

CS 586 Final Project, Part 3

Dylan Laufenberg

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5.7 Launcher

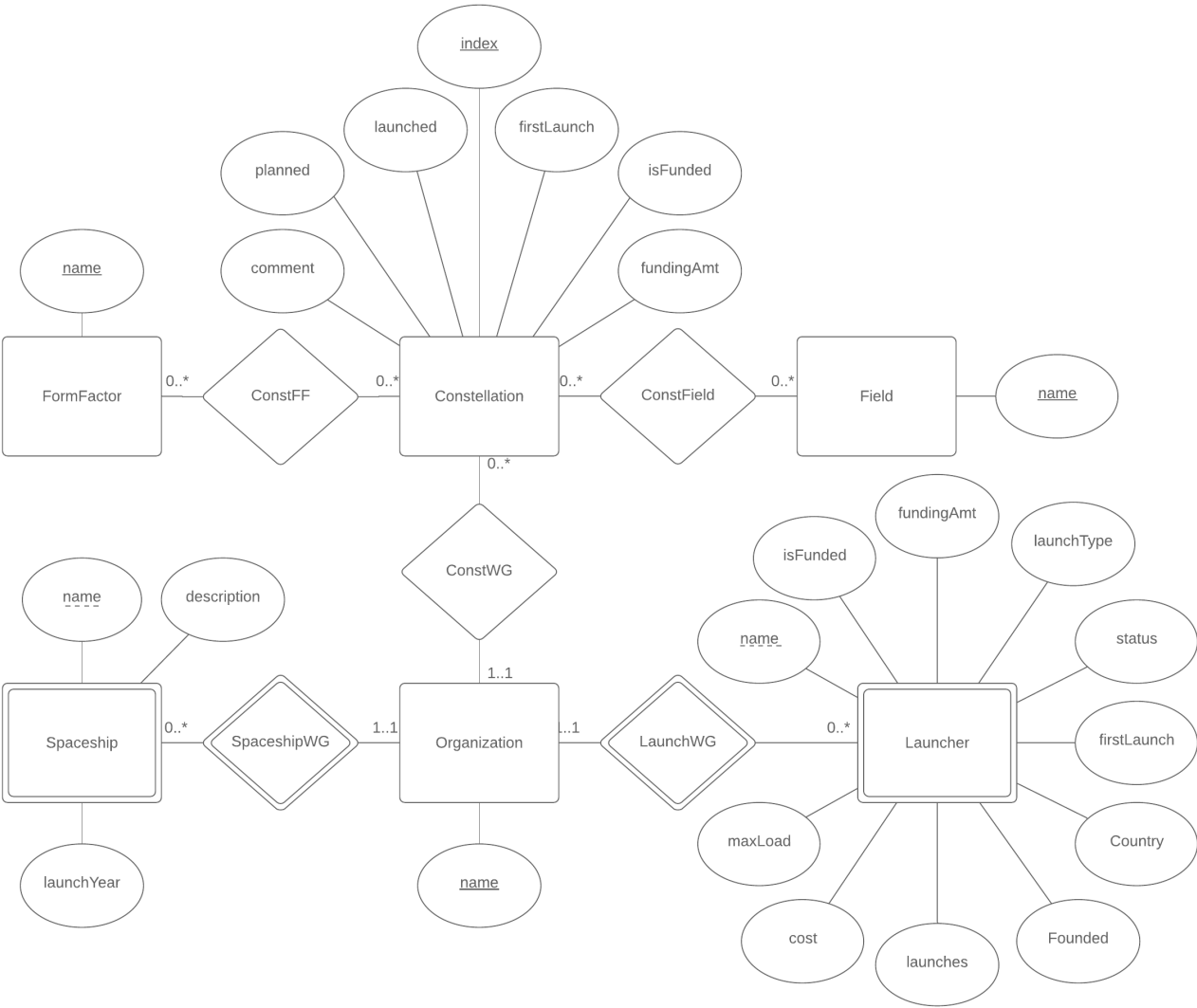
5.8 Spaceship

32

34

1 E/R Diagram

Note: I made no changes to the E/R diagram or database schema.



2 CREATE TABLE Statements

```
CREATE TABLE Field(  
    name VARCHAR(64) PRIMARY KEY  
);
```

```
CREATE TABLE Organization (  
    name VARCHAR(64) PRIMARY KEY  
);
```

```
CREATE TABLE Constellation (  
    index INT PRIMARY KEY,  
    orgName VARCHAR(64) REFERENCES Organization(name),  
    comment VARCHAR(512),  
    planned INT,  
    launched INT,  
    firstLaunch INT,  
    isFunded VARCHAR(16),  
    fundingAmt BIGINT  
);
```

```
CREATE TABLE ConstField (  
    constIndex INT REFERENCES Constellation(index),  
    fieldName VARCHAR(64) REFERENCES Field(name),  
    PRIMARY KEY(constIndex, fieldName)  
);
```

```
CREATE TABLE FormFactor (  
    name VARCHAR(64) PRIMARY KEY  
);
```

```
CREATE TABLE ConstFF (  
    constIndex INT REFERENCES Constellation(index),  
    ffName VARCHAR(64) REFERENCES FormFactor(name),  
    PRIMARY KEY (constIndex, ffName)  
);
```

```
CREATE TABLE Launcher (  
    orgName VARCHAR(64) REFERENCES Organization(name),  
    name VARCHAR(64),  
    isFunded VARCHAR(16),  
    fundingAmt BIGINT,  
    launchType VARCHAR(32),  
    status VARCHAR(32),  
    firstLaunch INT,  
    country VARCHAR(64),  
    founded INT,  
    launches INT,  
    cost BIGINT,
```

```

    maxLoad INT,
    UNIQUE (orgName, name)
);

CREATE TABLE Spaceship (
    orgName VARCHAR(64) REFERENCES Organization(name),
    name VARCHAR(64),
    description VARCHAR(512),
    launchYear INT,
    PRIMARY KEY (orgName, name)
);

```

3 Populating the Database

[View Project on GitHub](#)

To populate the database, I used a combination of Excel, LibreOffice Calc, Visual Studio Code (VSCode), Vim, and Python 3 (written using JetBrains PyCharm).

