IMMS

INSTITUT FÜR MIKROELEKTRONIK- UND MECHATRONIK-SYSTEME GEMEINNÜTZIGE GMBH

Artificially IntelligEnt EDA?!

Georg Gläser

edaBarCamp 2020

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State of the EDA

- Autonomous Driving in SAE J3016

Level 0 | **Level 1** hands on | **Level 2** hands off | **Level 3** eyes off | **Level 4** mind off | **Level 5** steering wheel optional

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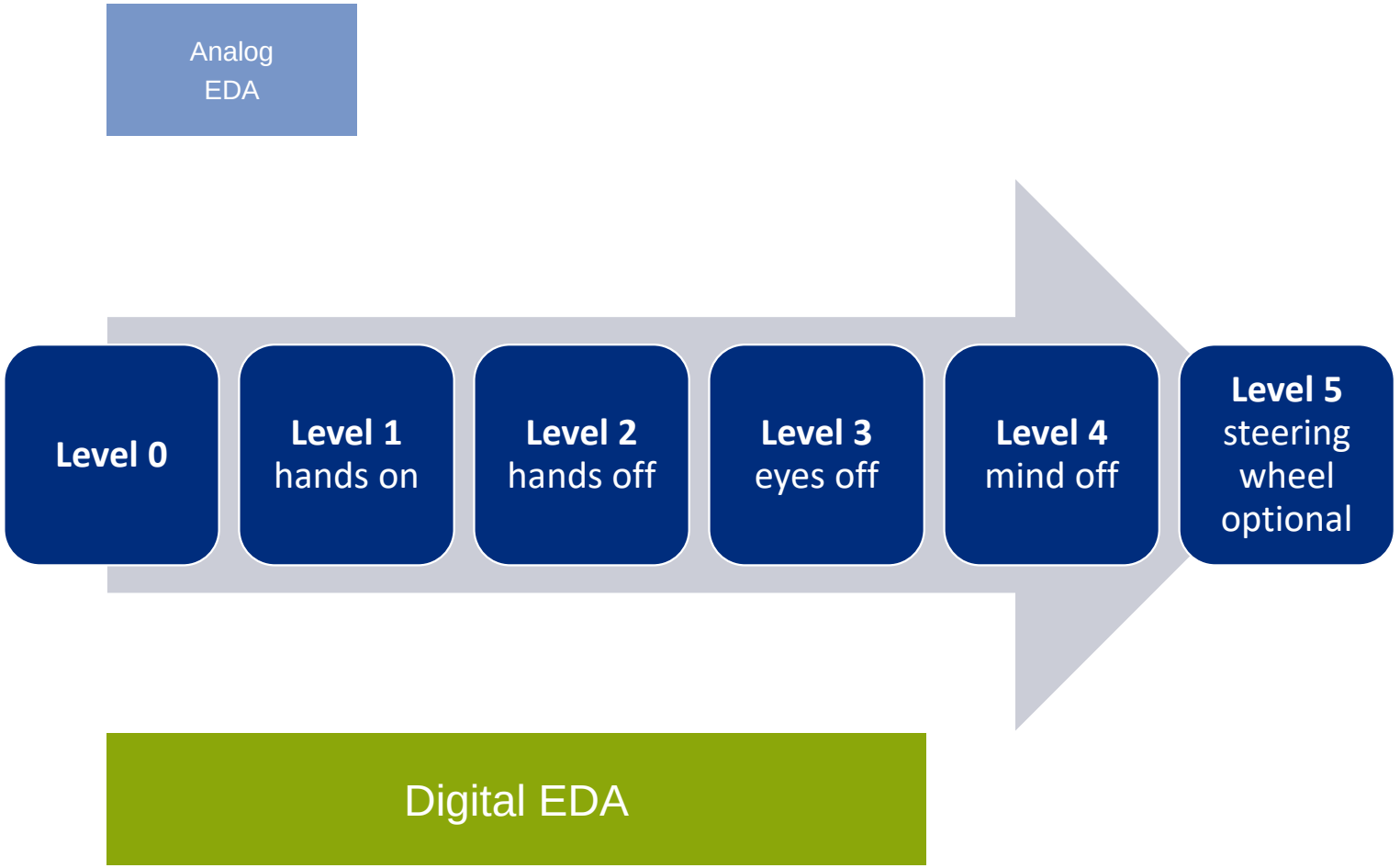
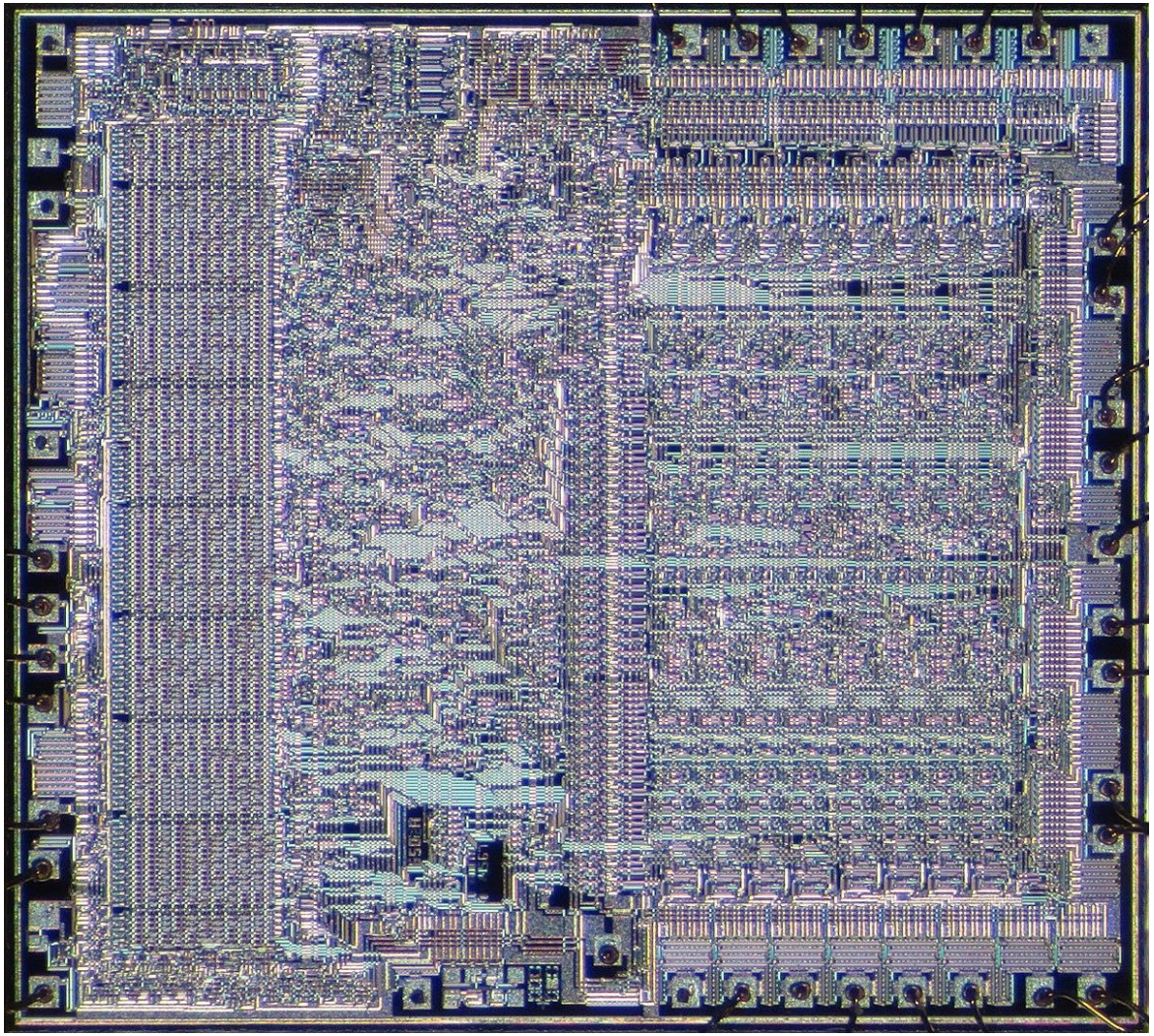


