We now reach the second step and will construct a backtest signal and analyze it deeply. This is a bit hard, but trust me, the vast majority of students can do it every year.

What you need:
1. The hw2 file labeled as such in the data folder
2. To help students out this year, I will provide some helper code, which may or may not work with your version of Python. I have precomputed some of the variables as well. I usually don't do this, but figure it is good to help people get started. However, if you are serious about learning to become a quant, I would recommend you actually implement fcode yourself.

Rules:
1. Due Friday Feb 28 6pm HKT
2. Max 4 people (+1 point for groups of 1-2), all groups must submit a peer evaluation form if you work in groups of 3 or 4. Both submission link/group form link will be submitted later.
3. Total is out of 100, so extra credit points are meant to provide those with interest or background room to go further **but without overburdening those with less background or interest in the material.**
4. Please submit a Python notebook with clear comments. Use markdown to point out what question is being answered. Jupyter is the preference of the TA for assignments 1 and 2.

Intraday versus Overnight Momentum

We are now going to think a little bit about past literature and create a better version of momentum. There is an observation that overnight and intraday returns differ. The paper "Tug of War: Overnight versus Intraday Expected Returns" by Polk, Sapienza, and Subrahmanyam explores how expected returns manifest differently during overnight and intraday periods.

Basically, the idea is that momentum is typically defined as $\prod_k^{2..12} 1 + r_{t-k}$

Now we consider momentum of overnight returns as $\prod_k^{2..12} 1 + r_{t-k}^{overnight}$ and of intraday returns as $\prod_k^{2..12} 1 + r_{t-k}^{intraday}$, where $r_{t-k}^{intraday}$ can be defined as $\frac{close}{open} - 1$ and $r_{t-k}^{overnight}$ can be defined as $\frac{1+r_{t-k}}{1+r_{t-k}^{intraday}} - 1$.

So that it's clear how I aligned momentum, here is how I calculated (per class), I have my query here: select date,sum(ln(ret_msf+1)) over (partition by permno order by month_index rows between 6 preceding and 2 preceding) as mom. Point: I've already aligned it to be tradeable at that point in time for you.[1]

1. What information events happen during market hours and outside of market hours? Specifically
   - When are earnings of companies announced?

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[1] Traditionally momentum is t-12, t-2. It doesn't make a difference in this case, as you'd get the same patterns qualitatively and quantitatively, but that's the version I gave you.

- Typically, are macro announcements like non-farm payrolls during trading day or before market hours? Hm, why would macro announcements matter for individual stocks?

2. Now read in the parquet file I provided. What is the correlation of intraday, overnight momentum and regular momentum?

3. Extra credit (3 points): Compute intraday/overnight momentum yourself using the crsp.dsf file, verify that you calculated it correctly by reporting the intraday momentum value for Tesla at the end of the sample. Specifically, the last day.

4. Let's now report three tables. Kick out anything that in the bottom 20% of market capitalization (already computed) at portfolio formation time (remember the return reported is the return you earn from close of t-1 to close of time t), and anything with a price less than 5 at that time. Now report the 12 row x 11 column table, where the columns are the average returns/t-statistics of those returns for portfolios 1..10 and then the long-short portfolio, and there are six sets of rows, one for EW, VW, EW overnight, VW overnight, EW intraday, EW overnight.

- Based on the tables you produced, does intraday momentum predict intraday future returns or overnight returns? What about total returns? Likewise, does overnight momentum predict intraday future returns or overnight returns? What about total returns? Interesting pattern, right?

- Extra credit (1 point): For just the regular momentum portfolio, for a typical month, what is the fraction of winners that outperform the market return (i.e. from the fama French factor file)? I would first compute the monthly fraction, then average across time. Why are portfolios necessary in our quant trading strategies, why can't we just pick one stock?

5. Now compute an "independent sort", whereby we sort independently on intraday momentum, overnight momentum. Sort into 5 bins each. Show me the five by five grid where from left to right is increasing in overnight momentum and top to bottom is increasing in intraday momentum. Report both the value-weighted and equal-weighted grids. (Hint: You first must construct monthly portfolios, and then average across time.)

6. Now answer a few questions about this:

- On average, do you see that intraday momentum explains returns within overnight momentum buckets?
- On average, do you see that overnight momentum explains returns within intraday momentum buckets?
- As both types of momentum increase, are the returns to the strategy increasingly profitable?
- What is the most profitable strategy long/short strategy you could construct? Does it make sense to you that combining intraday/overnight momentum produce a better return?

7. Does the strategy which shorts stocks which are low quintile of both momentum strategies, and long the high quintile of both momentum strategies (i.e. long the bottom right corner, short the top left corner), perform well?
   o Compute the Sharpe ratio of the equal/value weighted strategies. Does it have a higher Sharpe ratio than a factor that you construct yourself which is long tenth bucket of momentum and short the 1st bucket of momentum.

- o Produce the profit and loss curve
- o Does it have alpha with respect to the momentum portfolio you construct yourself?
- o Does it have alpha with respect to the momentum portfolio you construct yourself plus the FF5 factor?

8. Extra credit (4 points): estimate three regressions. First, the Fama-MacBeth regression of overnight return to future returns, second, the Fama-MacBeth cross-sectional regression of intraday momentum on returns, and then third, the specification with both terms included and an interaction. Does this result corroborate the barplot? Report a single table with coefficients and t-statistics.

9. Extra credit (2 point): based on the literature on calendar anomalies, if my supposition is correct that intraday and overnight returns offer different types of information, what other types of intraday/overnight segmentations can we do? Cite a literature to explain your argument. You don't need to code.