

Milestone 4

1. Project Description + Schema Changes

- Initial SQL Queries can be found in Database_GUI -> oracle-backend -> init_db.sql
- Final Project Description: Our project is a **Space Mission Tracker** designed to help users manage and monitor various aspects of space missions. The system models key entities such as **missions, astronauts, agencies, spacecraft, equipment, launch sites, training programs, mission logs, and celestial bodies**. It supports operations like assigning astronauts to missions, logging mission activities and details (e.g., targeted celestial bodies), and tracking spacecraft, launch sites, and overall mission progress.
- Schema changes from milestone 2: Our final schema (included below) differs slightly from the schema submitted in Milestone 2. The main change involved **denormalizing certain relations** to reduce the number of tables and simplify queries, especially where denormalization was logically sound.
 - **Agency:** Previously normalized into Agency, AgencyName, and AgencyLocation, was consolidated into a single Agency table. Since each agency has a unique name and location, these attributes had a one-to-one relationship and did not benefit from separation.
 - **LaunchSite:** Similarly, LaunchSite and LaunchSiteLocation were merged. Each launch site exists at exactly one geographic location and vice-versa, so normalization only added unnecessary complexity.
 - Additionally, in the **Mission** relation, we marked the attributes start_date, end_date, and launch_date as NOT NULL. This was not a design necessity but a practical choice made during development to simplify form handling and avoid errors related to null or empty Date objects in the frontend during creation or edition of Missions.
- Copy of the final schema below with primary keys underlined and foreign keys bolded.
- Screenshots of the data in each table (following execution of the SQL script) are also included after the schema: please note that we added some more tuples to our initial script but did not have enough time to capture them again, apologies!
- SQL Queries used listed below.
- Screenshots demonstrating the functionality listed alongside each query.

2. Final Schema

- **Equipment** (equipment_serial_num: VARCHAR(30), equipment_name: VARCHAR(100), eq_type: VARCHAR(30))
- **Mission** (mission_id: VARCHAR(30), **site_id**: VARCHAR(30), **body_id**: VARCHAR(30), **spacecraft_id**: VARCHAR(30), spacecraft_name: VARCHAR(30), mission_name: VARCHAR(100), start_date: DATE, end_date: DATE, launch_date: DATE)
 - site_id: NOT NULL
 - body_id: NOT NULL
 - spacecraft_id: NOT NULL
 - start_date: NOT NULL
 - end_date: NOT NULL
 - launch_date: NOT NULL
- **MissionLog** (log_date: DATE, mission_id: VARCHAR(30), entry_type: VARCHAR(100), status: VARCHAR(100), description: VARCHAR(100))
- **LaunchSite** (site_id: VARCHAR(30), site_city: VARCHAR(100), site_name: VARCHAR(30), site_country: VARCHAR(30))
 - site_name: UNIQUE
- **Spacecraft** (spacecraft_id: VARCHAR(30), manufacturer: VARCHAR(30), **model_name**: VARCHAR(50))
- **SpacecraftModel** (manufacturer: VARCHAR(30), model_name: VARCHAR(50), sc_type: VARCHAR(10), crew_capacity: INTEGER, cargo_capacity_kg: DECIMAL(8,2))
- **Carries** (spacecraft_id: VARCHAR(30), mission_id: VARCHAR(30), equipment_serial_number: VARCHAR(30))
- **Agency** (agency_id: INTEGER, agency_name: VARCHAR(100), acronym: VARCHAR(10), agency_location: VARCHAR(100), agency_city: VARCHAR(30), agency_country: VARCHAR(30))
 - agency_name: UNIQUE, NOT NULL
 - acronym: UNIQUE

- **ParticipateIn** (agency_id: INTEGER, mission_id: VARCHAR(30), role: VARCHAR(50))
 - **Astronaut** (astronaut_id: INTEGER, astronaut_name: VARCHAR(50), nationality: VARCHAR(5), dob: DATE)
 - **Pilot** (astronaut_id: INTEGER, flight_hours DECIMAL(6,2))
 - **Engineer** (astronaut_id: INTEGER, flight_hours DECIMAL(6,2))
 - **Researcher** (astronaut_id: INTEGER, field: VARCHAR(30))
 - **AssignedTo** (astronaut_id: INTEGER, mission_id: VARCHAR(30))
 - **TrainingProgram** (program_name: VARCHAR(50), program_location: VARCHAR(100), tp_type: VARCHAR(50))

tp_type: NOT NULL
 - **TrainedIn** (astronaut_id: INTEGER, program_name: VARCHAR(50), program_location: VARCHAR(100))
-

3. Screenshots of the database after the initial SQL script (taken using SQLFiddle)

Equipment:

EQUIPMENT_SERIAL_NUM	EQUIPMENT_NAME	EQ_TYPE
EQ001	Lunar Module Eagle	Lunar Lander
EQ002	Alice	Orbiter Instrument
EQ003	CONCERT	Orbiter Instrument

LaunchSite:

SITE_ID	SITE_NAME	SITE_CITY	SITE_COUNTRY
LS001	Kennedy Space Center	Florida	USA
LS002	Guiana Space Centre	Kourou	South America
LS003	Cape Canaveral AFS	Florida	USA

CelestialBody:

BODY_ID	NAME	CB_TYPE	HAS_ATMOSPHERE
CB001	Moon	Natural Satellite	1
CB002	67P/Churyumov-Gerasimenko	Comet	0
CB003	International Space Station	Orbital Space Station	1
CB004	Bennu	Asteroid	0
CB005	81P/Wild2	Comet	0

SpacecraftModel:

MODEL_NAME	MANUFACTURER	SC_TYPE	CREW_CAPACITY	CARGO_CAPACITY_KG
Command Module	North American Aviation	crew	3	0
Rosetta Orbiter	Astrium	cargo	0	300
Crew Dragon	SpaceX	hybrid	7	3300
OSIRIS-REx	Lockheed Martin	cargo	0	1
Stardust	Lockheed Martin	cargo	0	1

Spacecraft:

SPACECRAFT_ID	MODEL_NAME	MANUFACTURER
SC001	Command Module	North American Aviation
SC002	Rosetta Orbiter	Astrium
SC003	Crew Dragon	SpaceX
SC004	OSIRIS-REx	Lockheed Martin
SC005	Stardust	Lockheed Martin

Astronaut:

ASTRONAUT_ID	ASTRONAUT_NAME	NATIO	DOB
1	Armstrong, Neil A.	US	05-AUG-30
2	Aldrin, Edwin "Buzz"	US	20-JAN-30
3	Collins, Michael	US	31-OCT-30
4	Cardman, Zena	US	26-OCT-87

Pilot:

ASTRONAUT_ID	FLIGHT_HOURS
1	2400
5	1900

Researcher:

ASTRONAUT_ID	FIELD
4	Geobiology

Engineer: no values to displayTrainingProgram:

PROGRAM_NAME	PROGRAM_LOCATION	TP_TYPE
Topography Recognition	Cinder Lake Crater Field, Arizona	Field
Sample Collection	Grand Canyon, Arizona	Field

TrainedIn:

ASTRONAUT_ID	PROGRAM_NAME	PROGRAM_LOCATION
1	Sample Collection	Grand Canyon, Arizona
1	Topography Recognition	Cinder Lake Crater Field, Arizona
2	Sample Collection	Grand Canyon, Arizona
2	Topography Recognition	Cinder Lake Crater Field, Arizona
3	Sample Collection	Grand Canyon, Arizona
3	Topography Recognition	Cinder Lake Crater Field, Arizona

Agency:

AGENCY_ID	AGENCY_NAME	ACRONYM	AGENCY_LOCATION	AGENCY_CITY	AGENCY_COUNTRY
1	National Aeronautics and Space Administration	NASA	300 Hidden Figures Way SW	Washington	USA
2	European Space Agency	ESA	8-10 rue Mario Nikis	Paris	France
3	Canadian Space Agency	CSA	6767 Rte de la Report	Saint-Hubert, QC	Canada
4	Indian Space Research Organization	ISRO	Antariksh Bhavan, New BEL Road	Bangalore	India
5	German Aerospace Center	DLR	Rutherfordstraße 2	Berlin	Germany

Mission:

MISSION_ID	SITE_ID	BODY_ID	SPACECRAFT_ID	SPACECRAFT_NAME	MISSION_NAME	START_DATE	END_DATE	LAUNCH_DATE
M001	LS001	CB001	SC001	Columbia	Apollo 11	16-JUL-69	24-JUL-69	16-JUL-69
M002	LS002	CB002	SC002	Rosetta Orbiter	Rosetta	02-MAR-04	30-SEP-16	02-MAR-04
M003	LS001	CB003	SC003		SpaceX Crew-11	01-AUG-25	01-AUG-25	01-AUG-25
M004	LS003	CB004	SC004		OSIRIS-REx	08-SEP-16	24-SEP-23	08-SEP-16
M005	LS003	CB005	SC005		Stardust	07-FEB-99	15-JAN-06	07-FEB-99

MissionLog:

LOG_DATE	MISSION_ID	ENTRY_TYPE	STATUS	DESCRIPTION
16-JUL-69	M001	Launch	Success	Lift-off on Apollo 11
20-JUL-69	M001	Landing	Success	The Eagle has landed
03-DEC-18	M004	Landing	Success	Arrived at Asteroid Bennu
02-JAN-04	M005	Comet Encounter	Success	Collected dust using aerogel collector

AssignedTo:

ASTRONAUT_ID	MISSION_ID
	1 M001
	2 M001
	3 M001
	4 M003

ParticipateIn:

AGENCY_ID	MISSION_ID	ROLE
	1 M001	Lead
	2 M002	Lead
	1 M003	Lead
	1 M004	Lead
	1 M005	Lead

Carries:

MISSION_ID	EQUIPMENT_SERIAL_NUM
M001	EQ001
M002	EQ002
M002	EQ003

4. SQL Queries used in the code

INSERT: We implemented INSERT for both Mission and MissionLog tables.