Do you remember?



Sources:

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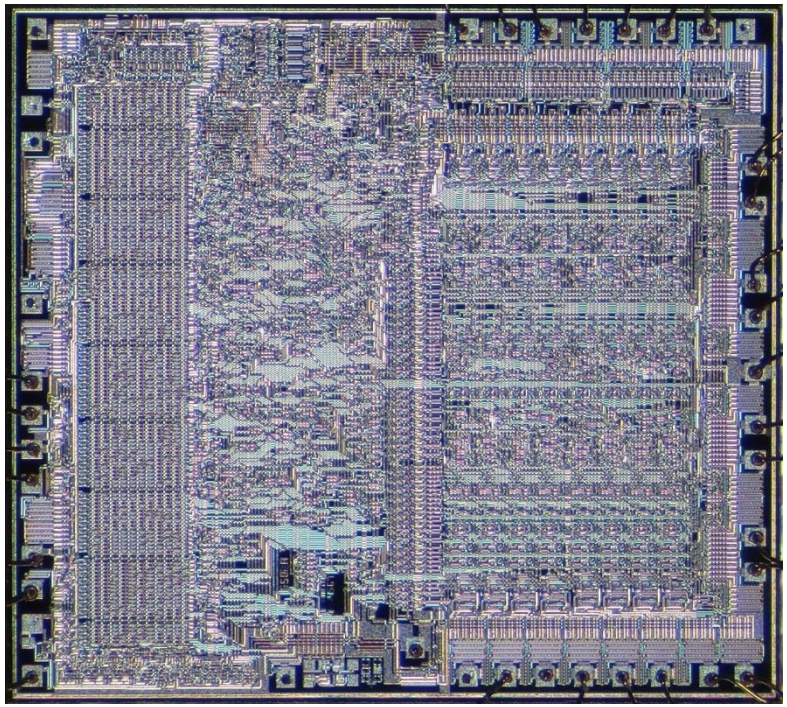
Do you remember? – THE 6502

