QED Options Trading Platform, Strategies, Risk-Adjusted Returns

Options pricing as one of the most complex mathematical problems in financial engineering, the unique, nonlinear gain-loss structure makes its trading strategy and risk management an actively studied topic among the practitioners in this area. Achieving maximum risk-adjusted option trading profit requires timely execution of perfectly engineered trading strategies. The KDS QED trading platform is built with this purpose in mind.

QED options trading strategies are engineered by our patented UBX operating principles:

1. Moving at the speed of strategic option trading thoughts automatically (敏行如思)
2. Seizing the tightly coupled option trading probabilities simultaneously (紧握概率)
3. Synchronizing bullish and bearish option trading strategies for any market (顺逆合一)
4. Analyzing all trading positions continuously to maximize option profits (循道蓄德)

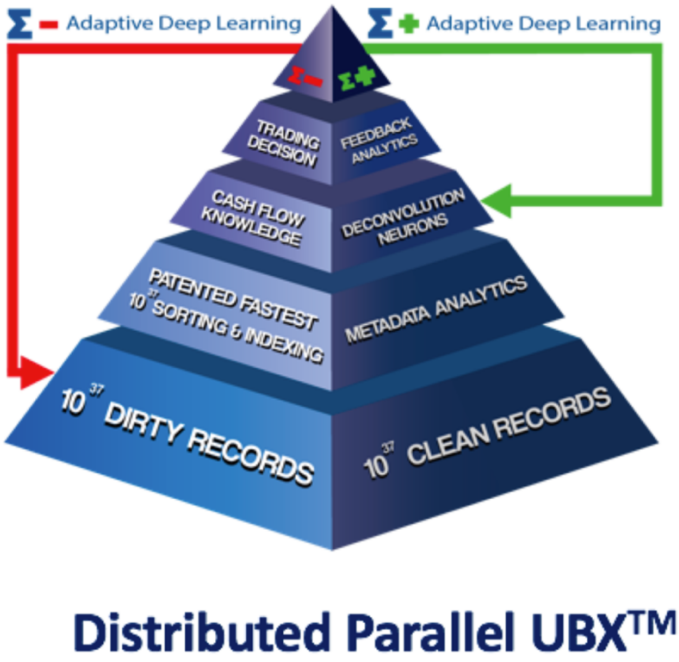


Figure 1. Operating principles of UBX

S1. Moving at the speed of strategic option trading thoughts automatically (敏行如思)

QED options trading is based on our patented UBX platform. And applied to options trading, the UBX options trading platform consists of two champion-challenger models

- QED: quantum electro dynamic field effect model.

