University of British Columbia, Vancouver
Department of Computer Science

CPSC 304 Project Cover Page

Milestone #: 2

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Group Number: 27

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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.)

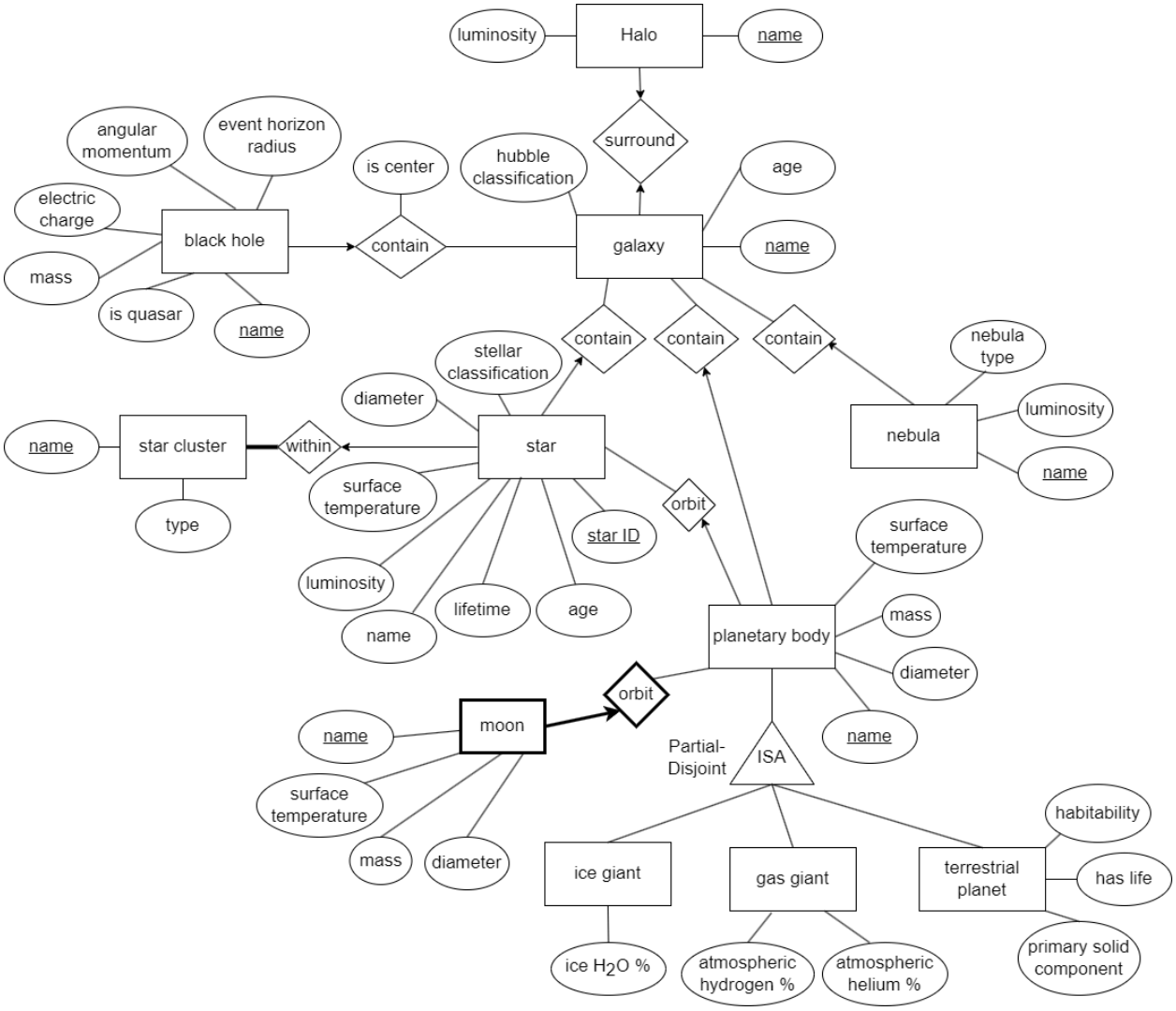
In addition, we indicate that we are fully aware of the rules and consequences of plagiarism, as set forth by the Department of Computer Science and the University of British Columbia.