- Some facts [1]:
  - Approx. 3500 Transistors
  - Up to 3MHz
  - Die size 16mm²
- Purely manual design
- Masks drawn by hand
- Prototyping?
- Verification?



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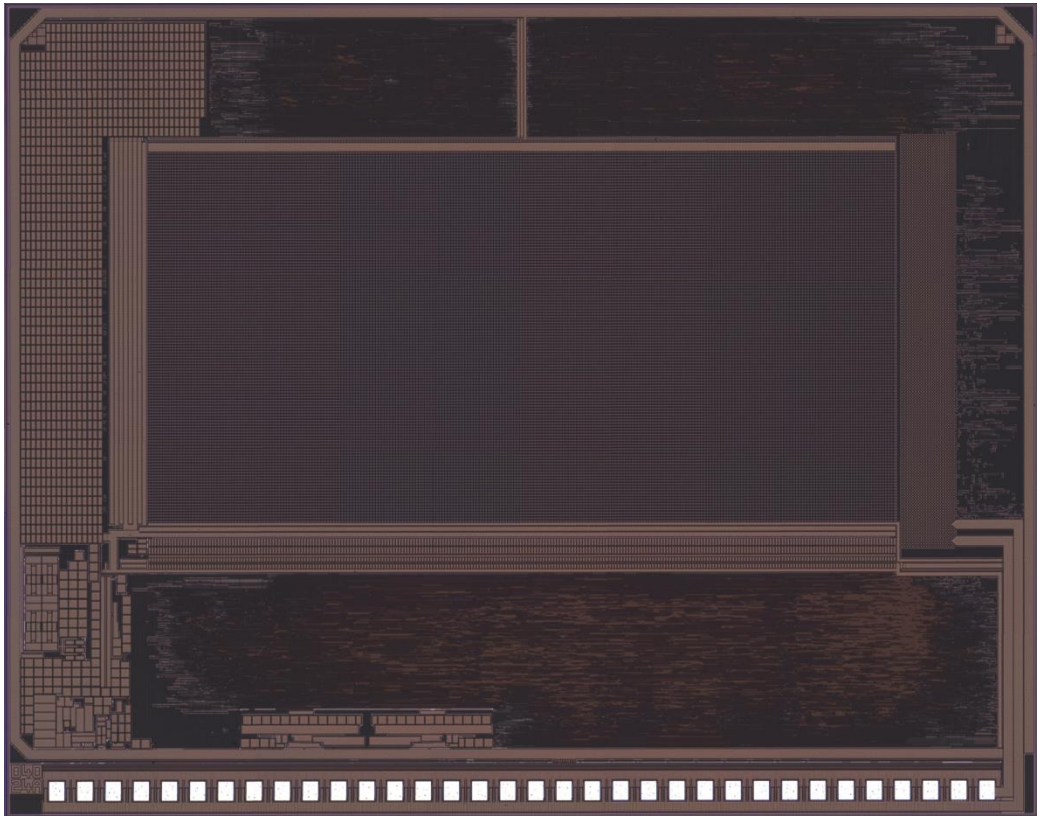
[1] https://en.wikipedia.org/wiki/MOS_Technology_6502

Our baby – An Imager for Life-Science Applications

- Approx 60kGates
- 50MHz
- Mixed-Signal System
  with sensitive analog part
- Currently in the lab ;)



