Deep Learning for Computer Vision

HSLU Hochschule Luzern

CAS Machine Learning 2

Wochentag	Datum	Zeit	Lektionen	Bezeichnung	Dozierende	Raum
Freitag	20.10.2023	09:15 - 16:45 Uhr	8	M1: Course Introduction (including the History & State of the Art of Machine Learning) Gemeinsames Mittagessen Python Refresher I: Grundlagen	Michael Calonder Umberto Michelucci	I.S1A_304
Samstag	21.10.2023	09:15 - 16:45 Uhr	8	M1: Python Refresher II: Fortgeschrittene Konzepte und idiomatische Verwendung der Sprache Algorithmik, Problem Solving und mathematische Grundlagen von Machine Learning	Michael Calonder	I.S1A_304
Freitag	27.10.2023	09:15 - 16:45 Uhr	8	M2: Supervised Learning 1: regression (Gradient Descent, regularisation, linear regression, Polynomial Regression, etc.) / Supervised Learning 1: regression Hands-on	Mark Rowan	I.S1A_401
Samstag	28.10.2023	09:15 - 16:45 Uhr	8	M2: Supervised Learning 2: classification (logistic regression) / Supervised Learning 2: classification Hands-on	Mark Rowan	I.S1A_401
Freitag	03.11.2023	09:15 - 16:45 Uhr	8	M3: Neural Networks: Introduction to Neural Networks Neural Networks: Model Validation and Tuning Hands-on	Javier Montoya	I.S1A_304
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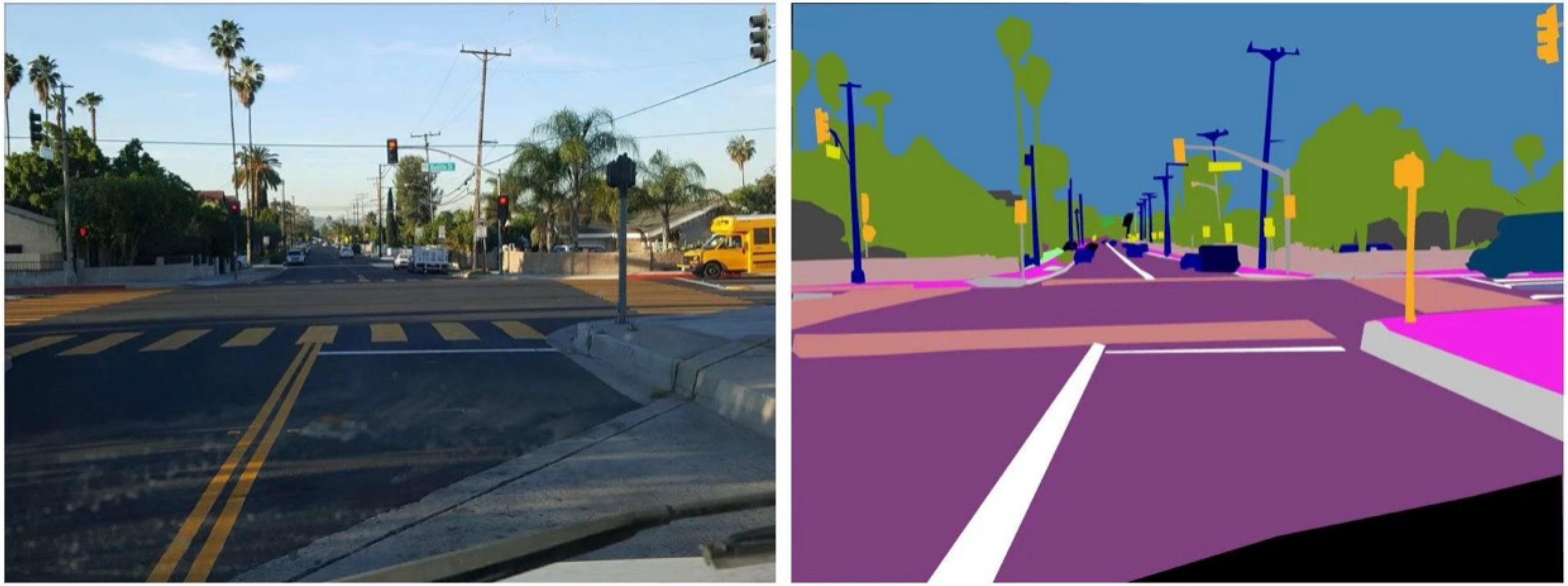
About me

