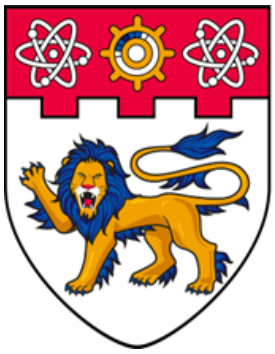

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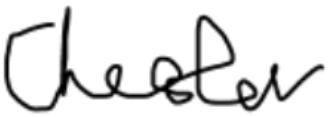
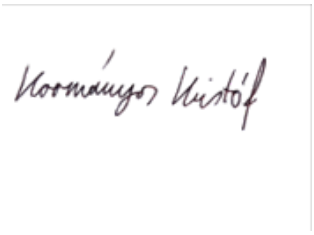
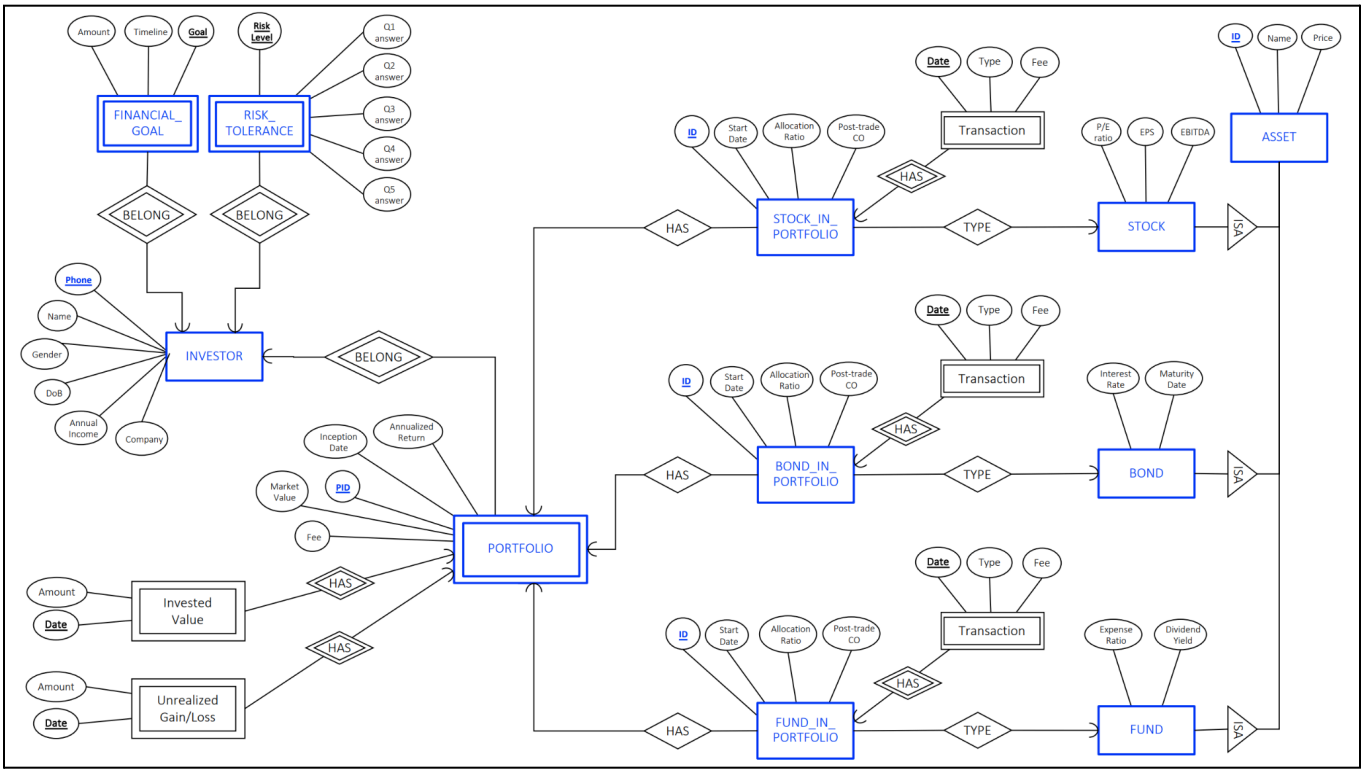
Individual Contribution Form:

