Chapter 5:

Conclusions

1. Benefits of Deep learning

1. Key concepts in review
   - ✓ Deep learning isn't synonymous with AI
   - ✓ Deep learning is one of many branches of machine learning, where the models are long chains of geometric functions, applied one after the other.
   - ✓ These operations are structured into modules called layers
   - ✓ Deep learning models are typically stacks of layers.
   - ✓ These layers are parameterized by weights, which are the parameters learned during training.
   - ✓ The knowledge of a model is stored in its weights, and the process of learning consists of finding good values for these weights.

1. Benefits of Deep learning

2. What makes deep learning special within the field of machine learning

- ✓ In the span of only a few years, deep learning has achieved tremendous breakthroughs across a wide range of tasks that have been historically perceived as extremely difficult for computers:
  - Machine perception in extracting useful information from images,
  - Extracting useful information videos, sound, and more.

1. Benefits of Deep learning

3. How to think about deep learning
   - ✓ Everything is a vector: everything is a point in a geometric space.
   - ✓ Model inputs (text, images, and so on) and targets are first vectorized: turned into an initial input vector space and target vector space.
   - ✓ Each layer in a deep-learning model operates on one simple geometric transformation on the data that goes through it.

1. Benefits of Deep learning

3. How to think about deep learning
   - ✓ The chain of layers in the model forms one complex geometric transformation based on a series of simple ones.
   - ✓ This complex transformation attempts to map the input space to the target space, one point at a time.
   - ✓ This transformation is parameterized by the weights of the layers, which are iteratively updated based on how well the model is currently performing.

1. Benefits of Deep learning

4. The space of possibilities
   - Mapping vector data to vector data
     - ✓ Predictive healthcare: Mapping patient medical records to predictions of patient outcomes
     - ✓ Behavioral targeting—Mapping a set of website attributes with data on how long a user will spend on the website
     - ✓ Product quality control—Mapping a set of attributes relative to an instance of a manufactured product with the probability that the product will fail by next year

1. Benefits of Deep learning

4. The space of possibilities
   - Mapping image data to vector data
     - ✓ Doctor assistant: Mapping slides of medical images with a prediction about the presence of a tumor
     - ✓ Self-driving vehicle: Mapping car dash-cam video frames to steering wheel angle commands
     - ✓ Board game AI: Mapping Go and chess boards to the next player move
     - ✓ Diet helper: Mapping pictures of a dish to its calorie count
     - ✓ Age prediction: Mapping selfies to the age of the person

1. Benefits of Deep learning

4. The space of possibilities
   - Mapping timeseries data to vector data
     - ✓ Weather prediction: Mapping timeseries of weather data in a grid of locations of weather data the following week at a specific location
     - ✓ Brain-computer interfaces: Mapping timeseries of magnetoencephalogram (MEG) data to computer commands
     - ✓ Behavioral targeting: Mapping timeseries of user interactions on a website to the probability that a user will buy something

1. Benefits of Deep learning

4. The space of possibilities
   - Mapping text to text
     - ✓ Smart reply: Mapping emails to possible one-line replies
     - ✓ Answering questions: Mapping general-knowledge questions to answers
     - ✓ :Summarization: Mapping a long article to a short summary of the article
   - Mapping images to text
     - ✓ Captioning: Mapping images to short captions describing the contents of the images

1. Benefits of Deep learning

4. The space of possibilities
   - Mapping text to images
     - ✓ Conditioned image generation: Mapping a short text description to images matching the description
     - ✓ Logo generation/selection: Mapping the name and description of a company to the company's logo
   - Mapping images to images
     - ✓ Super-resolution: Mapping downsized images to higher-resolution versions of the same images
     - ✓ Visual depth sensing: Mapping images of indoor environments to maps of depth predictions

1. Benefits of Deep learning

4. The space of possibilities
   - Mapping images and text to text
     - ✓ Visual QA: Mapping images and natural-language questions about the contents of images to natural-language answers
   - Mapping video and text to text
     - ✓ Video QA: Mapping short videos and natural-language questions about the contents of videos to natural-language answers

The limitations of deep learning

- The risk of anthropomorphizing machine-learning models.
  - ✓ The deep learning models don't have understanding of their input in a human sense
- Local generalization vs. extreme generalization
  - ✓ Person can it extreme generalization: an ability to adapt to novel, never-before-experienced situations using little data or even no new data at all.
  - ✓ Deep learning models can local generalization: The mapping from inputs to outputs performed by a deep net quickly stops making sense if new inputs differ even slightly from what the net saw at training time.