COSC344 Assignment 2 Report: Mapping and Normalization

Leader: Hayden McAlister

Members: Masaaki Fukushima, Jack Heikell, Nat Moore

Entity-Relationship Model

- Student

Attribute	Simplicity	Num-Values	Data Type
Student_ID	Simple, Not NULL	Single-valued	Int (key Attribute)
Name	Simple, Not NULL	Single-valued	String
Phone	Simple	Single-valued	String
Address	Composite (Street_Number: int[1,10000], Street_Name: Str, Suburb: Str)	Multi-valued	String
Course	Simple	Multi-valued	String
Enrollment_Date	Simple, Not NULL	Single-valued	Date
Graduate_Date	Simple	Single-valued	Date
Graduated_bool	Derived (From existence of Graduate_Date)	Single-valued	Boolean

- Staff

Attribute	Simplicity	Num-Values	Data Type
Staff_ID	Simple, Not NULL	Single-valued	Int (Key Attribute)
Name	Simple, Not NULL	Single-valued	String
Phone	Simple	Single-valued	String
Address	Composite (Street_Number: int[1,10000], Street_Name: Str, Suburb: Str)	Multi-valued	String
Salary	Simple, Not NULL	Single-valued	Float
IRD_Num	Simple, not NULL	Single-valued	Int

- Department

Attribute	Simplicity	Num-Values	Data Type
Name	Simple	Single-valued	String (Key Attribute)
Campus	Simple	Derived (From Campus Reference)	String
Number_of_Employees	Composite (Number_of_academic_staff: int, Number_of_nonacademic_staff: int)	Single-valued	int
Number_of_Students	Derived (from Student references)	Single-valued	int
Address	Derived (from Building references)	Multi-valued	String

- Course

Attribute	Simplicity	Num-Values	Data Type
Name	Simple	Single-valued	String (Key Attribute)
Years_required	Simple	Single-valued	int

Attribute	Simplicity	Num-Values	Data Type
Undergraduate	Simple	Single-valued	boolean
Postgraduate	Simple	Single-valued	boolean
Number_of_Students	Derived (from Student references)	Single-valued	int

- Paper

Attribute	Simplicity	Num-Values	Data Type
Paper_Code	Simple	Single-valued	String (Key Attribute)
Semester	Simple	Multi-valued	String (Enumerated)
Points	Simple	Single-valued	Int

- Campus

Attribute	Simplicity	Num-Values	Data Type
Name	Single-valued	Single-valued	String (Key Attribute)
Main_Office_Address	Single-valued	Single-valued	String
Phone	Simple	Single-valued	String (Candidate Key)
Email	Simple	Single-valued	String (Candidate Key)

- Building

Attribute	Simplicity	Num-Values	Data Type
Address	Composite (Street_Number: int[1,10000], Street_Name: Str, Suburb: Str)	Single-valued	String (Key Attribute)
Postcode	Simple	Single-valued	Int (Four Digit)
Name	Simple	Single-valued	String

- Room

Attribute	Simplicity	Num-Values	Data Type
Room Number	Simple	Single-valued	Int, [1,10000] (Partial Key)
Seating	Simple	Single-valued	Int [1,10000]
Accessibility	Simple	Single-valued	Boolean
Projector	Simple	Single-valued	Boolean

Mapping to Relational Model

Step 1: Mapping Regular Entity Types

BUILDING

- Decompose composite attribute and add all simple attributes, add weak key to primary key

Street_Number	**Street_Name**	**Suburb**	**Postcode**	**Name**

DEPARTMENT

Name	**Number_Of_Academic_Staff**	**Number_Of_Nonacademic_Staff**

COURSE

Name	**Years_Required**	**Postgradute_Bool**

PAPER

Paper_code	**Semester (Multi-value)**	**Points**

CAMPUS

Name	**Street_Number**	**Street_Name**	**Suburb**	**Phone**	**Email**

STUDENT

- Decompose composite attributes and add all simple attributes.

Student_ID	**Name**	**Phone**	**Street_Number**	**Street_Name**	**Suburb**	**Enrollment**	**Graduation**	**Graduated**

STAFF

- Decompose composite attributes and add all simple attributes.

