

# Deep Learning Explained

Module 1: Introduction and Overview

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Roland Fernandez, Senior Researcher, Microsoft

## **Course outline**

*what is deep learning?*

*who are the audience?*

*what to expect from this course?*

# What to expect

## Deep learning basics (6 modules):

- Module 1: Introduction and high-level modeling workflow
- Module 2: Logística regression for optical character recognition
- Module 3: Multi-layer perceptron
- Module 4: Convolution networks
- Module 5: Recurrence for time-series modeling
- Module 6: Long-short term memory (LSTM) recurrence for text modeling

## Assignments:

- 5 hands-on lab and 5 quizzes (required for certification)
- Use Python/Jupyter notebooks

## Upon completion, students will:

- Have a working knowledge of deep learning concepts and algorithms
- Be able to build deep neural network models
- Solve practical problems in AI involving large data

## **Who are the audience?**

**Data Scientists and Engineers who are new to deep learning**

**Technical Managers who are interested and involved in development of AI based technologies**

**Machine learning scientists looking to build deep models with agility and ease**

# Who are the instructors?

Sayan Pathak, PhD.

## Industry

- Principal ML Scientist @ Microsoft
- Principal Investigator, National Institutes of Health funded projects in Healthcare
- Allen Institute for Brain Sciences
- Practical ML experience in Computer Vision, On-line Advertisement, Social Networks, Neuro and healthcare informatics

## Academic

- Instructor at AI School @ Microsoft
- Affl Faculty @ University of Washington in Bioengineering / EE (from 2001)
- Affl Professor @ IIT (Indian Institute of Technology), Kharagpur in CS (from 2012)
- Courses taught:
  - Image Computing Systems, Information Retrieval, Social Computing, Machine Learning



# Who are the instructors?

Roland Fernandez



- Researcher and AI School instructor @ Microsoft

- Research Areas:
  - reinforcement learning, autonomous multitask learning, symbolic representation, information visualization, and Computer Human Interaction
  - Worked in the areas of Natural user interfaces, activity based computing, advanced prototyping, programmer tools, operating systems, and databases.
  - Actively involved in AI education efforts within Microsoft

# Programming environment

## Toolkit:

- Microsoft Cognitive Toolkit (CNTK) Tutorials with Python Notebooks



## Environments:

- Install locally (recommended)
- Use pre-installed notebooks in Azure Notebooks (CPU only) for free
- Azure Data Science Virtual Machines (sign up trial account)

## References

Deep Learning by I. Goodfellow, Y. Bengio & A. Courville, MIT Press, <http://www.deeplearningbook.org>, 2016

Stanford cs231n: <http://cs231n.github.io/>

Neural Networks Tutorials by G. Hinton  
<https://www.cs.toronto.edu/~hinton/mntut.html>

## Acknowledgement

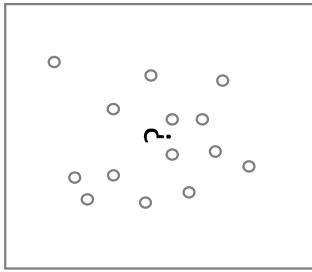
**Chris Basoglu, Ph.D., & Cha Zhang, Ph.D., @ Microsoft**  
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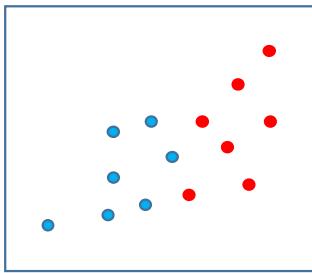
**Jonathan Savito, Content Developer @ Microsoft,**  
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**Nikos Karampatziakis, Ph.D.,**  
for help with course material preparation (especially the Text Classification tutorial).