University of British Columbia, Vancouver
Department of Computer Science

(2) Summary

Our project's application is in the astronomy area, especially aiming for the teaching of basic astronomical knowledge about stars and galaxies. Our database models the basic structure of the universe from moon to halo and contains fundamental information about each celestial body.

(3) ER Diagram



Notes about changes:

- For the ER diagram, we added the “event horizon radius” attribute to black hole.
- Also, we made the naming scheme for attributes more consistent (e.g. “hasLife” -> “has life”, “isQuasar” -> “is quasar”, etc.)
- The naming scheme differs between the ER diagram and our table names because we didn’t want spaces between attribute and entity names and, so all spaces are replaced with underscores (_) for all naming purposes.

(4) Schema

Underline = primary key
Bold = foreign key
Italics = candidate key (unique)

Galaxy (name: varchar, age: float, hubble_classification: varchar)

Halo (name: varchar, luminosity: float, ***galaxy_name***: varchar)

Black_hole (name: varchar, angular_momentum: float, electric_charge: float, mass: float, is_quasar: boolean, ***galaxy_name***: varchar, is_center: boolean, event_horizon_radius: float)

Star (star_ID: integer, age: float, lifetime: float, name: varchar, luminosity: float, surface_temperature: float, diameter: float, stellar_classification: varchar, ***star_cluster_name***: varchar, ***galaxy_name***: varchar)

Star_cluster (name: varchar, type: varchar)

Nebula (name: varchar, nebula_type: varchar, luminosity: float, ***galaxy_name***: varchar)

Planetary_body (name: varchar, surface_temperature: float, mass: float, diameter: float, ***galaxy_name***: varchar)

Ice_giant (**name**: varchar, ice_H_2O%: float)

Gas_giant (**name**: varchar, atmospheric_hydrogen%: float, atmospheric_helium%: float)

Terrestrial_planet (**name**: varchar, habitability: float, has_life: boolean, primary_solid_component: varchar)

Moon (**planetary_body_name**: varchar, moon_name: varchar, surface_temperature: float, mass: float, diameter: float)

(5) Functional Dependencies

Galaxy:
- name -> age, hubble_classification

Halo:
- name -> luminosity, galaxy_name

Black_hole:
- name -> angular_momentum, electric_charge, mass, is_quasar, galaxy_name, is_center
- mass -> event_horizon_radius
- event_horizon_radius -> mass

Star:
- star_ID -> stellar_classification, diameter, surface_temperature, luminosity, name, lifetime, age, star_cluster_name, galaxy_name
- surface_temperature -> stellar_classification
- luminosity, diameter -> surface_temperature
- surface_temperature, diameter -> luminosity
- luminosity, temperature -> diameter

Star_cluster:
- name -> type

Planetary_body:
- name -> diameter, mass, surface_temperature, galaxy_name

Nebula:
- name -> luminosity, nebula_type, galaxy_name

Moon:
- planetary_body_name, moon_name -> surface_temperature, mass, diameter

Ice_giant:
- name -> ice_H_2O%

Gas_giant:
- name -> atmospheric_hydrogn%, atmospheric_helium%

Terrestrial_planet:
- name -> habitability, has_life, primarary_solid_component

(6) Normalization into BCNF

Black_hole:

Black_hole(name: varchar, angular_momentum: float, electric_charge: float, mass: float, is_quasar: boolean, galaxy_name: varchar, is_center: boolean, event_horizon_radius: float)
Primary key: name
Foreign keys: galaxy_name

Closures:
name+ = {name, angular_momentum, electric_charge, mass, is_quasar, galaxy_name, is_center, event_horizon_radius}
mass+ = {mass, event_horizon_radius}
event_horizon_radius+ = {event_horizon_radius, mass}

Decomposition:
mass -> event_horizon_radius violates BCNF in Black_hole, so decompose to:
Black_hole1(name, angular_momentum, electric_charge, is_quasar, galaxy_name, is_center, mass)
Black_hole2(mass, event_horizon_radius)
All are in BCNF.