Full Name	Individual Contribution to Lab3 Submission	Percentage of Contribution	Signature
Liong Xun Qi	Entities: Bond_In_Portfolio, Transaction, Bond	16.67%	
Balajee Viswanath Akshay Narayanan	Entities: Financial_Goal, Risk_Tolerance, Investor. Aided in Portfolio.	16.67%	
Chester Chan Hong Kai	Entities: Transaction, Fund_In_Portfolio, Fund	16.67%	
Glynis Looi Xin Lin	Entities: Portfolio, Invested_Value, Unrealized_Gain_Loss	16.67%	
Jothilingam Dheeraj	Entities: Stock, Stock_In_Portfolio, Transaction	16.67%	
Kristof Kormanyos	Entities: Asset, Portfolio normalization, Finalisation of Risk_Tolerance, Asset_In_Portfolio	16.67%	

ER Diagram followed (Suggested Solution):



Schema:

INVESTOR(<u>Phone</u>, Name, Gender, DoB, Annual Income, Company)

- Key: Phone
- Primary Key: Phone
- FDs:
  - Phone → Name, Gender, DoB, Annual Income, Company
- The relation is in BCNF, hence it is in 3NF.

RISK_TOLERANCE(<u>Risk Level</u>, <u>Phone</u>, Q1 Answer, Q2 Answer, Q3 Answer, Q4 Answer, Q5 Answer)

- Key (Composite): (Risk Level, Phone)
- Primary Key (Composite): (Risk Level, Phone)
- Foreign Key: Investor.Phone
- FDs:
  - Risk Level, Phone → Q1 Answer, Q2 Answer, Q3 Answer, Q4 Answer, Q5 Answer
- The relation is in BCNF, hence it is in 3NF.

FINANCIAL_GOAL(<u>Goal</u>, <u>Phone</u>, Amount, Timeline)

- Key (Composite): (Goal, Phone)
- Primary Key (Composite): (Goal, Phone)
- Foreign Key: Investor.Phone
- FDs:
    - Goal, Phone → Timeline, Amount
- The relation is in BCNF, hence it is in 3NF.

PORTFOLIO(<u>PID</u>, <u>Phone</u>, Annualized Return, Inception Date, Market Value, Fee)

- Key (Composite): (PID, Phone)
- Primary Key (Composite): (PID, Phone)
- Foreign Key: Investor.Phone
- FDs:
    - PID, Phone → Annualized Return, Inception Date, Market Value, Fee
    - Market Value, Inception Date → Annualized Return
- The relation violates 3NF.
- Normalization:
    - Start: S = {PID, Phone → Annualized Return, Inception Date, Market Value, Fee; Market Value, Inception Date → Annualized Return}
    - Minimal Basis:
        - Condition 1.: S = {PID, Phone → Annualized Return; PID, Phone → Inception Date; PID, Phone → Market Value; PID, Phone → Fee; Market Value, Inception Date → Annualized Return}
        - Condition 2.:
            - Is PID, Phone → Annualized Return redundant?
                - {PID, Phone}+ = {PID, Phone, Inception Date, Market Value, Fee, Annualized Return}, it is redundant.
            - Is PID, Phone → Inception Date redundant?
                - {PID, Phone}+ = {PID, Phone, Market Value, Fee}, not redundant.
            - Is PID, Phone → Market Value redundant?
                - {PID, Phone}+ = {PID, Phone, Inception Date, Fee}, not redundant.
            - For all LHS (PID, Phone) not redundant.
            - Is Market Value, Inception Date → Annualized Return?
                - {Market Value, Inception Date}+ = {Market Value, Inception Date}, not redundant.
            - S = {PID, Phone → Inception Date; PID, Phone → Market Value; PID, Phone → Fee; Market Value, Inception Date → Annualized Return}
        - Condition 3.:
            - Is PID redundant?
                - {Phone}+ = {Phone}, not redundant.
            - Is Phone redundant?