Deep Learning for Computer Vision

Real-time image segmentation



https://viso.ai/deep-learning/image-segmentation-using-deep-learning/

Real-time image segmentation

https://viso.ai/deep-learning/image-segmentation-using-deep-learning/

What a Telsa sees…

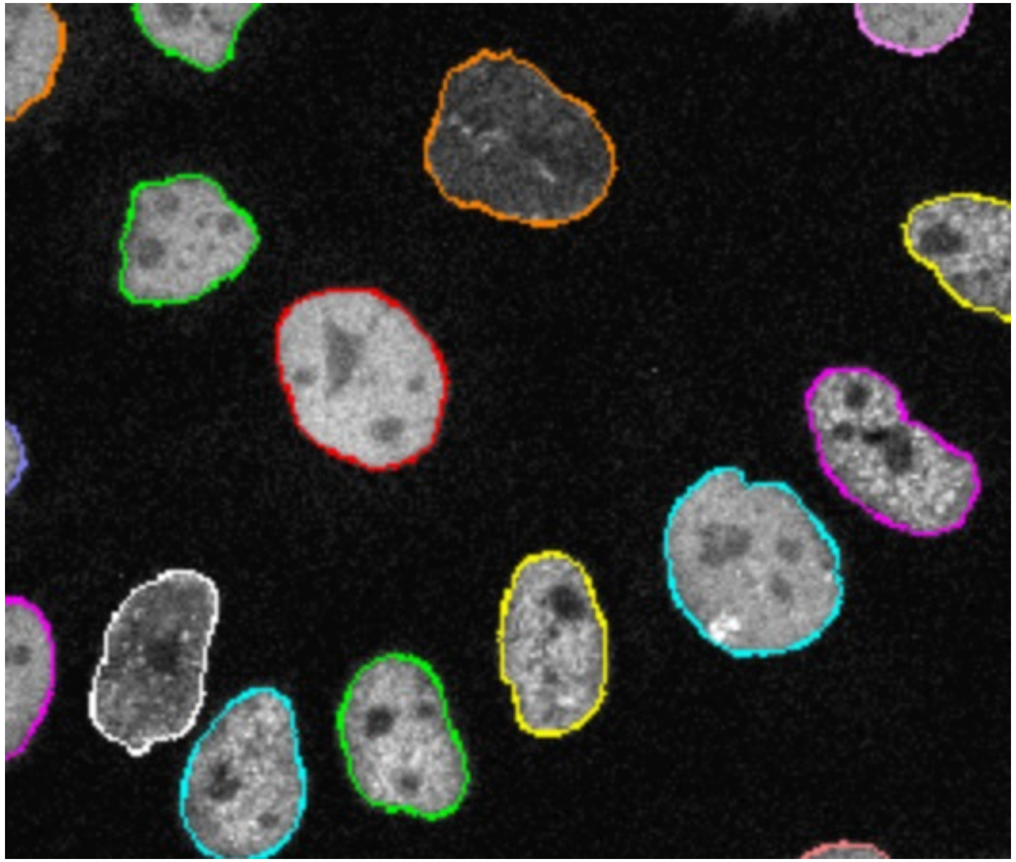
- https://www.youtube.com/watch?v=XfqabC_akV0

Cell Tracking Challenge

- Segmentation and tracking of moving cells in time-lapse video sequences
- Correctly characterizing the way cells change shape and move while interacting with their environment is key to understanding the mechanobiology of cell migration and its multiple implications for both normal tissue development and many diseases.

