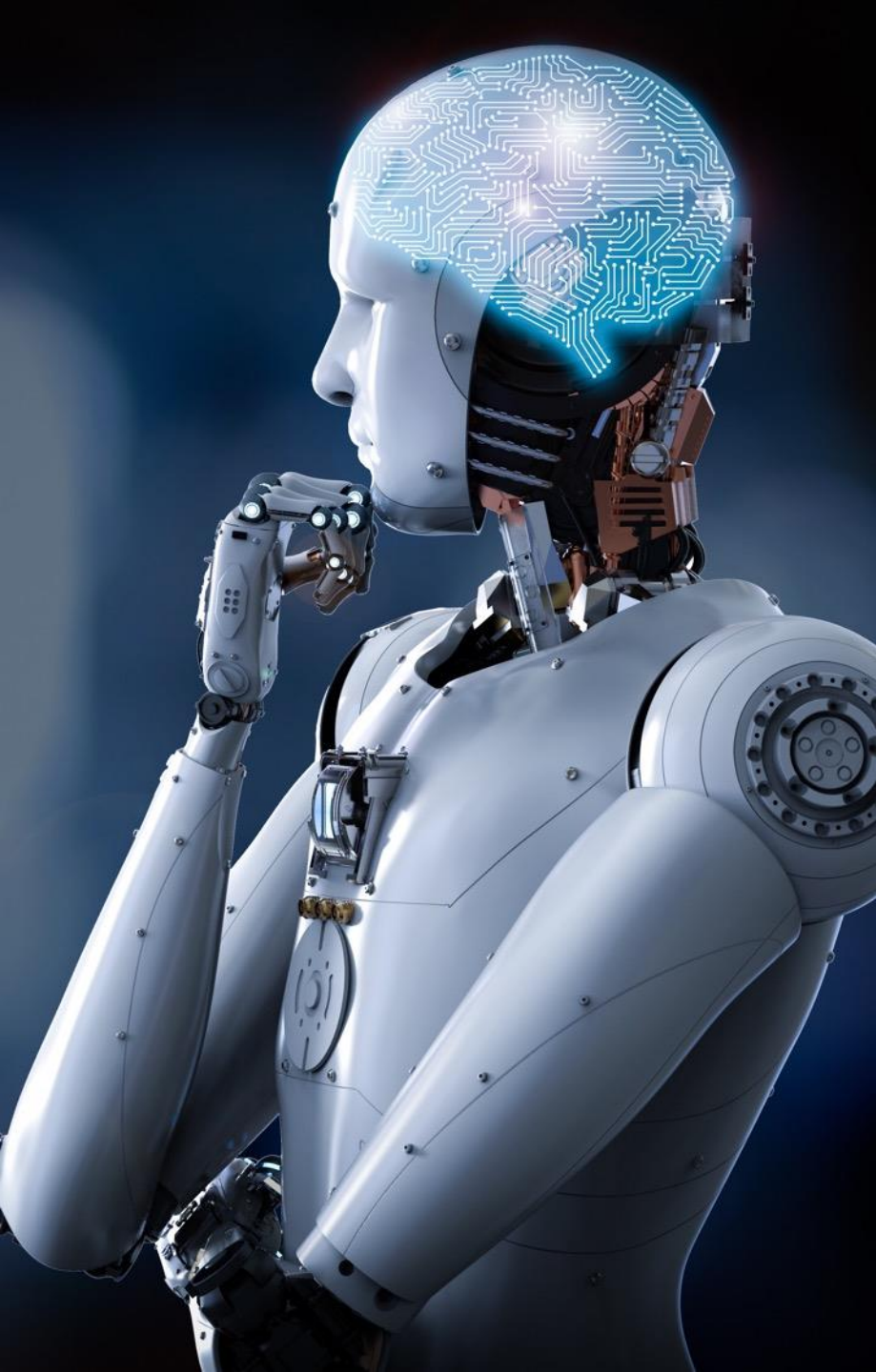
