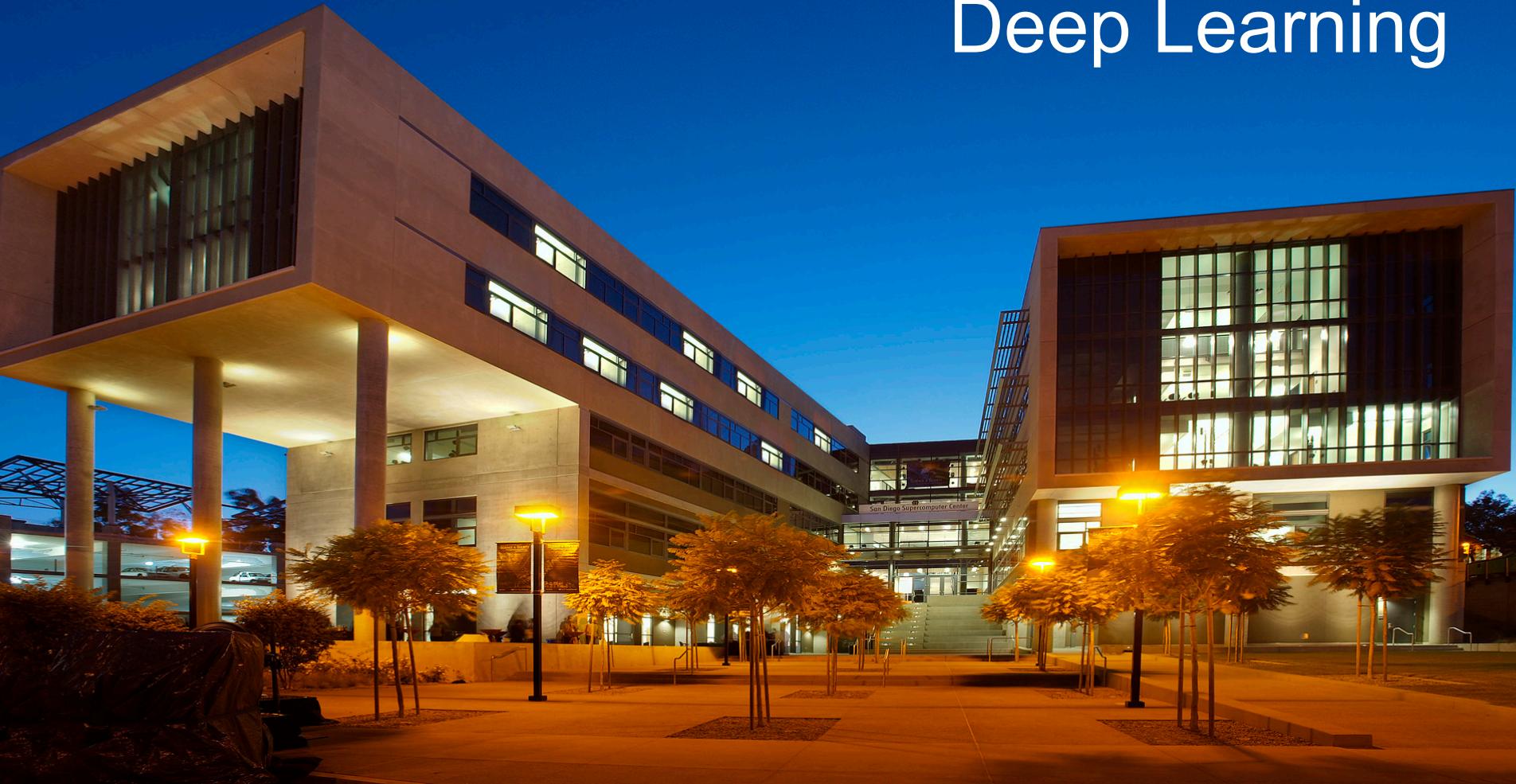


2018 Summer Institute Deep Learning



U-Net and LSTM

Mai H. Nguyen, Ph.D.