Final:
Black_hole1(name, angular_momentum, electric_charge, is_quasar, galaxy_name, is_center, mass)
Primary key: name
Foreign keys:
- galaxy_name
- mass

Black_hole2(mass, event_horizon_radius)
Primary key: mass
Candidate keys: event_horizon_radius

Star:
Star (star_ID: integer, age: float, lifetime: float, name: varchar, luminosity: float, surface_temperature: float, diameter: float, stellar_classification: varchar, *star_cluster_name*: varchar, *galaxy_name*: varchar)
Primary key: star_ID
Foreign keys:

- galaxy_name
- star_cluster_name

Closures:
star_ID+ = {star_ID, stellar_classification, diameter, surface_temperature, luminosity, name, lifetime, age, star_cluster_name, galaxy_name}
surface_temperature+ = {stellar_classification}
luminosity, diameter+ = {luminosity, diameter, surface_temperature}
diameter, surface_temperature+ = {luminosity, diameter, surface_temperature}
luminosity, surface_temperature+ = {luminosity, diameter, surface_temperature}

Decomposition:
surface_temperature -> stellar_classification violates BCNF in Star, so decompose:
Star1(star_ID, diameter, luminosity, name, lifetime, age, star_cluster_name, galaxy_name, surface_temperature)
Star2(surface_temperature, stellar_classification)

luminosity, diameter -> surface_temperature violates BCNF in Star1, so decompose:
Star3(star_ID, name, lifetime, age, star_cluster_name, galaxy_name, diameter, luminosity)
Star4(diameter, luminosity, surface_temperature)

All in BCNF.
(final continued on next page)

Final:
Star2(surface_temperature, stellar_classification)
Primary key: surface_temperature

Star3(star_ID, name, lifetime, age, star_cluster_name, galaxy_name, diameter, luminosity)
Primary key: star_ID
Foreign keys:
- galaxy_name
- star_cluster_name
- diameter, luminosity

Star4(diameter, luminosity, surface_temperature)
Primary key: diameter, luminosity
Candidate keys:
- luminosity, surface_temperature
- diameter, surface_temperature

Foreign key: surface_temperature

(7) SQL DDL

```
CREATE TABLE Galaxy (
      name                  VARCHAR,
      age                   FLOAT,
      hubble_classification VARCHAR,
      PRIMARY KEY (name)
)

CREATE TABLE Halo (
      name                  VARCHAR,
      luminosity            FLOAT,
      galaxy_name           VARCHAR,
      PRIMARY KEY (name),
      FOREIGN KEY (galaxy_name)REFERENCES Galaxy(name)
)

CREATE TABLE Black_hole1 (
      name                  VARCHAR,
      angular_momentum      FLOAT,
      electric_charge       FLOAT,
      is_quasar             BOOLEAN,
      is_center             BOOLEAN,
      mass:                 FLOAT,
      galaxy_name           VARCHAR,
      PRIMARY KEY (name),
      FOREIGN KEY (galaxy_name) REFERENCES Galaxy(name),
      FOREIGN KEY (mass) REFERENCES Black_hole2(mass)
)

CREATE TABLE Black_hole2 (
      mass                  FLOAT,
      event_horizon_radius  FLOAT,
      PRIMARY KEY (mass),
      UNIQUE (event_horizon_radius)
)

CREATE TABLE Star_cluster (
      name       VARCHAR,
      type       VARCHAR,
      PRIMARY KEY (name),
)
```

```
CREATE TABLE Star2 (
      surface_temperature         FLOAT,
      stellar_classification      VARCHAR,
      PRIMARY KEY (surface_temperature)
)

CREATE TABLE Star3 (
      star_ID                INTEGER,
      name                   VARCHAR,
      lifetime               FLOAT,
      age                    FLOAT,
      star_cluster_name      VARCHAR,
      galaxy_name            VARCHAR,
      diameter               FLOAT,
      luminosity             FLOAT,
      PRIMARY KEY (star_ID),
      FOREIGN KEY (galaxy_name) REFERENCES Galaxy(name),
      FOREIGN KEY (star_cluster_name) REFERENCES Star_cluster(name),
      FOREIGN KEY (diameter, luminosity) REFERENCES Star4(diameter,
luminosity)
)

CREATE TABLE Star4 (
      diameter               FLOAT,
      luminosity             FLOAT,
      surface_temperature    FLOAT,
      PRIMARY KEY (diameter, luminosity),
      UNIQUE (luminosity, surface_temperature),
      UNIQUE (diameter, surface_temperature),
      FOREIGN KEY (surface_temperature) REFERENCES Star2(surface
temperature)
)

CREATE TABLE Planetary_body (
      name                   VARCHAR,
      diameter               FLOAT,
      mass                   FLOAT,
      surface_temperature    FLOAT,
      galaxy_name            FLOAT,
      PRIMARY KEY (name),
      FOREIGN KEY (galaxy_name) REFERENCES Galaxy(name)
)
```

```
CREATE TABLE Terrestrial_planet (
      name                          VARCHAR,
      habitability                  FLOAT,
      has_life                      BOOLEAN,
      primary_solid_component       VARCHAR,
      PRIMARY KEY (name),
      FOREIGN KEY (name) REFERENCES Planetary_body(name)
)

CREATE TABLE Gas_giant (
      name                          VARCHAR,
      atmospheric_hydrogen%         FLOAT,
      atmospheric_helium%           FLOAT,
      PRIMARY KEY (name),
      FOREIGN KEY (name) REFERENCES Planetary_body(name)
)

CREATE TABLE Ice_giant (
      name                          VARCHAR,
      ice_H2O%                      FLOAT,
      PRIMARY KEY (name),
      FOREIGN KEY (name) REFERENCES Planetary_body(name)
)

CREATE TABLE Nebula (
      name                          VARCHAR,
      nebula_type                   VARCHAR,
      luminosity                    FLOAT,
      galaxy_name                   VARCHAR,
      PRIMARY KEY (name),
      FOREIGN KEY (galaxy_name) REFERENCES Galaxy(name)
)

CREATE TABLE Moon (
      planetary_body_name           VARCHAR,
      moon_name                     VARCHAR,
      surface_temperature           FLOAT,
      mass                          FLOAT,
      diameter                      FLOAT,
      PRIMARY KEY (planetary_body_name,moon_name),
      FOREIGN KEY (planetary_body_name)
            REFERENCES Planetary_body(name) ON DELETE CASCADE
)
```