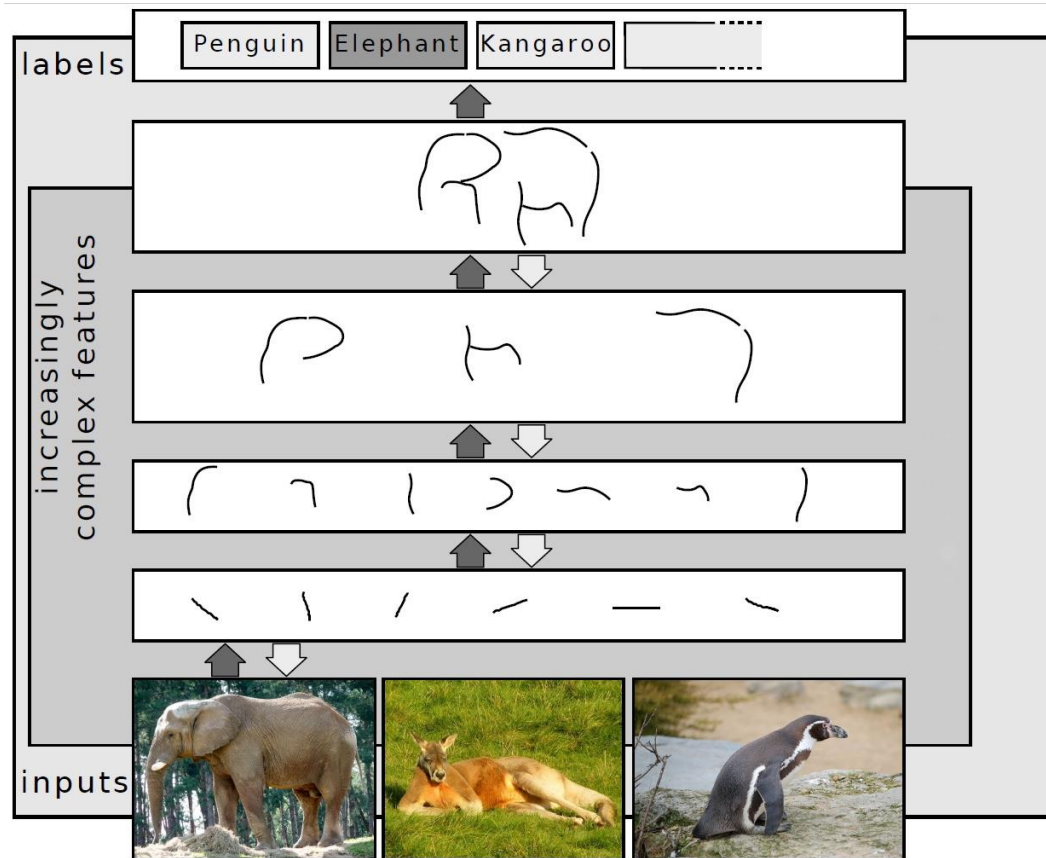