U-Net

Image Segmentation

- Dividing image into multiple salient image regions
 - Assign label to every pixel in image
 - Pixels with same label are similar

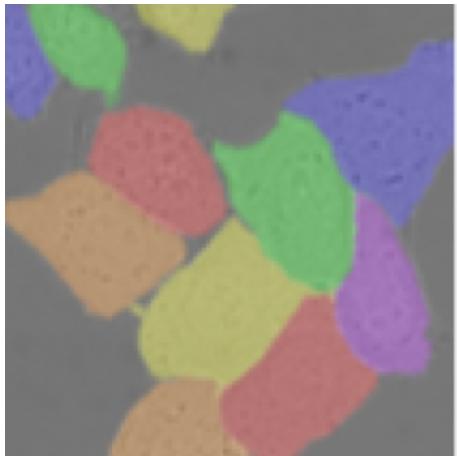


<https://medium.com/@keremturgutlu/semantic-segmentation-u-net-part-1-d8d6f6005066>

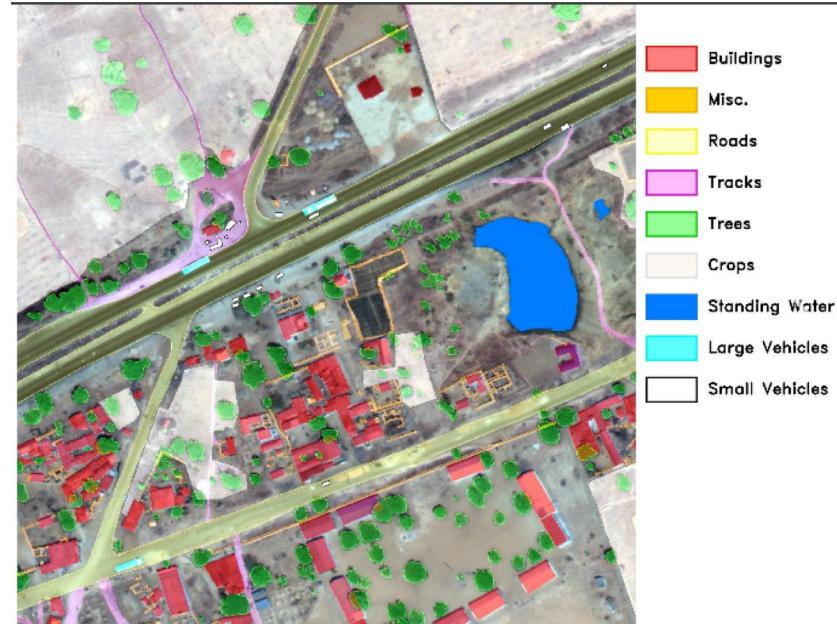
U-Net

- **Used for image segmentation**
- **Architecture**
 - Encoder-decoder network
 - Contracting part of network performs feature extraction
 - Encoding path
 - Expansion part of network performs segmentation
 - Decoding path

