# 1 Introduction and Background

- Order books, order types, inventory risk, market participants, why market making is important
- Probability spaces, martingales
- Continuous-time stochastic processes
- Brownian motion
- Stochastic integration
- Itô's formula
- Girsanov's theorem?
- SDEs and Feynman-Kac?

# 2 Stochastic Optimal Control

- Controlled diffusion
- The Dynamic Programming Principle
- Hamilton-Jacobi-Bellman
- Verification theorem
- Maybe a simple worked example? e.g. Merton's portfolio optimisation

# 3 Formalising the Market-Making Problem

- What are we actually trying to optimise? Define the value function
- Reservation prices accounting for inventory risk
- Market impact of trades
- Trading intensity models

# 4 The Avellaneda-Stoikov Model

- Solve the HJB equation for $r^b(s,q,t)$ and $r^a(s,q,t)$
- Obtain the optimal distances $\delta^b(s,q,t)$ and $\delta^a(s,q,t)$
- Derive approximate and more computationally tractable solutions by asymptotic expansion in $q$
- Possible extensions: Options, interest, drift in the stock price, stochastic volatility model/autocorrelation, transaction costs, order sizes $> 1$,

# 5 Implementation in Python

- Python code and discussion of implementation methodology e.g. discrete time steps, correction for floating point computation errors with small values

# 6 Empirical Results

- Simulate paths of stock price, plot optimal bids/asks
- Simulate a limit orderbook with orders being placed, can plot inventory over time of the agent, PnL
- Maybe download orderbook data from cryptocurrency exchange API and backtest strategy?