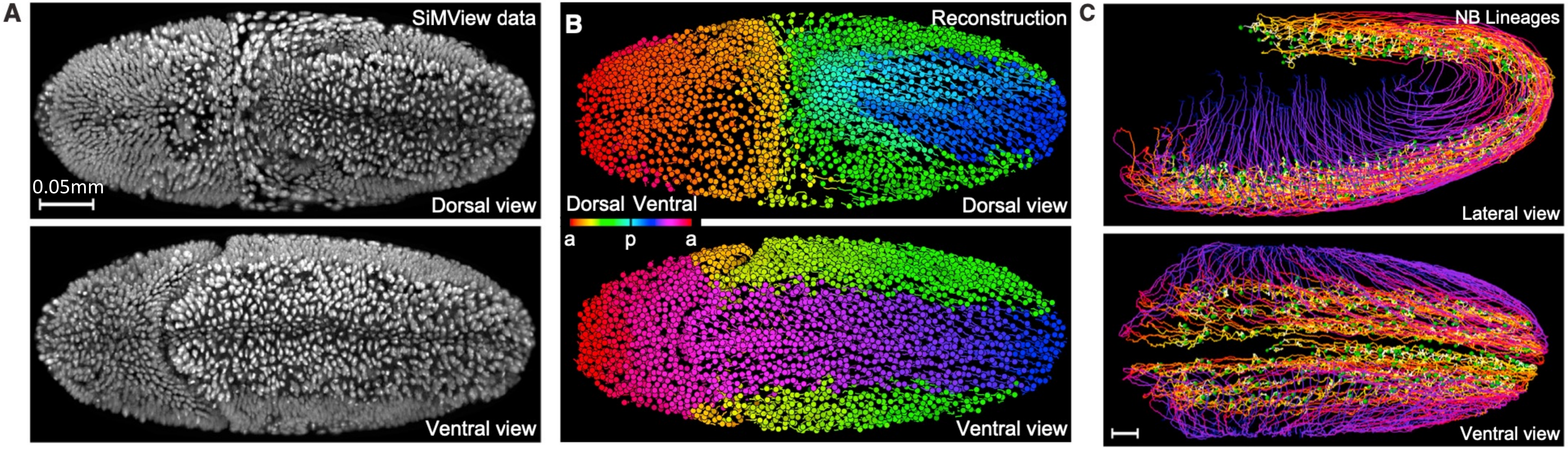
* http://celltrackingchallenge.net

Cell Tracking Challenge



https://www.nature.com/articles/nmeth.4473.epdf?author_access_token=Mj5kggiDp2htInd5UyiRltRgN0jAjWel9jnR3ZoTv0NWiTJxsvvXxc9w-srxwdrk7HK6uGWKgYfqUE8omSsDqffjaFMcGZi1tPx9FWzw6hGdqQSmtqPCWlM95fEuI67f

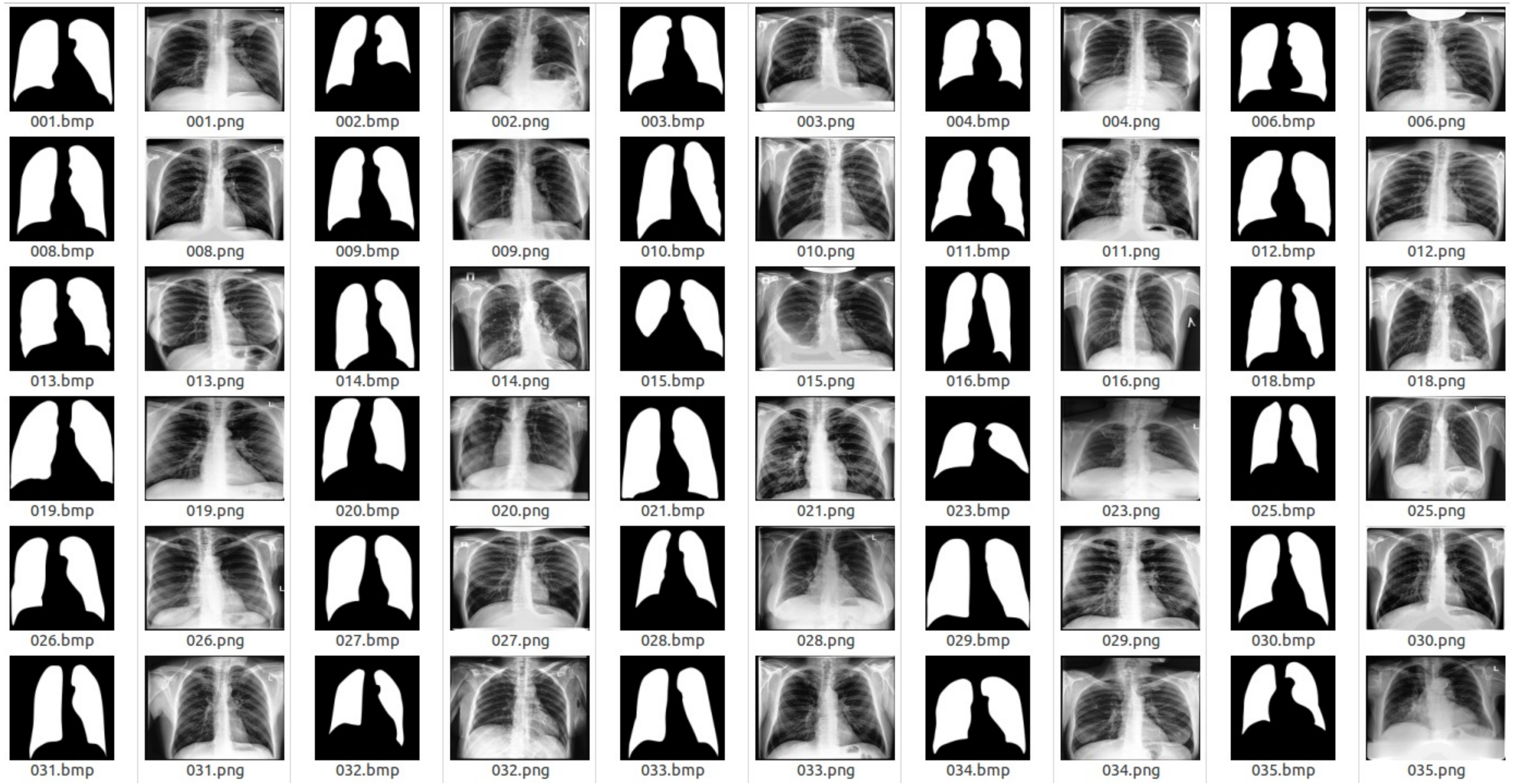
Cell Tracking



Tracking the development of the fruit fly nervous systems (2.9-5.4 hours after egg laying)