- DNN: deep neural network option pricing model

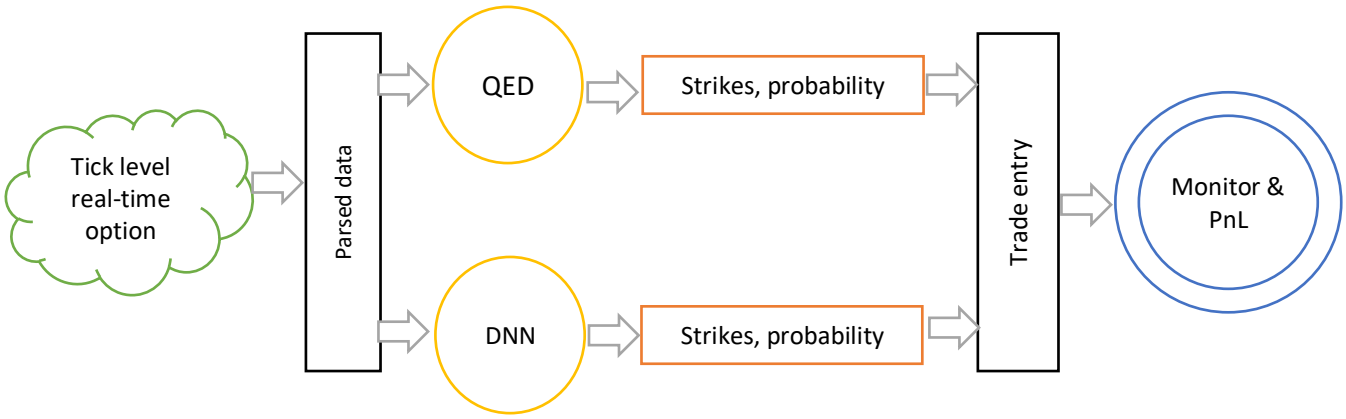


Figure 2. Champion-challenger models: QED (Quantum Electrodynamics) and DNN (Deep Neural Network), the essential component of our automated trading system

With the solid UBX infrastructure and superior models, we can act on market with swiftness and confidence. We implement the strategies into automated trading utilizing our broker's programming interface, for efficiency, profitability, and consistency.

S2. Seizing the tightly coupled option trading probabilities simultaneously (紧握概率)

Instead of attempting to predict the underlying price at a future time, our models compute the probability of the range of price within which underlying will fall at the time option maturity. Utilizing this probability, we profit from options trades with proper strategies. Such probability captures many factors such as market condition including current and historical spot prices, volume, option bid and ask premium, bid and ask sizes, time to expire, price volatility, etc. This probability is one of the most import metrics used in our trading strategies. The price range of the given model predicated probability corresponds to the two strike prices we use in our short strangle trades.

S3. Synchronizing bullish and bearish option trading strategies for any market (顺逆合一)

Based on price range probability, our trading strategies make profit in both bulls and bears market. For a given probability of spot price range at a future time, we construct our trades to make the most profit with the given level of risk. For instance, given a 3% of probability of a pair of out-of-money option strikes being exercised at maturity as computed by our models, we can place a short strangle trade and capture the premium at maturity, with 97% of confidence.

S4. Analyzing all trading positions continuously to maximize option profits (循道蓄德)

Our options models (QED and DNN) provide guidance of price volatility, based on which our trading strategies are formed. By encoding these strategies into automated trading, the system continuously analyzes new potential trades and existing positions, during the market hours. It helps us avoiding mistakes that are frequently seen with human traders under influence of strong emotion of fear and greed. On a daily basis, market and trades data are analyzed to re-validate our strategies, to ensure newly formed market conditions are factored back into our strategies to achieve consistency. All of the trades parameters are based our backtesting results.

S5. Trade Types

Using the real-time results from our models, we make these various types of trades:

1. Basic short strangle: when QED and DNN generates a new trade signal, such as May 29th SPY Put 266.5 and Call 269. 5 at 3% of probability of exercise, we enter a limit credit order to sale this pair of strikes at bid price to ensure we quickly enter the position.