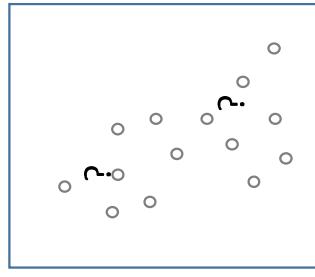
# Machine Learning (ML)



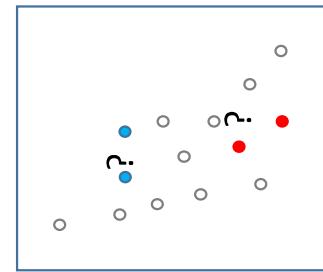
Supervised  
Learning



Semi - supervised  
Learning



Unsupervised  
Learning



# Supervised Machine Learning

Input

Model

Predicted

## Classification



SPAM  
vs.  
Not SPAM



Data: E-mail  
Label: Spam / not Spam

Categories: Spam / Not Spam

## Regression



850k

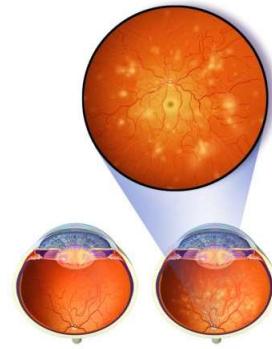
Data: House features  
Label: Price

House price: a real number

# Real-world applications

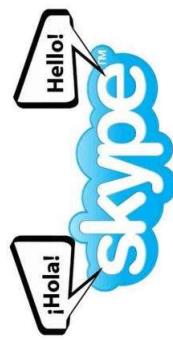
## Image

- Autonomous Driving
- Disease detection



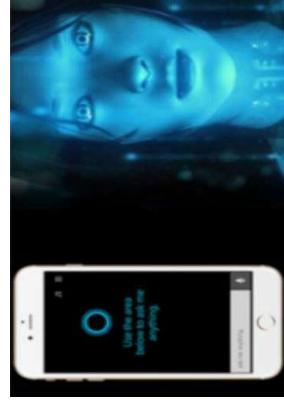
## Text

- Machine translation
- Document comprehension



## Speech

- Voice recognition
- Speech to text



[https://en.wikipedia.org/wiki/Autonomous\\_car](https://en.wikipedia.org/wiki/Autonomous_car)

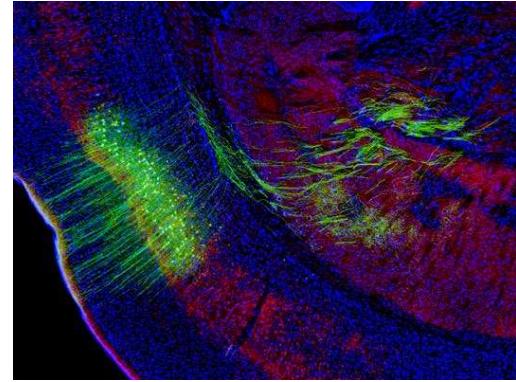
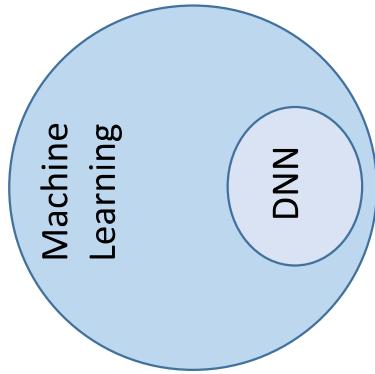
# What is deep learning?

Deep learning = Deep Neural Networks (DNN)

- Mimics several layers in the brain

Deep Neural Networks

- Have multiple layers
- Each layer learns a higher abstraction on the input from the layer before it
- Requires fitting a large number of parameters (100+ Millions)
- Facilitated by (1) large amount of data and (2) computing capabilities

