

# Hackathon Docs

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## Introduction

### Task 1

### Task 2

$$\begin{aligned}\hat{D} = & \sum_{t_0}^{t_f-1} \sum_i -\mu(i, t) \left[ \frac{1}{K} \sum_{q=0}^{N_q-1} d^q \hat{n}(i, t, q) \right] + \frac{\gamma}{2} \sum_{t=t_0}^{t_f-1} \sum_{ij} \Sigma_{ij}^t \left[ \frac{1}{K} \sum_{q=0}^{N_q-1} d^q \hat{n}(i, t, q) \right] \left[ \frac{1}{K} \sum_{\bar{q}=0}^{N_q-1} d^q \hat{n}(j, t, \bar{q}) \right] \\ & + \sum_{t_0}^{t_f-1} \sum_{ij} \lambda(t, i) \lambda(t, j) \left\{ \left[ \frac{1}{K} \sum_{q=0}^{N_q-1} d^q \hat{n}(j, t+1, q) \right] \left[ \frac{1}{K} \sum_{q=0}^{N_q-1} d^q \hat{n}(i, t+1, q) \right] \right. \\ & - 2 \left[ \frac{1}{K} \sum_{q=0}^{N_q-1} d^q \hat{n}(i, t+1, q) \right] \left[ \frac{1}{K} \sum_{q=0}^{N_q-1} d^q \hat{n}(j, t, q) \right] + \left[ \frac{1}{K} \sum_{q=0}^{N_q-1} d^q \hat{n}(i, t, q) \right] \left[ \frac{1}{K} \sum_{q=0}^{N_q-1} d^q \hat{n}(j, t, q) \right] \left. \vphantom{\sum_{q=0}^{N_q-1}} \right\} \\ & + \rho \sum_{t_0}^{t_f} \sum_{ij} \left[ \frac{1}{K} \sum_{q=0}^{N_q-1} d^q \hat{n}(i, t, q) \right] \left[ \frac{1}{K} \sum_{\bar{q}=0}^{N_q-1} d^q \hat{n}(j, t, \bar{q}) \right] - 2\rho \sum_{t_0}^{t_f} \sum_i \left[ \frac{1}{K} \sum_{q=0}^{N_q-1} d^q \hat{n}(i, t, q) \right] + N_t \cdot N^2\end{aligned}\tag{1}$$

Which we may further simplify by collecting terms:

$$\begin{aligned}K\hat{D} = & \sum_{t_0}^{t_f-1} \sum_i \sum_{q=0}^{N_q-1} (-\mu(i, t) - 2\rho) d^q \hat{n}(i, t, q) \\ & + \frac{1}{K} \sum_{t_0}^{t_f-1} \sum_{ij} \sum_{q=0}^{N_q-1} \sum_{\bar{q}=0}^{N_q-1} \left[ \frac{\gamma}{2} \Sigma_{ij}^t + \lambda(t, i) \lambda(t, j) + \rho \right] d^q \hat{n}(i, t, q) d^q \hat{n}(j, t, \bar{q}) \\ & + \frac{1}{K} \sum_{t_0}^{t_f-1} \sum_{ij} \sum_{q=0}^{N_q-1} \sum_{\bar{q}=0}^{N_q-1} \lambda(t, i) \lambda(t, j) [d^q \hat{n}(i, t+1, q) d^q \hat{n}(j, t+1, \bar{q}) - 2d^q \hat{n}(i, t+1, q) d^q \hat{n}(j, t, \bar{q})] \\ & + \frac{\rho}{K} \sum_{ij} \sum_{q=0}^{N_q-1} \sum_{\bar{q}=0}^{N_q-1} d^q \hat{n}(i, t_f, q) d^q \hat{n}(i, t_f, \bar{q}) - 2\rho \sum_i \sum_{q=0}^{N_q-1} d^q \hat{n}(i, t_f, q) \\ & + K \cdot N_t \cdot N^2\end{aligned}\tag{2}$$

Note that while the boundary term contributes to the inner Hamiltonian, it only appears as a separate term due to the constraint. We have no information available about relative profits  $(\mu(i, t_f))$ , risk  $(\Sigma_{ij}^{t_f})$ , and transaction cost  $(\lambda(t, i))$  at the final time  $t = t_f$ .

## References