I copied the data from the original source ([link](#)) into multiple sheets in Excel, which, fortunately, preserved most of the cell data properly. I cleaned the data up as much as possible within Excel, saved a .xls document, and exported a tab-separated value (TSV) file with UTF-8 encoding containing just the Constellation table. Next, I wrote a simple [TsvReader](#) class in Python to give me a line-by-line, iterable reader for TSV files. I attempted to parse and print the data, and Python raised exceptions for unrecognized characters.

Excel didn't show any odd characters at the locations where Python raised exceptions. I opened the .xls and TSV files in LibreOffice Calc to attempt to see if it would show them, but it did not. Next, I opened the TSV file in Vim, to no avail. Back on Windows, VSCode finally showed me diamond question marks for the unrecognized characters and let me replace them with find-replace. (The culprits turned out to be non-breaking spaces in the HTML that Excel didn't handle gracefully, plus some characters in description text that were from highly unusual Chinese character sets.) After this clean-up, Python read and outputted the data correctly. I repeated the VSCode clean-up process for all of the Excel sheets.

With Python able to read the data, I created a simple library of data classes ([link](#)) to store records in Python and generate SQL output. I wrote a simple, heavily-commented [script](#) to parse each TSV file in turn using TsvReader and the data classes. The script built a list of records for each table, pulling out denormalized information and generating junction table entries as needed. The script wrote a series of SQL files each containing an INSERT statement to populate one table. (For details of what the script does, please see the script itself. The comments should make it quite easy to follow.)

I wrote CREATE TABLE statements by hand and executed them via `psql`. Next, I ran the generated SQL INSERT statements in an order that would satisfy foreign key dependencies, e.g. I loaded Organization before Constellation/Launcher/Spaceship. I ran SELECT queries to verify that all data appeared to be successfully imported.

4 Questions

4.1 How many different organizations have satellite constellations?

```
SELECT COUNT(DISTINCT Organization.name)
FROM Constellation JOIN Organization ON Constellation.orgName = Organization.name;
```

```
count
-----
      87
(1 row)
```

4.2 How many satellite constellations does each organization have?

Note: due to the insertion order (and the lack of any ORDER BY clauses), some ordering artifacts will appear in queries, such as all organizations with constellations appearing first due to their order of insertion and the lack of an index on Organization.name.

```
SELECT O1.name,
       (SELECT COUNT(*)
        FROM   Organization O2 JOIN Constellation C2 ON O2.name = C2.orgName
        WHERE  O2.name = O1.name)
FROM Organization O1;
```

name	count
ExactEarth	1
Planet	1
Spire	1
Planet (Terra Bella / Skybox)	1
Astro Digital (Aquila)	1
BlackSky / Spaceflight	1
GHGSat	1
Satellogic	1
Space View	1
Xingyun	1
Sky and Space Global	1
GeoOptics	1
Zhuhai Orbita Control	1
Canon	1
Aireon	1
Helios Wire	1
Swarm Technologies	1
Kepler Communications	1
ICEYE	1
SpaceX	1
Orbital Sidekick	1
Analytical Space	1

PlanetiQ		1
Hiber (Magnitude Space)		1
Fleet Space		1
Astrocast (ELSE)		1
Blink Astro		1
AISTech		1
HawkEye360		1
Axelspace		1
Capella Space		1
OneWeb		1
Karten Space		1
UnSeenLabs		1
NSLComm (SkyFi)		1
Kaskilo / eightyLEO		1
Orbital Micro Systems		1
Hera Systems		1
Hongyan		1
SRT Marine		1
Reaktor Space		1
SatRevolution		1
Aerial & Maritime		1
Rupercorp		1
Harris		1
Earth-i		1
Synspective		1
Space Systems Engineering		1
Astrome		1
Audacy Space		1
Cloud Constellation		1
Transcelestial		1
Dauria / SatByul		1
Kleos Space		1
HyperSat		1
LaserFleet		1
Kineis		1
XpressSAR		1
Orora Tech		1
Methera		1
Trident Space (Magna Parva)		1
VEOWARE		1
Scepter		1
Astranis		1
Umbra Lab		1
EarthNow		1
OQ Technology		1
Tekever		1
ArQit		1
NorStar NorthStar		1
Laser Light		1

Koolock		1
Alba Orbital		1
Galaktika		1
Ubiquitilink		1
Hypercubes		1
Efir		1
B612 Foundation		1
Planetary Resources		1
Outernet		1
Ursa Space Systems		1
Earthcube		1
Terran Orbital (Tyvak)		1
ISIS / Innovative Data Services		1
Promethean Labs		1
BitSat (Dunvegan Space Systems)		1
4skies (NovaNano)		1
Orbital ATK		0
CASIC / Exspace		0
Rocket Lab		0
JAXA		0
LandSpace		0
Virgin Galactic		0
Vector Space		0
Zero 2 Infinity		0
bspace		0
CloudIX (Nine)		0
Astra Space		0
CTA		0
One Space		0
i-Space		0
Aevum		0
Rocketcrafters		0
CONAE		0
Firefly		0
ISRO		0
RocketStar		0
SpaceOps		0
Equatorial Space Industries		0
Link Space		0
Cubecab		0
Nammo		0
Gilmour Space		0
Open Space		0
abl space systems		0
Relativity Space		0
Reaction Dynamics		0
bluShift Aerospace		0
Thor Launch Systems		0
UP Aerospace		0