Staff_ID	**Name**	**Phone**	**Street_Number**	**Street_Name**	**Suburb**	**Salary**	**IRD_Num**

Step 2: Mapping Weak Entity Types

ROOM

- Add as primary key reference the primary key of building

Street_Number (REFERENCES Building)	**Street_Name (REFERENCES Building)**	**Suburb (REFERENCES Building)**	**Room Number**	**Seating**	**Accessibility**	**Projector**

Step 3: Mapping of binary 1:1 Relationships

DEAN_OF (Campus 1:1 Staff)

- The Staff_ID is added to the campus table to represent a DEAN_OF relationship, as campus has total participation.

CAMPUS

Name	**Main_Office_Address**	**Phone**	**Email**	**Dean (REFERENCES Staff)**

COORDINATES (Course 1:1 Staff)

- Staff_ID is added to course as staff members have total participation in the COORDINATES relationship.

COURSE

Name	**Years_Required**	**Postgradute_Bool**	**Coordinator_id (REFERENCES Staff)**

Step 4: Mapping of Binary 1:N Relationships

LOCATED_ON (Building N:1 Campus)

- Add as foreign key to Building the primary key of Campus

BUILDING

Street_Number	**Street_Name**	**Suburb**	**Postcode**	**Building_Name**	**Campus_Name (REFERENCES Campus)**

OFFICE_OF (Room 1:N Staff)

- Create a new table OFFICE_OF that includes the primary key of staff as primary and foreign key, and primary key of room as foreign key
- This avoids many NULLs for staff with no office

OFFICE_OF

Staff_ID (REFERENCES Staff)	**Street_Number (REFERENCES Building)**	**Street_Name (REFERENCES Building)**	**Suburb (REFERENCES Building)**	**Room_Number**

LOCATED_IN (Room N:1 Building)

- Add as foreign key to Room the primary key of Campus
- Already done in step 2 (weak entity mapping), so no extra work is needed

STUDENT_AT (Student N:1 Campus)

- Reference for the campus a student is located at/in.

STUDENT

Student_ID	**Name**	**Phone**	**Street_Number**	**Street_Name**	**Suburb**	**Enrollment**	**Graduation**	**Graduated**	**Campus**

STAFF_AT (Student N:1 Campus)

- Reference for the campus a staff member is located at/in.

STAFF

Staff_ID	**Name**	**Phone**	**Street_Number**	**Street_Name**	**Suburb**	**Salary**	**IRD_Num**	**Campus**

SUPERVISES (Staff M:1 Student)

- We decided to change this into its own supervises entity, to eliminate excessive NULL's if many students did not have supervisors.

STAFF_SUPERVISES_STUDENT

Staff_ID (REFERENCES Staff)	**Student_ID (REFERENCES Student)**

Step 4.5: Mapping of Binary 2:N Relationships

ENROLLED_IN (Student 2:N Course)

- Though originally Enrolled_In was going to be handled by data fields within the Student entity, we decided to model enrollment through a separate entity. This is so a student can enroll in more than one course.

ENROLLED_IN

Student_ID	**Course**

Step 5: Mapping of Binary M:N Relationships

BASED_IN (Building M:N Department)

- Create new Relation with primary key of each related entity

DEPT_BASED_IN_BUILDING

Dept_Name (REFERENCES Department)	**Street_Number (REFERENCES Building)**	**Street_Name (REFERENCES Building)**	**Suburb (REFERENCES Building)**

LECTURED_IN (Room M:N Paper)

- Create new Relation with primary key of each related entity

PAPER_LECTURED_IN_ROOM

Paper_Code (REFERENCES Paper)	**Street_Number (REFERENCES Building)**	**Street_Name (REFERENCES Building)**	**Suburb (REFERENCES Building)**	**Room_Number**

WORKS_FOR(Staff M:N Department)

- Create new Relation with primary key of each related entity

- Originally it was decided that staff members could work for multiple departments, but for realism and ease of use, we have since agreed staff members may only work for one department, and combination departments could be added where necessary. A cleaner would work for the cleaning department, rather than each department that they clean, for example. This is represented below:

STAFF

Staff_ID	**Name**	**Phone**	**Street_Number**	**Street_Name**	**Suburb**	**Salary**	**IRD_Num**	**Campus**	**Supervises_Student (REFERENCES Student)**	**Department (REFERENCES Department)**

COUNTS_TOWARD(Paper M:N Course)

- Create new Relation with primary key of each related entity

PAPER_COUNTS_TOWARD_COURSE

Paper_Code (REFERENCES Paper)	**Course_Name (REFERENCES Course)**

POSSIBLE_MAJOR_FOR(Department M:N Course)

- Create new Relation with primary key of each related entity

DEPARTMENT_OFFERS_MAJOR_FOR_COURSE

Department_Name (REFERENCES Department)	**Course_Name (REFERENCES Course)**

TEACHES (Staff N:M Paper)

- Relationship refers to the keys of both staff and paper.

TEACHES

Teaching staff (Staff ID)	**Paper (Paper_code)**

OFFERED_AT (Paper N:M Campus)

- Relationship refers to both paper and campus.

OFFERED_AT

Paper (Paper_Code)	**Campus Name**

TAKES (Student N:M Paper)

- Relationship refers to student and paper.

STUDENT_TAKES_PAPER

Student_ID	**Paper_code**

Step 6: Mapping of Multi-valued attributes

PAPER_SEMESTERS

Paper_code	**Semester**

PAPER

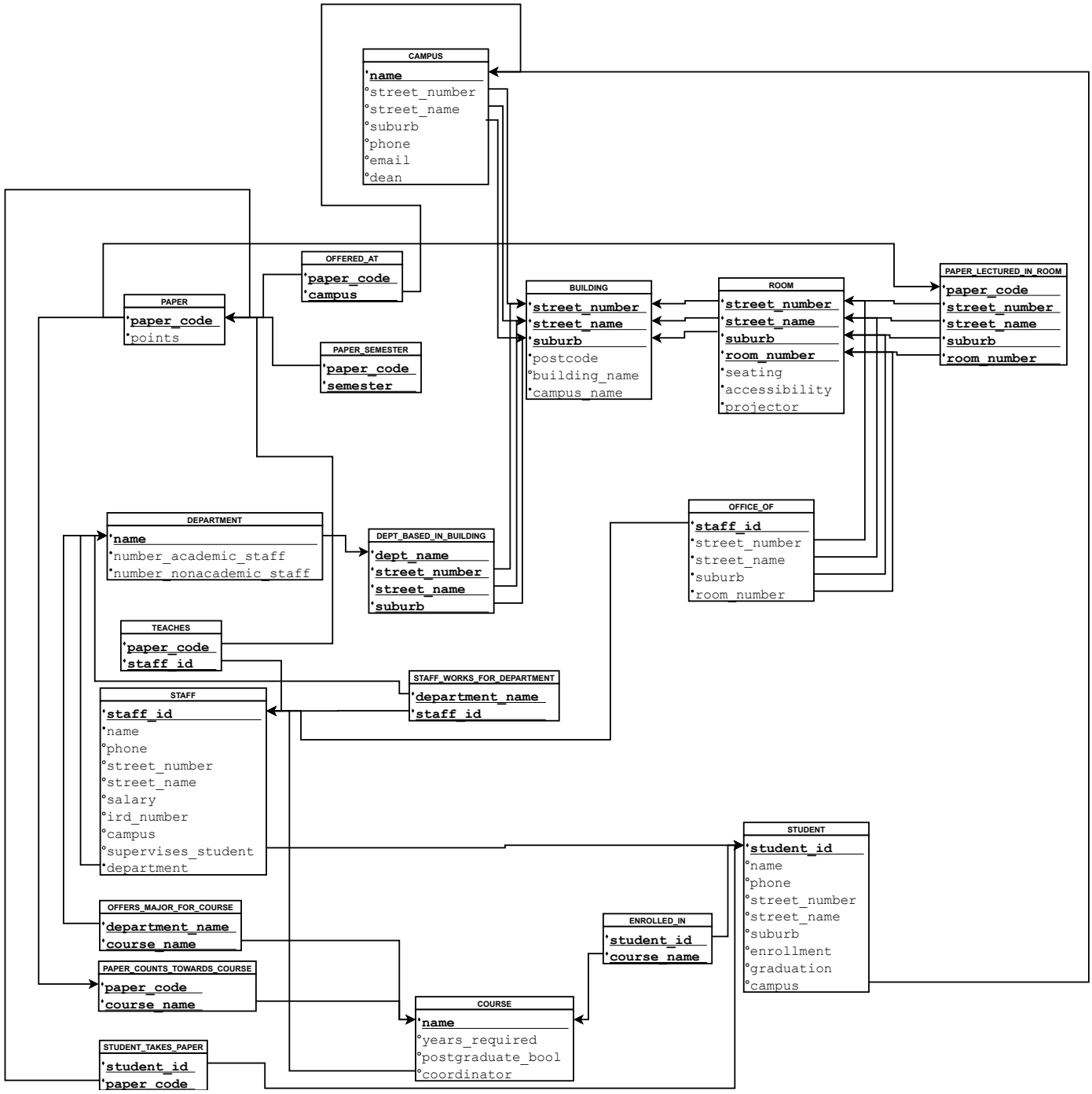
Paper_code	**Points**

- Semesters was previously a multi-valued attribute of paper, as a paper could be taught in multiple semesters. The table was split so one represents a paper and all the semesters it is taught in, and another refers to the paper code and the points associated with it.

Step 7: Mapping of N-ary Relationship types

- We had no N-ary relationship types to map

Mapped Relational Model



BUILDING

Street_Number	Street_Name	Suburb	Postcode	Building_Name	Campus_Name (REFERENCES Campus)

ROOM

Street_Number (REFERENCES Building)	Street_Name (REFERENCES Building)	Suburb (REFERENCES Building)	Room_Number	Seating	Accessibility	Projector

DEPARTMENT

Name	Number_Of_Academic_Staff	Number_Of_Nonacademic_Staff