Complexity… and non-formal knowledge

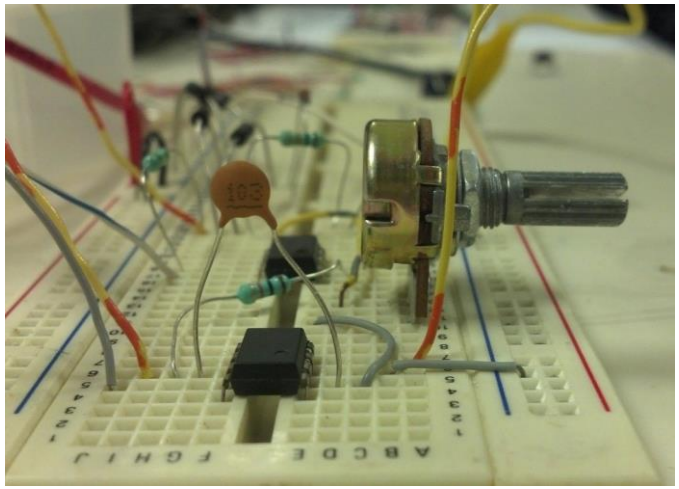
- EDA = Handling complexity
  - It‘s all about abstraction!
- Analog/Mixed-Signal EDA
  - Still remains on lower-level abstraction
  - Many „informal“ rules
  - Relies on designer‘s experience
    - High-dimensional optimization
    - Layout with constraints
    - „If it looks nice, it has a high probability to work“
  - Verification based on slow simulations and reviews

Complexity… and non-formal knowledge

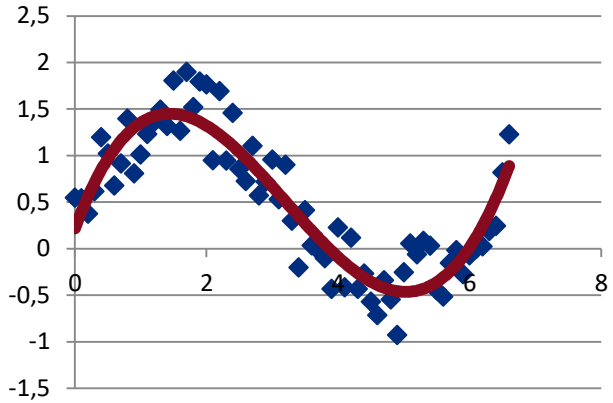
- Why can‘t we automate analog design like the code-driven digital RTL2GDS flow (yet)?
- Design space is too large (and continuous)!
- Non-formal knowledge & designer experience
  - When to use which structure?
  - Does it look nice?
- This helps determining a good starting point for possible optimization

What‘s learning here?

Humans learn by exploration



Machines learn by training



ML is mostly about curve fitting or statistical analysis.

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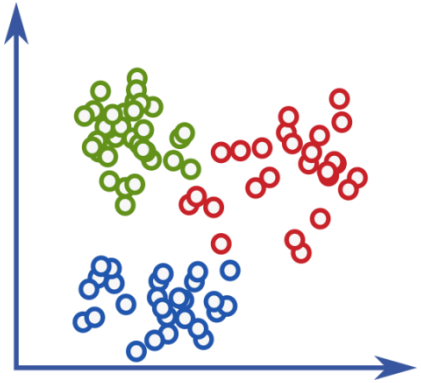
Things where machine learning algorithms work well…

- Supervised / Semi-Supervised
  - Classification
  - Regression
  - (Sampling)

- Unsupervised
  - Clustering
  - Feature extraction



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Supervised learning relies on curve fitting

- What does supervised learning do?

Given a function
$f: \mathbb{R}^n \rightarrow \mathbb{R}^m$ with Parameters **W,**
find **W** out of given values of f
such that some cost function is minimized.

- Example: Cat-Classification

f() = 1

f() = 0

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https://pixabay.com/photos/kitty-cat-kitten-pet-animal-cute-551554/
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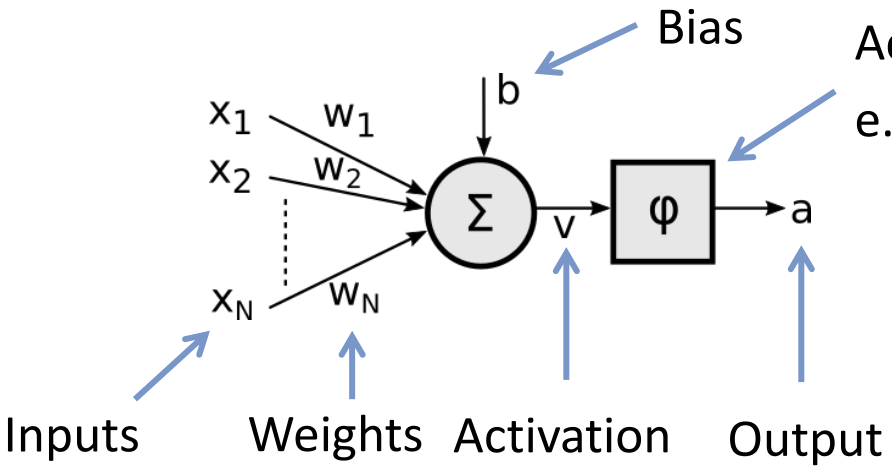
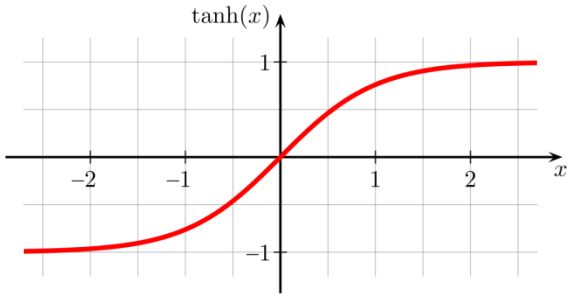
Artificial Neural Nets – What are they actually?