PLD Space		0
Interstellar Technologies		0
Aphelion Orbitals		0
Avio		0
Masterra Space		0
Space One (Canon, IHI)		0
SpinLaunch		0
Orbital Access		0
Smallspark Space Systems		0
Independence-X		0
Rocketsan		0
Bagaveev Corporation		0
Horizon Space Tech		0
Scorpius Space Launch		0
Tranquility Aerospace		0
MISHAAL Aerospace		0
SpaceLS		0
Celestia Aerospace		0
VALT Enterprises		0
Lin Industrial		0
Orbex Space		0
Fore Dynamics		0
Skyrora		0
LAUNCHER Space		0
Rocketplane Global		0
Odyne Space		0
Ripple Aerospace		0
Swedish Space Corporation		0
Generation Orbit		0
Exos Aerospace		0
Chinarocket		0
Heliaq		0
LEO Aerospace		0
Bellatrix Aerospace		0
Stofiel Aerospace		0
New Rocket Technologies		0
Dawn Aerospace		0
i-Space (Space Honor)		0
Agnikul		0
MT Aerospace		0
Pythom		0
Rose Galactic		0
Advanced Rockets Coporation		0
HyImpulse		0
Pangea Aerospace		0
Spacedarts		0
Frontier Astronautics		0
Wagner Industries		0
Interorbital Systems		0


```
Leaf Space          |    0
ARCA Space          |    0
Open Space Orbital  |    0
Swiss Space Systems |    0
Boeing              |    0
Sierra Nevada Corp  |    0
Lockheed Martin     |    0
ULA (United Launch Alliance) |    0
Reaction Engines    |    0
(178 rows)
```

4.3 What is the average number of constellations per organization, excluding organizations that have no constellations?

```
SELECT AVG(ct)
FROM
  (SELECT COUNT(*) AS ct
   FROM Constellation
   GROUP BY orgName) AS Counts;

      avg
-----
1.00000000000000000000
(1 row)
```

4.4 What organizations have both constellations and upcoming spaceships?

```
(
  SELECT orgName
  FROM Constellation
) INTERSECT (
  SELECT orgName
  FROM Spaceship
);

orgname
-----
SpaceX
(1 row)
```

4.5 How many organizations have constellations or launchers?

Original: “What organizations have both constellations and launchers?” (Changed to add variety, based on grader feedback from Part I of the project.

```
SELECT COUNT(*)
FROM
```

```
((
    SELECT orgName
    FROM Constellation
) UNION (
    SELECT orgName
    FROM Launcher
)) AS OrgList;

count
-----
    173
(1 row)
```

4.6 What organizations have launchers but no upcoming spaceships?

Original: “What organizations have both launchers and upcoming spaceships?” (Changed to add variety, based on grader feedback from Part I of the project.

```
(
    SELECT orgName
    FROM Launcher
) EXCEPT (
    SELECT orgName
    FROM Spaceship
);

orgname
-----
Orbital ATK
Advanced Rockets Coporation
Rocketcrafters
Rocket Lab
Reaction Dynamics
bspace
Vector Space
Leaf Space
Chinarocket
Interorbital Systems
HyImpulse
MT Aerospace
Orbital Access
Nammo
Lin Industrial
Exos Aerospace
CONAE
Aevum
SpinLaunch
Smallspark Space Systems
Link Space
```

Swedish Space Corporation
Masterra Space
Orbex Space
New Rocket Technologies
One Space
i-Space
VALT Enterprises
Agnikul
Fore Dynamics
Tranquility Aerospace
Rocketsan
Stofiel Aerospace
CTA
Rocketplane Global
Pangea Aerospace
Pythom
LandSpace
Spacedarts
Odyne Space
Avio
Interstellar Technologies
Virgin Galactic
Astra Space
MISHAAL Aerospace
LEO Aerospace
CASIC / Exspace
UP Aerospace
Wagner Industries
Independence-X
Thor Launch Systems
Space One (Canon, IHI)
Open Space
Horizon Space Tech
Skyrora
SpaceOps
JAXA
Bellatrix Aerospace
Heliaq
LAUNCHER Space
Relativity Space
ISRO
i-Space (Space Honor)
PLD Space
RocketStar
Ripple Aerospace
bluShift Aerospace
Open Space Orbital
Cubecab
Zero 2 Infinity

```
Celestia Aerospace
Gilmour Space
Equatorial Space Industries
Scorpius Space Launch
Aphelion Orbitals
abl space systems
Dawn Aerospace
Frontier Astronautics
CloudIX (Nine)
Firefly
SpaceLS
ARCA Space
Swiss Space Systems
Rose Galactic
Generation Orbit
Bagaveev Corporation
(86 rows)
```

4.7 What organizations have all 3?

```
(
    SELECT orgName
    FROM Constellation
) INTERSECT (
    SELECT orgName
    FROM Launcher
) INTERSECT (
    SELECT orgName
    FROM Spaceship
);

orgname
-----
SpaceX
(1 row)
```

4.8 How many constellations use more than 1 form factor?

Note: because constellations do not have names in the original data set, answering this question requires me to make a decision, as the user, about how to identify constellations. I will use the Constellation.index attribute to uniquely identify constellations and include the Constellation.orgName attribute to make the query's results more human-readable. {index, orgName} is a superkey, so including orgName will not change the results of the query except to add the orgName column. I also add a count column for easier grading/verification.

```
SELECT C.index, C.orgName, COUNT(*)
FROM Constellation C JOIN ConstFF CFF ON C.index = CFF.constIndex
GROUP BY index, orgName
HAVING COUNT(*) > 1;
```

index	orgname	count
80	Outernet	2
16	Helios Wire	2
25	Fleet Space	2
17	Swarm Technologies	2
28	AISTech	2
1	ExactEarth	2
5	Astro Digital (Aquila)	2
18	Kepler Communications	2

(8 rows)

4.9 What constellations use the most form factors?

Note: The same notes as question 8 apply here as well.

```
SELECT C.index, C.orgName, COUNT(*)
FROM Constellation C JOIN ConstFF CFF ON C.index = CFF.constIndex
GROUP BY C.index, C.orgName
HAVING COUNT(*) =
    (SELECT MAX(ct)
     FROM
        (SELECT COUNT(*) AS ct
         FROM ConstFF
          GROUP BY constIndex) AS counts);
```

index	orgname	count
80	Outernet	2
16	Helios Wire	2
25	Fleet Space	2
17	Swarm Technologies	2
28	AISTech	2
1	ExactEarth	2
5	Astro Digital (Aquila)	2
18	Kepler Communications	2

(8 rows)