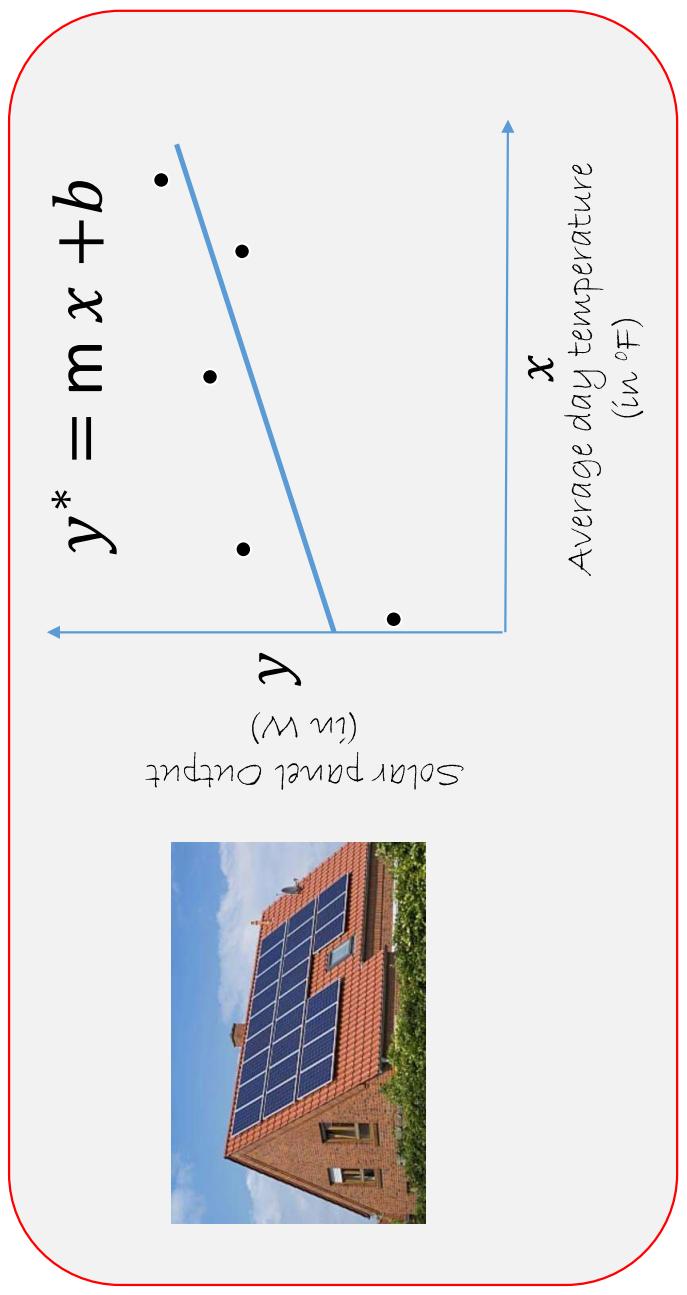


Application domains

- Image / videos
- Speech
- Text
- Multimodality and IoT data

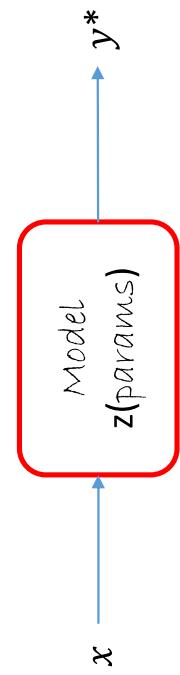
<https://www.nih.gov/news/science-news/2013/transgenic-mice-lines-aid-in-brain-circuit-imaging.shtml>

# ML recap



Model function ( $z$ )