            - {PID}+ = {PID}, not redundant.
        - Is Market Value redundant?
            - {Market Value}+ = {Market Value}, not redundant.
        - Is Inception Date redundant?
            - {Inception Date}+ = {Inception Date}, not redundant.
    - Final Result of Minimal Basis: S = {PID, Phone → Inception Date; PID, Phone → Market Value; PID, Phone → Fee; Market Value, Inception Date → Annualized Return}
- Combining matching LHS: S = {PID, Phone → Inception Date, Market Value, Fee; Market Value, Inception Date → Annualized Return}
- Normalized Tables:
    - ***PORTFOLIO1(PID, Phone, Inception Date, Market Value, Fee)***
    - ***RETURNS(Market Value, Inception Date, Annualized Returns)***

PORTFOLIO1(PID, Phone, Inception Date, Market Value, Fee)

- Key (Composite): (PID, Phone)
- Primary Key (Composite): (PID, Phone)
- Foreign Key: Investor.Phone
- FDs:
    - PID, Phone → Inception Date, Market Value, Fee
- The relation is in BCNF, hence it is in 3NF.

RETURNS(Market Value, Inception Date, Annualized Returns)

- Key (Composite): (Market Value, Inception Date)
- Primary Key (Composite): (Market Value, Inception Date)
- FDs:
    - Market Value, Inception Date → Annualized Return
- The relation is in BCNF, hence it is in 3NF.

INVESTED_VALUE(PID, Phone, Date, Amount)

- Key (Composite): (PID, Phone, Date)
- Primary Key (Composite): (PID, Phone, Date)
- Foreign Key: Portfolio.PID, Investor.Phone
- FDs:
    - PID, Phone, Date → Amount
- The relation is in BCNF, hence it is in 3NF.

UNREALIZED_GAIN_LOSS(PID, Phone, Date, Amount)

- Key (Composite): (PID, Phone, Date)
- Primary Key (Composite): (PID, Phone, Date)
- Foreign Key: Portfolio.PID, Investor.Phone
- FDs:
    - PID, Phone, Date → Amount
- The relation is in BCNF, hence it is in 3NF.

ASSET(<u>ID</u>, Name, Price)

- Key: ID
- Primary Key: ID
- FDs:
    - ID → Name, Price
- The relation is in BCNF, hence it is in 3NF.
- *Superclass ER approach.*

FUND(<u>ID</u>, Expense Ratio, Dividend Yield)

- Keys: ID
- Primary Key: ID
- Foreign Key: ID (Asset.ID)
- FDs:
    - ID → Expense Ratio, Dividend Yield
- The relation is in BCNF, hence it is in 3NF.
- *Subclass ER approach.*

BOND(<u>ID</u>, Interest Rate, Maturity Date)

- Keys: ID
- Primary Key: ID
- Foreign Key: ID (Asset.ID)
- FDs:
    - ID → Interest Rate, Maturity Date
- The relation is in BCNF, hence it is in 3NF.
- *Subclass ER approach.*

STOCK(<u>ID</u>, P/E ratio, EPS, EBITDA)

- Keys: ID
- Primary Key: ID
- Foreign Key: ID (Asset.ID)
- FDs:
    - ID → P/E ratio, EPS, EBITDA
- The relation is in BCNF, hence it is in 3NF.
- *Subclass ER approach.*

FUND_IN_PORTFOLIO(<u>ID</u>, Start date, Allocation ratio, Post-trade CO, Asset ID, PID, Phone)

- Keys: ID
- Primary Key: ID
- Foreign Key: Asset ID (Bond.ID), Portfolio.PID, Investor.Phone
- FDs:
    - ID → Start Date, Allocation Ratio, Post-Trade CO, Asset ID, PID, Phone
- The relation is in BCNF, hence it is in 3NF.