U-Net Applications



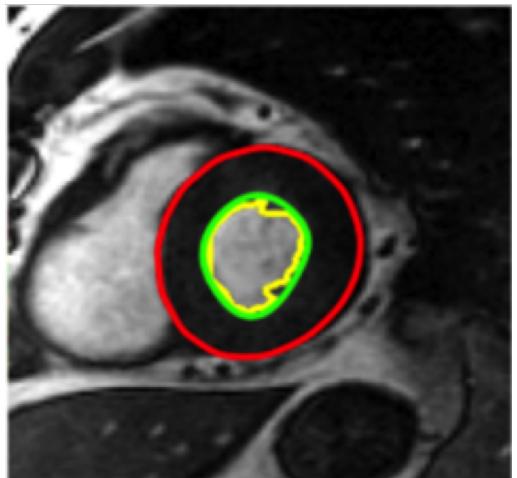
Biomedical Segmentation



Satellite Image Processing

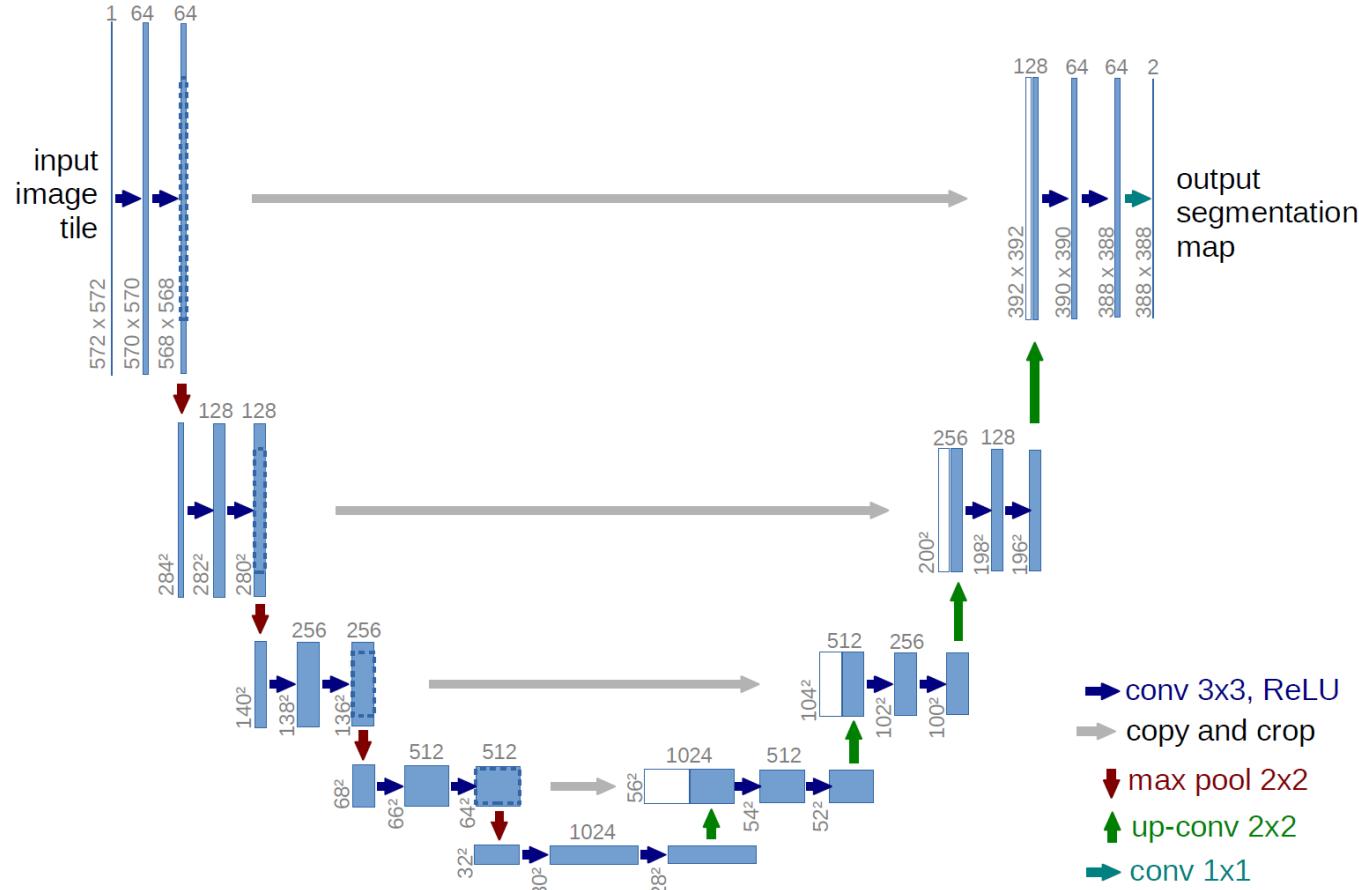


Object Detection



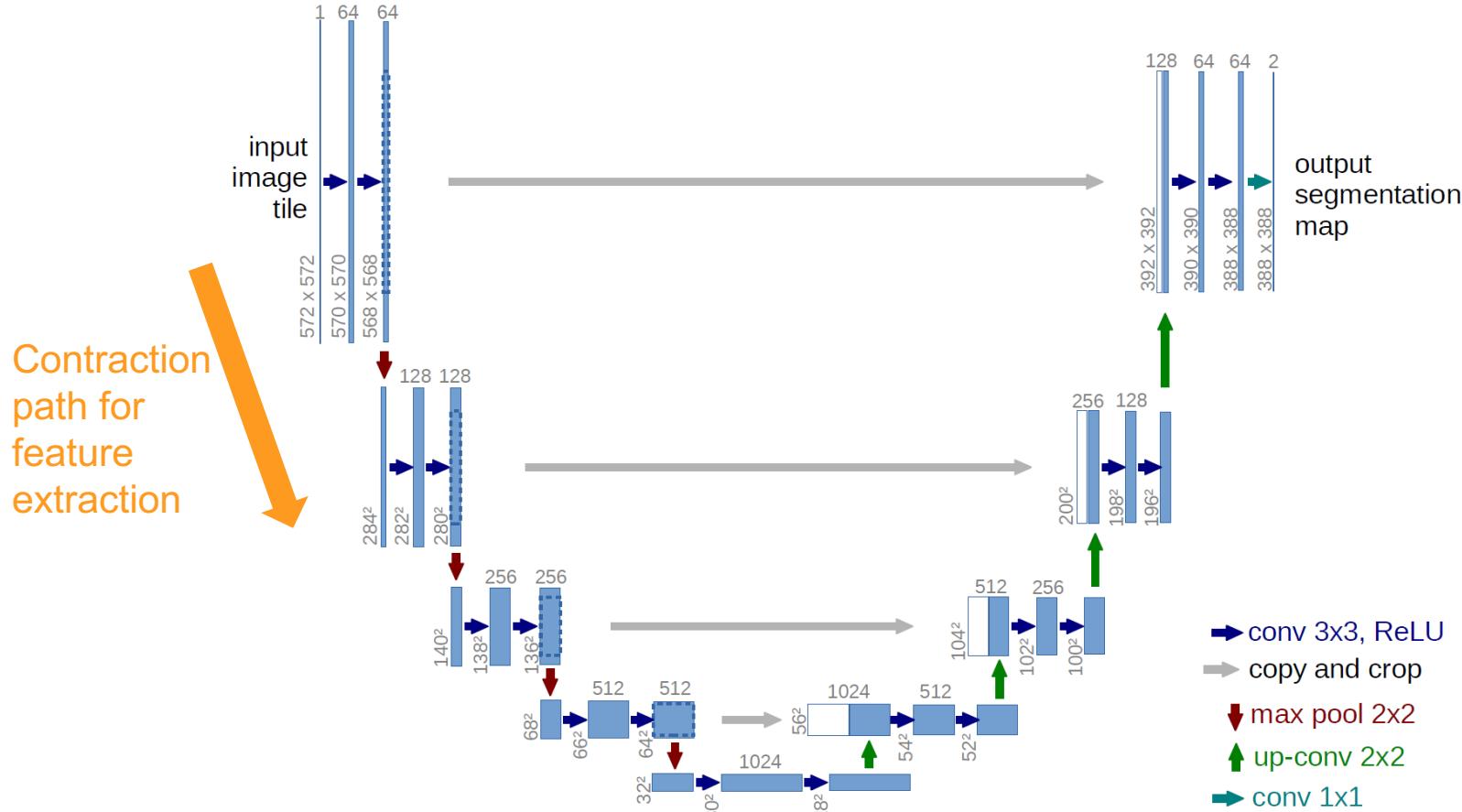
Medical Image Analysis

