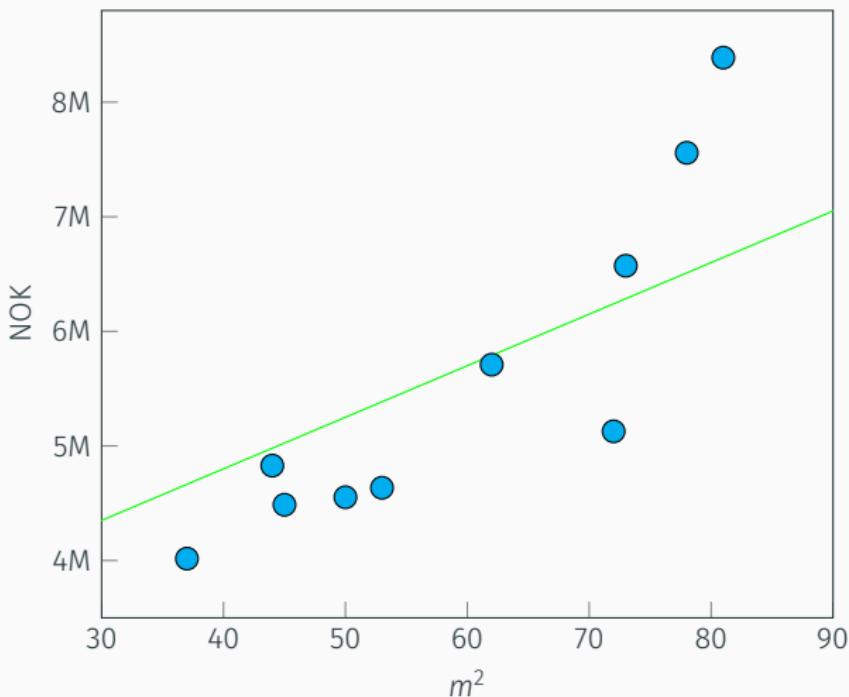
$$\ell = \sum(y - (Wx + b))^2$$

Training



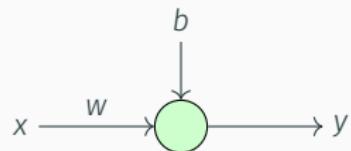
$$1.10 \times 10^{13} = \sum(y - (30000x + 3500000))^2$$

Training



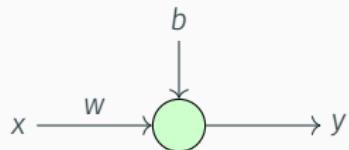
$$7.24 \times 10^{12} = \sum(y - (45000x + 3000000))^2$$

Building a neural network

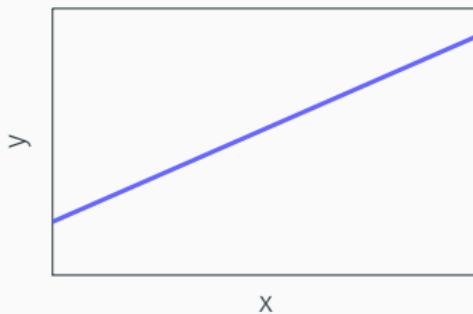


$$\hat{y} = wx + b$$

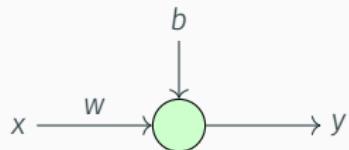
Building a neural network



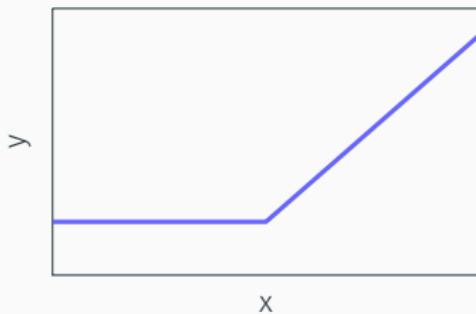
$$\hat{y} = wx + b$$



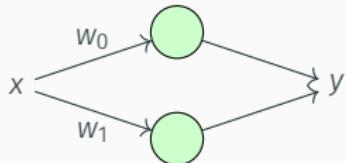
Building a neural network



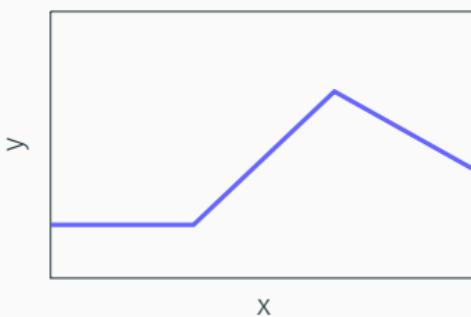
$$\hat{y} = \max(0, wx + b)$$



Building a neural network



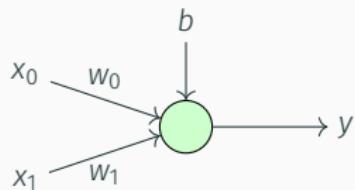
$$\hat{y} = \max(0, w_0x + b_0) + \max(0, w_1x + b_1)$$