$m$ : Slope  
 $b$ : Intercept  
are model parameters



# ML Recap

Input

Model

Predicted

## Classification



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## Regression

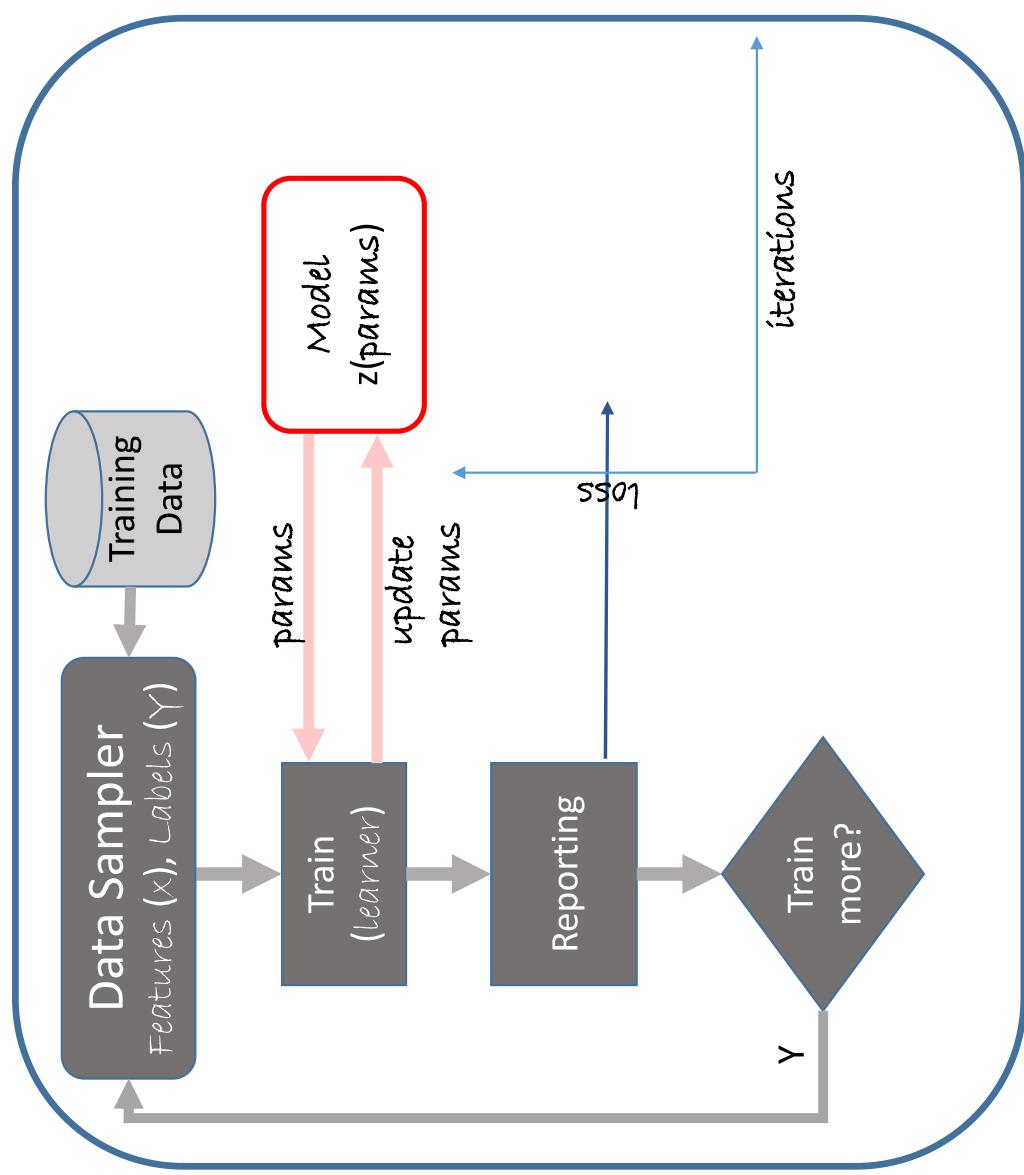


