2019 Annual Letter

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Abstract

This is the 2019 annual letter to shareholders. This year our after-tax return was 31% while S&P 500 Index ETF 31%. We land this fiscal year on a performance rather similar to that of benchmark, 31%. However, we did this with holding about 40% of our account in cash the rest two quarters. This requires our holdings to be absolutely robust and over 60% growth rate which in our perspective is a rather difficult thing to do. In return, we are able to deliver a portfolio with much less risk that benchmark index.

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1 PERFORMANCE

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Date	My Return	S&P 500	$1 Simulation: My Performance	Market
			$1	$1
January 3, 2011	(0.35)	0.02	0.65	1.02
February 1, 2011	0.24	0.03	0.81	1.06
March 1, 2011	(0.02)	(0.00)	0.79	1.05
April 1, 2011	0.10	0.03	0.88	1.08
May 2, 2011	0.06	(0.01)	0.93	1.07
June 1, 2011	(0.04)	(0.02)	0.89	1.05
July 1, 2011	(0.04)	(0.02)	0.85	1.03
August 1, 2011	0.05	(0.05)	0.89	0.97
September 1, 2011	0.05	(0.07)	0.93	0.90
October 3, 2011	0.06	0.11	0.99	1.00
November 1, 2011	0.49	(0.00)	1.47	0.99
December 1, 2011	(0.27)	0.00	1.08	1.00
January 3, 2012	0.10	0.05	1.18	1.04
February 1, 2012	0.09	0.04	1.28	1.09
March 1, 2012	0.10	0.03	1.41	1.12
April 2, 2012	(0.03)	(0.01)	1.36	1.11
May 1, 2012	(0.01)	(0.06)	1.35	1.05
June 1, 2012	0.54	0.04	2.08	1.08
July 2, 2012	0.06	0.01	2.19	1.10
August 1, 2012	(0.12)	0.03	1.92	1.12
September 4, 2012	(0.07)	0.02	1.78	1.14
October 1, 2012	0.90	(0.02)	3.39	1.12
November 1, 2012	0.04	0.01	3.51	1.13
December 3, 2012	(0.01)	0.00	3.49	1.13
January 2, 2013	0.02	0.05	3.55	1.19
February 1, 2013	0.11	0.01	3.95	1.21
March 1, 2013	0.03	0.03	4.07	1.25
April 1, 2013	0.02	0.02	4.17	1.27
May 1, 2013	0.20	0.02	5.00	1.30
June 3, 2013	0.19	(0.02)	5.96	1.28
July 1, 2013	(0.04)	0.05	5.72	1.34
August 1, 2013	0.06	(0.03)	6.07	1.30
September 3, 2013	0.06	0.03	6.43	1.34
October 1, 2013	0.06	0.05	6.82	1.40
November 1, 2013	0.06	0.03	7.23	1.44
December 2, 2013	0.06	0.02	7.66	1.47
January 2, 2014	0.06	(0.04)	8.12	1.42
February 3, 2014	0.06	0.05	8.61	1.48
March 3, 2014	0.01	0.00	8.70	1.49
April 1, 2014	(0.67)	0.01	2.83	1.50
May 1, 2014	(0.75)	0.02	0.71	1.53
June 2, 2014	4.96	0.02	4.23	1.56

