COMP250: Artificial Intelligence

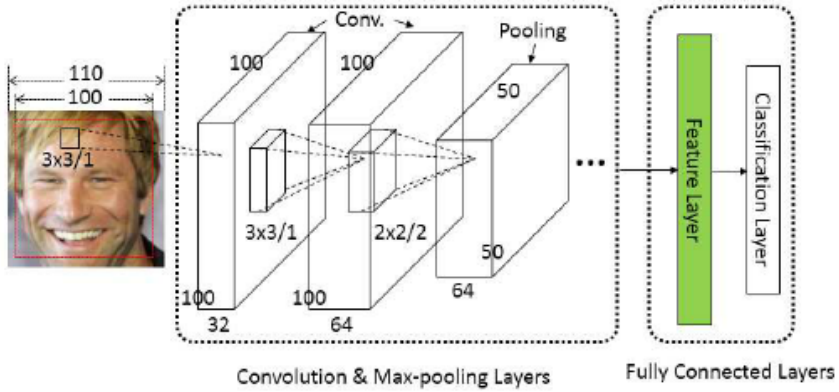
9: Deep Learning

Deep learning

Deep learning

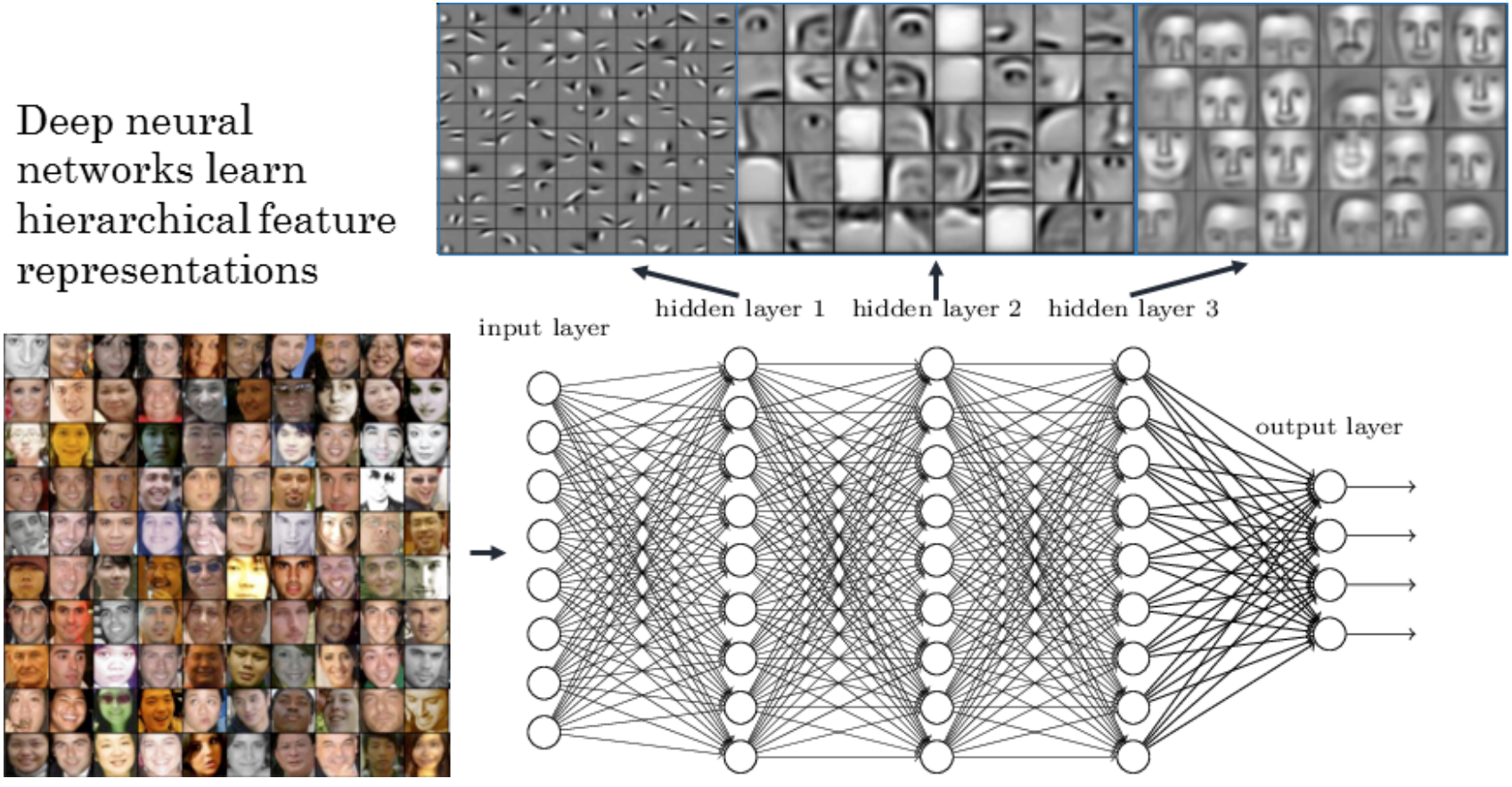
- Basically, the use of large ANNs with **many layers**
- Often uses **large training sets**
- Training often uses powerful **GPUs** — many times faster than training on the CPU