U-Net Architecture



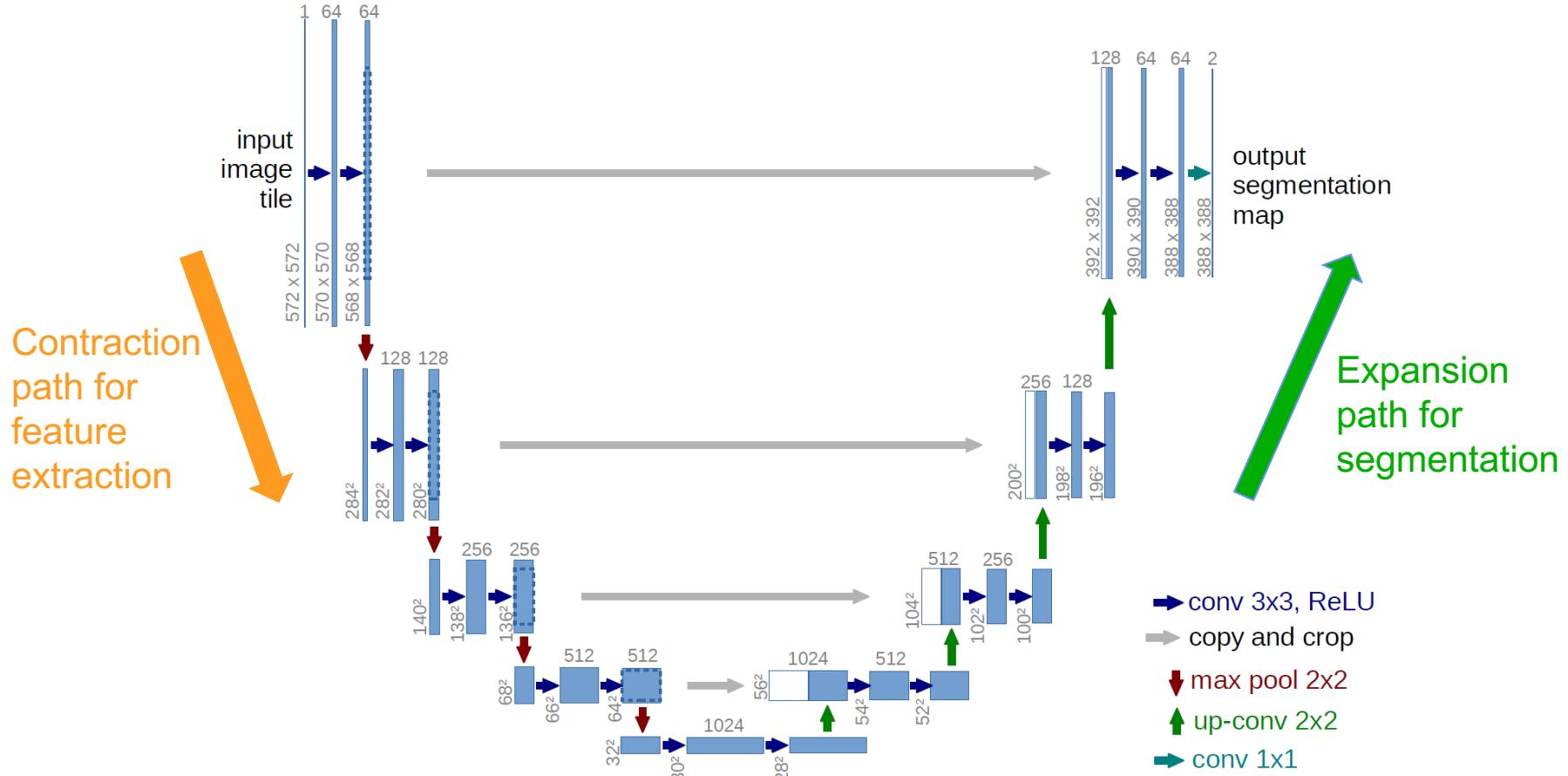
<https://lmb.informatik.uni-freiburg.de/people/ronneber/u-net/>