Date	My Return	S&P 500	$1 Simulation: My Performance	Market
July 1, 2014	0.14	(0.01)	4.81	1.54
August 1, 2014	0.04	0.04	4.98	1.60
September 2, 2014	0.28	(0.02)	6.38	1.57
October 1, 2014	0.01	0.02	6.47	1.60
November 3, 2014	(0.20)	0.03	5.16	1.65
December 1, 2014	(0.12)	(0.01)	4.52	1.63
January 2, 2015	(0.34)	(0.03)	2.98	1.59
February 2, 2015	(0.37)	0.06	1.88	1.68
March 2, 2015	0.37	(0.02)	2.57	1.64
April 1, 2015	0.27	0.01	3.26	1.66
May 1, 2015	0.74	0.01	5.66	1.68
June 1, 2015	(0.27)	(0.03)	4.13	1.64
July 1, 2015	0.00	0.02	4.15	1.67
August 3, 2015	0.12	(0.06)	4.66	1.57
September 1, 2015	(0.09)	(0.03)	4.24	1.52
October 1, 2015	(0.04)	0.09	4.07	1.65
November 2, 2015	(0.06)	0.00	3.84	1.66
December 1, 2015	(0.01)	(0.02)	3.82	1.62
January 4, 2016	0.08	(0.05)	4.12	1.54
February 1, 2016	(0.28)	(0.03)	2.95	1.49
March 1, 2016	1.14	0.07	6.32	1.59
April 1, 2016	0.23	0.03	7.76	1.65
May 1, 2016	0.21	(0.00)	9.41	1.64
June 1, 2016	(0.07)	0.01	8.79	1.66
July 1, 2016	(0.04)	0.00	8.48	1.67
August 1, 2016	0.02	0.04	8.69	1.73
September 1, 2016	0.08	0.00	9.39	1.73
October 1, 2016	0.06	(0.01)	9.93	1.72
November 1, 2016	(0.00)	0.00	9.92	1.72
December 1, 2016	(0.22)	0.02	7.72	1.75
January 1, 2017	0.15	0.02	8.84	1.78
February 1, 2017	(0.06)	0.02	8.33	1.82
March 1, 2017	0.40	0.05	11.67	1.91
April 1, 2017	(0.34)	(0.02)	7.69	1.87
May 1, 2017	(0.02)	0.01	7.56	1.90
June 1, 2017	(0.20)	0.01	6.07	1.92
July 1, 2017	0.17	0.00	7.12	1.93
August 1, 2017	0.05	0.02	7.47	1.97
September 1, 2017	(0.18)	0.00	6.16	1.97
October 1, 2017	(0.10)	0.01	5.53	2.00
November 1, 2017	0.36	0.02	7.54	2.05
December 1, 2017	0.10	0.02	8.27	2.09

Date	My Return	S&P 500	$1 Simulation: My Performance	Market
January 1, 2018	0.25	0.02	10.34	2.13
February 1, 2018	0.34	0.05	13.90	2.24
March 1, 2018	(0.12)	(0.04)	12.28	2.14
April 1, 2018	(0.13)	(0.04)	10.74	2.05
May 1, 2018	0.04	0.02	11.14	2.10
June 1, 2018	0.09	0.03	12.15	2.17
July 1, 2018	0.01	0.00	12.26	2.17
August 1, 2018	0.02	0.03	12.54	2.24
September 1, 2018	0.31	0.04	16.39	2.32
October 1, 2018	0.04	(0.01)	17.11	2.30
November 1, 2018	(0.08)	(0.06)	15.73	2.16
December 1, 2018	0.05	0.03	16.55	2.23
January 1, 2019	(0.02)	(0.11)	16.19	1.97
February 1, 2019	0.16	0.09	18.80	2.15
March 1, 2019	0.03	0.04	19.31	2.23
April 1, 2019	0.02	0.02	19.74	2.26
May 1, 2019	0.10	0.04	21.64	2.34
June 1, 2019	(0.06)	(0.07)	20.32	2.19
July 1, 2019	0.08	0.08	21.85	2.35
August 1, 2018	0.03	(0.00)	22.59	2.34
September 1, 2019	(0.02)	(0.01)	22.11	2.31
October 1, 2019	(0.00)	0.01	22.02	2.33
November 1, 2019	0.00	0.04	22.03	2.43
December 1, 2019	0.02	0.01	22.52	2.46
January 1, 2019	0.03	0.05	23.11	2.58

2 ANNUAL SUMMARY

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This section quickly debrief the audience what happened in the year of 2019 according to each quarter.

2.1 Q1 Summary

Yin's portfolio lucked out big time for the first quarter, finishing up a solid 24% while S&P 500 finished about 13%. Most of the luck came from last Christmas. I remembered my family was asking me what was I doing on my computer on December 24th. I said looking at stock markets and I probably did not explain what I was doing clearly. Truth is I did not know what would happen either. My AI gave me a heavy buy signal starting from December 21st. Frankly speaking, this is the first time in history I have never wanted to override AI decision this bad. This stream of unease, frustration, and uncertainty never happened to this level in my career.