- Neural Nets are a way to construct parameterized functions



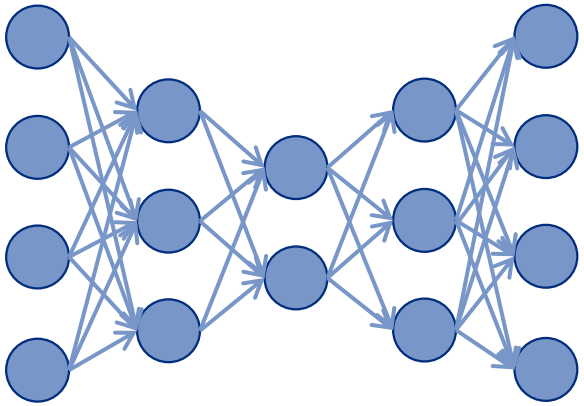
Activation function

e.g. *tanh()*



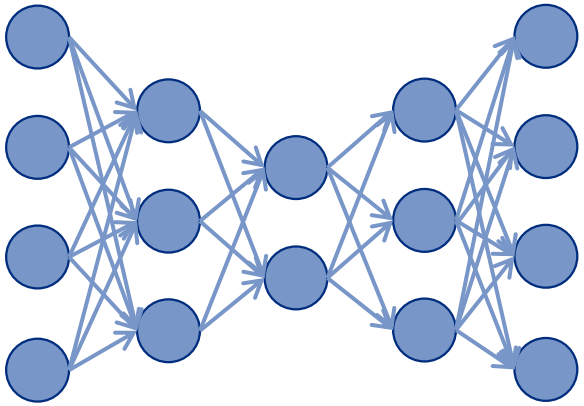
Artificial Neural Nets – What are they actually?

- Neural Nets are a way to construct parameterized functions
  - Using many neurons
  - Resulting in a structure that can be differentiated (for optimization)
- Structure and activation functions of neurons boosted deep learning
  - Convolutional nets
  - LSTMs
  - …



Aren‘t Regression Problems Boring?!

- No, they can be used to do lots of things
  - Classification
  - Transformation
  - Data reduction / Feature extraction
  - Data generation from noise



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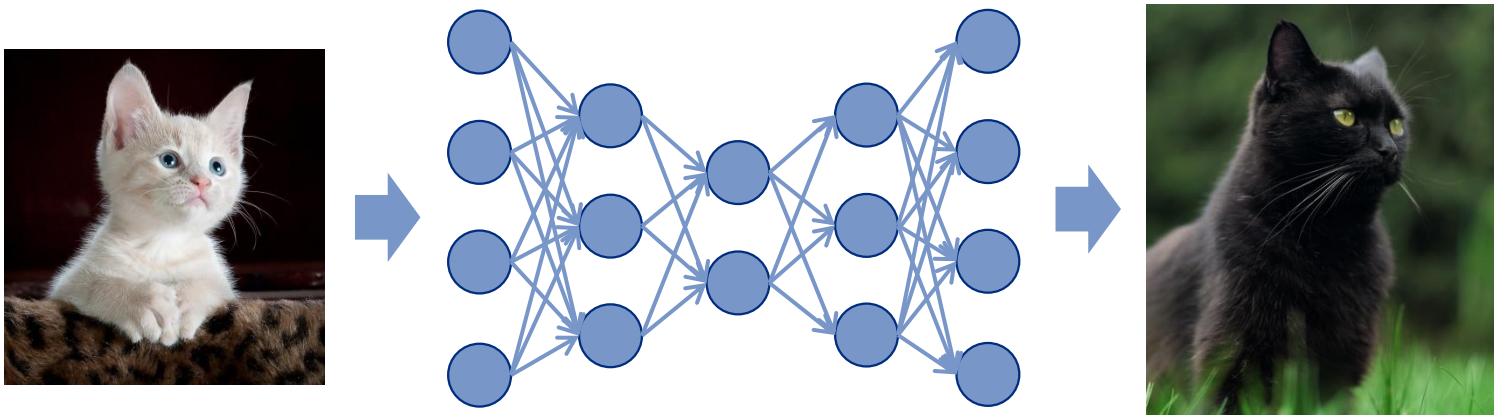