4.10 What constellations use only 1 form factor?

Note: The same notes as question 8 apply here as well.

```
SELECT C.index, C.orgName, COUNT(*)
FROM Constellation C JOIN ConstFF CFF ON C.index = CFF.constIndex
GROUP BY C.index, C.orgName
HAVING COUNT(*) = 1;
```

index	orgname	count
-------	---------	-------

8		Satellogic		1
87		4skies (NovaNano)		1
74		Galaktika		1
54		Kleos Space		1
29		HawkEye360		1
71		Laser Light		1
68		Tekever		1
4		Planet (Terra Bella / Skybox)		1
34		UnSeenLabs		1
70		NorStar NorthStar		1
52		Transcelestial		1
83		Terran Orbital (Tyvak)		1
67		OQ Technology		1
63		Scepter		1
10		Xingyun		1
35		NSLComm (SkyFi)		1
45		Harris		1
6		BlackSky / Spaceflight		1
86		BitSat (Dunvegan Space Systems)		1
84		ISIS / Innovative Data Services		1
39		Hongyan		1
69		ArQit		1
36		Kaskilo / eightyLEO		1
31		Capella Space		1
60		Methera		1
14		Canon		1
66		EarthNow		1
22		Analytical Space		1
59		Orora Tech		1
13		Zhuhai Orbita Control		1
65		Umbra Lab		1
2		Planet		1
62		VEOWARE		1
75		Ubiquitilink		1
73		Alba Orbital		1
44		Rupercorp		1
11		Sky and Space Global		1
42		SatRevolution		1
82		Earthcube		1
41		Reaktor Space		1
46		Earth-i		1
40		SRT Marine		1
43		Aerial & Maritime		1
53		Dauria / SatByul		1
32		OneWeb		1
9		Space View		1
7		GHGSat		1
38		Hera Systems		1

15	Aireon		1
79	Planetary Resources		1
26	Astrocast (ELSE)		1
12	GeoOptics		1
85	Promethean Labs		1
72	Koolock		1
78	B612 Foundation		1
57	Kineis		1
24	Hiber (Magnitude Space)		1
81	Ursa Space Systems		1
61	Trident Space (Magna Parva)		1
19	ICEYE		1
77	Efir		1
30	Axelspace		1
49	Astrome		1
47	Synspective		1
3	Spire		1
37	Orbital Micro Systems		1
20	SpaceX		1
33	Karten Space		1
76	Hypercubes		1
64	Astranis		1
55	HyperSat		1
27	Blink Astro		1
23	PlanetiQ		1
56	LaserFleet		1

(74 rows)

4.11 How many projects (constellations, upcoming spaceships, and launchers) first launch each year? (List the number of launches in each year.)

Note: I sort by year even though the question does not ask for it; it just seems like common sense, given the question.

```

SELECT year, COUNT(*)
FROM
  ((
    SELECT firstLaunch AS year
    FROM Constellation
  ) UNION ALL (
    SELECT firstLaunch AS year
    FROM Launcher
  ) UNION ALL (
    SELECT launchYear AS year
    FROM Spaceship
  )) AS YearList
GROUP BY year
ORDER BY year ASC;
```

year	count
1990	1
2008	2
2013	3
2014	1
2016	4
2017	8
2018	37
2019	25
2020	15
2021	11
2022	2
2023	4
2024	1
2025	1
	67

(15 rows)

4.12 What year saw the most launches (of any kind)?

Note: a vastly simpler query is possible by simply excluding the blank years from question 11 and using LIMIT 1, but in the event of a tie, that query would only display one. This might be valid/expected for some applications, but I use a query that will include any ties in my result.

```
SELECT year
FROM
  -- Union together all launch years, just like question 11
  ((
    SELECT firstLaunch AS year
    FROM Constellation
  ) UNION ALL (
    SELECT firstLaunch AS year
    FROM Launcher
  ) UNION ALL (
    SELECT launchYear AS year
    FROM Spaceship
  )) AS YearList
GROUP BY year
HAVING COUNT(*) =
  (SELECT MAX(ct)
  FROM
    -- Adapted from question 11, with the addition of a WHERE clause
    (SELECT year, COUNT(*) AS ct
    FROM
      ((
        SELECT firstLaunch AS year
        FROM Constellation
      ) UNION ALL (
```



```

        SELECT firstLaunch AS year
        FROM Launcher
    ) UNION ALL (
        SELECT launchYear AS year
        FROM Spaceship
    )) AS YearList
WHERE year IS NOT NULL
GROUP BY year
ORDER BY year ASC) AS Counts);

```

```

year
-----
2018
(1 row)

```

4.13 The launchers listed are in many different statuses (stages of their lifecycles). How many launchers are in each stage/status?

```

SELECT status, COUNT(*)
FROM Launcher
GROUP BY status;

```

```

    status      | count
-----+-----
Concept         |      1
Cancelled        |      3
In development  |     78
Retired         |      1
Operational     |      5
(5 rows)

```

4.14 Which launch type is most popular among launchers?

Note: in part I of the project submission, the grader asked, “Overall, or per launcher?” To answer this question: each launcher has a launchType field that stores a text value. This question is asking what launchType value is most popular.

```

SELECT launchType
FROM Launcher
GROUP BY launchType
HAVING COUNT(*) =
    (SELECT MAX(ct)
     FROM
        (SELECT launchType, COUNT(*) AS ct
         FROM Launcher
         GROUP BY launchType) AS LTCOUNTS);

```

```

launchtype

```

```
-----
Land
(1 row)
```

4.15 Which launch type is most popular among launchers that are currently in development?

```
SELECT launchType
FROM Launcher
WHERE status='In development'
GROUP BY launchType
HAVING COUNT(*) =
    (SELECT MAX(ct)
     FROM
        (SELECT launchType, COUNT(*) AS ct
         FROM Launcher
          WHERE status='In development'
          GROUP BY launchType) AS LTCounts);
```

4.16 How much does the most expensive launcher cost? How much does the least expensive launcher cost? What’s the average cost of a launcher?