Things could go right and things could go wrong. If AI is right, the market turned back up. I would never forgive myself wasting a good opportunity to buy down here. If AI is wrong, the market goes down further. I could potentially be collecting another 5% - 10% losses depending on market volatility. How do I handle this uncertainty in the market? More specifically, What do I do to capture the upside potential but minimize downside risk?

After some thoughts and simulations[1], I have decided to enter market in stages. I had about 60% of my account in cash so I know I had plenty of money to work on different scenarios. Let us make our life easier by assuming $4 in marketable equities and $6 cash. Upon the time my AI gave me a signal, I entered the market with approximately $2 of the portfolio so until now I had $6 in marketable equities and $4 in cash. I waited another few more days after Christmas and almost around New Year. I entered another $2 so now I am having $8 in market and $2 cash.

On Jan. 3rd, 2019, market fell 2.4% and the Wall Street news are scared again. Yet I received another signal from AI to tell me to buy. Now I know there this will very likely to be a V-bottom, which means the bottom will not last that long. This time I entered the market with everything I could and on top of that plus intra day leverage trading my way up.

Two directions I took: (1) I initiated long position (overnight position that I plan to wait and see for long term) starting from December 24th, and (2) daily leverage (intra-day trading on hot stocks, buy and sell finish within a day) starting from Jan 4th. I did not use a leverage that I used to use on trading floor. I am bounded by my overall trading protocol and risk profile of clients and myself so that I never go to a leverage level I am uncomfortable with.

Now not only did I book 10% alpha on a single quarter I also confirmed the precision that AI can deliver me. Now not only did I book 10% alpha on a single quarter I also confirmed the precision that AI can deliver me. An opportunity such as this one is valuable to meet and collect as a piece of experience. My willingness to try and to take risks paid off here not because of grades or skills but simply a will to step out of my comfort zone.

[1] I simulated 20 million alternative future to view the upcoming conflict and I designed a strategy for every single one of them.

2.2 Q2 Summary

The fiscal quarter of Q2 we beat market again, a little more than 4% (while S&P 500 is about 3.8%), which also happened to be the second to largest quarterly gain we pulled up since 2018. I am not at all surprised about this market and what this market can do. I am foreseeing a clear uptrend from here till the end of year and everything else looks straightforward. How? Tech and Financial Industries lead. Industrial and Consumer follows. Utilities and Energy are just being there. Gold is as crappy as usual. Overall alphas can be made simply by holding big names in Tech, Consumers, and Financial Industry, a blind bet if you will. Note that when I say good or bad, it's relative to S&P 500.

As discussed before, Yin's Capital does not associate ourselves with the current political volatility and we do not worry at all what this will do to US capital market or our portfolio. Hence, we keep the news as reference or breakfast stories only and we do not allocate wealth according to political risk at all. Political risk may be one factor (qualitative at best, but never quantifiable). We believe this way we are able to serve our clients the best interest we promised.

Currently, our R&D mainly focused on Markov Model and our target algorithm for the next stage exploration is in Recurrent Neural Network. We already have our AI devops deployed on this topic and accomplished projects seemed quite fruitful. Sample projects and packages can be found on Github link: https://github.com/yiqiao-yin/YinsCapital. Only those think alike can extract the full potential of this package. Hence, it is to allow transparency of our operations without losing intellectual properties.

2.3 Q3 Summary

The third quarter of this fiscal year we entered the market with some volatility. I did not change much for our holdings but rather liquidated some of the marketable securities. Starting from Q3, we are no longer heavy in any perspective of the market and non in any strategies.

Under my guidance, Yin's Capital have been concentrated heavy on developing advanced AI-based trading algorithms that not only do we take into account of all historical information but also generate decisions on future perspectives from both AI as well as my own opinions.

Q3 laid thorough ground work for Q4.