(7) INSERT statement

```
INSERT
INTO Galaxy(name, age, hubble_classfication)
VALUES ('Andromeda Galaxy', 9.00, 'SAsb')

INSERT
INTO Galaxy(name, age, hubble_classfication)
VALUES ('Milky Way', 13.60, 'SBbc')

INSERT
INTO Galaxy(name, age, hubble_classfication)
VALUES ('Triangulum Galaxy', 12.00, 'SAcd')

INSERT
INTO Galaxy(name, age, hubble_classfication
VALUES ('Sombrero Galaxy', 13.00, 'SAsa')

INSERT
INTO Galaxy(name, age, hubble_classfication)
VALUES ('Whirlpool Galaxy', 10.00, 'SAbc')
```

```
INSERT
INTO Halo(name, luminosity, galaxy_name)
VALUES ('Andromeda Halo', 1.0 * 10^12, 'Andromeda Galaxy')

INSERT
INTO Halo(name, luminosity, galaxy_name)
VALUES ('Milky Way Halo', 1.0 * 10^9, 'Milky Way')

INSERT
INTO Halo(name, luminosity, galaxy_name)
VALUES ('Triangulum Halo', 1.0 * 10^10, 'Triangulum Galaxy')

INSERT
INTO Halo(name, luminosity, galaxy_name)
VALUES ('Sombrero Halo', 1.0 * 10^11,'Sombrero Galaxy')

INSERT
INTO Halo(name, luminosity, galaxy_name)
VALUES ('Whirlpool Halo', 1.0 * 10^8, 'Whirlpool Galaxy')
```

```
INSERT
INTO Black_hole1 (name, angular_momentum, electric_charge, is_quasar,
galaxy_name, is_center, mass)
VALUES ('Sagittarius A*', 0.99, 0.0, False, 'Milky Way', True, 4.3*10^6)

INSERT
INTO Black_hole1 (name, angular_momentum, electric_charge, is_quasar,
galaxy_name, is_center, mass)
VALUES ('M87*', 0.9, 0.0, True, 'Messier 87', True, 6.5*10^9)

INSERT
INTO Black_hole1 (name, angular_momentum, electric_charge, is_quasar,
galaxy_name, is_center, mass)
VALUES ('TON 618', 0.8, 0.0, True, 'TON 618 galaxy', True, 6.6*10^10)

INSERT
INTO Black_hole1 (name, angular_momentum, electric_charge, is_quasar,
galaxy_name, is_center, mass)
VALUES ('NGC 1277 Black Hole', 0.92, 0.0, False, 'NGC 1277', True,
1.7*10^9)

INSERT
INTO Black_hole1 (name, angular_momentum, electric_charge, is_quasar,
galaxy_name, is_center, mass)
VALUES ('Centaurus A Black Hole', 0.98, 0.0, False, 'Centaurus A',
True, 5.5*10^7)
```

```
INSERT
INTO Black_hole2 (mass, event_horizon_radius)
VALUES (4.3*10^6, 12.7*10^6)

INSERT
INTO Black_hole2 (mass, event_horizon_radius)
VALUES (6.5*10^9, 19.5*10^9)

INSERT
INTO Black_hole2 (mass, event_horizon_radius)
VALUES (6.6*10^10, 195.0*10^9)

INSERT
INTO Black_hole2 (mass, event_horizon_radius)
VALUES (1.7*10^9, 5.1*10^9)

INSERT
INTO Black_hole2 (mass, event_horizon_radius)
VALUES (5.5*10^7, 165.0*10^6)
```

```
INSERT
INTO Star_cluster (name, type)
VALUES ('Pleiades', 'Open')

INSERT
INTO Star_cluster (name, type)
VALUES ('Hyades', 'Open')

INSERT
