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Tips on neuralnet design

Reminds of the age when "quantization" was discovered in quantum physics

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1. Write down the Hamiltonian of a system
2. Quantization of the Hamiltonian
3. Solve the Schrodinger equation
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Same applies to neural net design ?

1. Write down the "traditional" solution / algorithm
2. Identify the functions/components that could be switched out by neural network
   - Functions that can be learned with data (either existing or generatable (reinforcement framework)
   - Match with a repertoire of models
     - e.g. CNN for image, RNN for sequence, VAE for generative system
   - Applying tricks to neural network, e.g.
     - Collocation of information (e.g. channel in image processing)
     - Net-merger
     - Objective function customization

Scenario to use deep learning

- large amount of **data**
  - either existing or could be generated by rules

Scenario NOT to use deep learning

- deep / contextual understanding is required

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List of unanswered questions

1. To what extent can the network learning be transferred ?
    - CIFAR10 for medical image? astronomimcal images?
2. What do we build an effective model management system
    - Repository/catalogue of neural networks
3. How much data is enough to learn the function?
4. How do we find the hyperparameters?
    - structural, e.g. number of neurons, number of layers; optimizer, e.g. learning rate, momentum; initialization
5. How to reduce the computing power needed
    - e.g. Less parameters with performance trade-off (no one knows the trade-off curve)
6. How to synergize with other technology
    - e.g. robotics
7. How to incorporate knowledge
    - Through data
8. Resillence
    - How do we make a resilent network (to attack)
        - model averaging ?
9. Better methodology to control/incorporate the sub-nets / layers
10. How to extract "knowledge" (itself a fuzzy definition) from neural network
    - e.g. convert to decision tree, rules
11. What are the other possible useful deep layers representation? Can we design / control them?
    - think neural style transfer - uses VGG. What others to use?
12. Further development of drop-out like technique
13. Further development of net-merger technique

    A. "Circuit tester"?
14. Further development of dynamic neural network topology
15. ... (many many more) ...

Neural network and Scientific method

- Is it *Science* that we use a method is unfalsifiable?
- Are we heading (again) into Big science?
    - e.g. NASA / CERN, no other people can check their result
    - Neural network uses a lot of computing power

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How to get a cheap paper in deep learning field

- Take one of the formula and slightly improve it

How to get a decent paper in deep learning field

- Come out with an architecture that fit with the data, generalize

How to get a good paper in deep learning field

- Cocktail with other algorithms
- AlphaZero = (ResNet + Reinforcement learning + MCTS)
- Variational autoencoder = (Generative network + Latent Gaussian mixture model + Variational bayesian)
- NEAT = (Simple) Neural network + Genetic algorithm

How to get a great paper in deep learning field

- Theorectical research
- Transfer concept from other fields

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