DEPT_BASED_IN_BUILDING

Dept_Name (REFERENCES Department)	**Street_Number** (REFERENCES Building)	**Street_Name** (REFERENCES Building)	**Suburb** (REFERENCES Building)

CAMPUS

Name	**Street_Number**	**Street_Name**	**Suburb**	**Phone**	**Email**

COURSE

Name	**Years_Required**	**Postgradute_Bool**	**Coordinator_id (REFERENCES Staff)**

DEPARTMENT_OFFERS_MAJOR_FOR_COURSE

Department_Name (REFERENCES Department)	**Course_Name** (REFERENCES Course)

STUDENT

Student_ID	**Name**	**Phone**	**Street_Number**	**Street_Name**	**Suburb**	**Enrollment**	**Graduation**	**Graduated**	**Campus**

ENROLLED_IN

Student_ID	**Course**

STAFF

Staff_ID	**Name**	**Phone**	**Street_Number**	**Street_Name**	**Suburb**	**Salary**	**IRD_Num**	**Campus** (REFERENCES Campus)	**Supervises_Student** (REFERENCES Student)	**Department** (REFERENCES Department)

STAFF_SUPERVISES_STUDENT

Staff_ID (REFERENCES Staff)	**Student_ID (REFERENCES Student)**

PAPER

Paper_code	**Points**

PAPER_SEMESTERS

Paper_code	**Semester**

PAPER_COUNTS_TOWARD_COURSE

Paper_Code (REFERENCES Paper)	**Course_Name** (REFERENCES Course)

OFFERED_AT

Paper (Paper_Code) (REFERENCES Paper)	**Campus_Name** (REFERENCES Campus)

PAPER_LECTURED_IN_ROOM

Paper_Code (REFERENCES Paper)	**Street_Number** (REFERENCES Room)	**Street_Name** (REFERENCES Room)	**Suburb** (REFERENCES Room)	**Room_Number** (REFERENCES Room)

STUDENT_TAKES_PAPER

Student_ID (REFERENCES Student)	**Paper_code** (REFERENCES Paper)

TEACHES

Teaching staff (Staff ID)	Paper (Paper_code)

OFFICE_OF

Staff_ID (REFERENCES Staff)	Street_Number (REFERENCES Building)	Street_Name (REFERENCES Building)	Suburb (REFERENCES Building)	Room_Number

Normalization

1NF

Definition: All values are atomic

- This is true from the mapping process from ERD to Relational Model
- The multi-value attribute of papers, semesters, is already converted to be atomic.