INTO Star_cluster (name, type)
VALUES ('Messier 13', 'Globular')

INSERT
INTO Star_cluster (name, type)
VALUES ('Omega Centauri', 'Globular')

INSERT
INTO Star_cluster (name, type)
VALUES ('Carina Nebula', 'Open')
```

```
INSERT
INTO Star2(surface_temperature, stellar_classification)
VALUES(1080.0, 'M6e')

INSERT
INTO Star2(surface_temperature, stellar_classification)
VALUES(3200.0, 'M3.5')

INSERT
INTO Star2(surface_temperature, stellar_classification)
VALUES(1440.0, 'M5.5e')

INSERT
INTO Star2(surface_temperature, stellar_classification)
VALUES(1440.0, 'M2e')

INSERT
INTO Star2(surface_temperature, stellar_classification)
VALUES(1405.0, 'M3')
```

```
INSERT
INTO Star3(star_ID, name, lifetime, age, star_cluster_name,
galaxy_name, diameter, luminosity)
VALUES(359, 'CN Leonis', 3.79, 1.0*10^4, NULL, 'Milky Way', 0.13,
0.0000207)

INSERT
INTO Star3(star_ID, name, lifetime, age, star_cluster_name,
galaxy_name, diameter, luminosity)
VALUES(154, 'V1216 Sagittarii', 1.0, 1.0*10^4, NULL, 'Milky Way', 0.2,
0.000306)

INSERT
INTO Star3(star_ID, name, lifetime, age, star_cluster_name,
galaxy_name, diameter, luminosity)
VALUES(248, 'Giclas', 2.9, 1.0*10^4, NULL, 'Milky Way', 0.17, 0.000106)

INSERT
INTO Star3(star_ID, name, lifetime, age, star_cluster_name,
galaxy_name, diameter, luminosity)
VALUES(9352, 'Henry Draper', 0.397, 1.0*10^4, NULL, 'Milky Way', 0.491,
0.0108)

INSERT
INTO Star3(star_ID, name, lifetime, age, star_cluster_name,
galaxy_name, diameter, luminosity)
VALUES(1061, 'Vyssotsky McCormick', 0.693, 1.0*10^4, NULL, 'Milky Way',
0.3, 0.00145)
```

```
INSERT
INTO Star4(diameter, luminosity, surface_temperature)
VALUES(0.13, 0.0000207, 1080.0)

INSERT
INTO Star4(diameter, luminosity, surface_temperature)
VALUES(0.2, 0.000306, 3200.0)

INSERT
INTO Star4(diameter, luminosity, surface_temperature)
VALUES(0.17, 0.000106, 1277.0)

INSERT
INTO Star4(diameter, luminosity, surface_temperature)
VALUES(0.491, 0.0108, 1440.0)

INSERT
INTO Star4(diameter, luminosity, surface_temperature)
VALUES(0.3, 0.00145, 1405.0)
```

```
INSERT
INTO Planetary_body (name, surface_temperature, mass, diameter,
galaxy_name)
VALUES ('Earth', 15.0, 5.972*10^24, 12742.0, 'Milky Way')

INSERT
INTO Planetary_body (name, surface_temperature, mass, diameter,
galaxy_name)
VALUES ('Mars', -63.0, 0.641*10^24, 6779.0, 'Milky Way')

INSERT
INTO Planetary_body (name, surface_temperature, mass, diameter,
galaxy_name)
VALUES ('Jupiter', -108.0, 1.898*10^27, 139820.0, 'Milky Way')

INSERT
INTO Planetary_body (name, surface_temperature, mass, diameter,