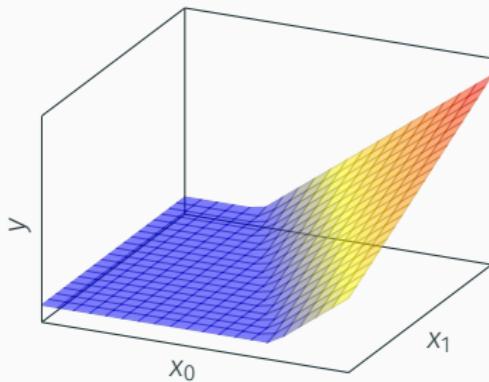
Building a neural network

"Any relationship that can be described with a polynomial function can be approximated by a neural network with a single hidden layer."

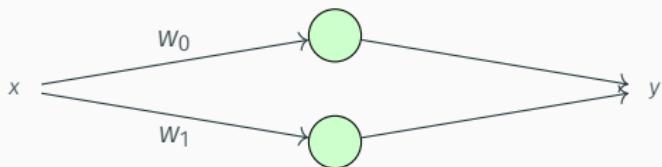
Building a neural network



$$\hat{y} = \max(0, w_0x_0 + w_1x_1 + b)$$

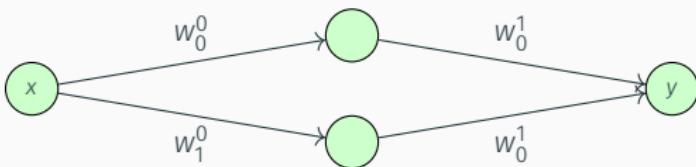


Building a neural network



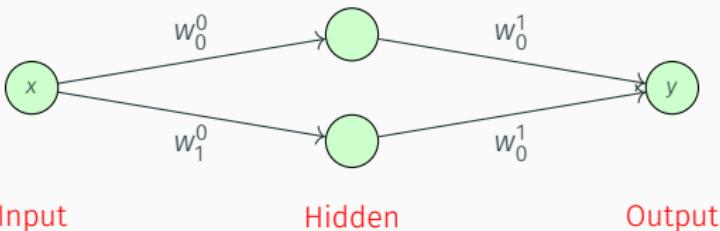
$$\hat{y} = \max(0, w_0x + b_0) + \max(0, w_1x + b_1)$$

Building a neural network



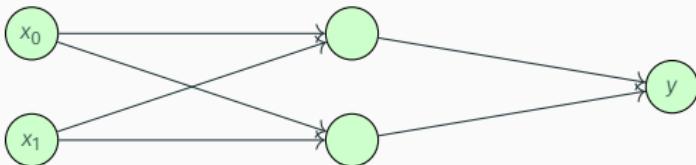
$$\hat{y} = \max(0, w_{0,0}^1 * \max(0, w_{0,0}^0 * x + b_{0,0}) + w_{1,0}^1 * \max(0, w_{0,1}^0 * x + b_{1,0}) + b_1)$$

Building a neural network



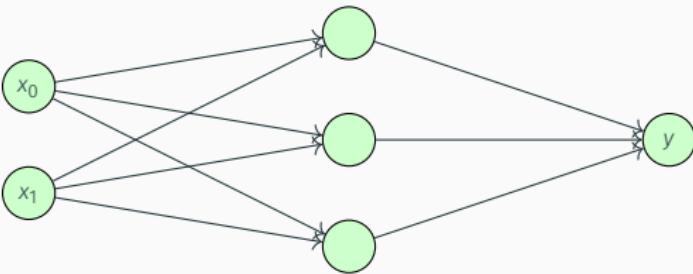
$$\hat{y} = \max(0, w_{0,0}^1 * \max(0, w_{0,0}^0 * x + b_{0,0}) + w_{1,0}^1 * \max(0, w_{0,1}^0 * x + b_{1,0}) + b_1)$$