Keller and Ahrens (2015) Cell

Deep Neural Networks für X-Ray - Image Segmentation



https://www.altoros.com/blog/experimenting-with-deep-neural-networks-for-x-ray-image-segmentation/

Medicine - X-Rays

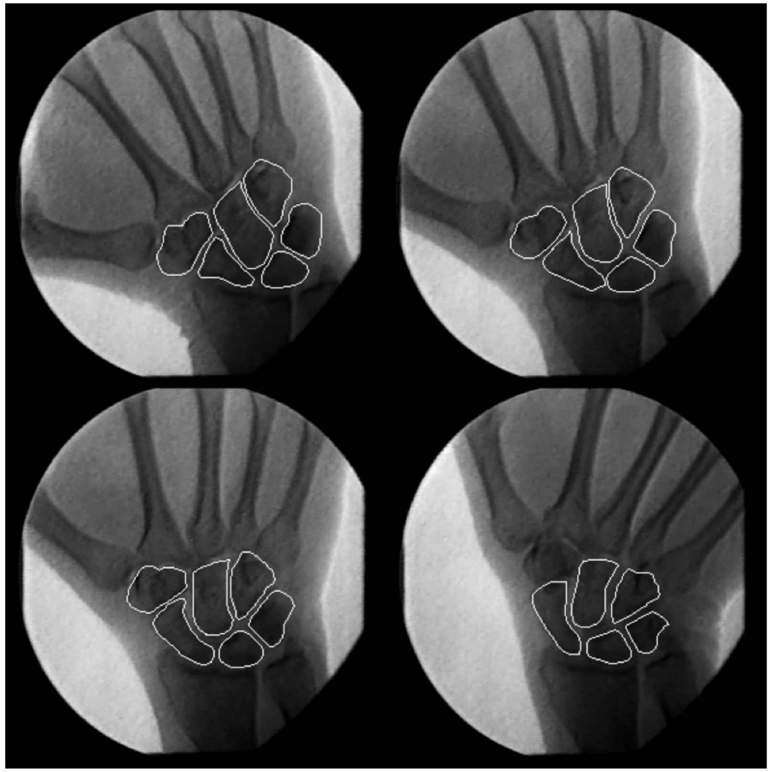


Fig. 5. Carpal Bone Segmentation from X-ray

Spiller, J. M., & Marwala, T. (2007). Medical image segmentation and localization using deformable templates. In *World Congress on Medical Physics and Biomedical Engineering 2006* (pp. 2292-2295). Springer, Berlin, Heidelberg.

