University of British Columbia, Vancouver
Department of Computer Science

CPSC 304 Project Cover Page

Milestone #: 2

Date: Feb 28, 2024

Group Number: 102

| Name	Student Number	CS Alias (Userid)	Preferred E-mail Address
Jaskirat Gill	97471445	t9h6b	gilljaskirat04@gmail.com
Dildeep Dhillon	20025276	i6h3o	dhillon_32@hotmail.com
Temirlan Sabanshi	14123335	04e7q	t.sabanshi@gmail.com

By typing our names and student numbers in the above table, we certify that the work in the attached assignment was performed solely by those whose names and student IDs are included above. (In the case of Project Milestone 0, the main purpose of this page is for you to let us know your e-mail address, and then let us assign you to a TA for your project supervisor.)

In addition, we indicate that we are fully aware of the rules and consequences of plagiarism, as set forth by the Department of Computer Science and the University of British Columbia

Summary Of Project:

The project revolves around construction management, focusing on the budgeting and financial management aspect of projects. This contains planning, monitoring and controlling of financial resources.

ER Diagram:
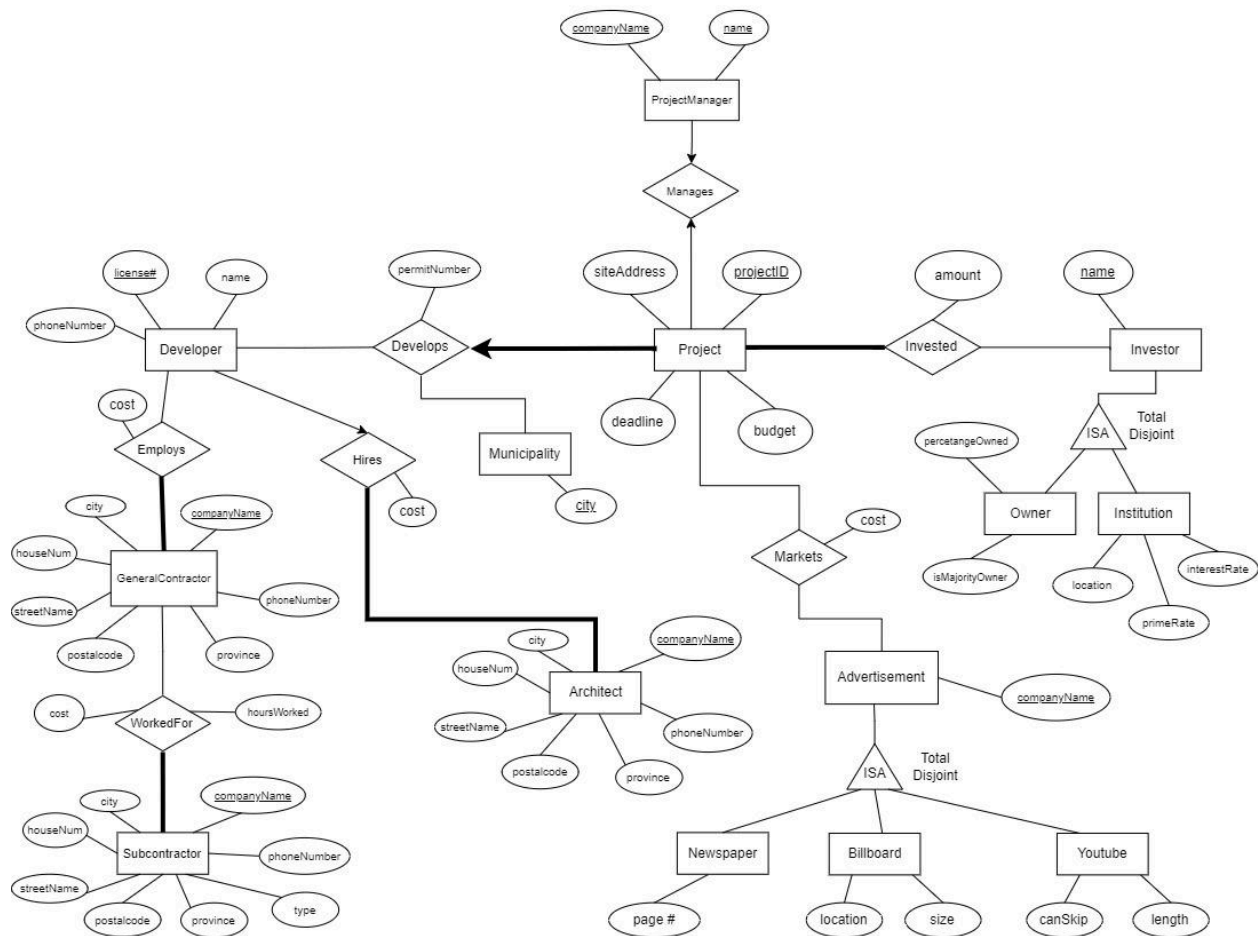
Changes From Milestone 1:
- Changed Develops relation to be one-to-many between project and developer to better reflect that a developer can develop multiple projects but a project has one developer
- Changed Invested relation to be many-to-many to better reflect that multiple investors can invest in multiple projects