Mission: Database_GUI -> oracle-backend -> [server.js](#) -> lines 237-238 and 255-256

```
INSERT INTO Mission (mission_id, site_id, body_id, spacecraft_id,
spacecraft_name, mission_name, start_date, end_date, launch_date)
VALUES (:mission_id, :site_id, :body_id, :spacecraft_id, :spacecraft_name,
:mission_name, TO_DATE(:start_date, 'YYYY-MM-DD'), TO_DATE(:end_date,
'YYYY-MM-DD'), TO_DATE(:launch_date, 'YYYY-MM-DD'))
```

Subsequently, if user has identified an agency for the mission, we also insert into ParticipateIn:

```
INSERT INTO ParticipateIn (agency_id, mission_id, role)
VALUES (:agency_id, :mission_id, :role)
```

MissionLog: Database_GUI -> oracle-backend -> [server.js](#) -> lines 466-467

```
INSERT INTO MissionLog (mission_id, log_date, entry_type, status, description)
VALUES (:mission_id, TO_DATE(:log_date, 'YYYY-MM-DD'), :entry_type, :status,
:description)
```

Demonstrating on Mission:

Before the query is executed:

The screenshot shows a web-based application titled "Space Missions". At the top, there is a header with a rocket icon and a "Space Missions" title. Below the header, there is a search bar with placeholder text "Search by mission ID or name" and a "Search" button. Underneath the search bar, there is a section with several checkboxes: "Mission ID" (checked), "Mission Name" (checked), "Spacecraft" (checked), "Launch Site" (checked), "Destination" (checked), "Agency Name" (checked), "Agency's Role" (checked), and "Launch Date" (checked). A button labeled "+ Add Mission" is located to the left of these checkboxes. The main content area displays a table of mission data. The table has columns: Mission ID, Mission Name, Spacecraft, Launch Site, Destination, Agency Name, Agency's Role, Launch Date, and Actions. There are five rows of data in the table, each representing a different mission. Each row includes edit and delete buttons in the "Actions" column. At the bottom of the table, it says "Total missions: 5".

Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M001	Apollo 11	Columbia	Kennedy Space Center	Moon	National Aeronautics and Space Administration	Lead	1969-07-16	<button>Edit</button> <button>Delete</button>
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	<button>Edit</button> <button>Delete</button>
M003	SpaceX Crew-11		Kennedy Space Center	International Space Station	National Aeronautics and Space Administration	Lead	2025-08-01	<button>Edit</button> <button>Delete</button>
M004	OSIRIS-REx		Cape Canaveral AFS	Bennu	National Aeronautics and Space Administration	Lead	2016-09-08	<button>Edit</button> <button>Delete</button>
M005	Stardust		Cape Canaveral AFS	81P/Wild2	National Aeronautics and Space Administration	Lead	1999-02-07	<button>Edit</button> <button>Delete</button>

Total missions: 5

During:

The screenshot shows the same "Space Missions" application after a query has been executed. The interface is identical to the one above, but the data in the table has been updated. The fifth row (M005) has been removed, indicating it has been deleted. The other four missions (M001, M002, M003, M004) remain in the list.

Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M006	Apollo 16	LS002	CB002	SC003	Eagle	Lead	2025-08-01	<button>Edit</button> <button>Delete</button>
4	Lead	<button>Add</button>	<button>Cancel</button>					
<input checked="" type="checkbox"/> Mission ID <input checked="" type="checkbox"/> Mission Name <input checked="" type="checkbox"/> Spacecraft <input checked="" type="checkbox"/> Launch Site <input checked="" type="checkbox"/> Destination <input checked="" type="checkbox"/> Agency Name <input checked="" type="checkbox"/> Agency's Role <input checked="" type="checkbox"/> Launch Date								
M001	Apollo 11	Columbia	Kennedy Space Center	Moon	National Aeronautics and Space Administration	Lead	1969-07-16	<button>Edit</button> <button>Delete</button>
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	<button>Edit</button> <button>Delete</button>
M003	SpaceX Crew-11		Kennedy Space Center	International Space Station	National Aeronautics and Space Administration	Lead	2025-08-01	<button>Edit</button> <button>Delete</button>
M004	OSIRIS-REx		Cape Canaveral AFS	Bennu	National Aeronautics and Space Administration	Lead	2016-09-08	<button>Edit</button> <button>Delete</button>

