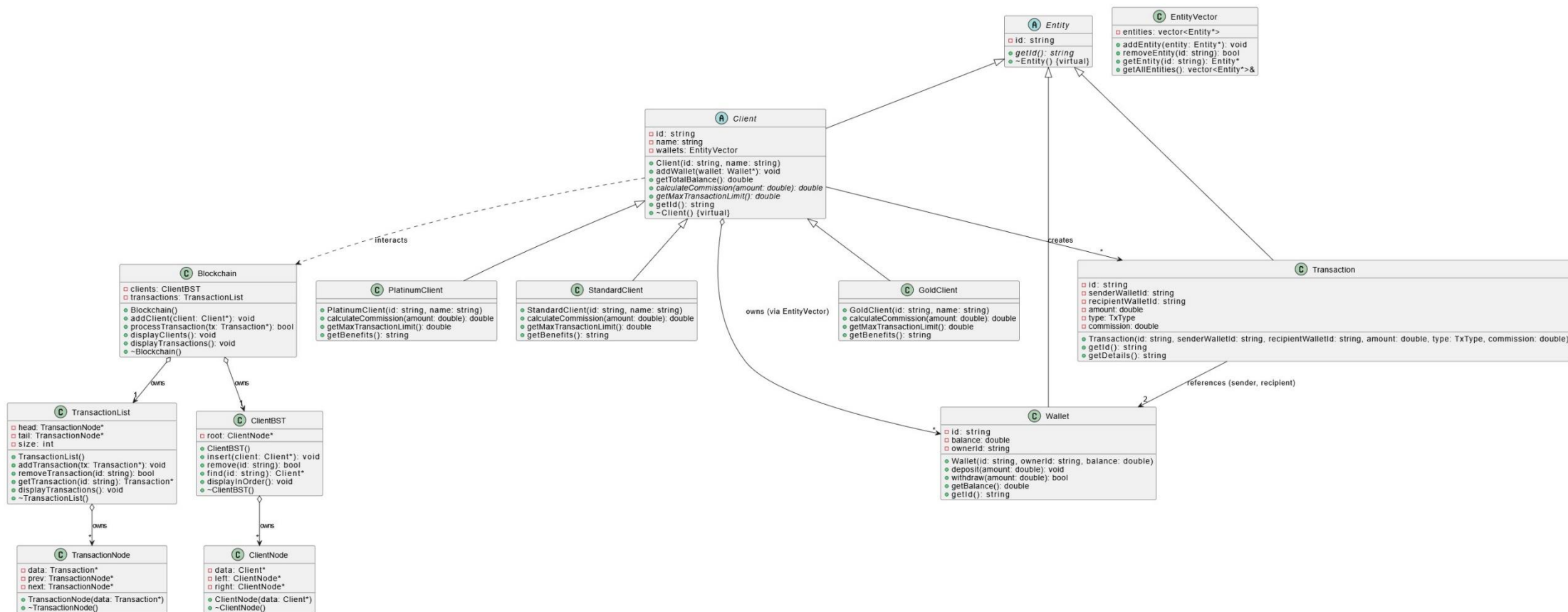# PROJECT OF END COURSE – LABORATORY OF FUNDATIONS OF ALGORITHMS AND PROGRAMMING

SIMPLIFIED SIMULATION OF A BLOCKCHAIN TRANSACTION SYSTEM

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UML DIAGRAM:

- **Description of Relationships:**

1. Inheritance:
   - Entity ← Client, Wallet, Transaction: Entities inherit from Entity for ID management.
   - Client ← GoldClient, PlatinumClient, StandardClient: Client types override commission and limit methods.
2. Composition:
   - Blockchain → ClientBST: Blockchain owns the ClientBST (1 to 1).
   - Blockchain → TransactionList: Blockchain owns the TransactionList (1 to 1).
   - ClientBST → ClientNode: ClientBST owns ClientNode objects (1 to *).
   - TransactionList → TransactionNode: TransactionList owns TransactionNode objects (1 to *).
3. Aggregation:
   - Client → Wallet: Client owns Wallets via EntityVector (1 to *), but Wallets could be reassigned.
4. Association:
   - Client ↔ Blockchain: Clients interact with Blockchain for transactions and queries (* to 1).
   - Client → Transaction: Clients create Transactions (1 to *).
   - Transaction → Wallet: Transactions reference sender and recipient wallets (1 to 2).

- **Notes:**

- Attributes: Private (-), Public (+).
- Multiplicity: 1 (one), * (many).
- TxType: Enum in Transaction (TRANSFER).
- EntityVector manages 1-to-many relationships (e.g., Wallets in Client).
- ClientBST orders clients by total balance.
- TransactionList uses a doubly-linked list for transactions.

- **Description of Classes, Attributes, and Methods**

Below are the simplified class specifications:

1. **Entity** (Abstract Base Class):
    - **Purpose**: Base class for entities (Client, Wallet, Transaction).
    - **Attributes**:
        - id: string (unique identifier)
    - **Methods**:
        - getId(): string (pure virtual)
        - ~Entity() (virtual destructor)
    - **Abstract**: Yes.
2. **EntityVector**:
    - **Purpose**: Manages a 1-to-many relationship for entities (e.g., wallets owned by a client).
    - **Attributes**:
        - entities: vector<Entity*> (stores entity pointers)
    - **Methods**:
        - addEntity(entity: Entity*): void
        - removeEntity(id: string): bool
        - getEntity(id: string): Entity*
        - getAllEntities(): vector<Entity*>&
3. **Client** (Abstract Base Class):
    - **Purpose**: Base class for client types.
    - **Attributes**:
        - id: string (inherited from Entity)
        - name: string
        - wallets: EntityVector (stores wallets)
    - **Methods**:
        - Client(id: string, name: string)
        - addWallet(wallet: Wallet*): void