Relational Model Scheme:
** TA: Please note that Primary Keys are UNDERLINED, Foreign Keys are BOLDED, and any other constraints (NOT NULL, UNIQUE etc) are mentioned on the right hand side) **

Advertisement(<u>companyName</u>: Varchar(20))
Newspaper(**<u>companyName</u>**: Varchar(20), page#: Integer(2))
   -   companyName is a foreign key referencing Advertisement
Billboard(**<u>companyName</u>**: Varchar(20), location: Varchar(20), size: Integer(3))
   -   companyName is a foreign key referencing Advertisement
YouTube(**<u>companyName</u>**: Varchar(20), canSkip: Boolean, length: Integer(2))
   -   companyName is a foreign key referencing Advertisement
Markets(**<u>projectID</u>**: Integer(5), **<u>companyName</u>**: Varchar(20), cost: Integer(10))
   -   projectID is a foreignKey referencing project
   -   companyName is a foreignKey referencing advertisement
   -   projectID and companyName together form primary key
Investor(<u>name</u>: Varchar(20))
Owner(**<u>name</u>**: Varchar(20), percentageOwned: Integer(3), isMajorityOwner: Boolean)
   -   name is a foreign key that references Investor
Institution(**<u>name</u>**: Varchar(20), interestRate: Decimal(4,2), primeRate: Decimal(4,2), location: Varchar(20))
   -   name is a foreign key that references Investor
ProjectManager(companyName: Varchar(20), name: Varchar(20), **projectID**: Integer(5))
   -   projectID is a foreign key referencing Project
   -   companyName and name are both unique
Project(<u>projectID</u>: Integer(2), siteAddress: Varchar(20), budget: Integer(10), deadline: DATE, **city:** Varchar(20), permitNumber: Integer(10), **license#:** Integer(10))
   -   license# is a foreign key referencing developer
   -   city is a foreign key referencing municipality
   -   permitNumber is UNIQUE
   -   siteAddress is UNIQUE
Invested(**<u>projectID</u>**: Integer(5), **<u>name</u>**: Varchar(20), amount: Integer(10))
   -   projectID and name together form a primary key
   -   projectID is a foreign key referencing Project
   -   name is a foreign key referencing Investor
Municipality(<u>city</u>: Varchar(20))
Developer(<u>license#</u>: Integer(10), name: Varchar(20), phoneNumber: Integer(10))
Hires(**<u>license#:</u>** Integer(10), **companyName**: Varchar(20), cost: Integer(10))
   -   companyName is NOT NULL
   -   companyName is foreign key referencing Architect
   -   license# is foreign key referencing developer and primary key
Architect(<u>companyName</u>: Varchar(20), phoneNumber: Integer(10),city: Varchar(20), houseNum: Varchar(5), streetName: Varchar(20), postalCode: Char(6), province: Varchar(20))
   -   phoneNumber is UNIQUE
Subcontractor(<u>companyName</u>: Varchar(20), phoneNumber: Integer(10), type: Varchar(20), city: Varchar(20), houseNum: Varchar(5), streetName: Varchar(20), postalCode: Char(6), province: Varchar(20))