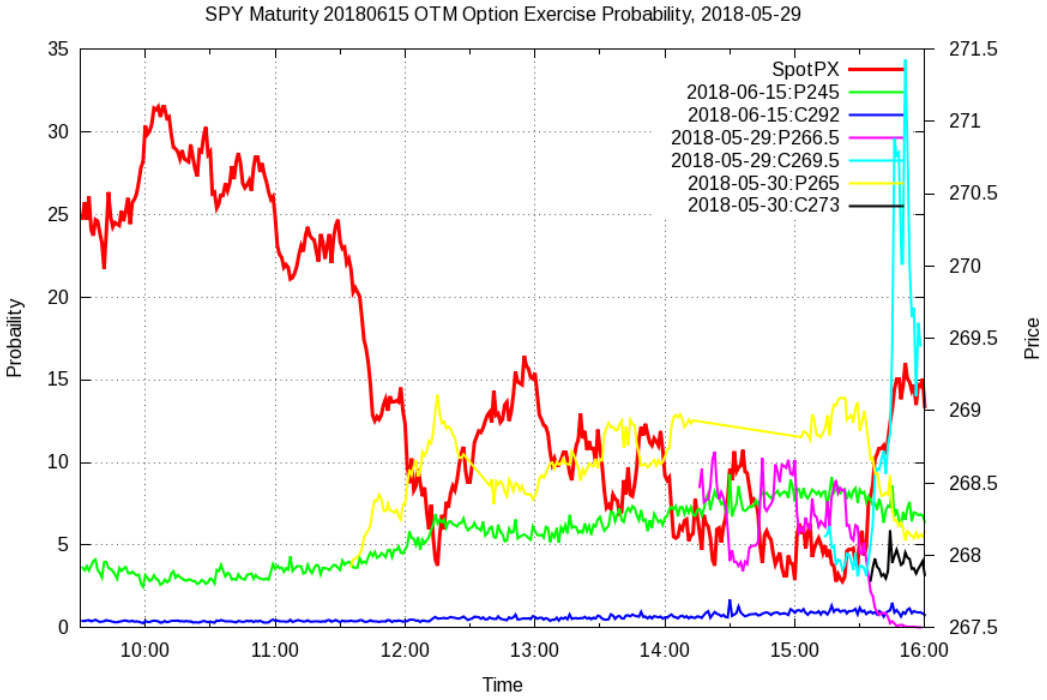


Figure 3. Exercising probability from QED model for SPY at various maturities and strikes

2. Roll-in short strangle: when a trade signal generated, we enter a series of limit credit orders at varying premium limits, such as 1.25, 1.5, 2, and 5 times the current premium. For instance, if the current total premium is $0.08 for a given put-call pair, we enter a series of limit credit orders with limit $0.10, $0.12, $0.16, and $0.40. These limit orders will allow us to capture larger premiums when the underlying spot oscillates during the market hours