2.4 Q4 Summary

Entering Q4 I have seen a good amount of short selling activities on the tape representing the market. I have seen tens of thousands of put options acquired for S&P 500 index fund. Though I overall hold long thesis for the market, I am well aware of the potential political volatility stirred and how that may shake the market to trigger a flow of selling orders. That being said, we liquidated some of major positions in Q3 and we are entering into Q4 with over 50% cash account.

We land this fiscal year on a performance rather similar to that of benchmark, 31%. However, we did this with holding about 40% of our account in cash the rest two quarters. This requires our holdings to be absolutely robust and over 60% growth rate which in our perspective is a rather difficult thing to do. In return, we are able to deliver a portfolio with much less risk that benchmark index.

3 OPTIONS FRENZY

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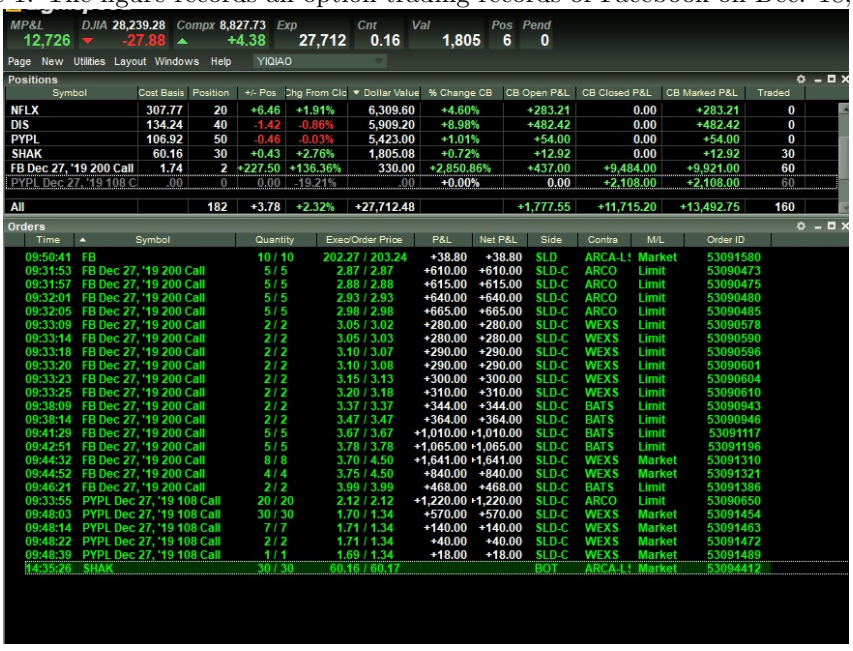
I still remember in 2013 there was one option position that I lost 2 thousands dollars within an hour. I did everything wrong in that trade. I was operating under hope. I never simulated the strategy. I did not work on any calculations even to check out some basic statistics for that position. I was also in school at that time which means I am not 100% devoted to handle that position and I was almost always distracted. The loss made sense.

I did one thing right. I wrote all of these things down. This is when things start to turn in my experience handling options. My opinion on options is not that different from Warren Buffett's. In my words, option is a financial nuclear weapon that cause massive destruction, sometimes fatal to one's financial situation. It does not matter how much experience one gains there is always situation when one person never foresees.

This is where risk management is extremely important. This is also an area I think machines may have a slight edge than humans. Under the same strategy and if things happen, machines take losses and strictly gets out the position. Human traders may still act stubbornly and force oneself to stay in the positions or perhaps retry again. This is an area machines may have a small edge.

When it comes to triggers, I think humans are not as consistent as machines but humans are able to detect some of the most dramatic trading frenzies in the market much better than machines. Though these situations may happen fairly infrequently. For example, the following figure presents an option records for Facebook executed myself without machine assistance on December 18, 2019. As one can see, the entire position was executed no longer than 15 minutes and the position pulled over 11 grand during this window frame.

Figure 1: The figure records an option trading records of Facebook on Dec. 18, 2019.