- phoneNumber is UNIQUE

WorkedFor(**subcontractorName**: Varchar(20), **generalContractorName**: Varchar 20, hoursWorked: Integer(4), cost: Integer(10))
- subcontractorName is foreign key referencing Subcontractor
- generalContractorName is a foreign key referencing General Contractor
- subcontractorName & generalContractorName together form primary key
- We can not currently express the participation constraint without knowledge of SQL assertions thus that will be enforced later

GeneralContractor(companyName: Varchar(20), phoneNumber: Integer(10), city: Varchar(20), houseNum: Varchar(5), streetName: Varchar(20), postalcode: Char(6), province: Varchar(20))
- phoneNumber is UNIQUE

Employs(**companyName**: Varchar(20), **license#**: Integer(10), cost: Integer(10))
- companyName is foreign key referencing GeneralContractor
- license# is foreign key referencing developer
- companyName and license# together form primary key

Functional Dependencies:

Advertisement
- companyName → NONE (PK)

Newspaper
- companyName → page # (PK)
  IC: companyName → Advertisement.companyName (FK)

Billboard
- companyName → location, size (PK)
  IC: companyName →Advertisement.companyName (FK)

YouTube
- companyName → canSkip, length (PK)
  IC: companyName →Advertisement.companyName (FK)

Markets
- projectID, companyName → cost (PK)
  IC: projectID → Project.projectID (FK)
  IC: companyName →Advertisement.companyName (FK)

Investor
- name → NONE (PK)

Owner
- name → percentageOwned, isMajorityOwner (PK)
- percentageOwned → isMajorityOwner
  IC: name → Investor.name (FK)

Institution
- name → interestRate, primeRate, location (PK)
- location → primeRate
  IC: name → Investor.name (FK)

ProjectManager
- companyName, name → projectID (CK)
- projectID →companyName, name (PK)
  IC: projectID → Project.projectID (FK)

Project
- projectID → siteAddress, budget, deadline, city, permitNumber, license# (PK)
- permitNumber → projectID, siteAddress, budget, deadline, city, license# (CK)
- siteAddress → projectID, budget, deadline, permitNumber, license#, city (CK)
  IC: license# → Developer.license# (FK)
  IC: city → Municipality.city (FK)
  IC: permitNumber is UNIQUE
  IC: siteAddress is UNIQUE

Invested
- projectID, name → amount (PK)
  IC: projectID → Project.projectID (FK)
  IC: name → Investor.name (FK)

Municipality
- city → NONE (PK)

Developer
- license# → name, phoneNumber (PK)
- phoneNumber → license#, name (CK)

Hires
- license# → companyName, cost (PK)
  IC: companyName → NOT NULL, Architect.companyName (FK)
  IC: license# → Developer.license# (FK)

Architect
- companyName → phoneNumber, streetName, houseNum, city, province, postalcode (PK)
- phoneNumber → companyName, province (CK)
- houseNum, streetName, city, province→ postalcode
- postalcode → city, province
  IC: phoneNumber is UNIQUE

Subcontractor
- companyName → phoneNumber, streetName, houseNum, city, province, postalcode, type (PK)
- phoneNumber → companyName, province (CK)
- postalCode → city, province
- houseNum, street, city, province→ postalcode
  IC: phoneNumber is UNIQUE

WorkedFor
- subcontractorName, generalContractorName → hoursWorked, cost (PK)
  IC: subcontractorName → Subcontractor.companyName (FK)
  IC: generalContractorName → GeneralContractor.companyName (FK)

GeneralContractor
- companyName → phoneNumber, streetName, houseNum, city, province, postalcode (PK)
- phoneNumber → companyName, province (CK)

- postalcode → city, province
- houseNum, street, city, province→ postalcode
  IC: phoneNumber is UNIQUE

Employs
- companyName, license#→ cost (PK)
  IC: companyName → GeneralContractor.companyName (FK)
  IC: license# → Developer.license# (FK)

Normalization:
Architect
- companyName → phoneNumber, streetName, houseNum, city, province, postalcode (PK)
- phoneNumber → companyName, province (CK)
- houseNum, streetName, city, province→ postalcode
- postalcode → city, province

1. postalcode → city, province violates BCNF
2. R_1(postalcode, city, province) and R_2(postalcode, companyName, phoneNumber, streetName, houseNum)

   Lose FD houseNum, streetName, city, province→ postalcode

   But now in BCNF

   So we have two tables ArchAddress and Architect.