Convolutional Neural Networks (ConvNets)



- Layers are **2D arrays**
- Neurons in convolutional layers are only connected to nearby neurons
- There are also fully connected layers

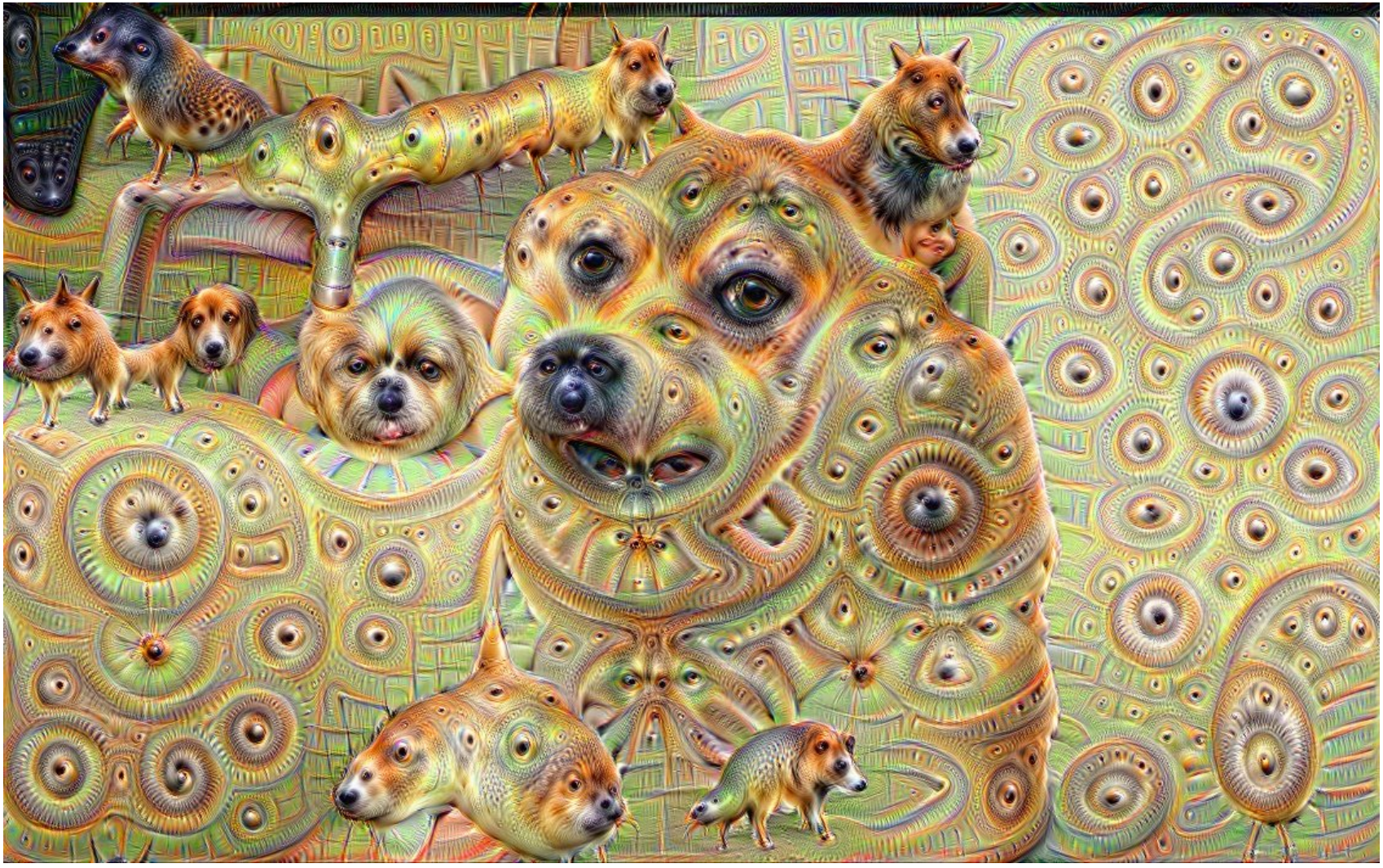
Deep neural networks learn hierarchical feature representations