MP&L 12,726 | DJIA 28,239.28 -27.88 | Compx 8,827.73 +4.38 | Exp 27,712 | Cnt 0.16 | Val 1,805 | Pos 6 | Pend 0

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Positions

Symbol	Cost Basis	Position	+/- Pos	Chg From Clo	Dollar Value	% Change CB	CB Open P&L	CB Closed P&L	CB Marked P&L	Traded
NFLX	307.77	20	+6.46	+1.91%	6,309.60	+4.60%	+283.21	0.00	+283.21	0
DIS	134.24	40	-1.42	-0.86%	5,909.20	+8.98%	+482.42	0.00	+482.42	0
PYPL	106.92	50	-0.46	-0.03%	5,423.00	+1.01%	+54.00	0.00	+54.00	0
SHAK	60.16	30	+0.43	+2.76%	1,805.08	+0.72%	+12.92	0.00	+12.92	30
FB Dec 27, '19 200 Call	1.74	2	+227.50	+136.36%	330.00	+2,850.86%	+437.00	+9,484.00	+9,921.00	60
PYPL Dec 27, '19 108 C	.00	0	0.00	.19.21%	.00	+0.00%	0.00	+2,108.00	+2,108.00	60
All		182	+3.78	+2.32%	+27,712.48		+1,777.55	+11,715.20	+13,492.75	160

Orders

Time	Symbol	Quantity	Exec/Order Price	P&L	Net P&L	Side	Contra	M/L	Order ID
09:50:41	FB	10 / 10	202.27 / 203.24	+38.80	+38.80	SLD	ARCA-L	Market	53091580
09:31:53	FB Dec 27, '19 200 Call	5 / 5	2.87 / 2.87	+610.00	+610.00	SLD-C	ARCO	Limit	53090473
09:31:57	FB Dec 27, '19 200 Call	5 / 5	2.88 / 2.88	+615.00	+615.00	SLD-C	ARCO	Limit	53090475
09:32:01	FB Dec 27, '19 200 Call	5 / 5	2.93 / 2.93	+640.00	+640.00	SLD-C	ARCO	Limit	53090480
09:32:05	FB Dec 27, '19 200 Call	5 / 5	2.98 / 2.98	+665.00	+665.00	SLD-C	ARCO	Limit	53090485
09:33:09	FB Dec 27, '19 200 Call	2 / 2	3.05 / 3.02	+280.00	+280.00	SLD-C	WEXS	Limit	53090578
09:33:14	FB Dec 27, '19 200 Call	2 / 2	3.05 / 3.03	+280.00	+280.00	SLD-C	WEXS	Limit	53090590
09:33:18	FB Dec 27, '19 200 Call	2 / 2	3.10 / 3.07	+290.00	+290.00	SLD-C	WEXS	Limit	53090596
09:33:20	FB Dec 27, '19 200 Call	2 / 2	3.10 / 3.08	+290.00	+290.00	SLD-C	WEXS	Limit	53090601
09:33:23	FB Dec 27, '19 200 Call	2 / 2	3.15 / 3.13	+300.00	+300.00	SLD-C	WEXS	Limit	53090604
09:33:25	FB Dec 27, '19 200 Call	2 / 2	3.20 / 3.18	+310.00	+310.00	SLD-C	WEXS	Limit	53090610
09:38:09	FB Dec 27, '19 200 Call	2 / 2	3.37 / 3.37	+344.00	+344.00	SLD-C	BATS	Limit	53090943
09:38:14	FB Dec 27, '19 200 Call	2 / 2	3.47 / 3.47	+364.00	+364.00	SLD-C	BATS	Limit	53090946
09:41:29	FB Dec 27, '19 200 Call	5 / 5	3.67 / 3.67	+1,010.00	+1,010.00	SLD-C	BATS	Limit	53091117
09:42:51	FB Dec 27, '19 200 Call	5 / 5	3.78 / 3.78	+1,065.00	+1,065.00	SLD-C	BATS	Limit	53091196
09:44:32	FB Dec 27, '19 200 Call	8 / 8	3.70 / 4.50	+1,641.00	+1,641.00	SLD-C	WEXS	Market	53091310
09:44:52	FB Dec 27, '19 200 Call	4 / 4	3.75 / 4.50	+840.00	+840.00	SLD-C	WEXS	Market	53091321
09:46:21	FB Dec 27, '19 200 Call	2 / 2	3.99 / 3.99	+468.00	+468.00	SLD-C	BATS	Limit	53091386
09:33:55	PYPL Dec 27, '19 108 Call	20 / 20	2.12 / 2.12	+1,220.00	+1,220.00	SLD-C	ARCO	Limit	53090650
09:48:03	PYPL Dec 27, '19 108 Call	30 / 30	1.70 / 1.34	+570.00	+570.00	SLD-C	WEXS	Market	53091454
09:48:14	PYPL Dec 27, '19 108 Call	7 / 7	1.71 / 1.34	+140.00	+140.00	SLD-C	WEXS	Market	53091463
09:48:22	PYPL Dec 27, '19 108 Call	2 / 2	1.71 / 1.34	+40.00	+40.00	SLD-C	WEXS	Market	53091472
09:48:39	PYPL Dec 27, '19 108 Call	1 / 1	1.69 / 1.34	+18.00	+18.00	SLD-C	WEXS	Market	53091489
14:35:26	SHAK	30 / 30	60.16 / 60.17			BOT	ARCA-L	Market	53094412