After execution:

Space Missions

+ Add Mission

Mission ID	Mission Name	Launch Site ID	Celestial Body ID	Spacecraft ID	Spacecraft Name	2025-08-06	2025-08-06	2025-08-06	
Agency ID (Optional)	Agency's Role (Optional)	Add	Cancel	<input checked="" type="checkbox"/> Mission ID <input checked="" type="checkbox"/> Mission Name <input checked="" type="checkbox"/> Spacecraft <input checked="" type="checkbox"/> Launch Site <input checked="" type="checkbox"/> Destination <input checked="" type="checkbox"/> Agency Name <input checked="" type="checkbox"/> Agency's Role <input checked="" type="checkbox"/> Launch Date					
Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions	
M001	Apollo 11	Columbia	Kennedy Space Center	Moon	National Aeronautics and Space Administration	Lead	1969-07-16	<button>Edit</button> <button>Delete</button>	
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	<button>Edit</button> <button>Delete</button>	
M003	SpaceX Crew-11		Kennedy Space Center	International Space Station	National Aeronautics and Space Administration	Lead	2025-08-01	<button>Edit</button> <button>Delete</button>	
M004	OSIRIS-REx		Cape Canaveral AFS	Bennu	National Aeronautics and Space Administration	Lead	2016-09-08	<button>Edit</button> <button>Delete</button>	
M005	Stardust		Cape Canaveral AFS	81P/Wild2	National Aeronautics and Space Administration	Lead	1999-02-07	<button>Edit</button> <button>Delete</button>	
M006	Apollo 16	Eagle	Guiana Space Centre	67P/Churyumov-Gerasimenko	Indian Space Research Organization	Lead	2025-08-01	<button>Edit</button> <button>Delete</button>	

Total missions: 6

DELETE: We implemented DELETE on Mission to demonstrate Cascade-On-DELETE

Mission: Database_GUI -> oracle-backend -> [server.js](#) -> lines 288-289

```
DELETE FROM Mission
WHERE mission_id = :mission_id
```

Before execution:

Space Missions

+ Add Mission

Mission ID Mission Name Spacecraft Launch Site Destination Agency Name Agency's Role Launch Date

Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M001	Apollo 11	Columbia	Kennedy Space Center	Moon	National Aeronautics and Space Administration	Lead	1969-07-16	<button>Edit</button> <button>Delete</button>
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	<button>Edit</button> <button>Delete</button>
M003	SpaceX Crew-11		Kennedy Space Center	International Space Station	National Aeronautics and Space Administration	Lead	2025-08-01	<button>Edit</button> <button>Delete</button>
M004	OSIRIS-REx		Cape Canaveral AFS	Bennu	National Aeronautics and Space Administration	Lead	2016-09-08	<button>Edit</button> <button>Delete</button>
M005	Stardust		Cape Canaveral AFS	81P/Wild2	National Aeronautics and Space Administration	Lead	1999-02-07	<button>Edit</button> <button>Delete</button>

Total missions: 5

Mission Logs

+ Add Log

Filter by Mission ID

Mission ID Mission Name Log Date Entry Type Status Description

Mission ID	Mission Name	Log Date	Entry Type	Status	Description	Action
M001	Apollo 11	1969-07-16	Launch	Success	Lift-off on Apollo 11	<button>Delete</button>
M001	Apollo 11	1969-07-20	Landing	Success	The Eagle has landed	<button>Delete</button>
M005	Stardust	2004-01-02	Comet Encounter	Success	Collected dust using aerogel collector	<button>Delete</button>
M004	OSIRIS-REx	2018-12-03	Landing	Success	Arrived at Asteroid Bennu	<button>Delete</button>

Total log entries: 4

During/After execution: (just click the Delete button next to the entry - in this case, I will delete M001)

Space Missions

[+ Add Mission](#)

Mission ID Mission Name Spacecraft Launch Site Destination Agency Name Agency's Role Launch Date

Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	Edit Delete
M003	SpaceX Crew-11		Kennedy Space Center	International Space Station	National Aeronautics and Space Administration	Lead	2025-08-01	Edit Delete
M004	OSIRIS-REx		Cape Canaveral AFS	Bennu	National Aeronautics and Space Administration	Lead	2016-09-08	Edit Delete
M005	Stardust		Cape Canaveral AFS	81P/Wild2	National Aeronautics and Space Administration	Lead	1999-02-07	Edit Delete

Total missions: 4

Mission Logs

[+ Add Log](#)

[Filter by Mission ID](#)

Mission ID Mission Name Log Date Entry Type Status Description

Mission ID	Mission Name	Log Date	Entry Type	Status	Description	Action
M005	Stardust	2004-01-02	Comet Encounter	Success	Collected dust using aerogel collector	Delete
M004	OSIRIS-REx	2018-12-03	Landing	Success	Arrived at Asteroid Bennu	Delete

Total log entries: 2

UPDATE: We implemented UPDATE on Mission - since Oracle does not allow ON UPDATE, we are updating Participateln manually since user can change the attached agency/role and that affects the Participateln table.

