High-Frequency Algorithmic Trading with Momentum and Order Imbalance

My goal is to establish and solve the stochastic optimal control problem that captures the momentum and order imbalance dynamics of the Limit Order Book (LOB). The solution will yield an optimal trading strategy that will permit statistical arbitrage of the underlying stock, which will then be backtested on historical data.

Progress Timeline

DATE	THESIS	STA4505
~~Dec 2014~~	~~Complete CTMC calibration~~	
~~Dec 2014~~	~~Backtest naive strategies based on CTMC~~	
~~Jan-May~~	~~Study stochastic controls: ECE1639, STA4505~~	
~~Jun 5~~	~~Establish models~~	~~Exam Study~~
~~Jun 12~~	~~Establish performance criteria~~	~~Exam Study~~
~~Jun 15~~	~~Derive DPP/DPE~~	~~EXAM~~
~~Jun 19~~	~~Derive DPP/DPE~~	
~~Jun 26~~	~~Derive continuous-time equations~~	
~~Jul 3~~	~~Derive discrete-time equations~~	
~~Jul 10~~	~~Set up MATLAB numerical integration~~	
~~Jul 17~~	~~Integrate functions and plot dynamics~~	~~Integrate and analyze~~
~~Jul 24~~	~~Empty promises; zero fucks given~~	
~~Jul 31~~	~~Code for numerical solutions, calibrations, plots~~	~~Simulate results~~
~~Aug 7~~	~~All in-sample backtests~~	
Aug 14	All out-of-sample backtests	
Aug 21	The Big Writeup Effort	Project writeup
Aug 24	**Submit first draft for review by panel**	
Sep 2		Presentation

Whiteboard Inspirational Quote of the Week

We had an uninspired lil' week.

For Our Colleagues at Duke University...

Thu 6th: man this shit is all total balls. that's just the general sentiment of the day, ok? like, fuck, so tired of this, and i'm totally doing a shit job of time management in terms of breaking this down into manageable tasks and crossing them off one by one. i really do lose a good chunk of time just looking at my todo list and thinking that i don't want to do any of it, largely because it's broken down into what i would say are unmanageable, not-specific-enough tasks such as "write the whole results section". goal for the weekend is to un-kertwang that: just sit down, take i dunno, the maximum hour that it takes, and just write out a really solid todo list that i can look at and not have any individual thing be crazy daunting.

anyway but that's not all. today i brought the entire coffee brewing station into the office: kettle, grinder, aeropress, accessories. i'm not certain that my labmates are thrilled about the occasional 2-minute grinding sessions, but i'm sipping some damn FINE coffee these days. i also had a visiting scholar in at the lab: Alex Mogyoros. she's currently consulting for the OECD, is getting married to Seb in a couple weeks, and in a month is starting her PhD in Law at Oxford.

i have found a Para Pan Am sport that i can actually watch: goalball. it's kind of like a hybrid of soccer and bowling, 3 vs 3, the ball has little bells inside and the game is played by blind people only (hence i can watch them in comfort). like, check this shit out. fucking nuts.

Fri 7th: Not even 9am and I'm here, optimizing code, drinking coffee, writing you a few shitty paragraphs. so look, bit of a faux pas during thesis crunch time, but i'm going to the zoo today with the gifty hall crew. by the way we might want to rebrand ourselves as The Northern Men and get that sewn onto leather jackets with skulls, something like that. anyway so i'll be getting out of here pretty soon for the majority of the afternoon. i'll try to suss out whether Alan is gay and run the hypothesis by Kevin - i think he'll be the voice of reason on this one. well what else is new today ... not much. i'm reading a book called Bravo Two Zero, it's a memoir about a troop of British SAS guys, which by the way is the regiment JTF2 is modelled after, during the gulf war that get dropped into Iraq and shit goes bad. i haven't gotten that far though. as far as i've gotten, they're a bunch of dipshits that seem to take every opportunity to take the piss out of each other, not even limited to when they were departing on their mission, the other regiment guys were making jokes like 'since you won't be coming back, you won't be needing that air mattress anymore right?', and whistling funeral marches, and gesturing digging graves, etc. pretty grim stuff, i dunno how that isn't taboo in the forces. but anyway, they get heli dropped in Iraq, it's flat as fuck everywhere, they have 203 lbs of equipment each, and they gotta spend 14 days there. so it's day two, they're hiding in a little crevice type thing they found, middle of

the day, and the point where i put the book down was when a little iraqi goat boy comes right to the ledge of the crevice, looks down, makes eye contact with the sergeant, and runs yelling toward the enemy guys who relocated during the night and are now 500ft away. shit is about to get REAL.

Sat 8th: had a cute little time at the zoo yesterday with peter's mom. turns out our tickets were provided Fidelity Investments and we were privy to their free bbq that also had free beer – had to partake, what can you do. the day once again reinforced that animals, and in particular primates, are the fucking shit. good on the swiss for working with these creatures. so today i'm happy to say i've crossed out one of the tasks of negligible importance, namely writing the LOB section, and in particular generating that fucking sick graphic in Figure 1.1. i won't reveal how many hours i spent coding that one out in latex. that aside, i would like to also cross out the 'run overnight out-of-sample' item but it's still currently running (i think...), already clocked over 24h, and also while i ran a few crude checks to ensure i didn't introduce any bugs, i've got no guarantee, so i'm really hoping the end result is usable. it's a costly experiment, can't really afford too many fuck ups with these.

P.S. if i don't hear about biz school soon i'ma get real pissed and possibly piss on your grave.

The Academic Week in Review

Here it is, the full shebang, a semi-prioritized list of what's standing between me and that Aug 24th deadline:

- ~~write script for out-of-sample (+1 week) backtest~~
- run overnight out-of-sample backtest for all strategies
- the results section: produce plots and tables to summarize all results.
- plot and compare dynamics of delta for the different stochastic methods.
- general comparison of the continuous and discrete time methods, note high correlation.
- mimic Seb's four plots to show mechanics of the stoch methods
- write introduction
- write algo trading section
- ~~write LOB dynamics section~~
- write ITCH data section

- write intro to stochastic chapter
- Link STA4505 project into dissertation with lead-in blurb.
- re-write lead-in to continuous time section
- re-write lead-in to discrete time section
- write abstract
- write acknowledgement
- write dedication
- any remaining time to proof-read the bitch
- STA4505 project standalone write-up.