galaxy_name)
VALUES ('Saturn', -139.0, 5.683*10^26, 116460.0, 'Milky Way')

INSERT
INTO Planetary_body (name, surface_temperature, mass, diameter,
galaxy_name)
VALUES ('Proxima Centauri b', 30.0, 1.17*10^24, 7400.0, 'Milky Way')
```

```
INSERT
INTO Terrestrial_planet (name, habitability, has_life,
primary_solid_component)
VALUES ('Earth', 0.9, True, 'Silicate Rock')

INSERT
INTO Terrestrial_planet (name, habitability, has_life,
primary_solid_component)
VALUES ('Mars', 0.3, False, 'Iron Oxide')

INSERT
INTO Terrestrial_planet (name, habitability, has_life,
primary_solid_component)
VALUES ('Venus', 0.1, False, 'Basalt')

INSERT
INTO Terrestrial_planet (name, habitability, has_life,
primary_solid_component)
VALUES ('Mercury', 0.0, False, 'Silicate Rock')

INSERT
INTO Terrestrial_planet (name, habitability, has_life,
primary_solid_component)
VALUES ('Proxima Centauri b', 0.6, False, 'Silicate Rock')
```

```
INSERT
INTO Ice_giant (name, ice_H2O%)
VALUES ('Neptune', 30.0)

INSERT
INTO Ice_giant (name, ice_H2O%)
VALUES ('Uranus', 35.0)

INSERT
INTO Ice_giant (name, ice_H2O%)
VALUES ('Gliese 436 b', 25.0)

INSERT
INTO Ice_giant (name, ice_H2O%)
VALUES ('HAT-P-11 b', 20.0)

INSERT
INTO Ice_giant (name, ice_H2O%)
VALUES ('GJ 3470 b', 22.0)



INSERT
INTO Gas_giant (name, atmospheric_hydrogen%, atmospheric_helium%)
VALUES ('Jupiter', 90.0, 10.0)

INSERT
INTO Gas_giant (name, atmospheric_hydrogen%, atmospheric_helium%)
VALUES ('Saturn', 96.3, 3.3)

INSERT
INTO Gas_giant (name, atmospheric_hydrogen%, atmospheric_helium%)
VALUES ('Uranus', 83.0, 15.0)

INSERT
INTO Gas_giant (name, atmospheric_hydrogen%, atmospheric_helium%)
VALUES ('Neptune', 80.0, 19.0)

INSERT
INTO Gas_giant (name, atmospheric_hydrogen%, atmospheric_helium%)
VALUES ('HD 189733 b', 85.0, 14.0)
INSERT
```

```
INTO Moon (planetary_body_name, moon_name, surface_temperature, mass,
diameter)
VALUES ('Earth', 'Moon', -53.0, 7.35*10^22, 3474.0)

INSERT
INTO Moon (planetary_body_name, moon_name, surface_temperature, mass,
diameter)
VALUES ('Jupiter', 'Europa', -160.0, 4.80*10^22, 3122.0)

INSERT
INTO Moon (planetary_body_name, moon_name, surface_temperature, mass,
diameter)
VALUES ('Jupiter', 'Ganymede', -160.0, 1.48*10^23, 5268.0)

INSERT
INTO Moon (planetary_body_name, moon_name, surface_temperature, mass,
diameter)
VALUES ('Saturn', 'Titan', -179.0, 1.35*10^23, 5151.0)

INSERT
INTO Moon (planetary_body_name, moon_name, surface_temperature, mass,
diameter)
VALUES ('Mars', 'Phobos', -4.0, 1.08*10^16, 22.4)
```