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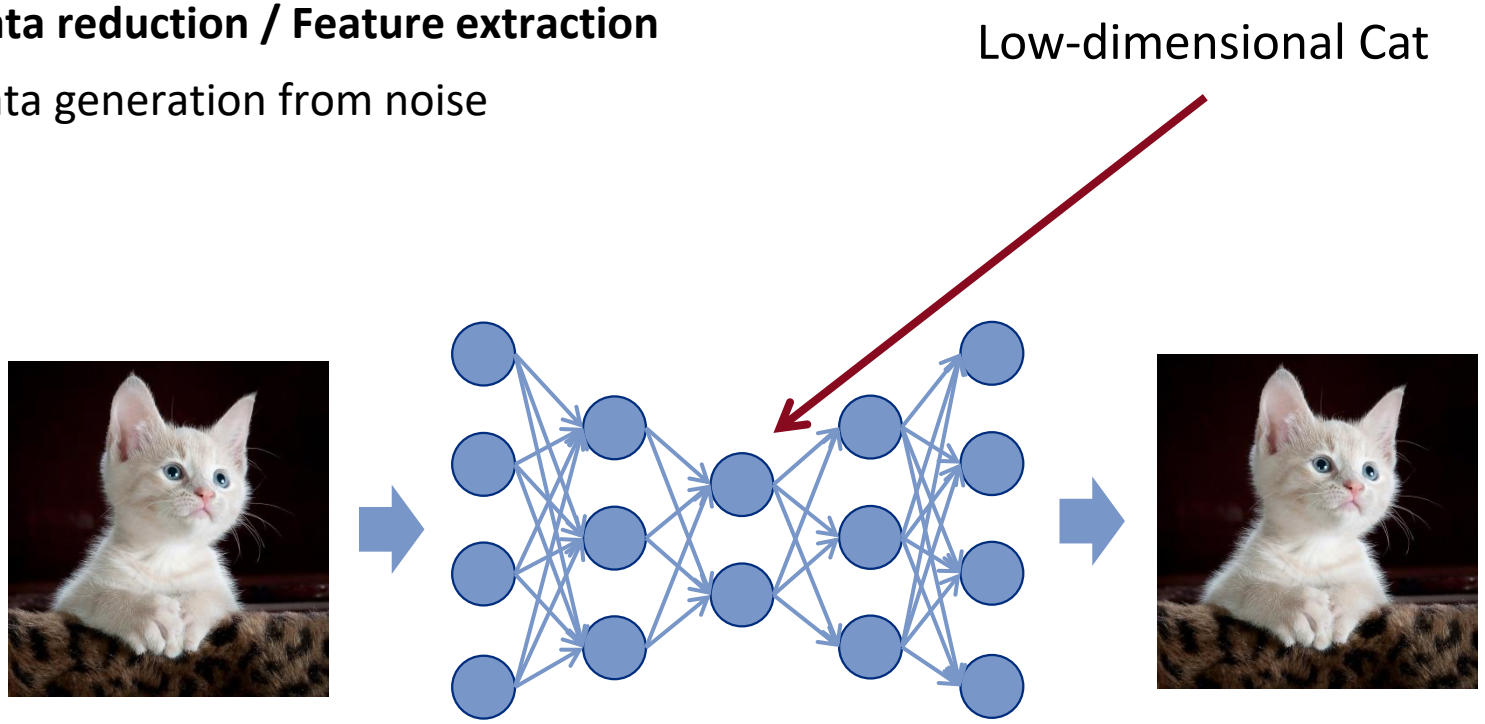

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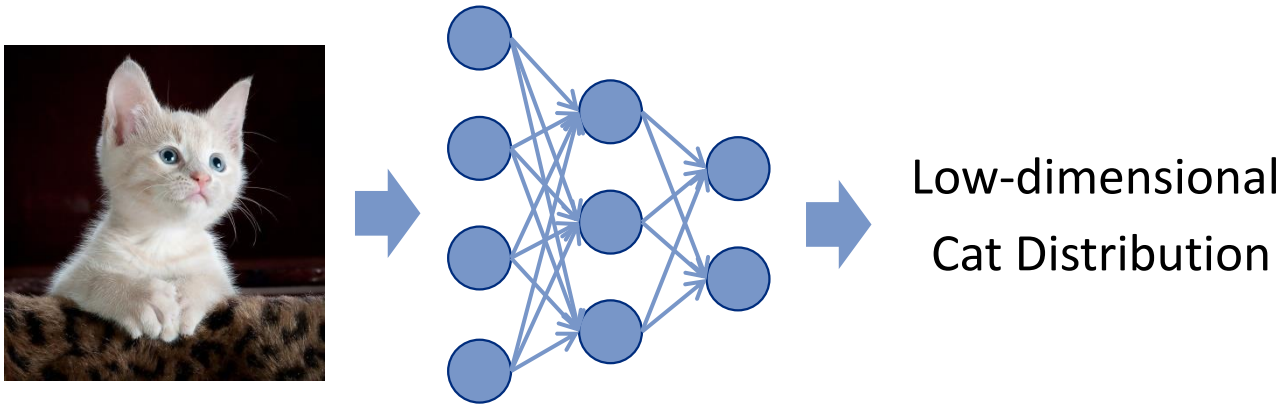