Subcontractor
- companyName → phoneNumber, streetName, houseNum, city, province, postalcode, type (PK)
- phoneNumber → companyName, province (CK)
- houseNum, streetName, city, province→ postalcode
- postalcode → city, province

1. postalcode → city, province violates BCNF
2. R_1(postalcode, city, province) and R_2(postalcode, companyName, phoneNumber, streetName, houseNum, type)

   Lose FD houseNum, streetName, city, province→ postalcode

   But now in BCNF

   So we have two tables SCAddress and Subcontractor.

GeneralContractor
- companyName → phoneNumber, streetName, houseNum, city, province, postalcode (PK)
- phoneNumber → companyName, province (CK)
- houseNum, streetName, city, province→ postalcode
- postalcode → city, province

1. postalcode → city, province violates BCNF
2. R_1(postalcode, city, province) and R_2(postalcode, companyName, phoneNumber, streetName, houseNum)

   Lose FD houseNum, streetName, city, province→ postalcode

   But now in BCNF

   So we have two tables GCAddress and GeneralContractor.

Owner
- name → percentageOwned, isMajorityOwner (PK)
- percentageOwned → isMajorityOwner
  IC: name → Investor.name (FK)

1. percentageOwned → isMajorityOwner violates BCNF
2. R_1(percentageOwned, isMajorityOwner) and R_2(name, percentageOwned)

   Now in BCNF

   So we have two tables MajorityOwn and Owner

Institution
- name → interestRate, primeRate, location (PK)
- location → primeRate
  IC: name → Investor.name (FK)

1. location → primeRate violates BCNF
2. R_1(location, primeRate) and R_2(location, name, interestRate)