2NF

Definition: 1NF and every non-key attribute is fully dependent on the primary key

BUILDING

- Postcode is dependent only on street name and suburb, but not street number
- Remove postcode to its own entity, make a foreign key reference

BUILDING

Street_Number	Street_Name (REFERENCES postcode)	Suburb (REFERENCES postcode)	Building_Name	Campus_Name (REFERENCES Campus)

POSTCODE

Street_Name	Suburb	Postcode

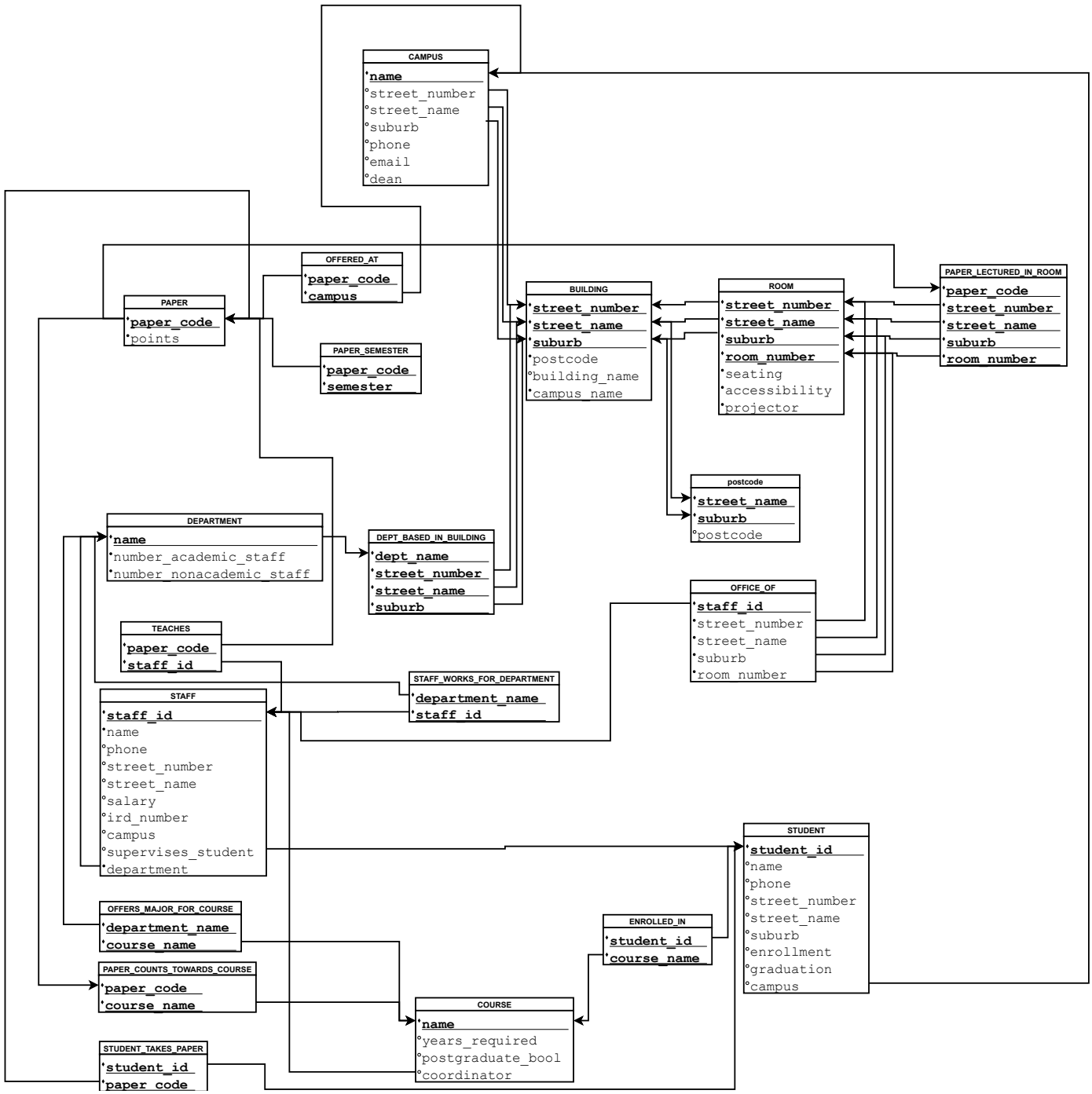
3NF

Definition: 2NF and no non-prime attribute is transitively dependent on the primary key

BCNF

Definition: 3NF and for every non-trivial functional dependency X->A, X is a superkey of R

Normalized Relational Model



POSTCODE

Street_Name	Suburb	Postcode

BUILDING

Street_Number	Street_Name (REFERENCES postcode)	Suburb (REFERENCES postcode)	Building_Name	Campus_Name (REFERENCES Campus)

ROOM

Street_Number (REFERENCES Building)	Street_Name (REFERENCES Building)	Suburb (REFERENCES Building)	Room_Number	Seating	Accessibility	Projector

DEPARTMENT

Name	Number_Of_Academic_Staff	Number_Of_Nonacademic_Staff

CAMPUS

Name	Main_Office_Address	Phone	Email	Dean (REFERENCES Staff)

COURSE

Name	Years_Required	Undergraduate	Postgraduate	Coordinator (REFERENCES Staff)

STUDENT

Student ID	Name	Phone	Street_Number	Street_Name	Suburb	Enrollment	Graduation	Graduated	Campus

ENROLLED_IN

Student ID	Course

STAFF

Staff ID	Name	Phone	Street_Number	Street_Name	Suburb	Salary	IRD_Num	Campus (REFERENCES Campus)	Supervises_Student (REFERENCES Student)	Department (REFERENCES Department)

STAFF_SUPERVISES_STUDENT

Staff ID (REFERENCES Staff)	Student ID (REFERENCES Student)

DEPT_BASED_IN_BUILDING