Building a neural network



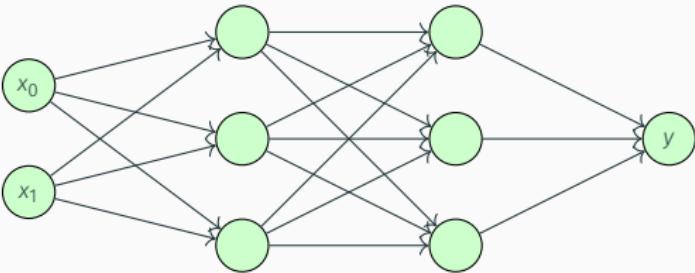
$$\hat{y} = \max(0, w_{0,0}^1 * \max(0, w_{0,0}^0 * x_0 + w_{1,0}^0 * x_1 + b_{0,0}) + \\ w_{1,0}^1 * \max(0, w_{0,1}^0 * x_0 + w_{1,1}^0 * x_1 + b_{0,1}) + \\ b_1)$$

Building a neural network



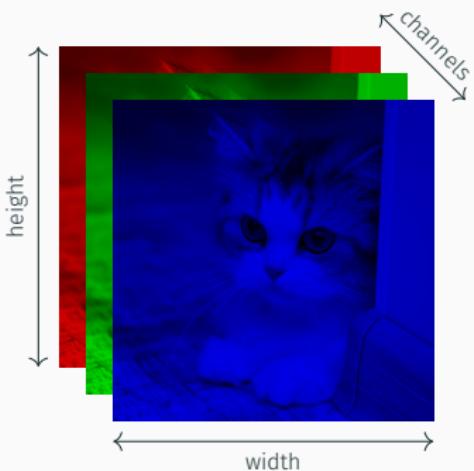
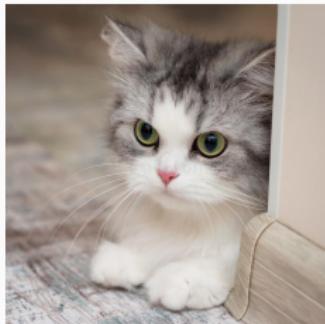
$$\hat{y} = \max(0, w_{0,0}^1 * \max(0, w_{0,0}^0 * x_0 + w_{1,0}^0 * x_1 + b_{0,0}) + \\ w_{1,0}^1 * \max(0, w_{0,1}^0 * x_0 + w_{1,1}^0 * x_1 + b_{0,1}) + \\ w_{2,0}^1 * \max(0, w_{0,2}^0 * x_0 + w_{1,2}^0 * x_1 + b_{0,2}) + \\ b_1)$$

Building a neural network



$$\hat{y} = \max(0, w_{0,0}^2 * \max(0, w_{0,0}^1 * \max(0, w_{0,0}^0 * x_0 + w_{1,0}^0 * x_1 + b_{0,0}) + \\ w_{1,0}^1 * \max(0, w_{0,1}^0 * x_0 + w_{1,1}^+ * w_1 + b_{0,1}) + \\ w_{2,0}^1 * \max(0, w_{0,2}^0 * x_0 + w_{1,2}^+ * w_1 + b_{0,2}) + \\ b_{1,0}) + \\ w_{1,0}^2 * \max(0, w_{0,1}^1 * \max(0, w_{0,0}^0 * x_0 + w_{1,0}^0 * x_1 + b_{0,0}) + \\ w_{1,1}^1 * \max(0, w_{0,1}^0 * x_0 + w_{1,1}^+ * w_1 + b_{0,1}) + \\ w_{2,1}^1 * \max(0, w_{0,2}^0 * x_0 + w_{1,2}^+ * w_1 + b_{0,2}) + \\ b_{1,1}) + \\ w_{2,0}^2 * \max(0, w_{0,2}^1 * \max(0, w_{0,0}^0 * x_0 + w_{1,0}^0 * x_1 + b_{0,0}) + \\ w_{1,2}^1 * \max(0, w_{0,1}^0 * x_0 + w_{1,1}^+ * w_1 + b_{0,1}) + \\ w_{2,2}^1 * \max(0, w_{0,2}^0 * x_0 + w_{1,2}^+ * w_1 + b_{0,2}) + \\ b_{1,2}) + \\ b_2)$$

Convolutional neural networks



Summary

- What is a statistical learning model?

A formula expressing a relationship between inputs and outputs

- What is a loss function?

A function quantifying how good a set of predictions are

- How do we train a statistical learning model?

By applying gradual updates of parameters using gradient descent

- How does a (deep) neural network work?

Sequentially applying (non-linear) artificial neurons to transform inputs

- What operations does a convolutional neural network use?

Alternating convolutions and pooling, to match patterns in the input

- What is transfer learning?

Retraining an already trained model for a new problem

- What is overfitting?

When a model learns patterns in the training data that does not hold generally

- How do we combat it?

Rigorous testing, regularization and data augmentation