

Introduction to Machine Learning, its potential usage in network area, & the proposed NMLRG

**Proposed NMLRG
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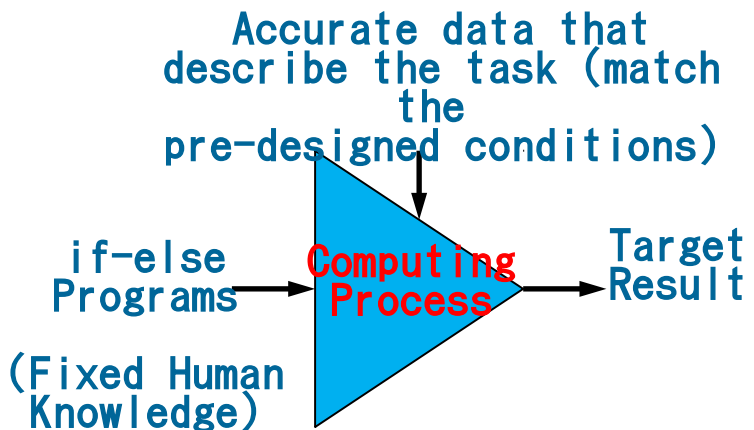
Motivation

- Networks and network problems become more and more complicated, many varieties and dynamically changing
 - Looking for new mechanism that can adapt to various and dynamic environment
 - Looking for autonomic mechanism to replace human operations, even human programming
- Machine learning was also motivated by tasks that are extremely difficult to program by hand
 - Advantages: robustly solve complicated tasks, reliance on real-world data instead of pure intuition, be able to adapt to new situations

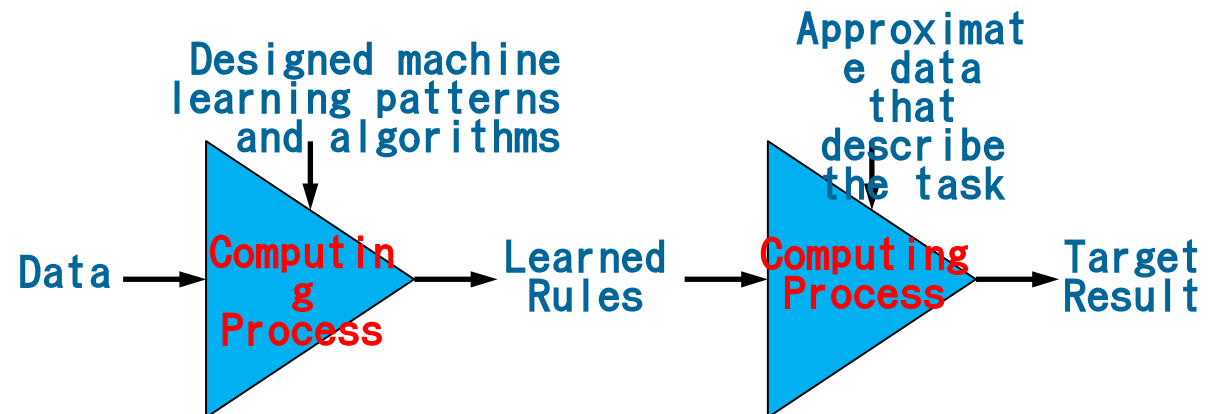
Machine Learning

- Machine learning technologies can learn from historical data, and make predictions or decisions, rather than following strictly static program instructions
- They can dynamically adapt to a changing situation and enhance their own intelligence by learning from new data
- They have been successful in image analysis, language recognition, conversation simulation, and many other applications

Traditional



Future



Machine Learning Categories

- Machine learning mechanisms are typically classified into three broad categories, depending on the nature of the learning “signal” or “feedback” available: supervised learning, unsupervised learning, reinforcement learning. Also semi-supervised learning
- There are a few basic machine learning approaches. They can be mixed together to complete complicated tasks
 - Classification, clustering, regression, anomaly detection, density estimation, dimensionality reduction, decision tree learning, association rule learning, artificial neural networks, reinforcement learning, similarity and metric learning, representation learning, etc.

Precondition of Applying Machine Learning Approach

- Although it is different from big data or data mining, machine learning does also need **data**. However, machine learning can be applied with small set of data or dynamic feedback from environment. The quality of data decides the efficient and accuracy of machine learning result
- There is **no generic machine learning mechanism** that could suitable for all or most of use cases. For each use case, the developers need to design a specific learning path, which may combine multiple approaches or algorithms together. The feature design and learning path design are the key factors in the machine learning applications

Limitation of Machine Learning Mechanism

- So far, the machine learning mechanism does not perform very well for accurate result. In most successful cases, it is used as an assistant analysis tool. Its results are usually accepted in fault- tolerant environment or with further human confirmation
- Quality requirements on data
- Most important elements must be measurable or quantifiable

More Considerations

- To achieve autonomic decision or minimize the human intervention, there should be evaluation system for the results of machine learning mechanism. The evaluation system and machine learning mechanism could compose a close decision loop for autonomic decision
- Priori knowledge vs. universal
- For many use cases, human interactive is very important to improve the usability of the result
- Combining with traditional mechanisms
- Incremental mining
- Self iterative optimization

Potential Usage in Network Area

- **The machine learning mechanism can be used to intelligently learn the various environments of networks and react to dynamic situations**
- **Many network aspect can benefit: network establishing, controlling, managing, network applications and customer services, etc.**
 - acquire knowledge from the existing networks so that new networks can be established with minimum efforts;
 - use machine learning mechanisms for routing control and optimization;
 - predict future network status in network management;
 - autonomic and dynamically manage the network;
 - analyze network faults and support recovery;
 - learn network attacks and their behaviors, so that protection mechanisms could be self-developed;
 - unify the data structure and the communication interface between network/network devices and customers, so that the upper-layer applications could easily obtain relevant network information, etc.

Proposed NMLRG

- The Network Machine Learning Research Group (NMLRG) provides a forum for researchers to explore the potential of machine learning technologies for networks. In particular, the NMLRG will work on potential approaches that apply machine learning technologies in network control, network management, and supplying network data for upper-layer applications
- The initial focus of the NMLRG will be on higher-layer concepts, use cases
- The NMLRG is expected to identify and document requirements, to survey possible approaches, to provide specifications for proposed solutions, and to prove concepts with prototype implementations that can be tested in real-world environments

**Comments & discussion
are welcomed!**

Thank You!

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