   Now in BCNF

   So we have two tables Rates and Institution

SQL DDL Statements:
CREATE TABLE Advertisement(
        companyName VARCHAR(20),
        PRIMARY KEY (companyName)
);

```
CREATE TABLE Newspaper(
        companyName VARCHAR(20),
        page# INTEGER(2),
        PRIMARY KEY (companyName),
        FOREIGN KEY (companyName) REFERENCES Advertisement
);

CREATE TABLE Billboard(
        companyName VARCHAR(20),
        location VARCHAR(20),
        size INTEGER(3),
        PRIMARY KEY (companyName),
        FOREIGN KEY (companyName) REFERENCES Advertisement
);

CREATE TABLE YouTube(
        companyName Varchar(20),
        canSkip BOOLEAN,
        length INTEGER(2)
        PRIMARY KEY (companyName),
        FOREIGN KEY (companyName) REFERENCES Advertisement
);

CREATE TABLE Project(
        projectID INTEGER(5),
        siteAddress VARCHAR(20) UNIQUE,
        budget INTEGER(10),
        deadline DATE,
        city VARCHAR(20),
        permitNumber INTEGER(10),
        license# INTEGER(10),
        FOREIGN KEY (license#) REFERENCES Developer,
        FOREIGN KEY (city) REFERENCES Municipality,
        UNIQUE (permitNumber)
);

CREATE TABLE Markets(
        projectID INTEGER(5),
        companyName VARCHAR(20),
        cost INTEGER(10)
        PRIMARY KEY (projectID, companyName),
        FOREIGN KEY (companyName) REFERENCES Advertisement
        FOREIGN KEY (projectID) REFERENCES Project
);
```

```
CREATE TABLE Investor(
      name VARCHAR(20),
      PRIMARY KEY (name)
);

CREATE TABLE Owner(
      name VARCHAR(20),
      percentageOwned INTEGER(3),
      FOREIGN KEY (name) REFERENCES Investor,
      PRIMARY KEY (name)
);

CREATE TABLE MajorityOwn(
      percentageOwned INTEGER(3),
      isMajorityOwner BOOLEAN,
      PRIMARY KEY (percentageOwned)
);

CREATE TABLE Institution(
      name VARCHAR(20),
      interestRate DECIMAL(4,2),
      location VARCHAR(20),
      PRIMARY KEY (name)
);

CREATE TABLE Rates(
      primeRate DECIMAL(4,2),
      location VARCHAR(20),
      PRIMARY KEY (location)
);

CREATE TABLE ProjectManager(
      companyName VARCHAR(20) UNIQUE,
      name VARCHAR(20) UNIQUE,
      projectID INTEGER(5),
      FOREIGN KEY (projectID) REFERENCES Project,
      PRIMARY KEY (projectID)
);

CREATE TABLE Invested(
      projectID INTEGER(5),
      name VARCHAR(20),
      amount INTEGER(10),
      PRIMARY KEY (projectID, name),
      FOREIGN KEY (projectID) REFERENCES Project,
      FOREIGN KEY (name) REFERENCES Investor
```

```
);

CREATE TABLE Municipality(
    city VARCHAR(20),
    PRIMARY KEY (city)
);

CREATE TABLE Developer(
    license# INTEGER(10),
    name VARCHAR(20),
    phoneNumber INTEGER(10) UNIQUE,
    PRIMARY KEY (license#)
);

CREATE TABLE Hires(
    license# INTEGER(10),
    company NAME VARCHAR(20) NOT NULL,
    cost INTEGER(10),
    FOREIGN KEY (companyName) REFERENCES Architect,
    FOREIGN KEY (license#) REFERENCES Developer,
    PRIMARY KEY (license#)
);


CREATE TABLE Architect(
    companyName VARCHAR(20),
    phoneNumber INTEGER(10) UNIQUE,
    houseNum VARCHAR(20),
    streetName VARCHAR(20),
    postalcode CHAR(6),
    PRIMARY KEY (companyName)
);

CREATE TABLE ArchAddress(
    city VARCHAR(20),
    postalcode CHAR(6),
    province VARCHAR(20),
    PRIMARY KEY (postalcode)
);


CREATE TABLE Subcontractor(
    companyName VARCHAR(20),
    phoneNumber INTEGER(10) UNIQUE,
    houseNum VARCHAR(20),
    streetName VARCHAR(20),
```

```
        postalcode CHAR(6),
        type VARCHAR(20),
        PRIMARY KEY (companyName)
);

CREATE TABLE SCAddress(
        city VARCHAR(20),
        postalcode CHAR(6),
        province VARCHAR(20),
        PRIMARY KEY (postalcode)
);

CREATE TABLE WorkedFor(
        subcontractorName VARCHAR(20),
        generalContractorName VARCHAR(20),
        hoursWorked INTEGER(4),
        cost INTEGER(10),
        PRIMARY KEY (subcontractorName, generalcontractorName),
        FOREIGN KEY (subcontractorName) REFERENCES Subcontractor,
        FOREIGN KEY (generalcontractorName) REFERENCES GeneralContractor
);

CREATE TABLE GeneralContractor(
        companyName VARCHAR(20),
        phoneNumber INTEGER(10) UNIQUE,
        houseNum VARCHAR(20),
        streetName VARCHAR(20),
        postalcode CHAR(6),
        PRIMARY KEY (companyName)
        );

CREATE TABLE GCAddress(
        city VARCHAR(20),
        postalcode CHAR(6),
        province VARCHAR(20),
        PRIMARY KEY (postalcode)
        );

CREATE TABLE Employs(
        companyName VARCHAR(20),
        license# INTEGER(10),
        cost INTEGER(10),
        FOREIGN KEY (companyName) REFERENCES GeneralContractor,
        FOREIGN KEY (license#) REFERENCES Developer,
        PRIMARY KEY (companyName, license#)
);
```

INSERT Statements:

INSERT INTO Advertisement(companyName) VALUES
('GlobalNews'),
('DailyDigest'),
('TheTimes'),
('NewsNetwork'),
('MorningPress'),
('CityNews'),
('StreamVideos'),
('ViralVideos'),
('ChannelOne'),
('GenericChannel'),
('AdvertNation'),
('CityBillboards'),
('LocalBoards'),
('SkyHighBillboards'),
('UrbanView'),
('GlobalAdverts');