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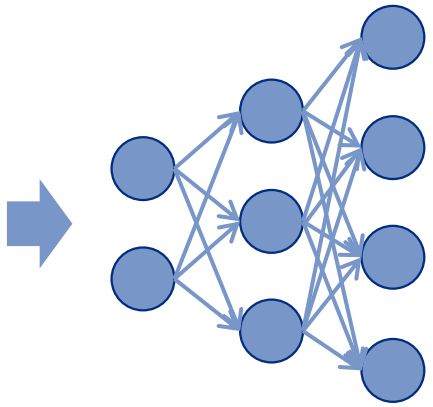
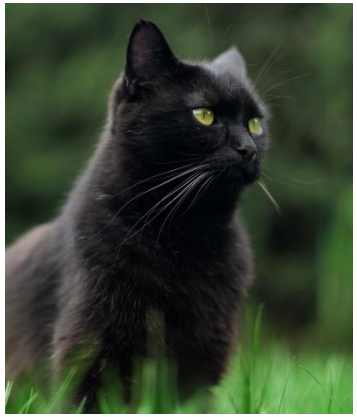
Sample from
Low-dimensional
Cat Distribution





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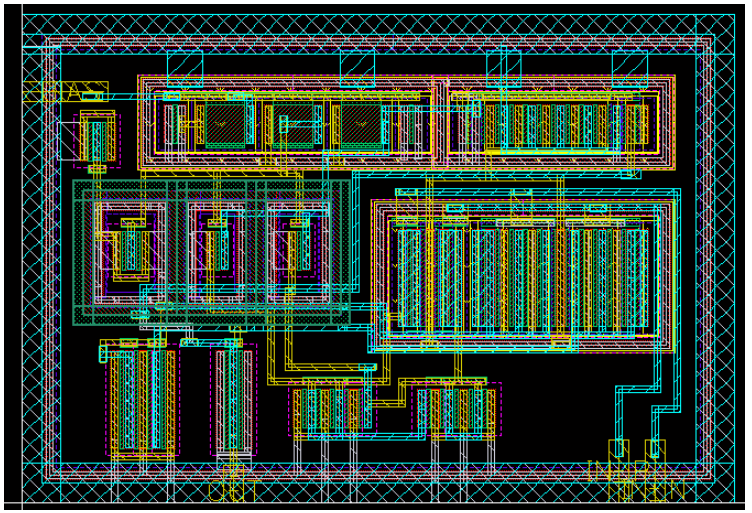
But… EDA is different than playing with cat pics

- **What we need**
  - Explainable algorithms for e.g. automotive design (functional safety)
  - Processing of large data sets
  - Representation of non-formal knowledge
  - Efficient and precise models for simulation

- **What we have**
  - Computing power
    (cheaper than engineering time or silicon)
  - Data (but under NDA or in bad form
    e.g. schematics on paper)
  - New Data ➔ Simulation gives us data
  - Only few labelled data sets



