Deep Learning for Business

Deep Learning Computing Systems & Software

Google AlphaGo

Google AlphaGo

- Developed by Google DeepMind (London, U.K.)
- AlphaGo is the first Go game program to defeat professional human players
  - Go is a Chinese board game played on a 19x19 grid with White & Black stones
  - Considered the most challenging of classic games due to (19x19)!=361! possibilities

Google AlphaGo

- 2015 October
  - AlphaGo wins all 5 games over the European Go champion Fan, Hui
  - "AlphaGo Fan" used 1,202 CPUs & 176 GPUs
    - ✓ CPU: Central Processing Unit
    - ✓ GPU: Graphics Processing Unit

Google AlphaGo

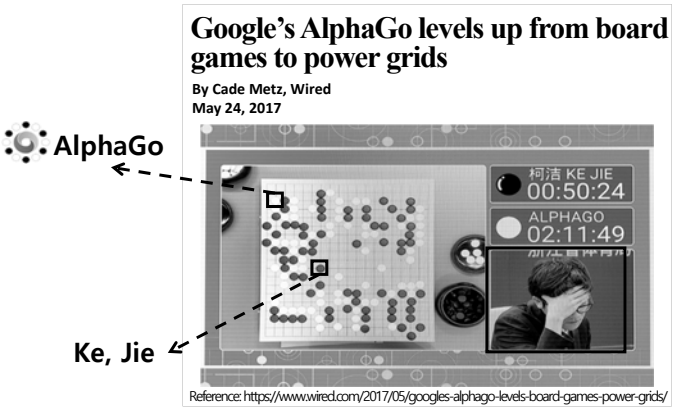
- 2016 March
  - AlphaGo won all but the fourth game (4-1) against Lee, Sedol of S. Korea, who is one of the world's top Go players
  - "AlphaGo Lee" used 50 first generation TPUs
    - ✓ TPU: Tensor Processing Unit

Google AlphaGo

- 2017 January
  - AlphaGo won all 60 unofficial online matches over the world's top Go players
  - "AlphaGo Master" used one 2nd Generation TPU
    - ✓ TPU: Tensor Processing Unit

Google AlphaGo

- 2017 May
  - AlphaGo wins all three games against the world No.1 ranked player Ke, Jie



Google AlphaGo

TPU (Tensor Processing Unit)

- Google's ML (Machine Learning) ASIC (Application-Specific Integrated Circuit) processor designed specifically for TensorFlow
- TPU 1st Generation
  - Integer calculations
  - 700 MHz clock speed

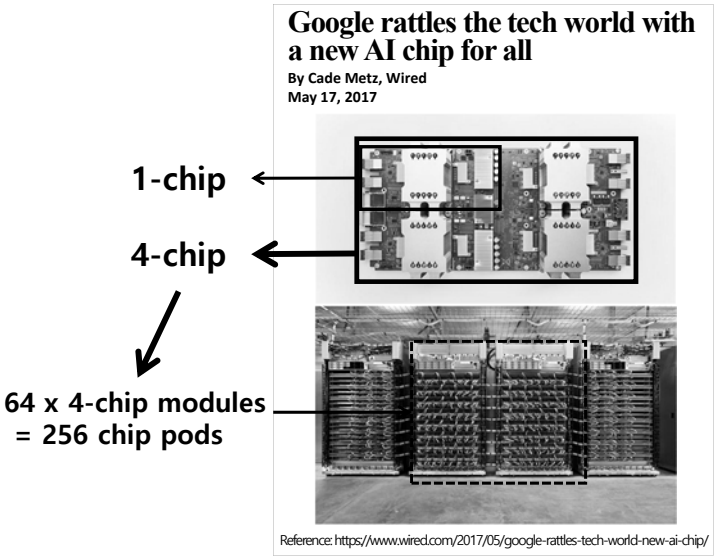
Google AlphaGo

TPU (Tensor Processing Unit)

- TPU 2nd Generation
  - Total performance 11.5 PFLOPS
    $= 11.5 \times 10^{15}$ FLOPS
    - ✓256 chip pods
    - ✓64 integrated 4-chip modules per chip pod
    - ✓1-chip module is rated at
      45 TFLOPS = 45×10^{12} FLOPS
  - FLOPS: Floating Point Operations Per Second

Google AlphaGo

TPU 2nd Generation



Google AlphaGo

TPU (Tensor Processing Unit)

- AlphaGo key technologies
  - ATS (Advanced Tree Search)
  - DNN (Deep Neural Network)

- AlphaGo Networks
  - Policy Network
    - ✓DNN that selects the next move to play
  - Value Network
    - ✓DNN that predicts the game winner

Google AlphaGo

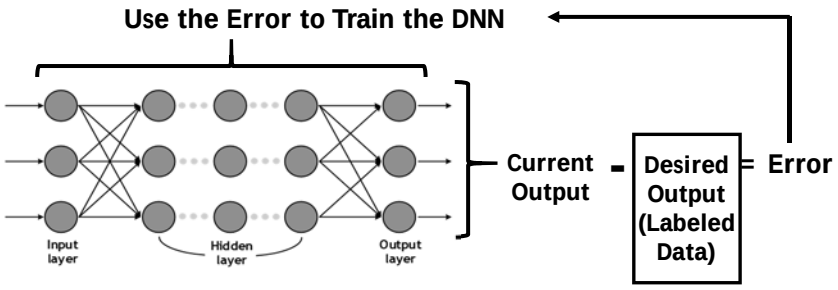
Training Process

- Training based on ATS and DNN
  - Initial training was based on **Supervised Learning** using data from 160,000 games (30 million human moves)
  - Advanced training (for AlphaGo Master) was based on **Reinforcement Learning** by playing games against itself

Training Methods

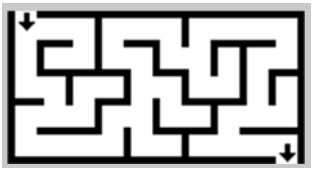
- Learning is a method used in training the weights of the DNN to make it perform in a desired way

- Supervised Learning
  - Training that uses labeled data (desired outputs)



Training Methods

- **Reinforcement Learning**
  - ✓ From Trial-and-Error, the best operation method is discovered by the DNN
  - ✓ Feedback is given back into the system
  - ✓ No labeled data is used
    - Different from Supervised Learning
  - ✓ Example: Maze Path Finding



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References

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