BOND_IN_PORTFOLIO(<u>ID</u>, Start date, Allocation ratio, Post-trade CO, Asset ID, PID, Phone)

- Keys: ID
- Primary Key: ID
- Foreign Keys: Asset ID (Bond.ID), Portfolio.PID, Investor.Phone
- FDs:
    - ID → Start Date, Allocation Ratio, Post-Trade CO, Asset ID, PID, Phone
- The relation is in BCNF, hence it is in 3NF.

STOCK_IN_ PORTFOLIO(<u>ID</u>, Start Date, Allocation Ratio, Post-Trade CO, Asset ID, PID, Phone)

- Keys: ID
- Primary Key: ID
- Foreign Keys: Asset ID (Stock.ID), Portfolio.PID, Investor.Phone
- FDs:
    - ID → Start Date, Allocation Ratio, Post-Trade CO, Asset ID, PID, Phone
- The relation is in BCNF, hence it is in 3NF.

TRANSACTION(<u>Date</u>, <u>ID</u>, Type, Fee)

- Key (Composite): (Date, ID)
- Primary Key: (Date, ID)
- Foreign Key: ID (STOCK_IN_ PORTFOLIO.ID or BOND_IN_ PORTFOLIO.ID or FUND_IN_ PORTFOLIO.ID)
- Assumption: The Type determines Fee through a rule. There must be 3 separate tables for each weak transaction entity for STOCK_IN_ PORTFOLIO, BOND_IN_ PORTFOLIO and FUND_IN_ PORTFOLIO, but since table name and attributes in the ER diagram are all the same, we have only shown a Transaction table once here.
- FDs:
    - Date, ID → Type, Fee
    - Type → Fee
- The relation violates 3NF.

- Normalization:
    - Hence, we first minimise the FDs.
    - The isolated FDs are:
        - Date, ID → Type
        - Date, ID → Fee
        - Type → Fee
    - On combining the FDs we get:
        - Date, ID→ Type, Fee
        - Type → Fee
    - Creating relations for each FDs.

TRANSACTION1(<u>Date</u>, <u>ID</u>, PID, Phone, Type)

- Key (Composite): ID, Date
- Primary Key: ID, Date
- FDs:
    - ID, Date → PID, Phone, Type
- The relation is in BCNF, hence it is in 3NF.

TRANSACTION_FEES(<u>Type</u>, Fee)

- Key: Type
- Primary Key: Type
- FDs:
    - Type → Fee
- The relation is in BCNF, hence it is in 3NF.

Additional Assumption: Since Transaction has a relation with Asset_In_Portfolio (where asset can be Bond/Fund/Stock), the (PID, Phone) combination can be taken from there instead of storing it in the Transaction table as well. This helps reduce redundant data in the database.

Final Relational Schema:

INVESTOR(Phone, Name, Gender, DoB, Annual Income, Company)

RISK_TOLERANCE(Risk Level, Phone, Q1 Answer, Q2 Answer, Q3 Answer, Q4 Answer, Q5 Answer)

FINANCIAL_GOAL(Goal, Phone, Amount, Timeline)

PORTFOLIO1(PID, Phone, Inception Date, Market Value, Fee)

RETURNS(Market Value, Inception Date, Annualized Returns)

INVESTED_VALUE(PID, Phone, Date, Amount)

UNREALIZED_GAIN_LOSS(PID, Phone, Date, Amount)

ASSET(ID, Name, Price)

FUND(ID, Expense Ratio, Dividend Yield)

BOND(ID, Interest Rate, Maturity Date)

STOCK(ID, P/E ratio, EPS, EBITDA)

FUND_IN_PORTFOLIO(ID, Start date, Allocation ratio, Post-trade CO, Asset ID, PID, Phone)

BOND_IN_PORTFOLIO(ID, Start date, Allocation ratio, Post-trade CO, Asset ID, PID, Phone)

STOCK_IN_ PORTFOLIO(ID, Start Date, Allocation Ratio, Post-Trade CO, Asset ID, PID, Phone)

TRANSACTION1(Date, ID, PID, Phone, Type)

TRANSACTION_FEES(Type, Fee)