Artificial Neural Network Analysis Diagnostics

KOLUMA GmbH – Dr. rer. nat. Lutz Kogel
2022-09-08

What is deep learning ?



Picture Credit: Wikipedia (Sven Behnke)

Principle

- Driving discipline between data analytics, artificial intelligence and big data
- Combination of intellect and knowledge
- Knowledge-based processing

Categorization

- Recognition of regularities
- Training with empirical data/examples
- Identification of unknown data

Classical Approach vs. Deep Learning

Classical Approach

- Hand made algorithm such as
Like:
if $X=Y$ than do SOMETHING
or
if $X<Y$ or $x>y$ than do SOMETHING ELSE
- Disadvantage
Complex problems need a lot of code
- Advantage
Extremely precise and clear

Deep Learning

- Computer is trained with empirical data and learns to find patterns
- Advantage:
Complex problems do not need to be programmed manually the computer learns from human categorized data
- Disadvantage
Pre-Processed empirical data is needed
Like humans not precise all the time

The process of Deep Learning

Train

- Pre-Process empirical data
- Train the model

Analyze

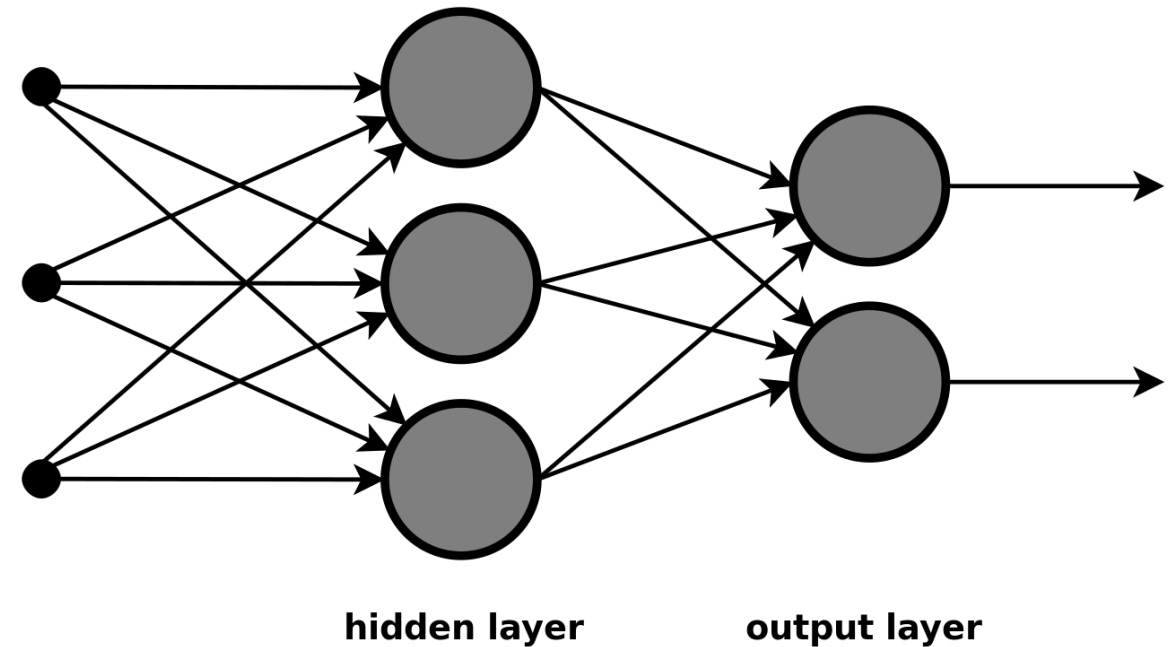
- Categorize unknown datasets
- Write diagnosis

Optimize

- Identify wrong categorizations
- Improve model due re-training

Deep Learning Network

- *Arrangement of neurons in layers*
- *Having a*
 - Input Layer
 - Hidden Layer(s)
 - Output Layer
- *Deep Learning is the case if several hidden layers are applied*



Picture Credit: Wikipedia (Chrislb)

Laboratory Diagnostics

- *Measurement results look like patterns*
- *Each specimen has its specific characteristics*
- *Patterns classify a beverage*
- *Each property has a specific distribution*
- *Measurement values will be taken for Deep Learning*

Cola	Lemonade	Juice	Sugar Conc. [%]	Transmission [%]	Residue [%]	Color
1	0	0	9,8	50	0	Brown
0	0	1	7,1	15	3	Yellow
0	1	0	9,0	90	0	Colorless

Training and Analysis applying neural networks

Training

- Categorized measurements will be taken to train the network
- This is called „Supervised Learning“
- The trained network is called a „Model“

Cola	Lemonade	Juice	Sugar Conc. [%]	Transmission [%]	Residue [%]	Color
1	0	0	9,8	50	0	Brown
0	0	1	7,1	15	3	Yellow
0	1	0	9,0	90	0	Colorless

Categorization

Training Dataset

Analysis

- Unknown values are shown to the network
- Probability of detection is evaluated as a value between zero and one

Cola	Lemonade	Juice	Sugar Conc. [%]	Transmission [%]	Residue [%]	Color
0,99	0,01	0,00	9,3	47	0	Brown
0,00	0,02	0,98	6,8	16	3	Yellow
0,23	0,99	0,03	8,9	87	0	Colorless