U-Net Architecture



<https://lmb.informatik.uni-freiburg.de/people/ronneber/u-net/>

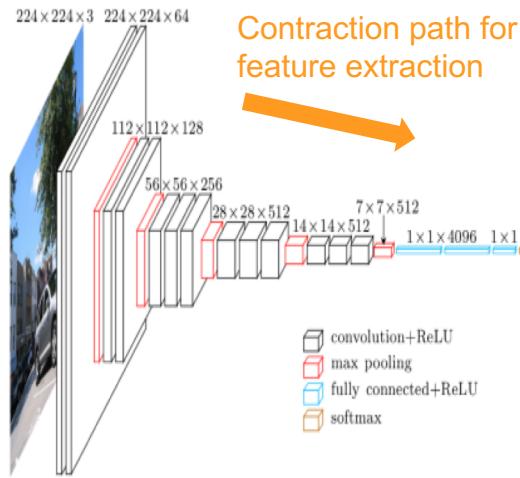
U-Net Architecture



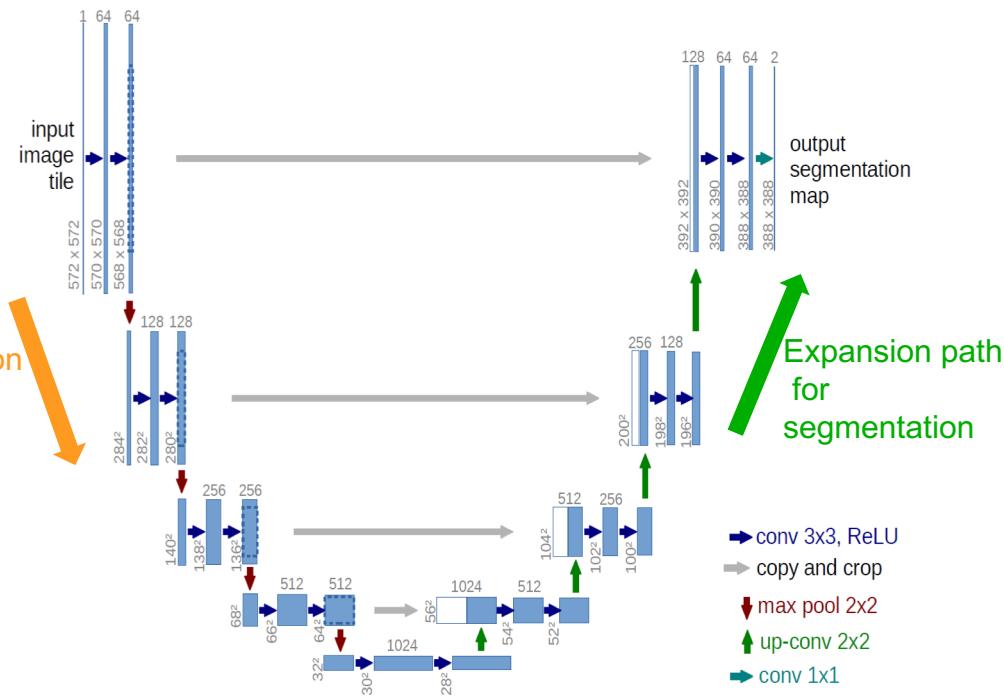
<https://lmb.informatik.uni-freiburg.de/people/ronneber/u-net/>