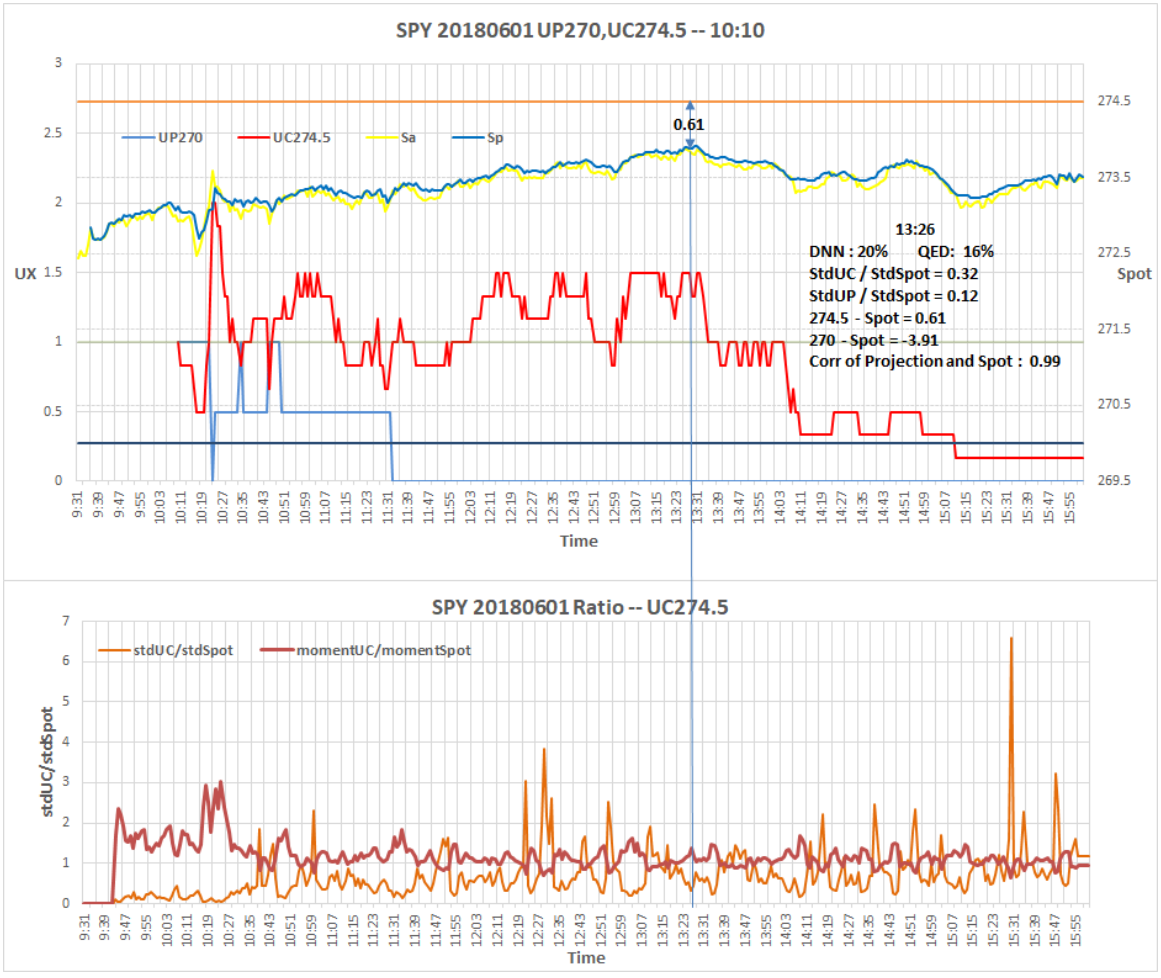


Figure 4. SPY spot price, projection from DNN model, and option prices. UX is the ratio of current option premium over that at the time of order entry.

3. Swap trades for short strangle positions: when the probability of exercise for our short strangle positions reach a predetermined value, such as 70%, we replace these positions with the next safer positions. We place vertical spread trades to buy-close the position in danger while simultaneously sale-open next safer strike confirmed earlier by our models. The benefit of such swap trades are two folds: 1) it reduces the risk of our positions expiring in-the-money and thus incurring large loss; 2) it captures the large

premium of the safer strike at the same time and thus reduces the realized loss.

4. Long put and call options: we buy put and call options with high probability of exercise, such as 35%, and profit from the large premium increase when the positions go in-the-money or near-the-money. The time of entry of the positions are critical. We use our momentum-rules to select the optimal points. Profit taking and stop limit orders are also set, with each level set based on backtesting results.

5. Momentum-trades: we buy put and call options using our momentum-rules to profit from large price swings of the underlying in the right direction. The momentum-rules are based on RSI, and various moving averages of the underlying and broader market indices, such SPY.

6. Iron condor trades: these trades use the same strategies as those applied to our short strangles, i.e., trade types S5.1, S5.2, and S5.3. The advantage of this trade type is the reduced margin requirement and thus much larger number of contracts can be traded for the same trade capital funds than can be done with the short strangles.

APPENDIX: QED and DNN, The Champion-Challenger Models

A1. QED Options Model

- QED model is calibrated using tick-level, real-time market data every minute during market hours
- One of the key output parameters is the exercising probability for any given tradeable options
- Our trading strategies are based on these computed exercising probabilities from UBX model:
    - short strangle
    - iron condor

The above strategies (short strangle and iron condor) dictate that our trades span over shortest possible time in the market to avoid large price move, thus our trades scenarios are confined to intra- or at most inter-day time horizon.

A2. Profit vs Loss

- Trading profits are the net premium received when Put and Call options are sold and then expired out-of-money, i.e., worthless.
- Loss will happen when either of the two legs goes in-the-money
- Due to the asymmetry in the magnitudes of potential profit vs loss, it is of paramount importance to ensure the selected strikes remain out-of-money

Therefore, proper triggers to enter the trades are required for profitable trades

A3. Backtesting

- The goals of the backtesting include:
    - Exploration: to find the proper trigger of trade entry points
    - Surveillance: to validate the trigger points on a continuing basis
    - Adjustment: to adjust trigger points if needed, based on surveillance results
- The backtesting data:
    - Over two years' tick-level, real-time options data
    - Testing over 800 thousands of possible trades on a daily basis