Original: “What’s the most expensive launcher? What’s the least expensive? What’s the average?” Edited for clarity.

```
SELECT MIN(cost), MAX(cost), AVG(cost)
FROM Launcher;
```

min	max	avg
40000	56000000	5366896.551724137931

(1 row)

4.17 How much money has been spent so far on constellations and launchers (ignoring the ones for which we do not have funding numbers)?

```
SELECT SUM(fundingAmt)
FROM
    ((
        SELECT fundingAmt
        FROM Constellation
    ) UNION ALL (
        SELECT fundingAmt
        FROM Launcher
    )) AS Funding;
```

```
sum
-----
4959430000
```

4.18 How many constellations at least 80% full (at least 80% of planned satellites are launched)?

Original: “How many constellations are full (all planned satellites are launched)?” Changed according to grader’s suggestion.

Note: I’ve opted to include a few additional, relevant fields for easier grading / out of general curiosity. Also, Planet’s constellation is indeed at 324/150, according to the original data source ([link](#)). This is not a SQL import error.

```
SELECT index, orgName, launched, planned, launched * 1.0 / planned AS percentFull
FROM Constellation
WHERE launched >= 0.8 * planned;
```

index	orgname	launched	planned	percentfull
1	ExactEarth	57	67	0.85074626865671641791
2	Planet	324	150	2.1600000000000000
15	Aireon	65	75	0.8666666666666666667

(3 rows)

4.19 How many constellations, launched satellites, and planned satellites pertain to each field?

```
SELECT F.name AS field, COUNT(*) AS constellations, SUM(launched) AS launched, SUM(planned) AS planned
FROM Constellation C JOIN ConstField CF ON C.index = CF.constIndex
JOIN Field F ON CF.fieldName = F.name
GROUP BY F.name;
```

field	constellations	launched	planned
Optical comms	5	1	12
SAR	7	1	134
QKD	1	0	
Asteroid tracking	1	0	
Earth observation	29	362	1257
Geolocation	1	0	20
IR imaging	4	0	210
Weather	6	90	320
IoT / M2M	21	11	1254
Data storage	2	0	24
ADS-B	5	150	337
Hyperspectral	7	11	117
AIS	9	142	385
RF spectrum monitoring	2	0	30

```
Internet | 12 | 4 | 6403
Emissions monitoring | 3 | 1 | 20
Orbital data relay | 3 | 1 | 3
(17 rows)
```

4.20 What constellations have the most planned but unlaunched satellites?

```
SELECT index, orgName, launched, planned, (planned - launched) AS unlaunched
FROM Constellation
WHERE planned - launched =
    (SELECT MAX(unlaunched)
     FROM
        (SELECT (planned - launched) AS unlaunched
         FROM Constellation) AS UnlaunchedCounts);
```

```
index | orgname | launched | planned | unlaunched
-----+-----+-----+-----+-----
20 | SpaceX | 2 | 4425 | 4423
(1 row)
```

5 Full Listing By Table

5.1 Organization

```
SELECT * FROM Organization;
```

```
name
-----
ExactEarth
Planet
Spire
Planet (Terra Bella / Skybox)
Astro Digital (Aquila)
BlackSky / Spaceflight
GHGSat
Satellogic
Space View
Xingyun
Sky and Space Global
GeoOptics
Zhuhai Orbita Control
Canon
Aireon
Helios Wire
Swarm Technologies
Kepler Communications
```

ICEYE
SpaceX
Orbital Sidekick
Analytical Space
PlanetiQ
Hiber (Magnitude Space)
Fleet Space
Astrocast (ELSE)
Blink Astro
AISTech
HawkEye360
Axelspace
Capella Space
OneWeb
Karten Space
UnSeenLabs
NSLComm (SkyFi)
Kaskilo / eightyLEO
Orbital Micro Systems
Hera Systems
Hongyan
SRT Marine
Reaktor Space
SatRevolution
Aerial & Maritime
Rupercorp
Harris
Earth-i
Synspective
Space Systems Engineering
Astrome
Audacy Space
Cloud Constellation
Transcelestial
Dauria / SatByul
Kleos Space
HyperSat
LaserFleet
Kineis
XpressSAR
Orora Tech
Methera
Trident Space (Magna Parva)
VEOWARE
Scepter
Astranis
Umbra Lab
EarthNow
OQ Technology

Tekever
ArQit
NorStar NorthStar
Laser Light
Koolock
Alba Orbital
Galaktika
Ubiquitilink
Hypercubes
Efir
B612 Foundation
Planetary Resources
Outernet
Ursa Space Systems
Earthcube
Terran Orbital (Tyvak)
ISIS / Innovative Data Services
Promethean Labs
BitSat (Dunvegan Space Systems)
4skies (NovaNano)
Orbital ATK
CASIC / Exspace
Rocket Lab
JAXA
LandSpace
Virgin Galactic
Vector Space
Zero 2 Infinity
bspace
CloudIX (Nine)
Astra Space
CTA
One Space
i-Space
Aevum
Rocketcrafters
CONAE
Firefly
ISRO
RocketStar
SpaceOps
Equatorial Space Industries
Link Space
Cubecab
Nammo
Gilmour Space
Open Space
abl space systems
Relativity Space

Reaction Dynamics
bluShift Aerospace
Thor Launch Systems
UP Aerospace
PLD Space
Interstellar Technologies
Aphelion Orbitals
Avio
Masterra Space
Space One (Canon, IHI)
SpinLaunch
Orbital Access
Smallspark Space Systems
Independence-X
Rocketsan
Bagaveev Corporation
Horizon Space Tech
Scorpius Space Launch
Tranquility Aerospace
MISHAAL Aerospace
SpaceLS
Celestia Aerospace
VALT Enterprises
Lin Industrial
Orbex Space
Fore Dynamics
Skyrora
LAUNCHER Space
Rocketplane Global
Odyne Space
Ripple Aerospace
Swedish Space Corporation
Generation Orbit
Exos Aerospace
Chinarocket
Heliaq
LEO Aerospace
Bellatrix Aerospace
Stofiel Aerospace
New Rocket Technologies
Dawn Aerospace
i-Space (Space Honor)
Agnikul
MT Aerospace
Pythom
Rose Galactic
Advanced Rockets Coporation
HyImpulse
Pangea Aerospace