Medicine - MRI Imaging

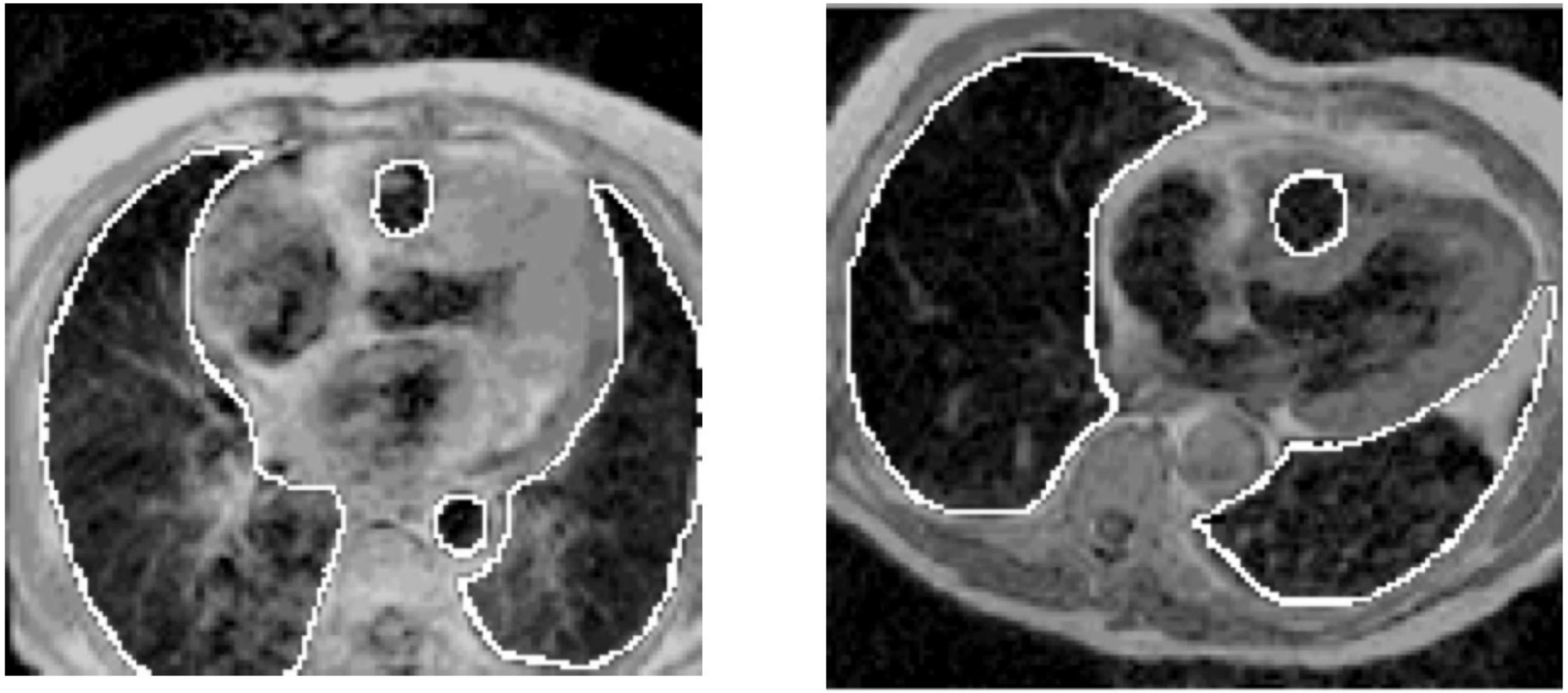
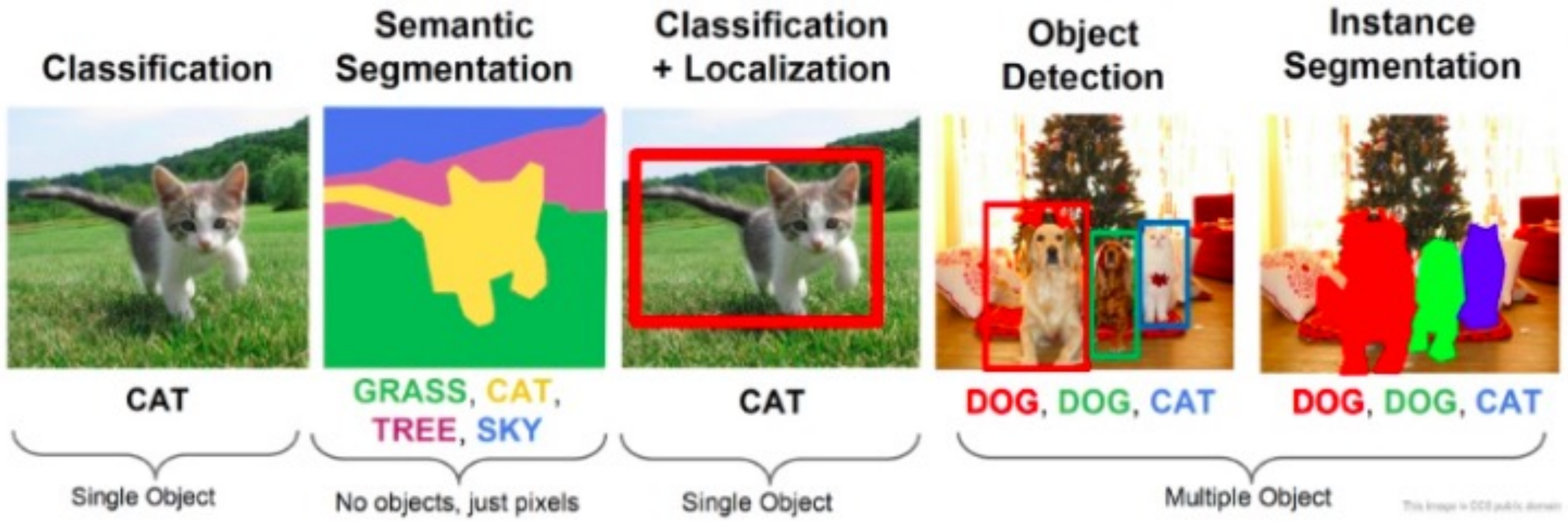


Fig. 4. Cardiac MRI segmentation.

