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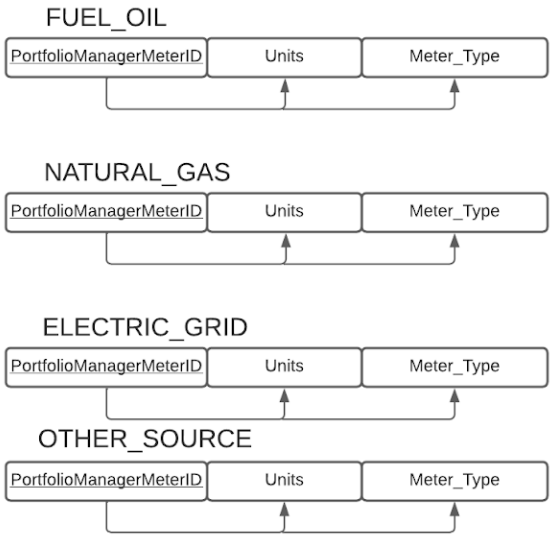
Stage 4 Database Design
ACC 311/CSC 315 Collaboration

1. **Demonstrate that all the relations in the relational schema are normalized to Boyce-Codd normal form (BCNF)**

After reviewing our model with the stakeholder and adjusting the relational schema, we were able to ensure that we were generating simplified tables that eliminated a copious number of update anomalies. We were then able to normalize each table into BCNF, keeping in mind that BCNF occurs when R is normalized to 3NF and all FDs, X→A, exist in a relation schema where X must be a superkey.

- ***FUEL_OIL, NATURAL_GAS, ELECTRIC_GRID, OTHER_SOURCE:***

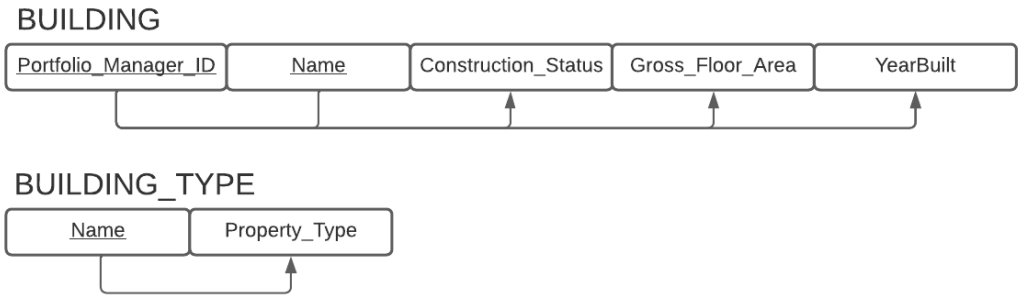
The FUEL_OIL, NATURAL_GAS, ELECTRIC_GRID, OTHER_SOURCE relations are in BCNF.The subclasses for the energy source relationships began in 1NF since there were no multivalued attributes and only single values were used. They were then converted to 2NF where every non-prime attribute, which involves units and meter type, were fully functionally dependent on the primary key, PortfolioManagerMeterID. After evaluating the second formal form, we determined that it was already in BCNF since both attributes, units and meter type, are fully functionally dependent on the primary key of PortfolioManagerMeterID.



- ***BUILDING:***

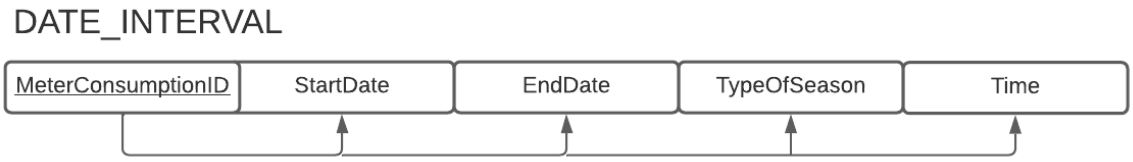
The relation, BUILDING, is in BCNF. It began in 1NF since there were no multivalued attributes and only single values were used. It was then converted to 2NF where every non-prime attribute must be fully functionally dependent on the primary key, Portfolio_Manager_ID and Name. Since the Portfolio_Manager_ID and Name uniquely identifies a building entity, the first FD where both parts of the key map to the non-prime attributes, Construction_Status,

Gross_Floor_Area, and Year_Built would remain in the BUILDING relation. However, for the second FD where Name can be used to determine the Property_Type, it followed a partial dependency, so it had to be decomposed into a new relation called BUILDING_TYPE. After the conclusion of the second formal form, both tables were determined to already be in BCNF since non-key attributes in BUILDING, Construction_Status, Gross_Floor_Area, and YearBuilt, depend on the primary key, Portfolio_Manager_ID and Name, and the non-key attribute in BUILDING_TYPE, Property_Type, depends on the primary key, Name.



- ***DATE_INTERVAL:***

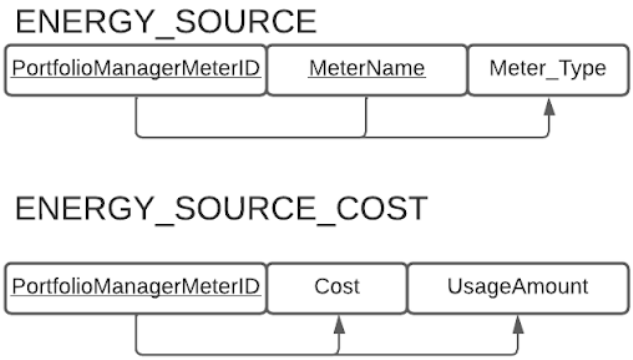
The relation, DATE_INTERVAL, is in BCNF. It began in 1NF since there were no multivalued attributes and only single values were used. It was then converted to 2NF where every non-prime attribute must be fully functionally dependent on the primary key, MeterConsumptionID. The DATE_INTERVAL relation was then determined to be in BCNF since the only functional dependency present has the key determining the dates measured along with the type of season that these dates fall within and the time.



- ***ENERGY_SOURCE:***

The relation, ENERGY_SOURCE, is in BCNF. It began in 1NF since there were no multivalued attributes and only single values were used. It was then converted to 2NF where every non-prime attribute must be fully functionally dependent on the primary key, PortfolioManagerMeterID and MeterName. Thus, the second FD, which has PortfolioManagerMeterID determining the cost and usage amount, followed a partial dependency, so it was decomposed into a new relation called ENERGY_SOURCE_COST. After the conclusion of the second formal form, both tables were determined to already be in BCNF since the non-key attribute in ENERGY_SOURCE, Meter_Type, depends on the primary key, PortfolioManagerMeterID and MeterName, and

non-key attributes in ENERGY_SOURCE_COST, Cost and UsageAmount, depend on the primary key, PortfolioManagerMeterID.



- ***POWERED_BY, MAPS_TO:***

The relation, POWERED_BY and MAPS_TO, began in 1NF since there were no multivalued attributes and only single values were used. It was then able to be converted into 2NF since there are no FDs and no non-prime attributes, meaning that the non-existent attributes would be fully functionally dependent on the primary key. The primary key for POWERED_BY would be PortfolioManagerMeterID and Portfolio_Manager_ID, and the primary key for MAPS_TO would be MeterConsumptionID and PortfolioManagerMeterID. It is then converted to a BCNF since there are no FDs and no non-prime attributes, so the non-existent non-prime attributes would be dependent on the key of each table.