Mission: Database_GUI -> oracle-backend -> [server.js](#) -> lines 312-319, 336-338 (to check if Participateln already has a tuple) and if yes, update: 348-352 or delete existing: 372-373 (per user's instruction). If no entry already exists in Participateln, create new: lines 361-362.

```
// Update Mission
UPDATE Mission
SET site_id = :site_id,
body_id = :body_id,
spacecraft_id = :spacecraft_id,
spacecraft_name = :spacecraft_name,
mission_name = :mission_name,
launch_date = TO_DATE(:launch_date, 'YYYY-MM-DD')
```

```

WHERE mission_id = :mission_id

// Check if ParticipateIn Tuple exists
SELECT COUNT(*) AS count
FROM ParticipateIn
WHERE mission_id = :mission_id

// If yes and updating
UPDATE ParticipateIn
SET agency_id = :agency_id,
role = :role
WHERE mission_id = :mission_id
AND role = :role

// If yes and deleting
DELETE FROM ParticipateIn
WHERE mission_id = :mission_id

// If no and inserting
INSERT INTO ParticipateIn (agency_id, mission_id, role)
VALUES (:agency_id, :mission_id, :role)

```

Before execution:

Space Missions

[+ Add Mission](#)

Mission ID Mission Name Spacecraft Launch Site Destination Agency Name Agency's Role Launch Date

Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M001	Apollo 11	Columbia	Kennedy Space Center	Moon	National Aeronautics and Space Administration	Lead	1969-07-16	<button>Edit</button> <button>Delete</button>
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	<button>Edit</button> <button>Delete</button>
M003	SpaceX Crew-11		Kennedy Space Center	International Space Station	National Aeronautics and Space Administration	Lead	2025-08-01	<button>Edit</button> <button>Delete</button>
M004	OSIRIS-REx		Cape Canaveral AFS	Bennu	National Aeronautics and Space Administration	Lead	2016-09-08	<button>Edit</button> <button>Delete</button>
M005	Stardust		Cape Canaveral AFS	81P/Wild2	National Aeronautics and Space Administration	Lead	1999-02-07	<button>Edit</button> <button>Delete</button>

Total missions: 5

During execution:

Space Missions

[+ Add Mission](#)

M003	SpaceX Crew-11	LS001	CB001	SC002	Eagle	2025-08-06	2025-08-06	2025-08-01
3	<input type="button" value="Lead"/>	<input type="button" value="Update"/>	<input type="button" value="Cancel"/>					

Mission ID Mission Name Spacecraft Launch Site Destination Agency Name Agency's Role Launch Date

Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M001	Apollo 11	Columbia	Kennedy Space Center	Moon	National Aeronautics and Space Administration	Lead	1969-07-16	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M003	SpaceX Crew-11		Kennedy Space Center	International Space Station	National Aeronautics and Space Administration	Lead	2025-08-01	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M004	OSIRIS-REx		Cape Canaveral AFS	Bennu	National Aeronautics and Space Administration	Lead	2016-09-08	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M005	Stardust		Cape Canaveral AFS	81P/Wild2	National Aeronautics and Space Administration	Lead	1999-02-07	<input type="button" value="Edit"/> <input type="button" value="Delete"/>

Total missions: 5

After execution:

Space Missions

[+ Add Mission](#)

Mission ID Mission Name Spacecraft Launch Site Destination Agency Name Agency's Role Launch Date

Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M001	Apollo 11	Columbia	Kennedy Space Center	Moon	National Aeronautics and Space Administration	Lead	1969-07-16	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M003	SpaceX Crew-11	Eagle	Kennedy Space Center	Moon	Canadian Space Agency	Lead	2025-08-01	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M004	OSIRIS-REx		Cape Canaveral AFS	Bennu	National Aeronautics and Space Administration	Lead	2016-09-08	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M005	Stardust		Cape Canaveral AFS	81P/Wild2	National Aeronautics and Space Administration	Lead	1999-02-07	<input type="button" value="Edit"/> <input type="button" value="Delete"/>

Total missions: 5

Projection: We provided projection for all the relations that we are displaying. I will display this for Astronaut.

Astronaut: Database_GUI -> oracle-backend -> [server.js](#) -> lines 63-66, Database_GUI -> oracle-frontend -> AstronautTable.js -> lines 30-73

```
SELECT astronaut_id, astronaut_name, nationality,  
TO_CHAR(dob, 'YYYY-MM-DD') as date_of_birth  
FROM Astronaut  
ORDER BY astronaut_id
```

The projection happens in the frontend depending on the checkboxes that user selects.