Spiller, J. M., & Marwala, T. (2007). Medical image segmentation and localization using deformable templates. In *World Congress on Medical Physics and Biomedical Engineering 2006* (pp. 2292-2295). Springer, Berlin, Heidelberg.



http://cs231n.stanford.edu/slides/2017/cs231n_2017_lecture11.pdf

Tomorrow

Generative AI

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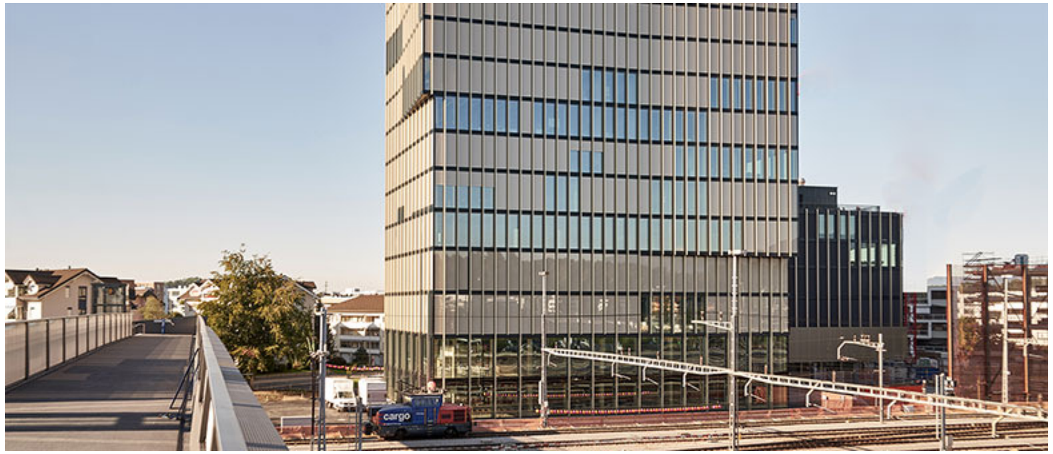
Generative AI

https://thispersondoesnotexist.com/

Image to caption

a tall building with a lot of windows



Check: https://www.analyticsvidhya.com/blog/2021/12/step-by-step-guide-to-build-image-caption-generator-using-deep-learning/

https://compressjpg.net/image-to-caption/

Caption to image

A nice beach with lots of trees

https://picsart.com/create

Generative AI in Photoshop

Generative Fill

Source: https://www.adobe.com/products/photoshop/generative-fill.html

Generative Expand

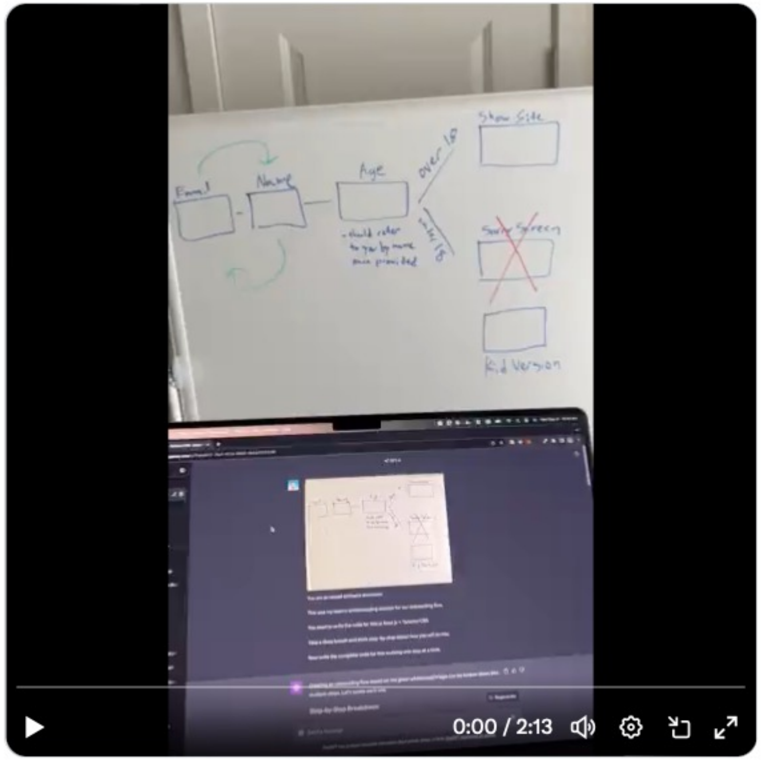
Source: https://helpx.adobe.com/photoshop/using/generative-expand.html

Image to Code

Mckay Wrigley
@mckaywrigley

You can give ChatGPT a picture of your team's whiteboarding session and have it write the code for you.

This is absolutely insane.