3.1 Mathematical Nonsense

I have never been able to fully adopt the seemingly nonsense "Black-Scholes" model. As a mathematician myself, I often times find math formulas interesting to read and look at but most of the times a highly complex description that requires strong defense on necessary conditions of which are assumptions difficult to defend.

That is a problem. The very problem that we all face when transfer complex quantitative trading algorithms in to live trading with actual money.

Under the definitions of options, we know that options are contracts that state a certain series of potential actions that may be executed if conditions are satisfied by the holder of the contracts. There should not be any confusion there. In some sense, a contract embeds fear and hope for both writers and holders of the contracts and this is where the problem initiates.

Let us forget about options or stock market for a second. To be able to price something, we either look at the past or look at the future. In this case, the Black and Scholes model look at the future. If stock price follow random walk, then options price may act in a certain way and we can discount the option prices back to present time to be able to tell how much the option contracts are worth today. This is a beautiful story written and derived on a false assumption, an assumption even our Nobel laureates found difficult to defend.

It is indeed an advanced version of "nonsense" that the non-mathematicians cannot really appreciate and the applied mathematicians cannot really apply. All theoretical evidence aside, the authors of Black Scholes model proved to us that they are indeed very wrong by running a hedge fund into bankruptcy[2]

3.2 How to Appreciate Nonsense

My grandparents always told me horrible stories about Japanese people. I came to United States in 2010 and I found out that out of every 10 Japanese students I met they are fond of helping other people out. They do not have the evilness in them described by my grandparents.

Who is at fault? No one. But how do we resolve this discrepancy? Our grandparents are making decisions on a different sets of data, a data that we no longer have and do not use anymore. They are not necessarily wrong and the Japanese students I met are not necessarily evil either. No one is at blame here. The world changes and unfortunately the decisions we are told no longer apply.

This is the very core of how I would start resolving this mathematical nonsense brought up by Black and Scholes. It is indeed true that the Black and Scholes model is difficult to apply to real world situation to realize actual profits. However, they provide a direction that all of us can refer to. To understand something today, perhaps you should look at the future. This philosophy is, in my humble opinion, correct in almost every aspect. We differ on how to look at the future and actions presumed when looking at the future, but looking at the future is still very necessary especially when it comes to security analysis.

I would argue that Black and Scholes provide an okay model but a very valuable philosophy. Those critics who laser focus on the mathematical model can only enjoy themselves in their well like a cute frog while missing the entire heavenly glory outside.

[2]Please see Long Term Capital Management here.

4 ON THE RECORD

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This year I started my YouTube channel. The biggest motivation is about documentation some of the interesting strategies as well as patterns.

My wife and I discussed that it is our goal to devote majority of our wealth and knowledge back to the society. It is definitely our top priority to deliver impact to the people. We found it important to not just generate wealth to fulfill fiduciary duty but also to distribute to ensure that we can help our allocate resources in an efficient manner that we believe that can help our those who needed the most.

Video record is the most easy and intuitive way to broadcast our philosophy and methodologies.