A4. Methodology

- Start from exercising probability ranging from 2% to 15%
    - 2%, 3%, 5%, 6%, 7%, 10%, 15%: 7 testing cases
- Compute the Put and Call strikes for a given maturity at a moment
    - Paper trades at different moment and strikes
- Compare the strikes against actual underlying high and low price, over the time period from paper trades entry to exit or expiration

    - Success: if the high and low remain between the two strikes
    - Failure: otherwise
- Find sensitive market variable ranges that determine trades outcome

A5. Trade Scenarios

Principle: pursue of minimal risk with steady income

- Early Bird: 9:40am to 10am EST, rich premium, QED probability at 6%
    - High volatility and premium after market gapping up or down
    - Risk due to large price movement of the underlying
- Prime Time: 10am to 2:40pm EST, actions by medium sized market players, QED probability at 5%
    - Most of the market activities, news, events, etc
    - Overall market mood emerges
- Final Rush: 2:40pm EST to market close, final surprises, QED probability at 7%
    - institutional investors betting
    - computerized trading
- Inter-day: one day before expiration, profiting during SPY's non-expiration periods, QED probability set to 2%
    - Large time decay
    - Exit same day or early next, as soon as reaching profit goal

The backtesting is, therefore, to find and verify the proper ranges of market variables to ensure the above 4 trading scenarios exit safely.

A6. Trades Entry Points

- By using combination of multiple moving average price of the underlying, we are able to find appropriate boundaries that lead to successful trades
- These boundaries form the profitable trades' entry points
- The market bounds for each scenario eliminate trades which could otherwise result in huge loss

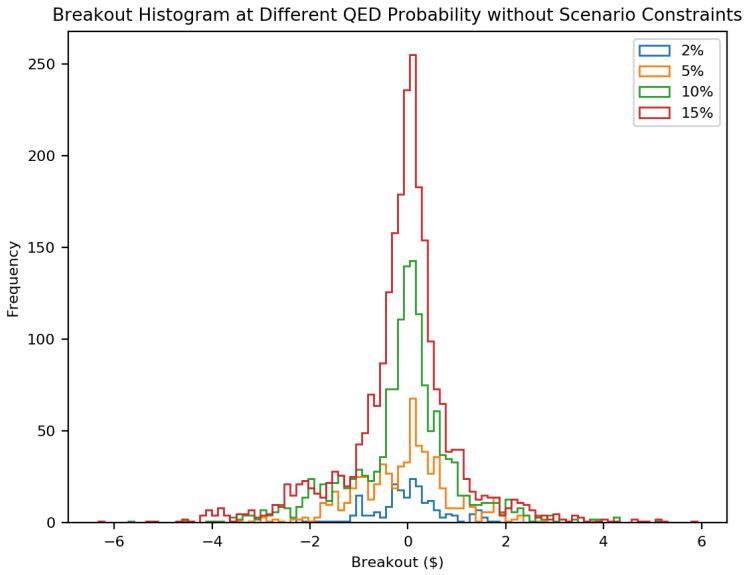
The following charts illustrates the selectivity of the 4 successful trading scenarios

A7. QED Probability vs Breakout

Breakout is the $ amount of the underlying high or low price breaking out the strikes of the two legs of the short strangle or iron condor trades, without applying scenario constraints.
The histogram excludes successful trades.
Without scenario constraints, the observed percentage of broken (exercised) trades are as follows:

QED	2%	5%	10%	15%
broken%	3.9	12	27	45

These results indicate the necessity of scenario constraints. The choice of these constraints can be found using backtest.



A7. Backtesting Results

For each trading scenario (EB, PT, FR, & ID), with the trading constraints applied, only a portion of the moment are will satisfy the constraints (captured). Among the computed strikes given an exercising probability, using backtesting data, the observed failed trades are counted and the percentage is computed (Fail%), as shown below.
Based on the testing results, the best fail rate is highlighted in blue for each trade scenario and QED probability.