DeepDream

- Train a ConvNet to recognise something (e.g. faces, objects, animals)
- Run the network in "reverse"
  - Adjust the image (e.g. via gradient ascent) so that it is more strongly recognised by the network

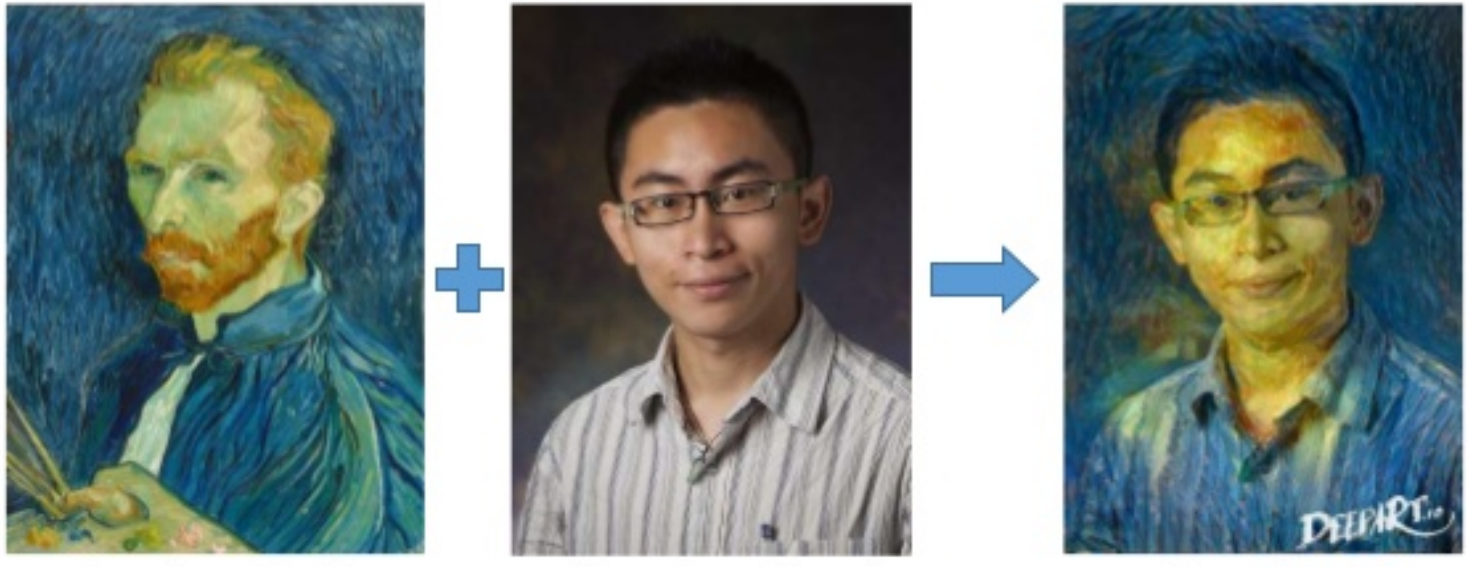
DeepDream



Style transfer

- Train a ConvNet to recognise a particular artistic style
- Run the network in "reverse" on an input image
  - Adjust the image (e.g. via gradient ascent) so that it is more strongly recognised by the network