- getTotalBalance(): double (sum of wallet balances)
- calculateCommission(amount: double): double (pure virtual)
- getMaxTransactionLimit(): double (pure virtual)
- getId(): string (override)
- ~Client() (virtual destructor)

4. **GoldClient** (Inherits from Client):
   - **Purpose**: Premium clients with low commissions.
   - **Attributes**: (Inherited)
   - **Methods**:
     - GoldClient(id: string, name: string)
     - calculateCommission(amount: double): double (e.g., 1%)
     - getMaxTransactionLimit(): double (e.g., 10000)
     - getBenefits(): string ("Priority processing, low fees")

5. **PlatinumClient** (Inherits from Client):
   - **Purpose**: Mid-tier clients with moderate commissions.
   - **Attributes**: (Inherited)
   - **Methods**:
     - PlatinumClient(id: string, name: string)
     - calculateCommission(amount: double): double (e.g., 2%)
     - getMaxTransactionLimit(): double (e.g., 5000)
     - getBenefits(): string ("Bonus rewards, moderate fees")

6. **StandardClient** (Inherits from Client):
   - **Purpose**: Standard clients with higher commissions.
   - **Attributes**: (Inherited)
   - **Methods**:
     - StandardClient(id: string, name: string)
     - calculateCommission(amount: double): double (e.g., 5%)
     - getMaxTransactionLimit(): double (e.g., 1000)
     - getBenefits(): string ("Standard access")

7. **Wallet** (Inherits from Entity):

- o **Purpose**: Stores funds for transactions.
- o **Attributes**:
  - id: string (inherited)
  - balance: double
  - ownerId: string (client ID)
- o **Methods**:
  - Wallet(id: string, ownerId: string, balance: double)
  - deposit(amount: double): void
  - withdraw(amount: double): bool
  - getBalance(): double
  - getId(): string (override)

8. **Transaction** (Inherits from Entity):
   - o **Purpose**: Represents a transfer between two wallets.
   - o **Attributes**:
     - id: string (inherited)
     - senderWalletId: string (sender's wallet ID)
     - recipientWalletId: string (recipient's wallet ID)
     - amount: double
     - type: TxType (enum: {TRANSFER})
     - commission: double
   - o **Methods**:
     - Transaction(id: string, senderWalletId: string, recipientWalletId: string, amount: double, type: TxType, commission: double)
     - getId(): string (override)
     - getDetails(): string

9. **TransactionNode**:
   - o **Purpose**: Node for the doubly-linked list of transactions.
   - o **Attributes**:
     - data: Transaction*
     - prev: TransactionNode*

- next: TransactionNode*
  - **Methods**:
    - TransactionNode(data: Transaction*)
    - ~TransactionNode()
10. **TransactionList**:
    - **Purpose**: Doubly-linked list for transactions.
    - **Attributes**:
      - head: TransactionNode*
      - tail: TransactionNode*
      - size: int
    - **Methods**:
      - TransactionList()
      - addTransaction(tx: Transaction*): void
      - removeTransaction(id: string): bool
      - getTransaction(id: string): Transaction*
      - displayTransactions(): void
      - ~TransactionList()
11. **ClientNode**:
    - **Purpose**: Node for the binary search tree of clients.
    - **Attributes**:
      - data: Client*
      - left: ClientNode*
      - right: ClientNode*
    - **Methods**:
      - ClientNode(data: Client*)
      - ~ClientNode()
12. **ClientBST**:
    - **Purpose**: Binary search tree for clients, ordered by balance.
    - **Attributes**:
      - root: ClientNode*

- o **Methods**:
  - ClientBST()
  - insert(client: Client*): void
  - remove(id: string): bool
  - find(id: string): Client*
  - displayInOrder(): void
  - ~ClientBST()
13. **Blockchain**:
    - o **Purpose**: Manages clients and transactions.
    - o **Attributes**:
      - clients: ClientBST
      - transactions: TransactionList
    - o **Methods**:
      - Blockchain()
      - addClient(client: Client*): void
      - processTransaction(tx: Transaction*): bool
      - displayClients(): void
      - displayTransactions(): void
      - ~Blockchain()

- **Instructions**

Implement the system which simulates a creative and very simplified version of BlockChain financial transaction operations between wallets of Clients. The core of the system is the BlockChain, which contains information about the Clients and the transactions. It is necessary do operations of deposits and withdraws. Implement the system in C++ following OOP paradigm using classes, methods, constructors, destructors and relationships between classes like inheritance, association, aggregation or composition when it is necessary. Use the data structures of Binary Tree Search and Double Linked List. Prepare necessary methods which can make reports of List of Clients and the List of transactions contained in the BlockChain. If you want, you can add or simplify the ideas

expressed in the UML diagram and this description (it is not necessary implement entire schema – all classes, attributes or methods, but the most critic ideas and functionalities are mandatory). Store the information of clients and the information of transactions in 2 files: **Clients.txt** and **Blockchain_transactions.txt** using functionalities to read and write in files through the functions **fopen, fscanf, fprintf** and **fclose** used in the lesson 09 of 1st semester in course Algorithmizing and Programming. The assignment should be completed in **groups of 4 students**. A report should be written following the instructions given by the theory teacher. The presentation will take place on the day of the laboratory evaluation. The project need be published in the Github repository of the leader of the group.