Reinforcement Learning

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1 Introduction

Involves an **Agent, Reward, Action, State and Environment** model to train the agent using reinforcement algorithms listed below.

2 History

- Value Iteration
    - Highly based on Bellman's equation
- Policy Iteration
- TD(Lambda)
- Q-Learning

3 Reinforcement learning in Trading

- What agent will do
    - Gain knowledge, experience through interaction with the environment using some reward functions.
    - **Interaction => Knowledge => Better Decisions => Max Reward**
- Challenges in Trading
    - Error free handling of large volumes of nearly continuous data
    - Agent's actions may result in long term changes which can't be measured by current ML techniques

- – Short-term impacts making the market environment more complex
- Components of DRL in trading
  - – Agent
    - ∗ Agent's action generally involves **New Order, Change Order or remain Passive**
  - – Environment
    - ∗ Environment includes other agents and humans
    - ∗ Order book(public liquidity)
    - ∗ Order Execution Strategies(hidden liquidity)
  - – State
    - ∗
  - – Reward **Very Crucial**
    - ∗ Absolute Reward Maximization may lead to high PnL volatility and even Unmanageable Drawdowns
    - ∗ Optimization default for reward function if the **Sharp Ratio: (Strategy Return)/(PnL Volatility)**

4 NOTES

- Financial markets are dynamic and turbulent structures

- One of the reasons for using reinforcement learning n finance is that large participation, leading to complex quantitative strategies which leads to short-term, hard to identify patterns and making historical data irrelevant, hence there comes our agent to quickly learn from the current status of the market and make financial decisions. Agents are capable to adapt to the changing environments

- So many funds are reducing the use of pattern based trading strategies

- Current successful trading strategies main consists of
  - – Strategy designed by trader and implemented by machine. (have some flaws)
  - – One main challenge is to gather a unbaised representative financial data.(currently implemented by a trader) ==> (now we wan't it to be implemented by the DRL agent)

- **RNN** Recurrnet neural network
  - – These replaces the infinite or very large sequence of neural network(sharing the same weights and baises) which could be used to maintain the order of the data.

- These neural networks consists of a feedback loop which inputs the output of the current input to the next input. **LIMITATIONS**
    * Gradients descent can quickly lead to the vanishing/exploding of weights which means that the network may forget the learnt information very fast.

- **LSTM**

- Different types of trading strategies
  - Momemtum
  - Mean Reversion
  - Market Making
  - Stat Arb
  - Sentiment Baseds

5 Important Financial Terms

- **Liquidity**

  - public liquidity
  - Hidden liquidity (private)

- **Volatility**
  Sharp changes in the price movements

- **PnL Voatility**

- **flash Crashes**

- **Ngrams**

  - Used to process the contiguous sequence of words

- EMH (Efficient Market hypothesis)

- RSI (Relative strength Index)

- Mean reverting Strategy

  -

- Delayed Gratification

- Portfolio Management

- Technical Indicators

- Sharpe Ratio

- Profit per tick

- Profit per trade

- Statistical Arbitrage