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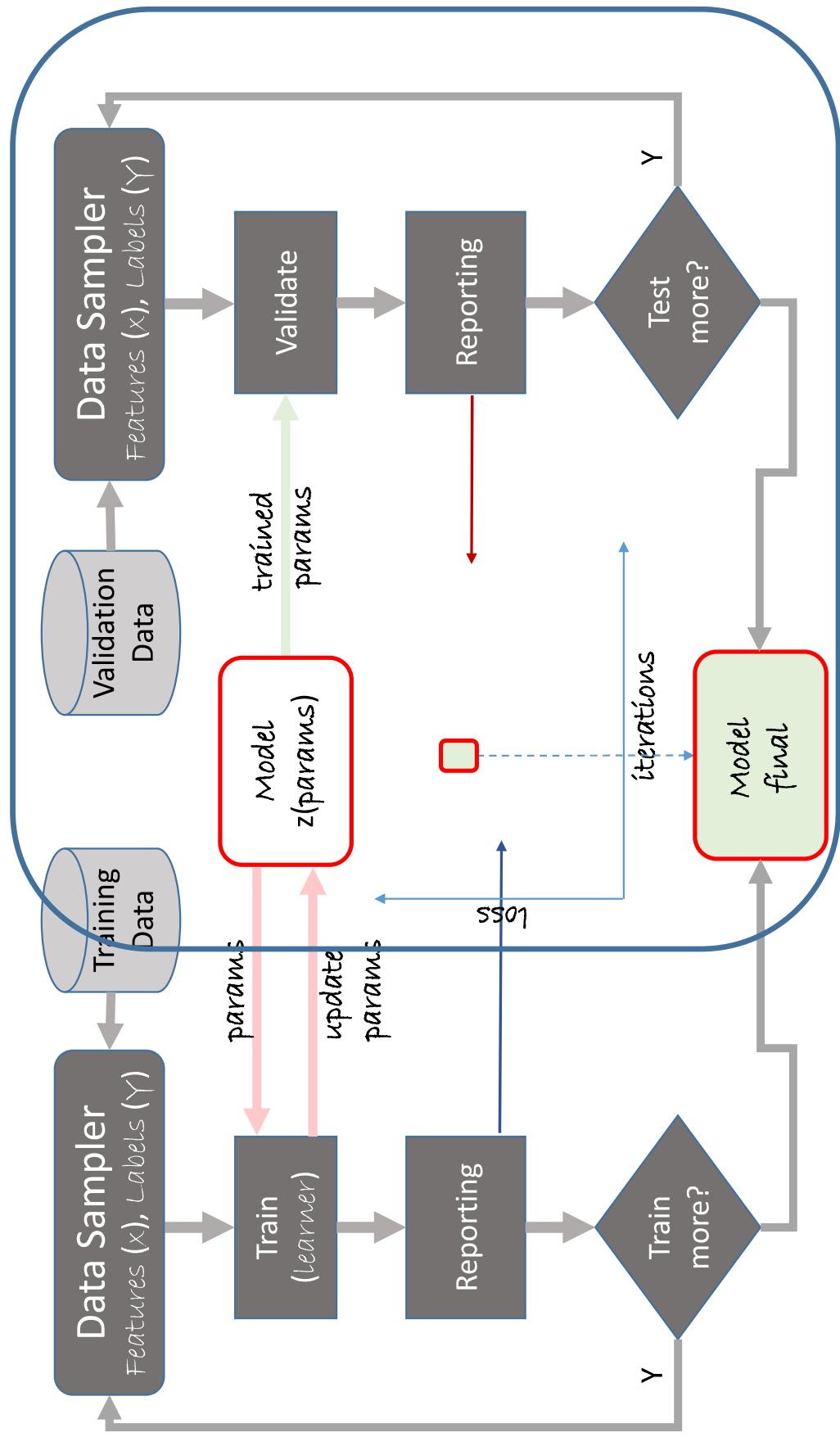
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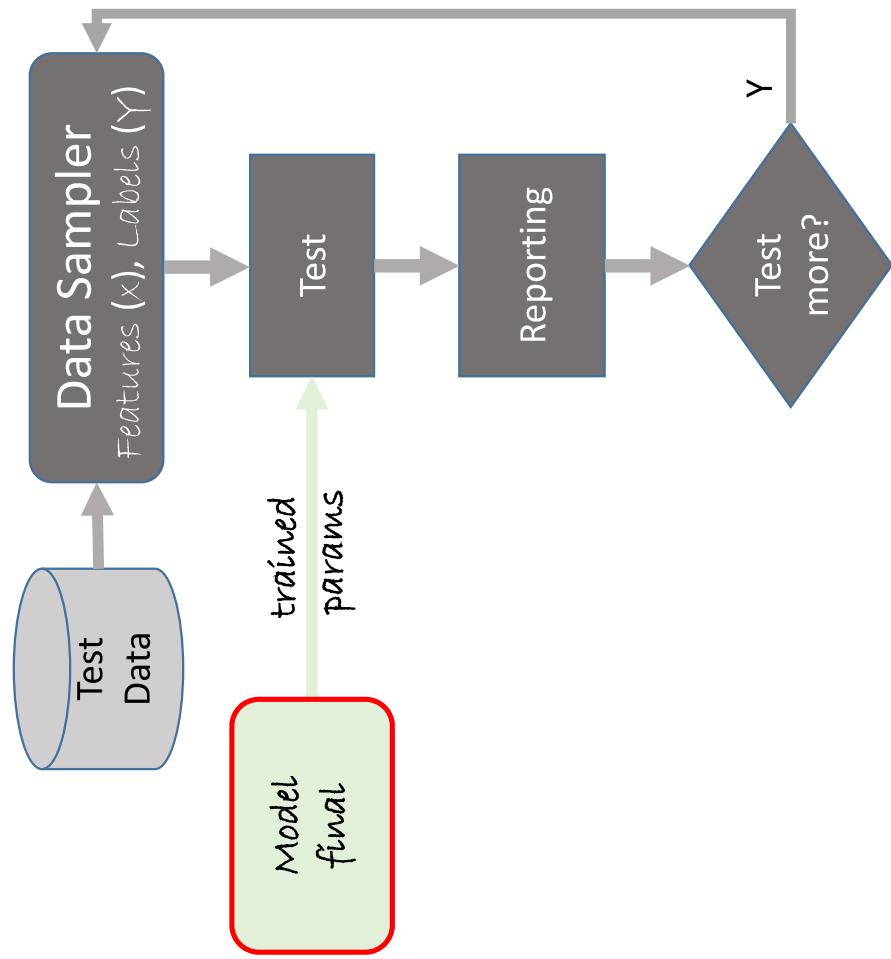
# Train Workflow



