Week-8

L1 IOT (IIOT/Sensorization)

- IOT → A network of interconnected devices ranging from comp. & elec. gadgets to vehicles, all connec. to the internet. The Term came in 1990s. Devices & prod. would eventually talk to each other & to network servers, in the interest of improving the performance.
- The IOT can be seen as connected to smart devices - watch, fridge, TV, bands, etc. It allows these devices to seamlessly exchange & consume data with minimal human interven". Once data gets to the cloud, software processes it & then might decide to perform an ac".
- 3 forms of internet - consumer, commercial & industrial. They have diff. target audience, TRs & strategies. Consumer market has market visibility.
- Commercial market has high marketability as they have services that compass financial & investment products. Enterprise IOT includes small, medium, & large businesses.
- By IIOT, we distinguish the assets that are connected, yet underlying idea is same.
- IIOT devices are wirelessly connected to the network.
- Obj. → ↑ efficiency & productivity thru automa".
- We wants to collect comprehensive data from assets or processes. The data can be sent to

a cloud server for processing & decision making.

- IOT in Manufacturing - IIOT (Use cases)

1. Inventory → used with RFID, every inventory has its UID. RFID scans the tag & data extracted gets transmitted to cloud. Tracks locaⁿ, movement along supply chain, real-time status, better handling time

2. Smart-Meter - monitors consumpⁿ of water, fuel, elec. → gauges for specific use & prevent over-usage of resources.

3 Quality Control → (Prognostics), use thermal & video sensors to collect prod. data, test at each manufacturing step to check for specificaⁿˢ.

4. Predictive Maintainence → monitor the operating equipment & perform analytics using related data to evaluate wear & tear.

5. Industrial Safety → optimize safety of workers, equipment & opⁿˢ. Track KPIs. IOT wearables measure health metrics.

- 7 principles of IOT -

1. Big Analog Data → convert digitizaⁿ
2. Constant Connecⁿ → monitor, maintenance, motivaⁿ
3. Real Time
4. Spectrum of Insights
5. Immediacy vs depth - quick analysis gives innr. insights, deeper results take time.

6. Shift left → Asset - Sensor → Server → Human
Left

7. The next "V" → Visibility

L2 Time Series Forecasting

- 2 basic task → identify pattern, discover rela" btw. variables of interest. The common method of identifying pattern is to decompose the data into components — trend, seasonal, cyclic & random.

- Exponential Smoothening
  - → F_t forecast of t, D_t data of t.
  - $$F_{t+1} = \alpha D_t + (1-\alpha) F_t$$
  - → F_1 → can be 1st value, last, or avg.
  - → for large datasets, impact of F_1 is smaller.
  - → value of α depends on demand varia" (smaller α if varia" is large)

- Time Series Model (+Trends)
  - → $F_t = a + bt + \varepsilon$ use least SSE
  - → linear reg. model — considers all data pts. & gives equal wt. to the past history.

- Double exp. smoothing
  - → ES + linear trend model
  - → when exponential fit is applied to data with linear trend, we know that forecast lags behind the most recent value.

$$\boxed{Lag = D_t - F_t = \frac{1-\alpha}{\alpha} \times b}$$

- Holt's Method for trend

$$\boxed{F_{t+1} = a_t + b_t}$$ → level, → slope

$$a_t = \alpha D_t + (1-\alpha)(a_{t-1} - b_{t-1})$$
$$b_t = \beta(a_t - a_{t-1}) + (1-\beta) b_{t-1}$$

$$a_1 = D_1 \quad , \quad b_1 = \frac{D_n - D_1}{n-1}$$

- Winter's model for seasonality

$$\boxed{F_{t+1} = (a_t + b_t) \times C_{t+1}}$$

fixed level. trend comp. seasonality index

$$a_{t+1} = \alpha \frac{D_{t+1}}{C_{t+1}} + (1-\alpha)(a_t + b_t)$$

$$b_{t+1} = \beta(a_{t+1} - a_t) + (1-\beta) b_t$$

$$C_{t+p+1} = \gamma \frac{D_{t+1}}{a_{t+1}} + (1-\gamma) C_{t+1}$$

- AR(1)

$$\hat{D}_t = D_t - \mu \Rightarrow \mu = E[D_t]$$

$$AR(1) \rightarrow \hat{D}_t = \phi_1 \hat{D}_{t-1} + \varepsilon_t$$

- MA(1)

$$F_t = \mu - \theta(\varepsilon_{t-1}) \qquad \varepsilon_{t-1} = D_{t-1} - F_{t-1}$$

HQ

- ARMA(1)

$$\hat{D}_t = \phi_1 \hat{D}_{t-1} - \theta(\varepsilon_{t-1}) + \varepsilon_t$$

L3 Excel Based Forecasting

- automatic paid solvers for excel.