Before execution:

 **Astronauts**

ID Name Nationality Date of Birth

ID	Name	Nationality	Date of Birth
1	Armstrong, Neil A.	US	1930-08-05
2	Aldrin, Edwin "Buzz"	US	1930-01-20
3	Collins, Michael	US	1930-10-31
4	Cardman, Zena	US	1987-10-26
5	Fincke, Michael	US	1967-03-14

Total astronauts: 5

During/after execution:

 **Astronauts**

ID Name Nationality Date of Birth

ID	Name	Nationality
1	Armstrong, Neil A.	US
2	Aldrin, Edwin "Buzz"	US
3	Collins, Michael	US
4	Cardman, Zena	US
5	Fincke, Michael	US

Total astronauts: 5

Selection: We added selection for MissionLog so that user can filter using a mission_id.

MissionLog: Database_GUI -> oracle-backend -> [server.js](#) -> lines 169, 174, 182-187

```
// If no mission_id is provided, show mission logs of all missions
let whereClause = 'WHERE ml.mission_id = m.mission_id';

// If mission_id is provided, we append to the whereClause
whereClause = whereClause + ' AND ml.mission_id = :mission_id';

// Get the required data
SELECT ml.mission_id, m.mission_name,
TO_CHAR(ml.log_date, 'YYYY-MM-DD') as log_date,
ml.entry_type, ml.status, ml.description
FROM MissionLog ml, Mission m
${whereClause}
ORDER BY ml.log_date
```

Before execution:

Mission Logs

+ Add Log

Filter by Mission ID

Mission ID Mission Name Log Date Entry Type Status Description

Mission ID	Mission Name	Log Date	Entry Type	Status	Description	Action
M001	Apollo 11	1969-07-16	Launch	Success	Lift-off on Apollo 11	Delete
M001	Apollo 11	1969-07-20	Landing	Success	The Eagle has landed	Delete
M005	Stardust	2004-01-02	Comet Encounter	Success	Collected dust using aerogel collector	Delete
M004	OSIRIS-REx	2018-12-03	Landing	Success	Arrived at Asteroid Bennu	Delete

Total log entries: 4

During/after execution:

Mission Logs

+ Add Log

M001

Mission ID Mission Name Log Date Entry Type Status Description

Mission ID	Mission Name	Log Date	Entry Type	Status	Description	Action
M001	Apollo 11	1969-07-16	Launch	Success	Lift-off on Apollo 11	Delete
M001	Apollo 11	1969-07-20	Landing	Success	The Eagle has landed	Delete

Total log entries: 2

Join: We provided join on Assignments. User can find astronauts who were assigned to missions being led by a particular agency. It does join on various tables.

Assignments: Database_GUI -> oracle-backend -> [server.js](#) -> lines 142-148

```
SELECT DISTINCT a.astronaut_name, m.mission_name
FROM Astronaut a, AssignedTo at, Mission m, ParticipateIn p
WHERE a.astronaut_id = at.astronaut_id AND
at.mission_id = m.mission_id AND
m.mission_id = p.mission_id AND
p.agency_id = :agency_id
ORDER BY a.astronaut_name, m.mission_name
```

Before execution:

Mission Assignments

Select Agency ID

Astronaut Mission

Astronaut	Mission
Armstrong, Neil A.	Apollo 11
Aldrin, Edwin "Buzz"	Apollo 11
Collins, Michael	Apollo 11
Cardman, Zena	SpaceX Crew-11
Fincke, Michael	SpaceX Crew-11

Total assignments: 5

During execution:

Mission Assignments

Select Agency ID

Astronaut Mission

Astronaut	Mission
Armstrong, Neil A.	Apollo 11
Aldrin, Edwin "Buzz"	Apollo 11
Collins, Michael	Apollo 11
Cardman, Zena	SpaceX Crew-11
Fincke, Michael	SpaceX Crew-11

Total assignments: 5

After execution:

The screenshot shows a user interface titled "Mission Assignments". At the top, there is a filter bar with the text "1 - National Aeronautics and Space Administration" and a "Filter by Agency" button. Below the filter bar, there are two checked checkboxes: "Astronaut" and "Mission". The main content is a table with two columns: "Astronaut" and "Mission". The table contains three rows of data:

Astronaut	Mission
Aldrin, Edwin "Buzz"	Apollo 11
Armstrong, Neil A.	Apollo 11
Collins, Michael	Apollo 11

Below the table, a message states "Total assignments: 3".

Aggregation with GROUP BY: Provided View Mode for user to view missions statistics based on agencies.