8:34 pm · 27 Sep 2023 · **11.3M** Views

Let’s get started

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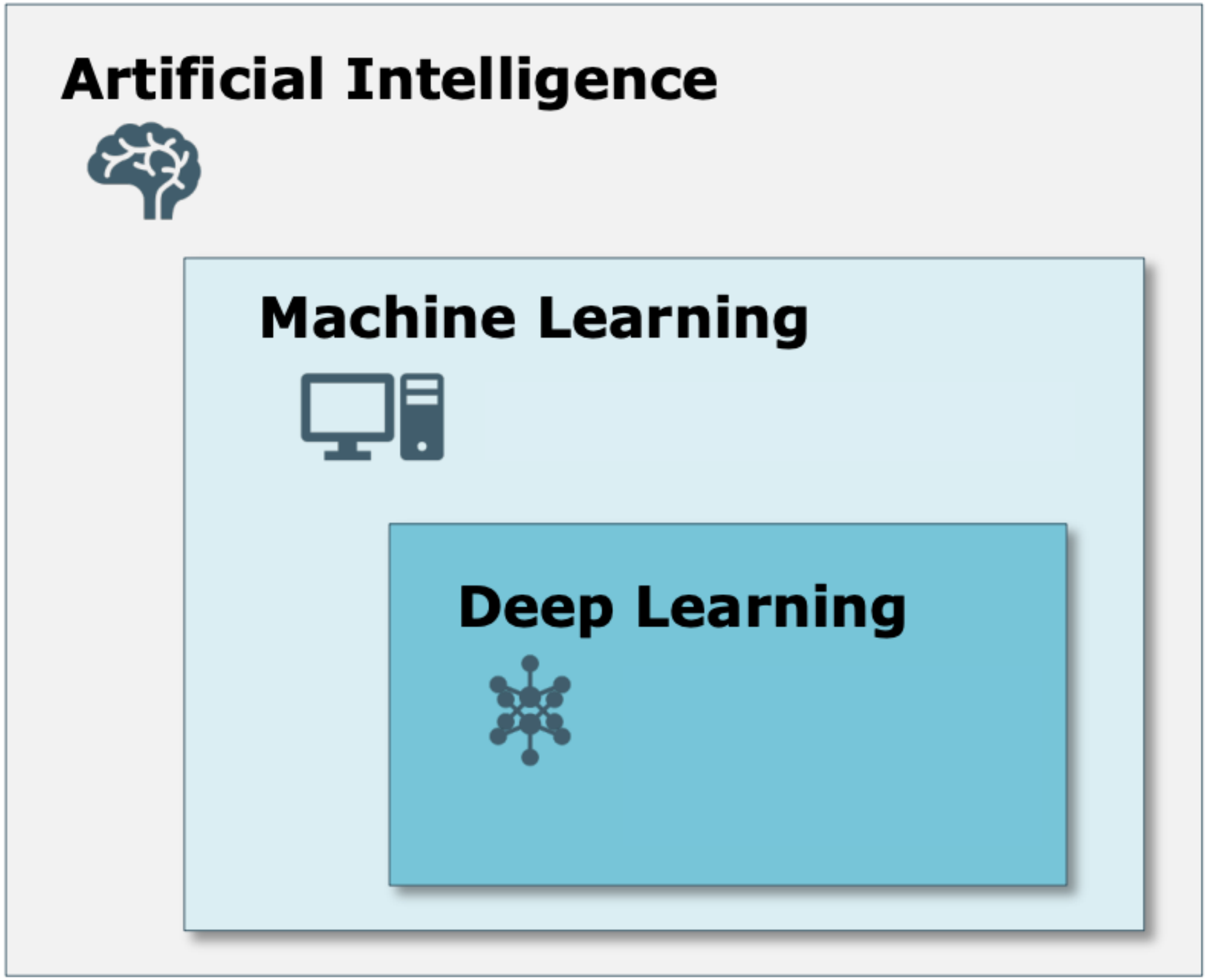
AI ≠ Machine Learning ≠ Deep Learning



Example Applications	Example Algorithms
• Boston Dynamics • IBM Deep Blue	• …
• …	• …
• AlphaGo (Go)	• …