Up to this point, we have covered mostly in data science, machine learning, and money management. We are entering into big data era and a time where people cannot avoid interact with artificial intelligence. We thought that this human-AI interaction is going to be an interface that cannot be avoided. We also observed the common practice done by the people in the society. Some are ethical and moral such as building mechanical limbs for people with disabilities. Some are not so helpful at generating value to the society and even harmful to others such as making fake videos and audios for personal attack or attacks to particular demographic groups. Under evaluation of all of these situations, I found it not just useful but actually necessary to contribute to the social media some truthfulness of how AI works and how human can interact with AI which is extremely important for nowadays society.

4.1 Branch: Coffee Time with Mr. Yin!

Coffee Time with Mr. Yin! is running short episodes for non-technical discussions covering topics in the field of data science, money management, and machine learning.

4.2 Branch: Yin's Q Branch

Yin's Q Branch is running mid to long episodes for technical and coding walk-through covering topics in the field of data science, money management, and machine learning.

For example, the following figure is taken from thumbnail of the episode "His Last Bow" from Asset Pricing series.

Figure 2: The figure is a thumbnail picture selected from YouTube Series "Yin's Q Branch" from episode "His Last Bow".

For this particular episode, video link is here.

5 TOOLKIT AND ANSWERS

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Under my guidance, the R&D of Yin's Capital have mostly been focusing on collection of a variety of machine learning and A.I. strategies that can be used or deployed to money management. The initial stage and also an ongoing one is about increasing the size of the toolkit. The more we have the easier it is to deploying. Only under such collection of wealth can we begin to discuss the ways of searching for answers assuming we know what is the questions to answer of course.

In 2012, I was an undergraduate student at University of Rochester and I published my first paper under supervision of Professor Mihai Bailesteanu. The paper proposed a simple mathematical model that can be derived into a linear regression model. I also presented empirical evidence to illustrate why such direction can lead to small error in predicting tomorrow's stock price. Paper is published in Journal of Undergraduate Research at University of Rochester.

In 2015, I started my research career under the guidance of Professor Novy-Marx at University of Rochester. I led the coding project partitioning stock universe into categories according to fundamental values. The work laid out the foundation for Novy-Marx (2013) and encouraged Nobel Laureate Gene Fama and Ken French to develop Fama-French 5-Factor Model in Fama and French (2015). Though fulfilling, it is an apparent trend with lack of evidence to develop complex statistical models by adding more and more variables in the regression model without specific explanation. I found this trend problematic and lack of theoretical support so I decided to pursue a more advanced and prestigious institute, Columbia University, to study higher level theoretical statistics and machine learning.

In 2016 Fall, I adopted convergence theorem and proposed a novel algorithm that translate stock price from random walk into a standard normal distribution. I presented successful timing effect in predicting what would be a good place to buy given buyers' "patience". The paper was published in Columbia University Science Journal.

In 2017 Spring I met *Professor Shaw-hwa Lo* and it is his guidance that inspired me to realize what can be achieved in the near future. The previous statistical approach is still rooted in the pioneering idea proposed by Gauss more than two centuries ago on simple linear regression. The idea of "least square" appeared in Gauss's paper addressing an astronomy problem using a simple linear model. After that, multiple applications using Gauss's original idea quickly spread across all science and engineering fields. Some are straightforward extensions toward more complicated linear or nonlinear models, but the idea of fitting data to a certain assumed model remains unchanged.

In 2018 and 2019, I produced an academic paper that is really the culmination of what I have achieved following Professor Shaw-hwa Lo. I conducted independent end-to-end research projects on van't Veer's Breast Cancer data set, MNIST Handwritten Digit Image data set and a few other data sets. Among these projects, I build a variety of machine learning architectures using interaction-based features which was build upon ideas introduced by Lo et. al. (2002, 2008, 2009, 2015, 2016).

Looking beyond 2020, data sets are growing exponentially large and that which is considered to be pioneering ideas may no longer serve us. It is becoming more imminent than ever to understand and measure the "predictivity" of a data set. Under this direction, I have attempted many projects in the field of Explainable Artificial Intelligence (X.A.I.) which provides guidance for us all into 2020 and perhaps longer term in the future.