INSERT INTO Newspaper(companyName, page#) VALUES
('GlobalNews', 12),
('DailyDigest', 3),
('TheTimes', 9),
('NewsNetwork', 8),
('MorningPress', 8),
('CityNews', 5);

INSERT INTO Billboard(companyName, location, size) VALUES
('CityBillboards', 'Downtown', 20),
('LocalBoards', 'Downtown', 18),
('SkyHighBillboards', 'Midtown, 15),
('UrbanView', 'CityCenter', 15),
('GlobalAdverts', 'Midtown', 15);

INSERT INTO YouTube(companyName, canSkip, length) VALUES
('StreamVideos', TRUE, 30),
('ViralVideos', TRUE, 30),
('ChannelOne', FALSE, 90),
('GenericChannel', FALSE, 60),
('AdvertNation', TRUE, 60);

INSERT INTO Project(projectID, siteAddress, budget, deadline, city, permitNumber, license#)
VALUES
(10001, '101 Project Ave', 100000, '2023-12-31', 'GreenVille', 111, 12345),
(10002, '202 Project Ave, 100000, '2023-05-15', GreenVille, 112, 12346),
(10003, '303 Project St, 150000, '2024-05-15', 'LakeView', 113, 12347),
(10004, '404 Project St', 300000, '2023-11-20', 'MountainTown', 114, 12348),
(10005, '505 Project St, 300000, '2024-01-10', GreenVille, 115, 12349);

INSERT INTO Markets(projectID, companyName, cost) VALUES
(10001, 'GlobalNews', 9000),
(10003, 'DailyDigest', 5000),
(10001, 'DailyDigest', 5000),
(10004, 'DailyDigest', 5000),
(10001, 'TheTimes', 4300),
(10004, 'NewsNetwork', 5000),
(10002, 'MorningPress', 10000),
(10002, 'CityNews', 9000),
(10004, 'CityNews', 7000),
(10001, 'CityNews', 9000),
(10003, 'CityNews', 8000),
(10003, 'StreamVideos'. 1000),
(10002, 'ViralVideos', 1300),
(10001, 'ChannelOne', 1300),
(10005, 'GenericChannel', 15000),
(10004, 'AdvertNation', 10000),
(10004, 'CityBillboards', 15000),
(10005, 'CityBillboards', 9000),
(10001, 'LocalBoards', 3000),
(10002, 'SkyHighBillboards', 2400),
(10004, 'UrbanView', 9300),
(10002, 'GlobalAdverts', 4300);

INSERT INTO Investor(name) VALUES
('WealthVentures'),
('CapitalPioneers'),
('FutureFunds'),
('GreenInvest'),
('TechCapital');

INSERT INTO Owner(name, percentageOwned) VALUES
('WealthVentures', 25),
('CapitalPioneers', 30),
('FutureFunds', 20),
('GreenInvest', 55),

```
('TechCapital', 80);

INSERT INTO MajorityOwn(percentageOwned, isMajorityOwner) VALUES
(25, FALSE),
(30, FALSE),
(20, FALSE),
(55, TRUE),
(80, TRUE);


INSERT INTO Institution(name, interestRate, location) VALUES
('WealthVentures', 5.0, 'locationA'),
('CapitalPioneers', 5.0, 'locationA'),
('FutureFunds', 6.0, 'locationB'),
('GreenInvest', 5.5, 'locationC'),
('TechCapital', 5.5, 'locationC');

INSERT INTO Rates(primeRate, location) VALUES
(7.1, 'locationA'),
(8.4, 'locationB'),
(9.1, 'locationC');


INSERT INTO ProjectManager(companyName, name, projectID) VALUES
('ProjManCo', 'Alice Smith', 10001),
('BuildLeadCorp', 'Bob Johnson', 10002),
('ConstructDirect', 'Carol Lee', 10003),
('DesignManageLLC', 'Dave Wilson', 10004),
('ProjectOverseers', 'Eve Martinez', 10005);


INSERT INTO Invested(projectID, name, amount) VALUES
(10001, 'WealthVentures', 25000),
(10001, 'CapitalPioneers', 30000),
(10002, 'CapitalPioneers', 15000),
(10004, 'CapitalPioneers', 20000),
(10003, 'FutureFunds', 20000),
(10004, 'GreenInvest', 15000),
(10001, 'TechCapital', 13000),
(10004, 'TechCapital', 13000),
(10005, 'TechCapital', 10000);


INSERT INTO Municipality(city) VALUES
('GreenVille'),
('LakeView'),
```