Mission: Database_GUI -> oracle-backend -> [server.js](#) -> lines 518-525

```
SELECT a.agency_name,
COUNT(*) as total_missions,
MIN(TO_CHAR(m.launch_date, 'YYYY-MM-DD')) as earliest_mission,
MAX(TO_CHAR(m.launch_date, 'YYYY-MM-DD')) as latest_mission
FROM Mission m, ParticipateIn p, Agency a
WHERE m.mission_id = p.mission_id AND p.agency_id = a.agency_id
GROUP BY a.agency_name
ORDER BY total_missions DESC
```

Before execution:

All Missions

View Mode:

Mission ID Mission Name Spacecraft Launch Site Destination Agency Name Agency's Role Launch Date

Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M001	Apollo 11	Columbia	Kennedy Space Center	Moon	National Aeronautics and Space Administration	Lead	1969-07-16	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M003	SpaceX Crew-11		Kennedy Space Center	International Space Station	National Aeronautics and Space Administration	Lead	2025-08-01	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M004	OSIRIS-REx		Cape Canaveral AFS	Bennu	National Aeronautics and Space Administration	Lead	2016-09-08	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M005	Stardust		Cape Canaveral AFS	81P/Wild2	National Aeronautics and Space Administration	Lead	1999-02-07	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M006	Chandrayaan		Guiana Space Centre	Moon	Indian Space Research Organization	Lead	2023-07-14	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M007	Aurora	Skywalker	Cape Canaveral AFS	Mars	European Space Agency	Lead	2023-03-10	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M008	Red Horizons		Kennedy Space Center	Mars	Indian Space Research Organization	Lead	2035-08-22	<input type="button" value="Edit"/> <input type="button" value="Delete"/>

Total missions: 8

Tr

During execution:

All Missions

View Mode: All Missions Mission Count by Agency Mars Missions Only

Mission ID Mission Name Spacecraft Launch Site Destination Agency Name Agency's Role Launch Date

Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M001	Apollo 11	Columbia	Kennedy Space Center	Moon	National Aeronautics and Space Administration	Lead	1969-07-16	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M003	SpaceX Crew-11		Kennedy Space Center	International Space Station	National Aeronautics and Space Administration	Lead	2025-08-01	<input type="button" value="Edit"/> <input type="button" value="Delete"/>

After execution:

Mission Count by Agency

View Mode:

Agency Name Total Missions Earliest Mission Latest Mission

Agency Name	Total Missions	Earliest Mission	Latest Mission
National Aeronautics and Space Administration	4	1969-07-16	2025-08-01
Indian Space Research Organization	2	2023-07-14	2035-08-22
European Space Agency	2	2004-03-02	2023-03-10

Total missions: 3

Aggregation with HAVING: Provided View Mode for user to view astronauts that have 3 or more mission assignments.

Assignment: Database_GUI -> oracle-backend -> [server.js](#) -> lines 620-625

```
SELECT a.astronaut_name, COUNT(at.mission_id) as total_assignments
FROM Astronaut a, AssignedTo at
WHERE a.astronaut_id = at.astronaut_id
GROUP BY a.astronaut_id, a.astronaut_name
HAVING COUNT(at.mission_id) >= 3
ORDER BY total_assignments DESC, a.astronaut_name
```

Before execution:

All Assignments

View Mode: All Assignments 

Select Agency ID  Filter by Agency 

Astronaut Mission

Astronaut	Mission
Armstrong, Neil A.	Apollo 11
Collins, Michael	Apollo 11
Aldrin, Edwin "Buzz"	Apollo 11
Fincke, Michael	SpaceX Crew-11
Cardman, Zena	SpaceX Crew-11
Armstrong, Neil A.	Chandrayaan
Collins, Michael	Chandrayaan
Aldrin, Edwin "Buzz"	Chandrayaan
Armstrong, Neil A.	Aurora
Cardman, Zena	Aurora

During execution:

All Assignments

View Mode All Assignments 

Astronauts with 3+ Assignments 

Select Agency ID 

Filter by Agency 

Astronaut Mission

After execution:

Astronauts with 3+ Assignments

View Mode: Astronauts with 3+ Assignments 

Astronaut Name Total Assignments

Astronaut Name	Total Assignments
Armstrong, Neil A.	4
Aldrin, Edwin "Buzz"	3
Cardman, Zena	3
Collins, Michael	3

Total assignments: 4

Nested Aggregation with GROUP BY: We provided View Mode for user to be able to view missions that target Mars and their information.