Spacedarts
Frontier Astronautics
Wagner Industries
Interorbital Systems
Leaf Space
ARCA Space
Open Space Orbital
Swiss Space Systems
Boeing
Sierra Nevada Corp
Lockheed Martin
ULA (United Launch Alliance)
Reaction Engines
(178 rows)

5.2 Constellation

Note: comment field is truncated to fit within page width.

```
SELECT index, orgName, launched, planned, firstLaunch, isFunded, fundingAmt
FROM Constellation;
```

index	orgname	launched	planned	firstlaunch	isfunded	fundingamt
1	ExactEarth	57	67	2008	true	
2	Planet	324	150	2013	true	183000000
3	Spire	85	150	2013	true	149500000
4	Planet (Terra Bella / Skybox)	13	24	2013		
5	Astro Digital (Aquila)	5	25	2014	true	16700000
6	BlackSky / Spaceflight	1	60	2016	true	203500000
7	GHGSat	1	20	2016	true	20000000
8	Satellologic	3	25	2016	true	29000000
9	Space View	5	16	2016		
10	Xingyun	1	156	2017		
11	Sky and Space Global	3	200	2017	true	11500000
12	GeoOptics	5		2017	true	5150000
13	Zhuhai Orbita Control	7	10	2017	true	
14	Canon	1	100	2017		
15	Aireon	65	75	2017	true	50000000
16	Helios Wire	1	30	2017	true	1000000
17	Swarm Technologies	4		2018		
18	Kepler Communications	1	140	2018	true	21000000
19	ICEYE	1	18	2018	true	53000000
20	SpaceX	2	4425	2018	true	1600000000
21	Orbital Sidekick	1		2018	true	4700000
22	Analytical Space	1		2018	true	4000000
23	PlanetiQ	0	18	2018	true	5000000
24	Hiber (Magnitude Space)	0	48	2018	true	6200000
25	Fleet Space	0	100	2018	true	3700000

26	Astrocast (ELSE)	0	64	2018	true	7100000
27	Blink Astro	0		2018		
28	AISTech	0	100	2018	true	310000
29	HawkEye360	0	30	2018	true	26000000
30	AxelSpace	0	50	2018	true	16000000
31	Capella Space	0	40	2018	true	34000000
32	OneWeb	0	648	2018	true	1700000000
33	Karten Space	0	14	2018		
34	UnSeenLabs	0		2018		
35	NSLComm (SkyFi)	0	60	2018	true	9250000
36	Kaskilo / eightyLEO	0	300	2018		
37	Orbital Micro Systems	0	40	2018	true	650000
38	Hera Systems	0	50	2019	true	4200000
39	Hongyan	0	320	2018		
40	SRT Marine	0	6	2019		
41	Reaktor Space	0	36	2018		
42	SatRevolution	0	66	2018	true	800000
43	Aerial & Maritime	0		2019	true	12200000
44	Rupercorp	0		2019		
45	Harris	0	12	2019		
46	Earth-i	0	15	2019		
47	Synspective	0	30	2019	true	13600000
48	Space Systems Engineering	0		2019		
49	Astrome	0	150	2019		
50	Audacy Space	0	3	2019	true	11100000
51	Cloud Constellation	0		2019	true	
52	Transcelestial	0		2019	true	1800000
53	Dauria / SatByul	0	8	2019		
54	Kleos Space	0	20	2019		
55	HyperSat	0	6	2020	true	85000000
56	LaserFleet	0		2020	true	2000000
57	Kineis	0	20	2020	true	
58	XpressSAR	0	4	2020		
59	Orora Tech	0	100	2021		
60	Methera	0	16	2021	true	
61	Trident Space (Magna Parva)	0	48	2021	true	7000000
62	VEOWARE	0		2021		
63	Scepter	0				
64	Astranis	0			true	18000000
65	Umbra Lab	0	12		true	
66	EarthNow	0	500		true	
67	OQ Technology	0				
68	Tekever	0	12			
69	ArQit	0				
70	NorStar NorthStar	0	40			
71	Laser Light	0	12			
72	Koolock	0				
73	Alba Orbital	0				
74	Galaktika	0				

75		Ubiquitilink						true		
76		Hypercubes		0						
77		Efir		0		288				
78		B612 Foundation		0						
79		Planetary Resources		2		10		true		50000000
80		Outernet		0		200		true		
81		Ursa Space Systems		0						
82		Earthcube		0		10		true		4500000
83		Terran Orbital (Tyvak)		0				true		
84		ISIS / Innovative Data Services		0		16				
85		Promethean Labs		0						
86		BitSat (Dunvegan Space Systems)		0		24				
87		4skies (NovaNano)		0						

(87 rows)

5.3 ConstFF

SELECT * FROM ConstFF;

constindex		ffname
-----+-----		
1		Nanosat
1		Hosted
2		3U
3		3U
4		Smallsat
5		6U
5		16U
6		Microsat
7		Microsat
8		Microsat
9		Satellite
10		Smallsat
11		8U
12		6U
13		Smallsat
14		Microsat
15		Hosted
16		6U
16		16U
17		0.25U
17		1U
18		3U
18		6U
19		Microsat
20		Smallsat
22		6U
23		6U

24		6U
25		3U
25		12U
26		3U
27		3U
28		2U
28		6U
29		Microsat
30		Microsat
31		Microsat
32		Smallsat
33		6U
34		6U
35		6U
36		Smallsat
37		3U
38		12U
39		Satellite
40		6U
41		6U
42		2U
43		3U
44		6U
45		6U
46		Microsat
47		Smallsat
49		Microsat
52		CubeSat
53		6U
54		CubeSat
55		Smallsat
56		Microsat
57		16U
59		3U
60		Smallsat
61		Smallsat
62		Satellite
63		Microsat
64		Smallsat
65		Microsat
66		Microsat
67		CubeSat
68		16U
69		CubeSat
70		Microsat
71		Satellite
72		CubeSat
73		PocketQube
74		Microsat

```
75 | CubeSat
76 | CubeSat
77 | Smallsat
78 | Microsat
79 | 12U
80 | 1U
80 | 3U
81 | Microsat
82 | CubeSat
83 | CubeSat
84 | 3U
85 | CubeSat
86 | 3U
87 | Microsat
(90 rows)
```