Analysis

Testing Dataset

Advanced models

Wear	Contamination	Depletion	Oxidation	Appearance	Visc. Kin. 40°C	Visc. Kin. 100°C	Water	Fe	Cr	V	Ni	Mn	Na	Ca	Si	Al	S	P	Zn	PQ-Index	FT-IR (Fit)	Density	Particles 4mu	Particles 6mu	Particles 14mu	TAN
0	0	0	0	0	49,96	7,52	10	4	2	2	2	3	7	8	5	1	34	14	0	46	95,92	0,9358	0	1	2	0,03
0	0	0	0	0	46,79	7,76	10	8	0	1	1	1	6	4	8	3	31	28	0	39	95,25	0,9266	2	3	7	0,04
0	0	0	0	1	41,36	7,56	13	4	2	0	1	1	5	6	6	5	37	20	0	64	97,48	0,9272	0	5	8	0,01
0	0	0	0	1	42,35	7,98	12	7	2	0	1	1	4	6	7	1	29	20	0	53	99,82	0,9333	2	2	6	0,07
0	0	0	0	0	46,48	7,5	4	3	1	1	3	1	4	4	3	3	39	25	0	45	98,29	0,9283	4	9	12	0,17
0	0	0	0	1	44	7,76	1	1	3	3	2	1	4	8	9	2	31	11	0	25	96,42	0,9352	3	3	6	0,08
0	0	0	0	0	41,68	7,87	5	4	1	1	2	3	4	5	3	1	35	20	0	28	95,88	0,9302	3	5	8	0,08
0	0	0	0	1	45,88	7,76	9	3	2	0	3	2	5	5	7	4	36	21	0	28	96,37	0,9359	5	7	12	0,04
0	0	0	0	1	42,73	7,2	14	1	0	1	1	0	8	8	4	2	35	23	0	46	98,55	0,9208	4	5	8	0,03
0	0	0	0	1	44,16	7,25	11	5	2	0	2	2	4	7	5	4	38	25	0	41	98,91	0,9331	2	2	2	0,02
0	0	0	0	0	45,97	7,43	1	4	1	1	2	2	8	5	5	5	40	20	0	34	99,47	0,9374	3	6	9	0,08
0	0	0	0	1	40,46	7,77	11	5	0	1	2	1	6	6	10	4	35	23	0	39	97,81	0,9361	2	5	7	0,1
0	0	0	0	0	44,43	7,9	6	1	2	1	1	1	5	6	2	3	27	22	0	33	99,84	0,921	1	6	6	0,19
0	0	0	0	0	40,57	7,86	18	1	1	1	1	1	5	3	10	5	20	16	0	43	98,29	0,9202	3	4	5	0,15
0	0	0	0	1	43,42	7,51	14	3	2	3	0	1	6	7	5	3	28	24	0	37	97,79	0,9379	3	3	3	0,18
0	0	0	0	1	41,84	7,04	16	0	1	1	3	1	6	3	7	0	21	28	0	67	97,3	0,9219	3	6	9	0,12
0	0	0	0	1	45,3	7,51	8	1	1	1	2	2	7	4	4	2	26	19	0	48	96,79	0,9315	2	6	10	0,16
0	0	0	0	0	49,63	7,7	0	2	2	2	1	2	6	7	5	4	39	26	0	52	99,08	0,9213	3	5	7	0,08
0	0	0	0	0	47,96	7,02	0	8	1	1	2	1	7	8	1	4	34	20	0	43	96,63	0,9312	3	7	11	0,15
0	0	0	0	0	45,53	7,48	20	1	2	3	3	1	6	7	7	4	37	25	0	48	98,54	0,9205	1	4	7	0,08
0	0	0	0	0	49,44	7,46	8	1	1	1	1	2	4	4	7	4	27	26	0	40	99,52	0,9379	5	6	9	0,16
0	0	0	0	1	46,61	7,76	8	6	2	3	0	0	3	6	1	4	38	18	0	52	95,3	0,9242	4	7	9	0,13

- *Advanced models quickly become complex*
- *Models can be trained with empirical or synthetic data*