Mission: Database_GUI -> oracle-backend -> [server.js](#) -> lines 548-562

```

SELECT data.mission_id, data.mission_name, data.spacecraft_name,
data.site_name, data.destination,
a.agency_name, p.role,
TO_CHAR(data.launch_date, 'YYYY-MM-DD') AS launch_date
FROM (SELECT m.mission_id, m.mission_name, m.spacecraft_name,
l.site_name, cb.name AS destination, m.launch_date
FROM Mission m, LaunchSite l, CelestialBody cb
WHERE m.site_id = l.site_id
AND m.body_id = cb.body_id
AND LOWER(cb.name) LIKE '%mars%'
GROUP BY m.mission_id, m.mission_name, m.spacecraft_name,
l.site_name, cb.name, m.launch_date) data
LEFT JOIN ParticipateIn p ON data.mission_id = p.mission_id
LEFT JOIN Agency a ON p.agency_id = a.agency_id
ORDER BY data.launch_date DESC

```

Before execution:

 All Missions

View Mode:

Mission ID Mission Name Spacecraft Launch Site Destination Agency Name Agency's Role Launch Date

Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M001	Apollo 11	Columbia	Kennedy Space Center	Moon	National Aeronautics and Space Administration	Lead	1969-07-16	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M003	SpaceX Crew-11		Kennedy Space Center	International Space Station	National Aeronautics and Space Administration	Lead	2025-08-01	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M004	OSIRIS-REx		Cape Canaveral AFS	Bennu	National Aeronautics and Space Administration	Lead	2016-09-08	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M005	Stardust		Cape Canaveral AFS	81P/Wild2	National Aeronautics and Space Administration	Lead	1999-02-07	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M006	Chandrayaan		Guiana Space Centre	Moon	Indian Space Research Organization	Lead	2023-07-14	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M007	Aurora	Skywalker	Cape Canaveral AFS	Mars	European Space Agency	Lead	2023-03-10	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M008	Red Horizons		Kennedy Space Center	Mars	Indian Space Research Organization	Lead	2035-08-22	<input type="button" value="Edit"/> <input type="button" value="Delete"/>

Total missions: 8

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During execution:

All Missions								
View Mode: <input checked="" type="checkbox"/> All Missions <input type="checkbox"/> Mission Count by Agency <input type="checkbox"/> Mars Missions Only <input type="button" value="+ Add Mission"/>								
Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M001	Apollo 11	Columbia	Kennedy Space Center	Moon	National Aeronautics and Space Administration	Lead	1969-07-16	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M002	Rosetta	Rosetta Orbiter	Guiana Space Centre	67P/Churyumov-Gerasimenko	European Space Agency	Lead	2004-03-02	<input type="button" value="Edit"/> <input type="button" value="Delete"/>
M003	SpaceX Crew-11		Kennedy Space Center	International Space Station	National Aeronautics and Space Administration	Lead	2025-08-01	<input type="button" value="Edit"/> <input type="button" value="Delete"/>

After execution:

Mars Missions Only								
View Mode: <input type="checkbox"/> Mars Missions Only <input type="button" value="Edit"/>								
Mission ID	Mission Name	Spacecraft	Launch Site	Destination	Agency Name	Agency's Role	Launch Date	Actions
M008	Red Horizons		Kennedy Space Center	Mars	Indian Space Research Organization	Lead	2035-08-22	<input type="button" value="Edit"/>
M007	Aurora	Skywalker	Cape Canaveral AFS	Mars	European Space Agency	Lead	2023-03-10	<input type="button" value="Edit"/>

Total missions: 2

Division: We provided View Mode for the user to be able to see all Astronauts assigned to ALL missions that target Mars.

Astronaut: Database_GUI -> oracle-backend -> [server.js](#) -> lines 586-596

```

SELECT a.astronaut_id, a.astronaut_name, a.nationality,
TO_CHAR(a.dob, 'YYYY-MM-DD') AS date_of_birth
FROM Astronaut a
WHERE NOT EXISTS (SELECT m.mission_id
FROM Mission m, CelestialBody cb
WHERE m.body_id = cb.body_id AND LOWER(cb.name) LIKE '%mars%'
MINUS
SELECT at.mission_id
FROM AssignedTo at
WHERE at.astronaut_id = a.astronaut_id)

```

```
ORDER BY a.astronaut_name
```

Before execution:

 **All Astronauts**

View Mode: All Astronauts 

ID Name Nationality Date of Birth

ID	Name	Nationality	Date of Birth
1	Armstrong, Neil A.	US	1930-08-05
2	Aldrin, Edwin "Buzz"	US	1930-01-20
3	Collins, Michael	US	1930-10-31
4	Cardman, Zena	US	1987-10-26
5	Fincke, Michael	US	1967-03-14

Total astronauts: 5

During execution:

 **All Astronauts**

View Mode  All Astronauts 

All Mars Mission Participants

ID Name Nationality Date of Birth

After execution:

All Mars Mission Participants

View Mode: All Mars Mission Participants 

ID Name Nationality Date of Birth

ID	Name	Nationality	Date of Birth
1	Armstrong, Neil A.	US	1930-08-05
4	Cardman, Zena	US	1987-10-26

Total astronauts: 2