# Validation Workflow



# Test Workflow



# Where to begin with Cognitive Toolkit?

On GitHub: <https://github.com/Microsoft/CNTK/wiki>

The Microsoft Cognitive Toolkit - CNTK - is a unified deep-learning toolkit by Microsoft Research. This video provides a high-level view of the toolkit.

The latest release of the Microsoft Cognitive Toolkit 2.0 is RC1 (release candidate 1). If you are a previous user of the toolkit, see this page for more information about (breaking) changes in this release.

It can be included as a library in your Python or C++ programs, or used as a standalone machine learning tool through its own model description language (BrainScript). CNTK supports 64-bit Linux or 64-bit Windows operating systems. To install you can either choose pre-compiled binary packages, or compile the Toolkit from the source provided in Github.

Here are a few pages to get started:

- Setting up CNTK on your machine
  - Try the tutorials on Azure Notebooks with pre-installed CNTK
- Tutorials, Examples, etc.
  - The CNTK Library APIs
    - Using CNTK from Python
    - Using CNTK from C++
  - CNTK as a machine learning tool through BrainScript
  - How to contribute to CNTK
    - Give us feedback through these channels.

► Pages 200

Home

- What's new
- Breaking changes
- CNTK installation
- Python API / Docs
- FAQ
- How do I...?
- Troubleshoot CNTK

Getting Started

- Setting up CNTK
- CNTK on Azure
- CNTK Usage Overview
- Tutorials

Additional Documentation

- Examples
- Articles
- Presentations
- Conference Appearances

How to use CNTK

- Using CNTK with Python

**Seek help on Stack Overflow:**

<http://stackoverflow.com/search?q=cntk> (please add *cntk* tag)