('MountainTown');

INSERT INTO Developer(license#, name, phoneNumber) VALUES
(12345, 'UrbanDevelopers', 7781112222),
(12346, 'EcoHomes', 7781112223),
(12347, 'SkyHighConstructions', 7781112224),
(12348, 'HeritageBuilders', 7781112225),
(12349, 'FutureLiving',7781112226);

INSERT INTO Architect(companyName, phoneNumber, houseNum, streetName, postalcode) VALUES
('DesignMasters', 1234567890, '124', 'Design St', 'V3V1T2'),
('InnovativeSpaces', 2345678901, '234', 'Innovation Ave', 'V3V1T2'),
('EcoArchitects', 3456789012, '345', 'Green Rd', 'V3V1T2'),
('UrbanBlueprints', 4567890123, '456', 'Urban Ln', 'V3V1T2'),
('HeritageDesigns', 5678901234, '567', 'Heritage Blvd', 'V3V1T2');

INSERT INTO ArchAddress(province, postalcode, city) VALUES
('British Columbia', 'V3V1T2', 'Surrey');

INSERT INTO Hires(license#, companyName, cost) VALUES
(12345, 'DesignMasters', 10000),
(12346, 'InnovativeSpaces', 15000),
(12347, 'EcoArchitects', 15000),
(12348, 'UrbanBlueprints', 10000),
(12349, 'HeritageDesigns', 13000);

INSERT INTO Subcontractor(companyName, phoneNumber, houseNum, streetName, postalcode, type) VALUES
('QuickFixElectrics', 6789012345, '101', 'Electric Ave', 'V3T1J2', 'Electrical'),
('PipingPros', 7890123456, '202', 'Plumbing St', 'V3T1J2', 'Plumbing'),
('StrongFoundation', 8901234567, '303', 'Foundation Rd', 'V3T1J2', 'Foundation'),
('BrightWiring', 9012345678, '404', 'Wiring Ln', 'V3T1J2', 'Electrical'),
('FlowingWaters', 1234567890, '505', 'Waterway Blvd', 'V3T1J2', 'Plumbing');

INSERT INTO Subcontractor(province, postalcode, city) VALUES
('British Columbia', 'V3T1J2', 'Vancouver');

INSERT INTO WorkedFor(subcontractorName, generalContractorName, hoursWorked, cost) VALUES
('QuickFixElectrics', 'BuildRightCo', 100, 5000),

('PipingPros', 'ConstructCorp', 120, 6000),
('StrongFoundation', 'ProjectPioneers', 140, 9000),
('BrightWiring', 'SkylineBuilders', 100, 8000),
('FlowingWaters', 'GroundUpConstructions', 120, 9000);

INSERT INTO GeneralContractor(companyName, phoneNumber, houseNum, streetName, postalcode) VALUES
('BuildRightCo', 2345678901, '101', 'Build Ave', 'V3V1J2'),
('ConstructCorp', 3456789012, '202', 'Construct St', 'V2J1Z2'),
('ProjectPioneers', 4567890123, '303', 'Pioneer Rd', 'V3V1J2'),
('SkylineBuilders', 5678901234, '404', 'Skyline Ln', 'V2J1Z2'),
('GroundUpConstructions', 6789012345, '505', 'Ground Blvd', 'V3V1J2');

INSERT INTO GCAddress(province, postalcode, city) VALUES
('British Columbia', 'V3V1J2', 'Surrey'),
('British Columbia', 'V2J1Z2', 'Delta');

INSERT INTO Employs(companyName, license#, cost) VALUES
('BuildRightCo', 12345, 20000),
('ConstructCorp', 12346, 18000),
('ProjectPioneers', 12347, 12000),
('SkylineBuilders', 12348, 18000),
('GroundUpConstructions', 12349, 28000);