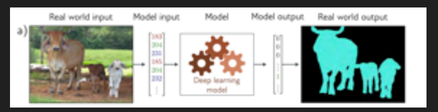
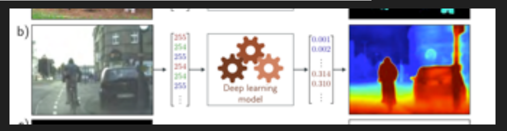
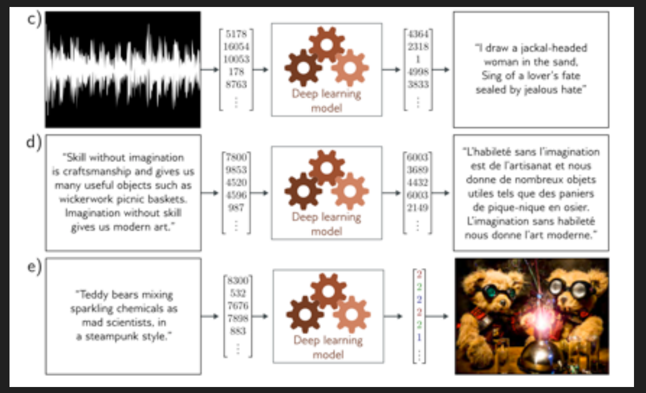
Chapter 1

Types of Problems
- Regression
  - Multivariate
- Classification
  - Binary
    - Segmentation
  - Multiclass
    - Segmentation





Deep Neural Networks
- Output types (some)
  - Single real numbers
  - Multiple numbers
  - Probabilities



Data Processing
- Audio
  - Sampled at 44.1 kHz
  - 16 bit integers
- Images
  - Concatenated RGB values per pixel
- Chemical data
  - Geometric structure of molecules + additional information per atom

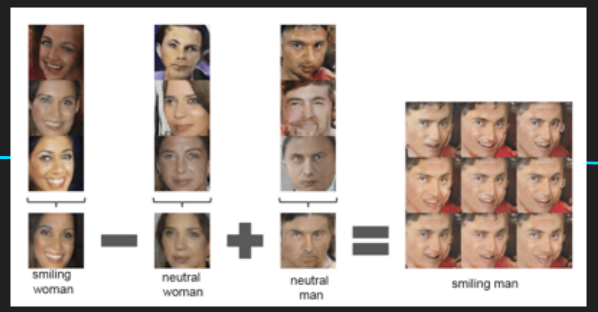
Domains
- Supervised
  - Requires labeled input/output pairs for training
- Unsupervised
  - No labels
  - Generative models
    - Synthesize new examples that are statistically indistinguishable from the training data
    - Might or might not explicitly describe the probability distribution over the input data
    - Examples
      - Image generation
        - Conditional

          - Some models can have additional constraints (eg: "diamond" ring as opposed to just a ring)

Figure 1.7 Inpainting. In the original image (left), the boy is obscured by metal cables. These undesirable regions (center) are removed and the generative model synthesizes a new image (right) under the constraint that the remaining pixels must stay the same. Adapted from Saharia et al. (2022a).

      - Inpainting
      - Chat GPT
        - Text generation
        - Conditional text synthesis
- RL
  - Agent that performs actions at every time step
  - World is not necessarily deterministic
  - Actions might or might not provide a reward
    - Temporal credit assignment
      - Reward may occur after the action
    - Exploration vs exploitation
      - Trade off between trying new things vs using it already knows
      - Not really obvious how this works directly
        - Policy network is used
  - Eg
    - Robot learning to walk
    - Chess
- Semi supervised
  - Partially labelled / semi automatic

Latent variables
- Describing each data using a smaller number of underlying values
- eg
  - Real world images can be generated from random RGB pixel values
  - A face is only a small subset of possibilities



      - (This is not from the book but I found it useful a few years ago)
- Uses
  - Image interpolation

  - Caption -> Image

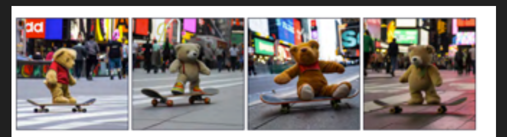


Figure 1.12 Multiple images generated from the caption "A teddy bear on a skateboard in Times Square." Generated by DALL-E-2 (Ramesh et al., 2022).

- Manifold hypothesis (also not from the book but massively helped me understand latent variables)
  - https://www.youtube.com/watch?v=BePQBWPnYuE
- Connects Supervised + unsupervised
  - Instead of a direct input -> output mapping
    - Learn relationship between latent variables
    - Why
      - Need less text/image pairs
      - Lower dimensional
      - Add Randomness
        - Generate multiple images easily

Ethics
- Bias
  - Historical bias
- Explainability
  - Somewhat easy to produce local explanations
  - Still hard to build a complex transparent system
- Weaponising
  - Existential risk
- Concentrating power
  - Companies can be assholes
  - Automating jobs