5.4 FormFactor

```
SELECT * FROM FormFactor;

name
-----
Nanosat
Hosted
3U
Smallsat
6U
16U
Microsat
Satellite
8U
0.25U
1U
12U
2U
CubeSat
PocketQube
(15 rows)
```

5.5 ConstField

```
SELECT * FROM ConstField;

constindex | fieldname
-----+-----
1 | AIS
2 | Earth observation
```

3 | Weather
3 | AIS
3 | ADS-B
4 | Earth observation
5 | Earth observation
6 | Earth observation
7 | Emissions monitoring
8 | Earth observation
8 | Hyperspectral
9 | Earth observation
10 | Internet
10 | IoT / M2M
11 | IoT / M2M
12 | Weather
13 | Earth observation
13 | Hyperspectral
14 | Earth observation
15 | ADS-B
16 | IoT / M2M
17 | IoT / M2M
18 | IoT / M2M
18 | Internet
19 | SAR
20 | Internet
21 | Earth observation
21 | Hyperspectral
22 | IoT / M2M
22 | Orbital data relay
22 | Optical comms
23 | Weather
24 | IoT / M2M
25 | IoT / M2M
26 | IoT / M2M
27 | IoT / M2M
28 | IoT / M2M
28 | ADS-B
28 | AIS
28 | IR imaging
29 | RF spectrum monitoring
30 | Earth observation
31 | SAR
32 | Internet
33 | Earth observation
33 | AIS
34 | RF spectrum monitoring
35 | Internet
35 | IoT / M2M
36 | IoT / M2M
37 | Weather

38 | Earth observation
39 | Internet
40 | AIS
41 | Earth observation
41 | Hyperspectral
42 | Earth observation
43 | AIS
43 | ADS-B
44 | Earth observation
45 | Weather
46 | Earth observation
47 | Earth observation
48 | Earth observation
49 | Internet
50 | Orbital data relay
51 | Data storage
52 | Orbital data relay
52 | Optical comms
53 | Earth observation
54 | AIS
54 | Geolocation
55 | Earth observation
55 | Hyperspectral
56 | Internet
56 | Optical comms
57 | IoT / M2M
58 | SAR
59 | Weather
59 | IR imaging
60 | Internet
61 | SAR
62 | Earth observation
63 | Emissions monitoring
64 | Internet
65 | SAR
66 | Earth observation
67 | IoT / M2M
68 | Earth observation
68 | SAR
68 | AIS
68 | ADS-B
68 | IoT / M2M
69 | QKD
69 | Optical comms
70 | Earth observation
70 | Hyperspectral
71 | Optical comms
72 | Earth observation
72 | IR imaging

```
73 | Earth observation
74 | IoT / M2M
75 | IoT / M2M
76 | Earth observation
76 | Hyperspectral
77 | Internet
78 | Asteroid tracking
79 | Earth observation
80 | Internet
81 | SAR
82 | Earth observation
82 | IR imaging
83 | IoT / M2M
84 | AIS
85 | Emissions monitoring
86 | IoT / M2M
86 | Data storage
87 | IoT / M2M
(118 rows)
```

5.6 Field

```
SELECT * FROM Field;
```

```
name
-----
AIS
Earth observation
Weather
ADS-B
Emissions monitoring
Hyperspectral
Internet
IoT / M2M
SAR
Orbital data relay
Optical comms
IR imaging
RF spectrum monitoring
Data storage
Geolocation
QKD
Asteroid tracking
(17 rows)
```

5.7 Launcher

```
SELECT * FROM Launcher;
```

orgname	name	isfunded	fundingamt	launchtype	status	firstlaunch	country	founded	launches	cost	maxload
Orbital ATK	Pegasus			Plane	Operational	1990	US	1982	43	56000000	443
SpaceX	Falcon 1e			Land	Retired	2008	US	2013	5	11000000	1000
CASIC / Exspace	Fei Tian 1 / Kuaizhou-1A	true		Land	Operational	2017	China	1999	2		300
Rocket Lab	Electron	true		Land	Operational	2018	US/New Zealand	2006	2	4900000	150
JAXA	SS-520-4	true		Land	Operational	2018	Japan	1969	1		4
LandSpace	Zhuque-1 (ZQ-1)			Land	Operational	2018	China	2015	1		300
Virgin Galactic	LauncherOne	true		Plane	In development	2018	US	2004	0	10000000	200
Vector Space	Vector-R	true	103000000	Land	In development	2018	US	2016	0	1500000	50
Zero 2 Infinity	Bloostar	true		Balloon	In development	2018	Spain	2009	0	4000000	75
bspace	Volant			Balloon	In development	2018	US	2016	0		215
CloudIX (Nine)				Balloon	In development	2018	US	2016	0		22
Astra Space	Astra			Land	In development	2018	US	2016	0		100
CTA	VLM			Land	In development	2018	Brazil	1953	0		150
One Space	OS-M1	true	116000000	Land	In development	2018	China	2015	0	100000	112
Vector Space	Vector-H	true	103000000	Land	In development	2019	US	2016	0	3000000	105
i-Space	Hyperbola-1 (Shian Quxian)			Land	In development	2019	China	2017	0		
Aevum	Ravn	true		Plane	In development	2019	US	2016	0		
Rocketcrafters	Intrepid-1			Land	In development	2019	US	2010	0	5400000	376
CONAE	Tronador II			Land	In development	2019	Argentina	1991	0		250
Firefly	Alpha (a)	true	21800000	Land	In development	2019	US	2014	0	9000000	1000
ISRO	PSLV Light?			Land	In development	2019	India	1969	0		700
RocketStar	StarLord			Sea	In development	2019	US	2015	0		300
SpaceOps	Rocky 1			Land	In development	2019	Australia	2016	0	100000	5
Equatorial Space Industries	Volans			Land	In development	2019	Singapore	2017	0	1000000	50
Link Space	New Line 1			Land	In development	2020	China	2014	0	4500000	200
Cubecab	Cab-3A			Plane	In development	2020	US	2014	0	250000	5
Nammo	North Star			Land	In development	2020	Norway	1998	0		20
Gilmour Space	Eris	true	17000000	Land	In development	2020	Singapore	2012	0		380
Open Space	Neutrino 1			Land	In development	2020	Canada	2014	0		
abl space systems	RS1			Land	In development	2020	US	2017	0		650
Relativity Space	Terran 1	true	45100000	Land	In development	2020	US	2016	0	10000000	1250
Reaction Dynamics		true	200000	Land	In development	2020	Canada	2017	0		150
bluShift Aerospace	Red Dwarf				In development	2020	US	2015	0		
Thor Launch Systems					In development	2020	US		0		
UP Aerospace	Spyder			Land	In development	2021	US	1998	0	1000000	10
PLD Space	Arion 2	true	1300000	Land	In development	2021	Spain	2011	0		150
Interstellar Technologies	Zero			Land	In development	2021	Japan	2003	0		100
Aphelion Orbitals	Helios / Feynman	true	500000	Land	In development	2021	US	2015	0	550000	14
Avio	Vega Light			Land	In development	2021	Italy	1908	0		250
Masterra Space	Equinox			Land	In development	2021	UK	1984	0	1000000	20
Space One (Canon, IHI)				Land	In development	2021	Japan	2017	0		100
SpinLaunch		true	50000000	Catapult	In development	2022	US	2014	0		
Orbital Access	Orbital 500			Plane	In development	2023	UK	2015	0		500