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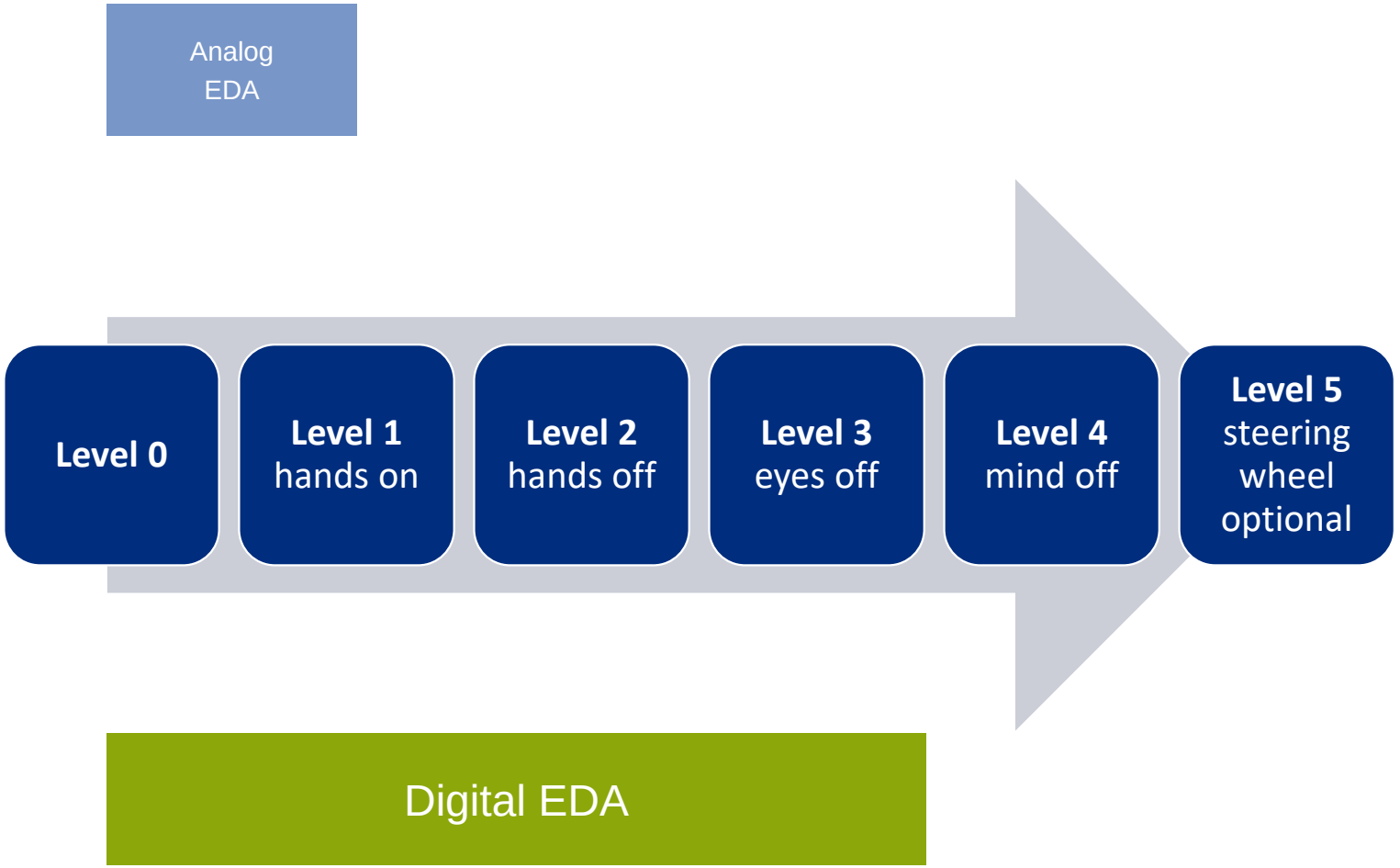
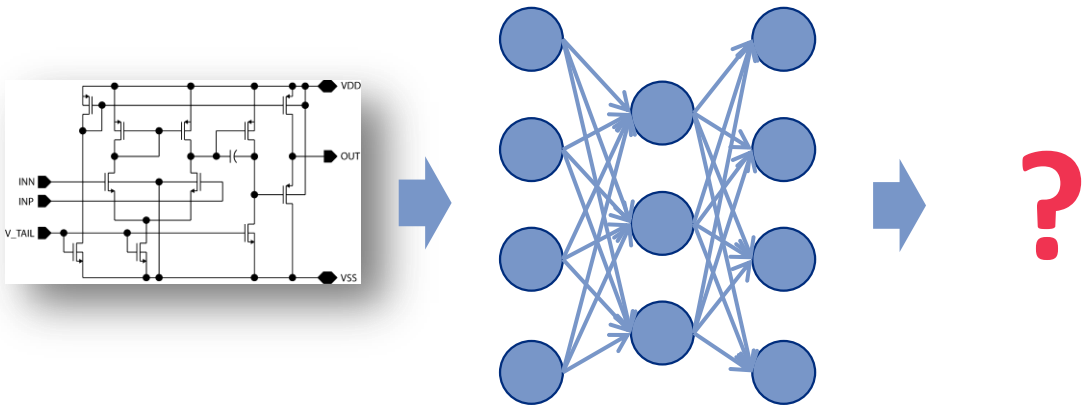


Key questions for using AI in your projects

- What‘s the actual application? Who should use it (and How)?
- How to formulate the problem for a learning algorithm?
- Where do you get the data? Are you allowed to use it?
- How do you represent the data to the algorithm?
- Is it reasonable?
  - If you train your algorithm for 5 weeks but only need 5 secs to simulate…
- How do you deal with uncertainty?



What do you need for a (research-)project?

- Applications and Users
- AI researcher ➔ You are an EDA specialist, no necessarily an AI expert.
- Pre-Project Discussions about
  - What does AI/ML mean in our project?
  - What should it do?
  - Does this sound reasonable to the AI expert? Why? Why not?
- Availability of computing ressources, licenses, etc.
- Communication, Communication, Communication

- Be realistic and pragmatic!

"*Insanity* is doing the same thing over and over again and expecting different results."
(A. Einstein)

IntelligEnt

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Thank you for your Attention

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