U-Net Architecture

VGG16 CNN Architecture



U-Net Architecture



<https://spark-in.me/post/unet-adventures-part-one-getting-acquainted-with-unet>.

<https://imb.informatik.uni-freiburg.de/people/ronneber/u-net/>

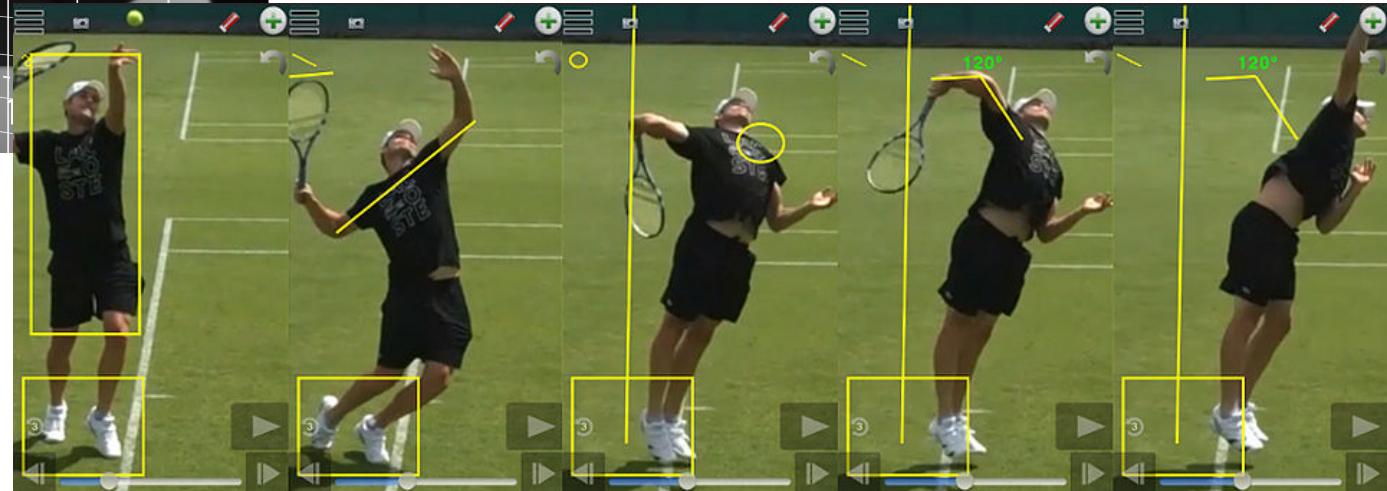
LSTM

Sequence Learning

- Problem description
 - Learning a signal with an ordering or time component

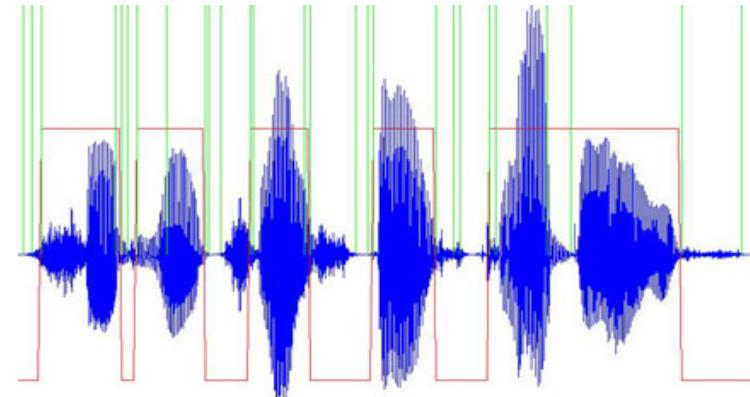


Stock Price



Video

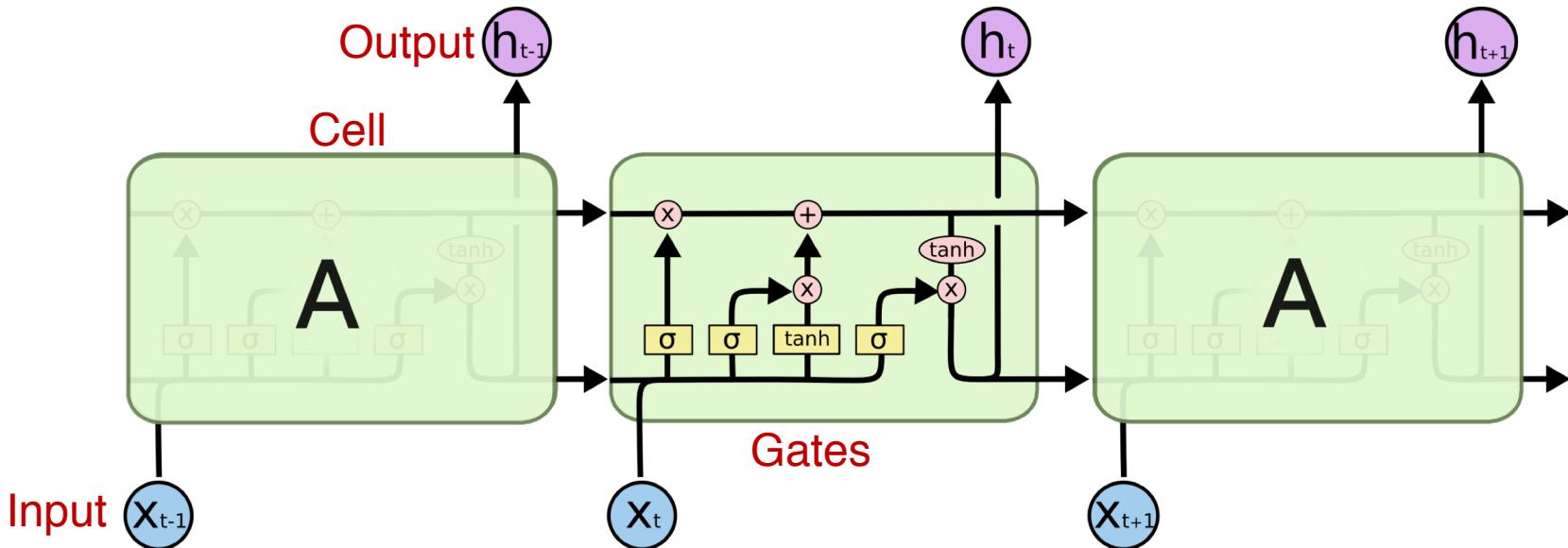
Speech



Long Short-Term Memory (LSTM)

- **Recurrent neural network (RNN)**
 - RNNs can model sequences and time-dependent signals
 - RNN architectures have cyclic connections that feed network activations from a previous time step as part of input back to network
 - Allows for temporal contextual information to be stored
 - Predictions at current time step depend on current input and previous predictions
 - Context required must be learned
- **LSTM**
 - Type of RNN
 - Addresses important issues with conventional RNN training