Smallspark Space Systems	Frost 1				In development	2023	UK	2018	0		100
Independence-X	DNLV			Land	In development	2023	Malaysia	1972	0	4500000	200
Rocketsan	UFS				In development	2023	Turkey		0		
Bagaveev Corporation	Bagaveev	true	670000	Land	In development		US	2013	0		10
Horizon Space Tech	Black Arrow 2			Land	In development		UK	2014	0	6300000	200
Scorpius Space Launch	Demi-Sprite			Land	In development		US	1984	0	3600000	160
Tranquility Aerospace	Devon Two			Land	In development		UK	2015	0		4
MISHAAL Aerospace	M-OV			Land	In development		US	2010	0		454
SpaceLS	Prometheus-1			Land	In development		UK	2010	0		250
Celestia Aerospace	Space Arrow CM			Plane	In development		Spain	2014	0	200000	16
VALT Enterprises	VALT			Land	In development		US	2015	0	1700000	
Lin Industrial	Taymyr-1A			Land	In development		Russia	2014	0	500000	12
Orbex Space		true	39800000	Land	In development		UK	2015	0		
Fore Dynamics	NFR-1			Land	In development		US	2017	0		200
Skyrora	Skyrora XL			Land	In development		UK/Ukraine	2017	0		
LAUNCHER Space				Land	In development		US	2016	0		
Rocketplane Global	Rocketplane XS			Plane	In development		US	2017	0		1500
Odyne Space				Land	In development		US	2016	0		
Ripple Aerospace	Sea Serpent One			Sea	In development		Norway	2014	0		2600
Swedish Space Corporation	Rainbow			Land	In development		Sweden	1972	0		100
Generation Orbit	GoLauncher 2			Land	In development		Italy	2011	0	3000000	40
Exos Aerospace	Jaguar			Land	In development		US	2014	0		100
Chinarocket	Lightning Dragon-1 (Jie Long-1)			Land	In development		China	2018	0		150
Heliaq	ALV-2			Land	In development		Australia	2015	0		30
LEO Aerospace				Balloon	In development		US	2017	0		
Bellatrix Aerospace	Chetak			Land	In development		India	2015	0	2000000	150
Stofiel Aerospace	BOREAS			Balloon	In development		US	2015	0		100
New Rocket Technologies				Land	In development		Russia	2017	0		500
Dawn Aerospace	MK-3			Plane	In development		Netherlands	2016	0		
i-Space (Space Honor)		true	90600000	Land	In development		China	2016	0		
Agnikul	AgniBaan			Land	In development		India	2017	0		100
MT Aerospace	MTA, WARR, Daneo			Plane	In development		Germany	2005	0		
Pythom	Pythom			Land	In development		Sweden	2017	0		70
Rose Galactic	Anthium Orbital Cannon			Cannon	In development		US	2017	0		
Advanced Rockets Coporation	DELV			Land	In development		US	2017	0		
HyImpulse					In development		Germany	2018	0		400
Pangea Aerospace	Meso			Land	In development		Spain	2018	0		150
Spacedarts				Land	In development		Russia	2017	0	40000	10
Frontier Astronautics					In development		US	2008	0		
Wagner Industries	Konshu				In development		US	2015	0		
Interorbital Systems	NEPTUNE N5			Land	In development		US	1996	0	500000	40
Leaf Space	Primo			Land	Concept		Italy	2014	0		
ARCA Space	Haas 2C			Land	Cancelled		US/Romania	1999	0		400
Open Space Orbital	Neutrino I			Land	Cancelled		Canada	2014	0		50
Swiss Space Systems	SOAR			Plane	Cancelled		Switzerland	2013	0	10000000	250
(88 rows)											

5.8 Spaceship

```
SELECT * FROM Spaceship;
```

orgname	name	description	launchyear
SpaceX	Dragon 2	Can land on Mars and on Earth propulsively. Up to 7 persons.	2018
Boeing	CST-100 Starliner	Up to 7 people and reusable up to 10 missions.	2018
Sierra Nevada Corp	Dream Chaser	Reusable automated cargo lifting-body spaceplane.	2019
Lockheed Martin	Orion	Intended to facilitate human exploration of asteroids and of Mars	2020
SpaceX	BFR Spaceship and Booster	Largest ever rocket. 150 tonnes to Mars surface.	2022
ULA (United Launch Alliance)	ACES (Advanced Cryogenic Evolved Stage)	Refuelable modular upper stage that can can be also used as propellant depot and land on the Moon.	2024
Reaction Engines	Skylon	Single-stage-to-orbit spaceplane.	2025

(7 rows)