Deep Learning vs. Machine Learning

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$\text{Deep}_{L}earning_{1}.0$

1 Deep Learning vs. Machine Learning

1.1 Data Dependency

Deep Learning:

- Data Hungry: Requires large datasets for training.
- Example: Image classification models need labeled data.
- Public datasets:
  - **Image**: Microsoft COCO
  - **Video**: YouTube 8M (6.1 million videos)
  - **Text**: SQuAD (150,000 Wikipedia entries)
  - **Audio**: Google AudioSet (20,000,000 sound clips, 600 categories)

Machine Learning:

- Works with smaller datasets (e.g., 100 rows can be sufficient).

1.2 Hardware Dependency

Deep Learning:

- Requires powerful hardware (GPUs, TPUs).
- Uses parallel processing capabilities of GPUs (NVIDIA CUDA).
- Advanced hardware:
  - FPGA: Fast, low power, reprogrammable (e.g., Xilinx)
  - ASIC: Custom chips
  - TPU: Tensor Processing Unit (Google)
  - Edge TPU: Used in drones, smart glasses
  - NPU: Neural Processing Unit (in phones)

Machine Learning:

- Can run on less powerful hardware (CPUs).

1.3 Training Time

Deep Learning:

- High training time (can take weeks).

Machine Learning:

- Lower training time (minutes to hours).

1.4 Feature Selection

- **Machine Learning:** Requires manual feature selection.
- **Deep Learning:** Automatically performs feature extraction.

1.5 Interpretability

- **Machine Learning:** Models are generally easier to interpret.
- **Deep Learning:** Models are often considered "black boxes."

2 Factors Contributing to the Popularity of Deep Learning

2.1 Datasets

- Exponential data generation due to smartphones and affordable internet.
- Large companies label data and make it publicly available.

2.2 Hardware

- Moore's Law: Transistor sizes reduce every two years.
- Significant increase in RAM and processing power in modern devices.
- Deep Learning requires high computational power for matrix operations, which are efficiently handled by GPUs.
- Advanced hardware for deep learning includes GPUs, TPUs, FPGAs, ASICs, and NPUs.

2.3 Frameworks/Libraries

- Development of accessible frameworks/libraries has simplified the training process.
- Key frameworks:
  - TensorFlow (Google)
  - PyTorch (Facebook)
- Integration of Keras with TensorFlow has made it more accessible.
- Other tools include AutoML and Apple's CreateML for simplified model building.

2.4 Architectures

- Various deep learning architectures designed for specific tasks.
- Examples of architectures:
  - ResNet for image classification
  - BERT for text classification
  - U-Net for image segmentation
  - Pix2Pix for image-to-image translation
  - YOLO for object detection
  - WaveNet for speech generation
- Transfer learning: Using pre-trained models for specific tasks instead of training from scratch.

2.5 Community

- Deep learning has a vibrant community of researchers, practitioners, and enthusiasts.
- Contributions from the community include detailed notes, tutorials, and resources, often made using LaTeX for documentation.