Style transfer



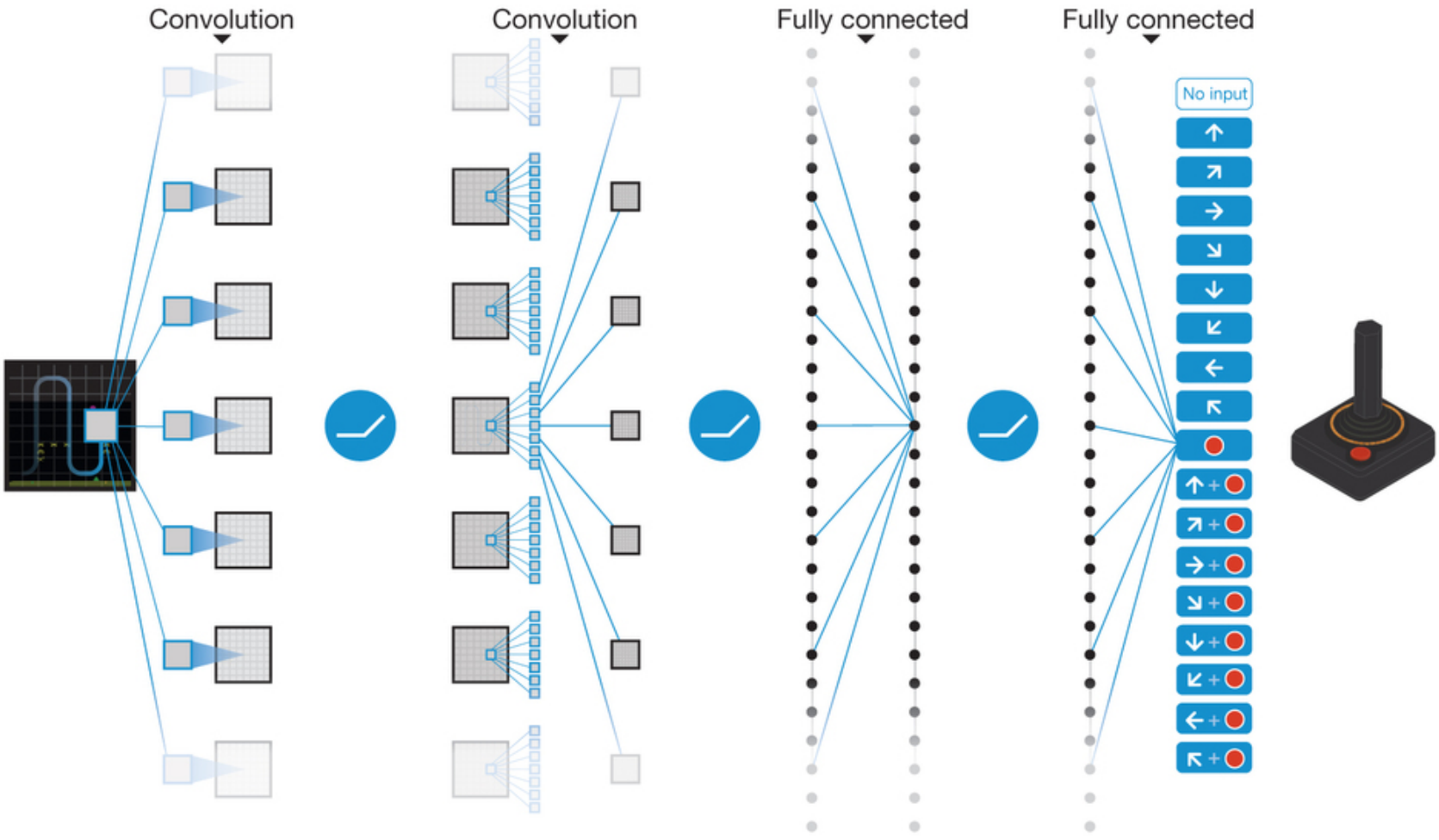
Source image (**Style**) Target image (**Content**) Output (deepart)

A Neural Algorithm of Artistic Style [Gatys et al. 2015]

Generative Adversarial Networks (GANs)

- Two ANNs trained in parallel
  - One to generate "fake" artefacts
  - One to distinguish "real" from "fake"
- `http://research.nvidia.com/publication/2017-10_Progressive-Growing-of`

Learning to play Atari games (Mnih et al, 2015)



AlphaGo (Silver et al, 2017)

- MCTS with ANNs for move pruning, simulation playouts and state evaluation
- ANNs trained on both expert human matches and self-play (reinforcement learning)
- Defeated Lee Sedol, world Go champion

AlphaZero (Silver et al, 2018)

- Similar MCTS+ANN architecture to AlphaGo
- Trained by reinforcement learning (self-play) only
- After only 9 hours* of training, defeated Stockfish (one of the strongest chess programs available) in a 100-match tournament
  - * On a cluster of 5000 of Google's custom Tensor Processing Units
- Stockfish is based on decades of research by expert chess players and AI programmers — AlphaZero started from no chess-specific knowledge whatsoever (other than the rules of the game)

Deep learning for PCG

https://www.youtube.com/watch?v=3wcpLwvBTYo