QED Prob	Eerly Bird (EB)			Prime Time (PT)			Final Rush (FR)			Inter-Day (ID)		
	Total	Capture%	Fail%	Total	Capture%	Fail%	Total	Capture%	Fail%	Total	Capture%	Fail%
2%	3,515	16.1	1.2	44,384	18.7	1.1	7,901	33.3	0.4	63,893	10.5	0.1
3%	3,515	16.1	1.2	44,384	18.7	1.6	7,902	33.3	0.7	63,893	10.5	1.0
5%	3,515	16.1	1.8	44,384	18.7	1.9	7,903	33.3	0.8	63,893	10.5	2.4
6%	3,515	16.1	1.9	44,384	18.7	2.2	7,904	33.3	0.9	63,893	10.5	2.9
7%	3,515	16.1	2.1	44,384	18.7	2.6	7,905	33.3	1.3	63,893	10.5	3.7
10%	3,515	16.1	18.3	44,384	18.7	5.9	7,906	33.3	2.5	63,893	10.5	5.8

B1. DNN Options Model

Using the real-time data of the underlying and options, we create two DNN options models

- Model-A: the pricing model that produces exercising probability options
- Model-B: the volatility model that generates the standard deviation of price variation in the next 10 minutes.

When analyzing an ETF, such as SPY, we also consider related tickers:

- S&P500 sectors: XLK, XLF, XLB, XLI, XLP, XLV, XLE, XLRE, XLU, XTL
- Volatility indicators: VXX, SPHB, SPLV
- Gold: GLD
- Treasury: TLT, IEF
- US dollar: UUP
- NASDAQ 100: QQQ

B2. DNN Trading Strategy

Our trading strategy are based on the following 3 constraints:

1. Expected return, which determines the minimal total premium of short strangle or iron condor trades
2. Minimal risk, which is computed by model A given minimal total premium
3. With both 1 & 2 requirements are satisfied, model B finds the best time for opening and closing positions, to achieve maximal return

B3. DNN Model A, Minimal Risks

During trading hours, for any given Put or Call strikes, model A computes the probability of them being exercised.

Using backtesting, for a given expected total premium (sum of Put and Call prices) we find the minimal probability (MP) of exercise, such that during majority of trading hours, there exists at least one moment that the exercising probability is less than MP while satisfying expected total premium.

B3. DNN Model B, Best Entry Time

For a given strike, the option price (premium) varies with time. The more volatile of the underlying, the more premium there will be, and vice versa.
Model B computes the expected standard deviation of the underlying price for the next 10 minutes. If the expected future standard deviation is larger than current value, we will not sale options. Reversely, we will not buy options if the future standard deviation is less than current value.

B4. DNN Backtesting

- Minimal Premium (MP)

For a given annual return rate, compute the minimal total required Put and Call premium per trading day, after considering trading cost

- Risk Combinations (RC)

For short strangle trades, exercised options mean failed trades. The exercising probability of options is the risk indicator. With probabilities ranging from 1%, 2%, to 50%, there are 2,500 probability combinations for the Put and Call being exercise. Each probability combination is one of 1%, 2%, …, 50%.

- Capture (CAP)

Given MP and RC for any trading moment, if there is a pair of Put and Call strikes such that 1) the exercising probability from model A is less than the RC; and 2) total premium is greater or equal to the MP, then a Capture (CAP) has occurred

- Capture Price (CP)

Among the captured (CAP) strike combinations, the combination that gives rise to the smallest product of exercising probability for the Put and Call is the Capture Price (CP)

- Minimal Risk (MR)

Given MP, for each RC, we compute the following:

  - Count of CAP: count of all capture moment
  - Ratio of CAP: ratio of days capture occurred over total trading days
  - Daily CAP Count: ratio of count of CAP over total trading days
  - Failure Rate: capture price being exercised over count of CAP

B5. DNN Backtesting Result

Based on SPY data from Jan 2017 to Mar 2018, here's the test result

Expected Return	Minimum Premium	Minimal Risk	Daily Count of Capture	Rate of Capture	Failure Rate
36%	0.13	(P3%, C2%)	3	95%	8%
20%	0.08	(P2%, C2%)	6	98%	5%
10%	0.05	(P1%, C1%)	10	100%	2%