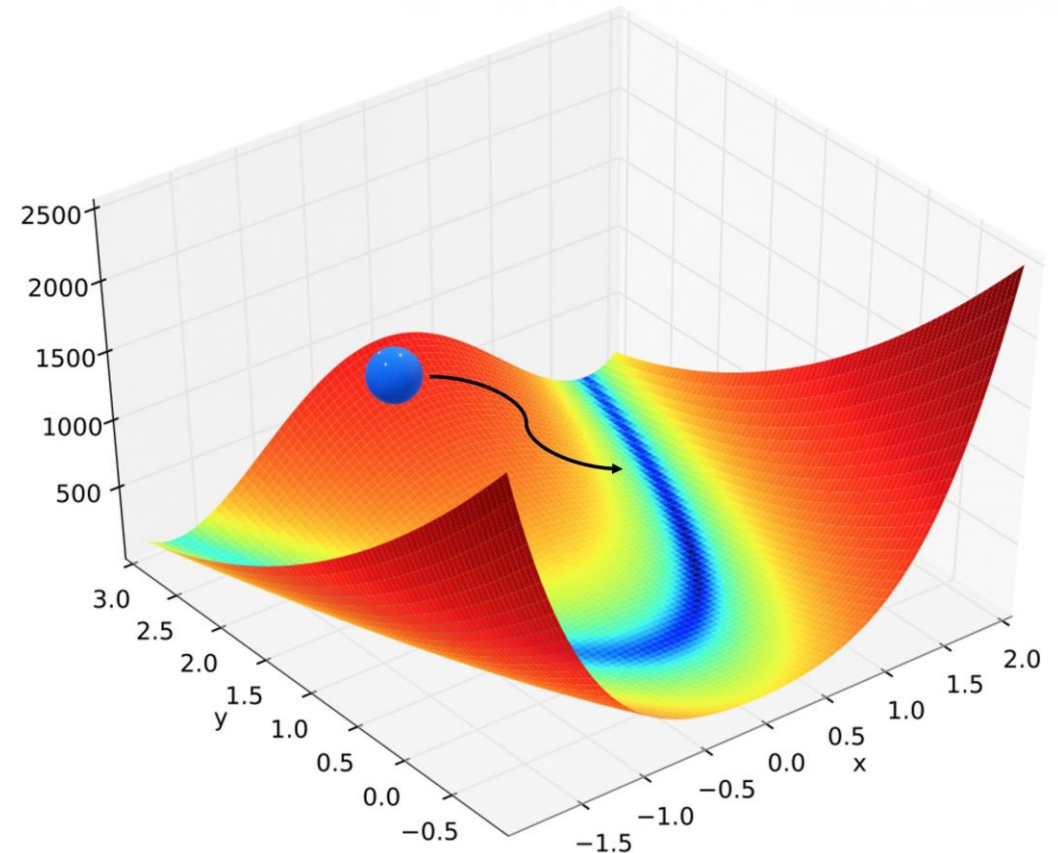
Optimization of the Model

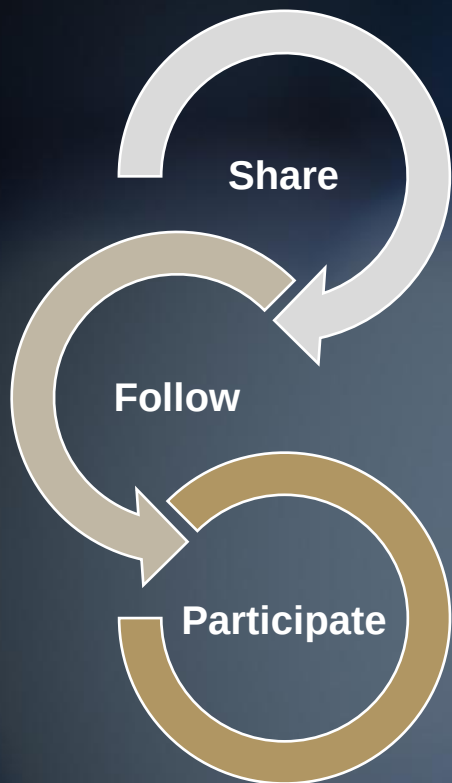
The world of Deep Learning

- Training of models is trying to map the input to the desired output values
- The network forms a hyperplane with several local minima, like climbing downhill
- Sometimes it is not trivial to find the best model
- Each model needs to be tested with Testing Datasets

The real world analogon

- Student may have misunderstood the context
- Student needs to be trained once more again and must look a bit different to the problem





KOLUMA GmbH

Dr. rer. nat. Dipl. Chem. Lutz Kogel (MBA)
Managing Director

web www.KOLUMA.net
email lutz.kogel@koluma.net
tel [+49 2941 9219 905](tel:+4929419219905)