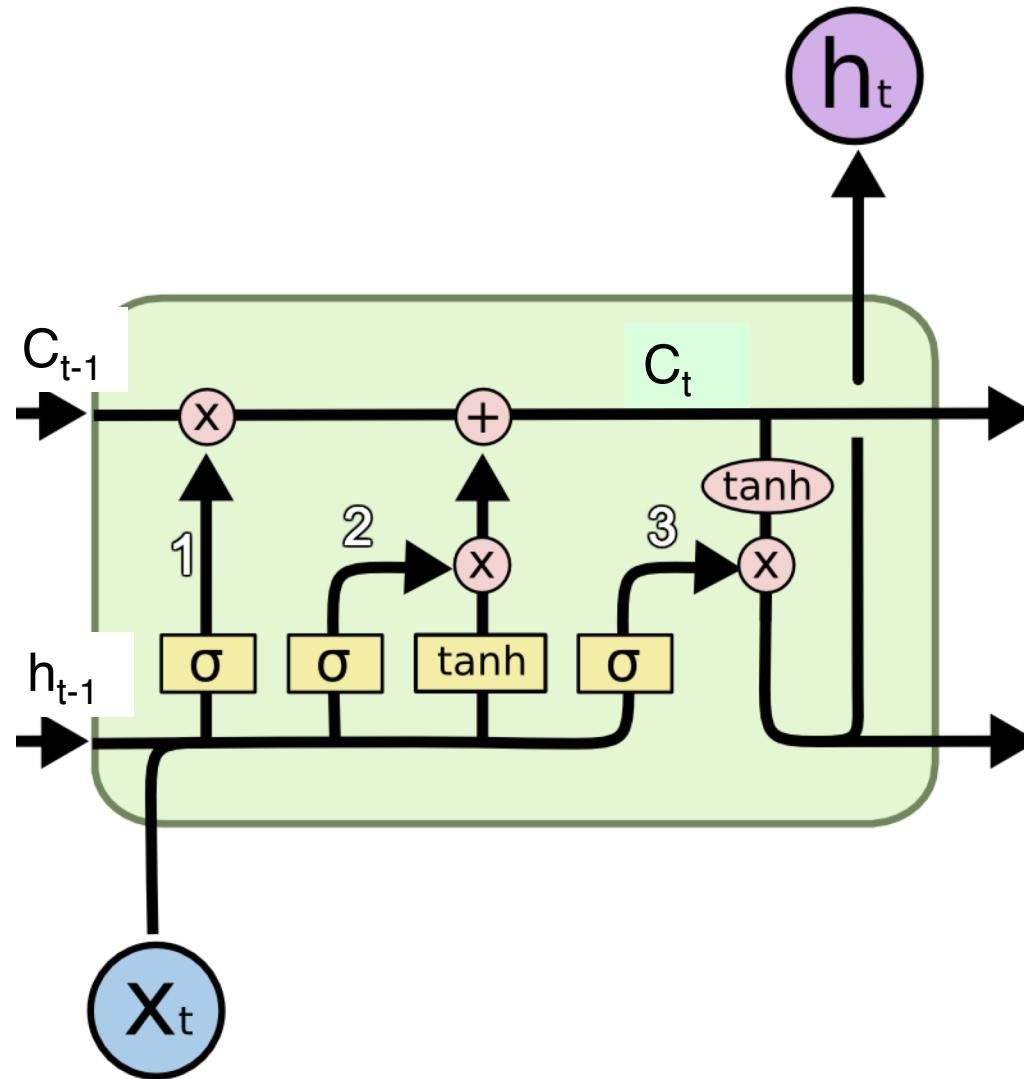
LSTM Architecture



<http://colah.github.io/posts/2015-08-Understanding-LSTMs/>

- Info flows through memory blocks called ‘cells’
- Structure of cell allows LSTM to selectively remember/forget pieces of information
- Each cell manipulates memory through ‘gates’

LSTM Cell



- X_t
 - Current input
- C_{t-1}
 - Memory from last cell
- h_{t-1}
 - Output from last cell
- h_t
 - Current output
- **1: forget gate**
 - Removes info
- **2: input gate**
 - Adds info
- **3: output gate**
 - Selects useful info as output

LSTM Applications

- Speech recognition
- Machine translation
- Language modeling
- Speech synthesis
- Handwriting recognition
- Text generation
- Video analysis
- Protein structure prediction
- Stock price prediction

References

- **U-Net**
 - Original paper:
 - <https://arxiv.org/abs/1505.04597>
 - Short description and video:
 - <https://lmb.informatik.uni-freiburg.de/people/ronneber/u-net/>
 - U-Net & Keras
 - <https://spark-in.me/post/unet-adventures-part-one-getting-acquainted-with-unet>
 - U-Net for medical image segmentation
 - <https://towardsdatascience.com/medical-image-segmentation-part-1-unet-convolutional-networks-with-interactive-code-70f0f17f46c6>
 - U-Net for satellite analysis
 - <https://medium.com/vooban-ai/satellite-image-segmentation-a-workflow-with-u-net-7ff992b2a56e>

References

- **LSTM**
 - Original paper
 - <https://www.mitpressjournals.org/doi/abs/10.1162/neco.1997.9.8.1735>
 - Understanding LSTM Networks
 - <http://colah.github.io/posts/2015-08-Understanding-LSTMs/>
 - Introduction to LSTM
 - <https://www.analyticsvidhya.com/blog/2017/12/fundamentals-of-deep-learning-introduction-to-lstm/>

Deep Learning Topics

- Deep Learning Overview
 - Neural network & deep learning overview
 - MNIST tutorial
- CNN Transfer Learning with Keras
 - Pre-trained CNN to speed up CNN training
 - Feature extraction & fine tuning
- FasterCNN
 - Object detection
- Unet
 - Segmentation
- LSTM
 - Sequence & temporal learning

Questions?