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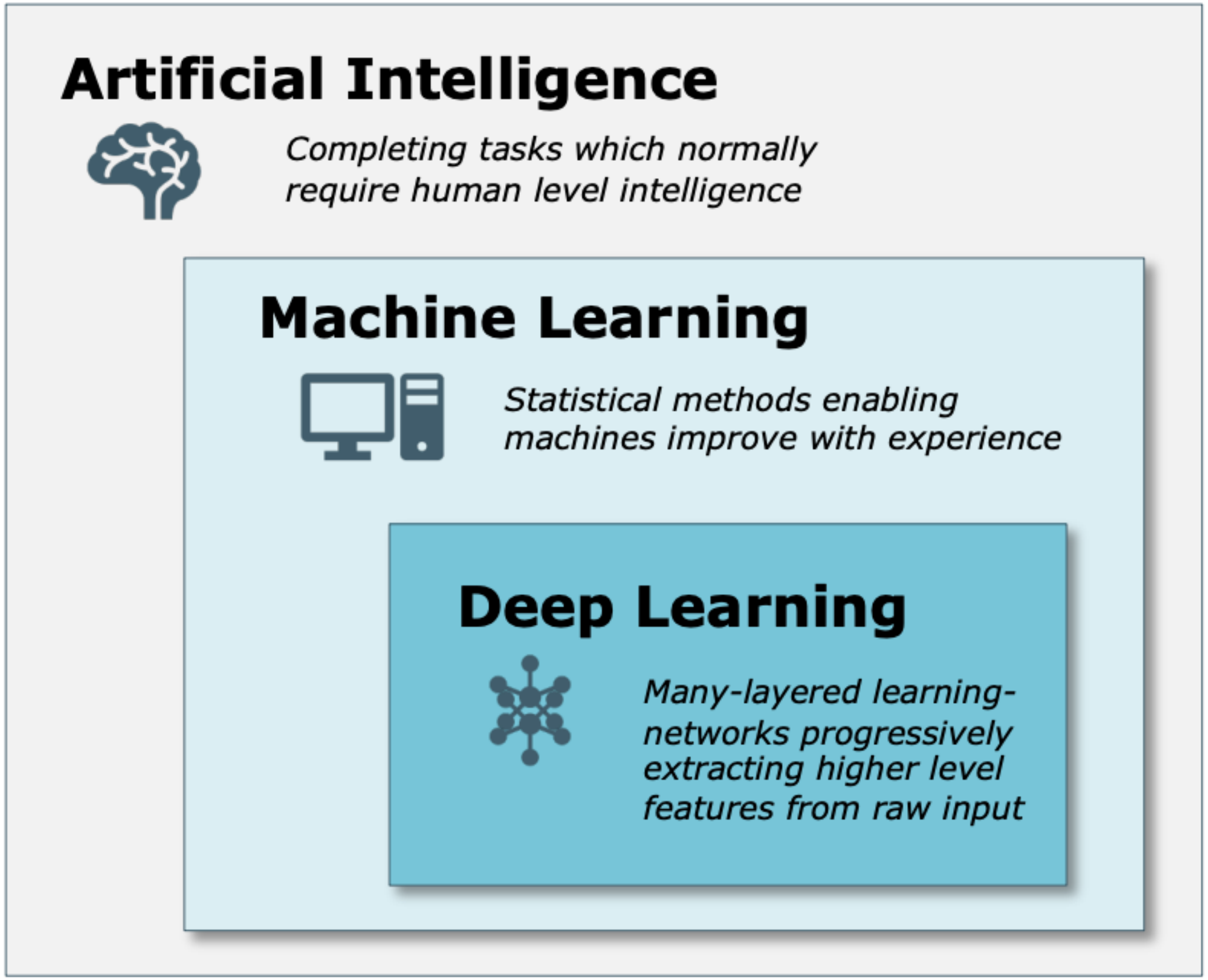

Example Applications	Example Algorithms
• Finding shortest path from A to B • 1996: Microsoft Clippy • 1997: IBM Deep Blue (chess) • Boston Dynamics robots	• Dijkstra's algorithm • Inferring user goal from text using predefined word-goal relationships • Rules and variables defined by chess masters
• Face detection in digital cameras • Product recommendations • Text classification	• Viola-Jones algorithm • Collaborative filtering • Support vector machines • Decision trees / random forests
• Speech recognition • AlphaGo • Playing Atari games • Odor recognition • Protein folding	• Convolutional neural networks • Recurrent neural networks / long short-term memory (LSTM) • Deep reinforcement learning • Graph neural networks

Key Components of a Deep Learning System

- Neurons
  - Non-linear transformation (threshold, sigmoid, rectified linear)
    - Everything, except for a line in the input-output plot
    - Important to gain from additional layers
  - Connected with certain strength (”weight”)
    - Strength is learned specifically for a task
- Organized in multiple layers
- …

Key Components of a Deep Learning System

- Artificial neural network
  - Neurons
    - Non-linear input-output transformation
    - Communicate via connections of different strengths (“weight”)
  - Organization of neurons (“architecture”)
    - Few layers with many neurons? (sufficient: universal function approximation)
    - Many layers with fewer neurons? (deep! more practical)
    - Encodes assumptions of input-output relationship (“inductive bias”)
- Specific to the task
  - Training data
    - Supervised learning requires (input, output) pairs
    - Large amounts thereof
  - Loss function
    - Given an input, how strongly the produced output differs from the target output?
- Learning algorithm
  - Change the weights such that loss function is minimized over training data
  - Gradient descent. Gradients are computed using the ”backpropagation” algorithm.

Learning from Data

1. **Supervised Learning**
   – The algorithm is given labeled training data
   – The algorithm learns to predict the label of yet unseen examples
2. **Unsupervised Learning**
   – The algorithm is given unlabeled data
   – The algorithm detects and exploits the inherent structure of the data
3. **Reinforcement Learning**
   – The algorithm is guided by a reward function
   – It searches the ideal behavior that maximizes the agent's reward