**Deep Learning for Business**

**Deep Learning Computing Systems & Software**

# ILSVRC (ImageNet Large Scale Visual Recognition Challenge)

## ILSVRC ImageNet Challenge

### ILSVRC (ImageNet Large Scale Visual Recognition Challenge)

- Annual contest started in 2010
- Object category classification & detection

- 3 main challenges used to benchmark large-scale object recognition capability
  - 1 Object localization (top-5)
  - 2 Object Detection challenges
    - ✓ Images & Videos

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## ILSVRC ImageNet Challenge

### 1. Object Localization (top-5)

- The *original* competition of ILSVRC
  - ✓ The other two *Object Detection* challenges were included into ILSVRC recently
- Training data set: 1.2 million images
- Labeled object categories: 1,000 categories
- Test image set: 150,000 photographs
- Each competing program lists its top 5 confident labels based on each test image in decreasing order of confidence and bounding boxes for each class label

## ILSVRC ImageNet Challenge

## 1. Object Localization (top-5)

- Evaluated based on accuracy of the program's localization labeling results, the test image's ground truth labels, and object in the bounding boxes
- Program with the minimum average error is the winner

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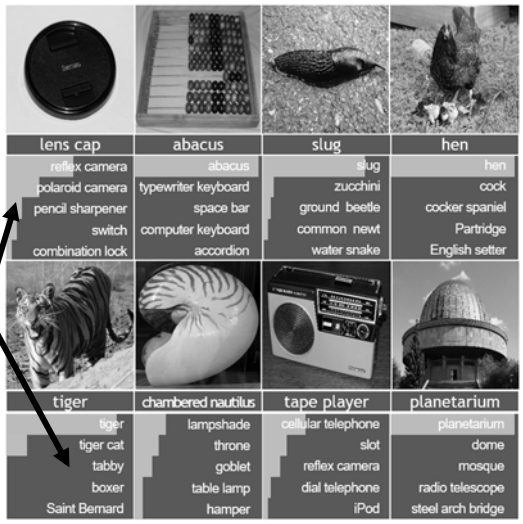
## ILSVRC ImageNet Challenge

## ILSVRC top-5 Example

- ILSVRC Object localization challenge (top-5) example
- Top-5 selections for each image listed with probability histograms

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## 2. Object Detection - Images

- Each program attempts identification of 200 basic-level categories
- Test image data set has fully annotated labels (for each bounding boxed object) on each image
- Winner is the program with the highest accuracy in annotated class labels, confidence scores, and bounding boxes

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### 3. Object Detection - Videos

- Contender program attempts identification of 30 basic-level categories
  - ✓ Subset of the 200 basic-level categories
- Each program will produce a set of annotations of frame number, class labels, confidence scores, and bounding boxes for the video clip
- Winner is the program with the highest accuracy on the most object categories

## ILSVRC ImageNet Challenge

### Participant's Program Requirements

- Each team is allowed 2 submissions per week
- No regulation on the number of neural network layers
- Learning scheme and parameters have to be based only on the training set

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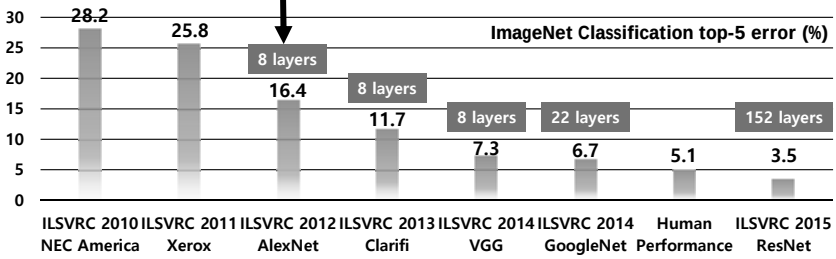
## ILSVRC ImageNet Challenge

## ILSVRC Annual Results

- Significant improvements in performance have been seen since Deep Learning has been used in 2012

- AlexNet
  - ✓ DL (Deep Learning) neural network used for the first time




## ILSVRC ImageNet Challenge

## 2012 Winner AlexNet

- Created by Alex Krizhevsky, Ilya Sutskever, and Geoffrey Hinton (University of Toronto)

- Results
  - 2011 Xerox ➔ 2012 AlexNet
    74.2% 83.6%
  - Significant 9.4% improvement in the performance in the Object Localization (top-5) competition

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## 2012 Winner AlexNet

- System Characteristics
  - DL (Deep Learning) was used for the first time
  - 8 layer DL neural network
  - 5 convolution layers
  - 3 fully connected layers
  - 60 million parameters
  - Trained for 6 days
  - Used two Nvidia GTX-580 with 3GB memory

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## 2014 Winner GoogleNet (Inception-v1)

- Results
  - 93.3% accuracy in the Object Localization (top-5) competition
  - 90% accuracy exceeded for the first time
- System Characteristics
  - 22 layer DL neural network with 5 million parameters
  - Trained for 1 week on the Google DistBelief cluster

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## ILSVRC ImageNet Challenge

## 2015 Winner Microsoft ResNet

- Results
  - 96.5% accuracy in the Object Localization (top-5) competition
  - 94.9% human accuracy level exceeded for the first time
- System Characteristics
  - 152 layer DL neural network
  - Trained for approximately 3 weeks on 4 NVIDIA Tesla K80 GPUs using a combined processing capability of 11.3 BFLOPs

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### ILSVRC ImageNet Challenge

# References

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