Dept Name (REFERENCES Department)	Street Number (REFERENCES Building)	Street Name (REFERENCES Building)	Suburb (REFERENCES Building)

DEPARTMENT_OFFERS_MAJOR_FOR_COURSE

Department Name (REFERENCES Department)	Course Name (REFERENCES Course)

PAPER

Paper code	Points

PAPER_SEMESTERS

Paper code	Semester

PAPER_COUNTS_TOWARD_COURSE

Paper Code (REFERENCES Paper)	Course Name (REFERENCES Course)

OFFERED_AT

Paper (Paper Code) (REFERENCES Paper)	Campus Name (REFERENCES Campus)

PAPER_LECTURED_IN_ROOM

Paper Code (REFERENCES Paper)	Street Number (REFERENCES Room)	Street Name (REFERENCES Room)	Suburb (REFERENCES Room)	Room Number (REFERENCES Room)

STUDENT_TAKES_PAPER

Student ID (REFERENCES Student)	Paper code (REFERENCES Paper)

TEACHES

Teaching staff (Staff ID)	Paper (Paper code)

OFFICE_OF

Staff_ID (REFERENCES Staff)	**Street_Number** (REFERENCES Building)	**Street_Name** (REFERENCES Building)	**Suburb** (REFERENCES Building)	**Room_Number**

TEAMWORK SUMMARY

- Hayden McAlister
    - Created template for report format
    - Mapped entities and relationships related to Building, Room
    - Created SQL for tables originating from Building, Room
    - Compiled teams report+SQL fragments into single documents with similar styles
    - Tested combined SQL
- Nat Moore
    - Mapped entities and relationships related to Department, Course
    - Created SQL for tables originating from Department, Course
- Jack Heikell
    - Mapped entities and relationships related to Student, Staff
    - Created SQL for tables originating from Student, Staff
- Masaaki Fukushima
    - Mapped entities and relationships related to Paper, Campus
    - Created SQL for tables originating from Paper, Campus