Project Title: AstroDB – Astronomical Observation Database

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Course: CS340 – Intro to Databases

http://flip1.engr.oregonstate.edu:9231/

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Executive Summary

The main goals and functionality of the database has remained consistent from the beginning of the project to now. However, valuable feedback provided by peers and TAs lead to a few updates to enhance functionality and clarity and are summarized below.

Actions Based on Feedback:

Increased Clarity:

- Separated the Add and Update forms on the UI to clarify how to add or simply update any entities.
- Added notes to the UI pages describing the observer to night log M:N and provided links to the necessary forms to properly add the data on each page of the UI.
- Added an asterisk to any required field and added a footnote at the bottom of each page that clarifies the field is required.

Updated Attributes and Entities:

- Updated Night_logs/id_observation_site to be listed as a foreign key (originally defined in Observation_sites).
- Removed Not Null in Night_logs/start_time and Night_logs/end_time.
- Updated Night_log_entries/id_target to note that it is a foreign key (originally defined in Targets). Added the observer's email address (rather than ID) when the observer's name is used to identify a foreign key as the name on its own is not required to be unqiue.

Updated Data Definition and Data Manipulation Queries:

- Added ON DELETE operations to DDL.sql to address all FK.
- Updated the DML to include inner join and other necessary queries to replace foreign keys in the UI with a more user-friendly display.
- Updated the INSERT statements to better accommodate the foreign key entries with a subquery to get the actual foreign key.
- Updated the SELECT for Night_logs in the DML to include start time and end time to match the UI. Also updated the SELECT for Night_logs in the DML to include both the full name and email address of the observer.
- Updated the DML to include SELECTs for all dropdowns in the UI.

Updated Relationships:

- Changed the relationship between the "Night_logs" and "Night_logs_entries" table from a M:N relationships to a 1:M relationship.

Upgrades:

- Changed the relationship between the "Night_logs" and "Night_logs_entries" tables so that there can be zero "Night_log_entries" entries associated with a single "Night_log" entry. It may be the case that observer(s) may be present for a night of observations, but that they were not able to acquire a single image (i.e., overcast).
- Reorganized the DML file to be organized by page on the UI rather than type of data manipulation query. We also added in a few update queries to better support functionality on the UI.
- When a form displays a drop-down menu for a foreign key selection, a note has been added to the bottom of the page with a link to the page where users can add new entries into the table that the drop-down menu options are selected from.

Project Outline

An important aspect of astronomical research comes through nighttime astronomical observations, where Astronomers need to take detailed notes about what they see (e.g., planet, star, etc.), when they see it, where it was seen, if it has been seen before, etc. Traditionally, Astronomers record these observations in paper notebooks or personal spreadsheets. However, in recording the data in this way, several normalization and consistency issues arise, and the data becomes difficult to sort through and compare to previous observations and observations made by other astronomers. The tables are also typically susceptible to deletion and update anomalies. We plan to develop a database to easily record these observations, which will create a consistent method for recording these observations and allow for easy access and data comparisons. The "Night_logs" table will serve as a summary table and there will be a row for each evening in which observations occurred. The "Night_log_entries" table will contain a row for each exposure that has occurred. The entries will be made as the exposures occur and relevant comments (e.g., Cloud cover, bright lights nearby, etc.).

The number of exposures that may be acquired during a single observation can vary wildly depending on size of the telescope, the magnitude of what is being observed, and how the data will be used. If we assume there will be approximately 60 seconds between each exposure, a safe assumption for most observatories, then 60 entries will be made in the "Night_log_entries" table per hour of observations. Assuming a 12-hour night, then the total number of rows in this table added in a single night will be approximately 720. A single entry in the "Night_logs" table per evening of observations will be required. This database will allow for all this data to be easily organized and retrieved.

Database Outline

Observation Sites: Used to record information about the location where the data was acquired.
Attributes:

- id_observation_site: INT, Primary Key, Not NULL, Unique, Auto Increment
- name: VARCHAR (300), Not NULL
- latitude: DECIMAL (19,6), Not NULL
- longitude: DECIMAL (19,6), Not NULL
- elevation: FLOAT, Not NULL
- notes: VARCHAR (300)

Relationships:

- 1:M Relationship with Night_logs. Each observation site could potentially be referenced in several night logs.

Night_logs: Used to create an entry for each night when observations occur, where only one entry is made in this table per night.
Attributes:

- id_night_log: INT, Primary Key, Not NULL, Unsigned, Auto Increment
- night_date: DATE, Not NULL, Unique
- start_time: DATETIME
- end_time: DATETIME
- id_observation_site: Foreign Key, INT, Not NULL

Relationships:

- M:1 Relationship with Observation_sites. Each night log will only reference one observation site, but observation sites can be referenced in multiple night logs.
- M:N Relationship with Observers (supported via the Night_logs_has_Observers intersection table). Each night log may have 1 or more Observers and each Observer can have 0 or more night logs.
- 1:M Relationship with Night_log_entries. Each night log may have zero or more entries, but each entry must be associated with just one night log.

Observers: Used to record information about the observer(s) who acquired the data.
Attributes:

- id_observer: INT, Primary Key, Not NULL, Unique, Auto Increment
- surname: VARCHAR (300), Not NULL
- given_name: VARCHAR (300), Not NULL
- title: VARCHAR (45)
- email: VARCHAR (300), Not NULL, Unique
- phone_number: VARCHAR (45)

Relationships:

- M:N Relationship with Night_logs (supported via the Night_logs_has_Observers intersection table). Observers may have many night logs and each night log could have many Observers (collaboration).

Night_log_entries: Used to create an entry for each exposure (i.e., image taken) of the designated target.

Attributes:

- id_night_log_entry: INT, Primary Key, Not NULL, Unique, Auto Increment
- exposure_start_time_utc: DATETIME, Not NULL
- exposure_length: FLOAT, Not NULL
- azimuth: DECIMAL(19,3), Not NULL
- elevation: FLOAT, Not NULL
- id_night_log: Foreign Key, INT, NOT NULL
- id_target: Foreign Key, INT
- comments: MEDIUMTEXT

Relationships:

- M:1 Relationship with Night_logs. There can be many "Night_log_entries" associated with a single "Night_logs" entry.
- M:1 Relationship with Targets. Each night log entry might have a target associated with it (but it is not required).

Targets: Used to record information about the target (i.e., what is being observed).

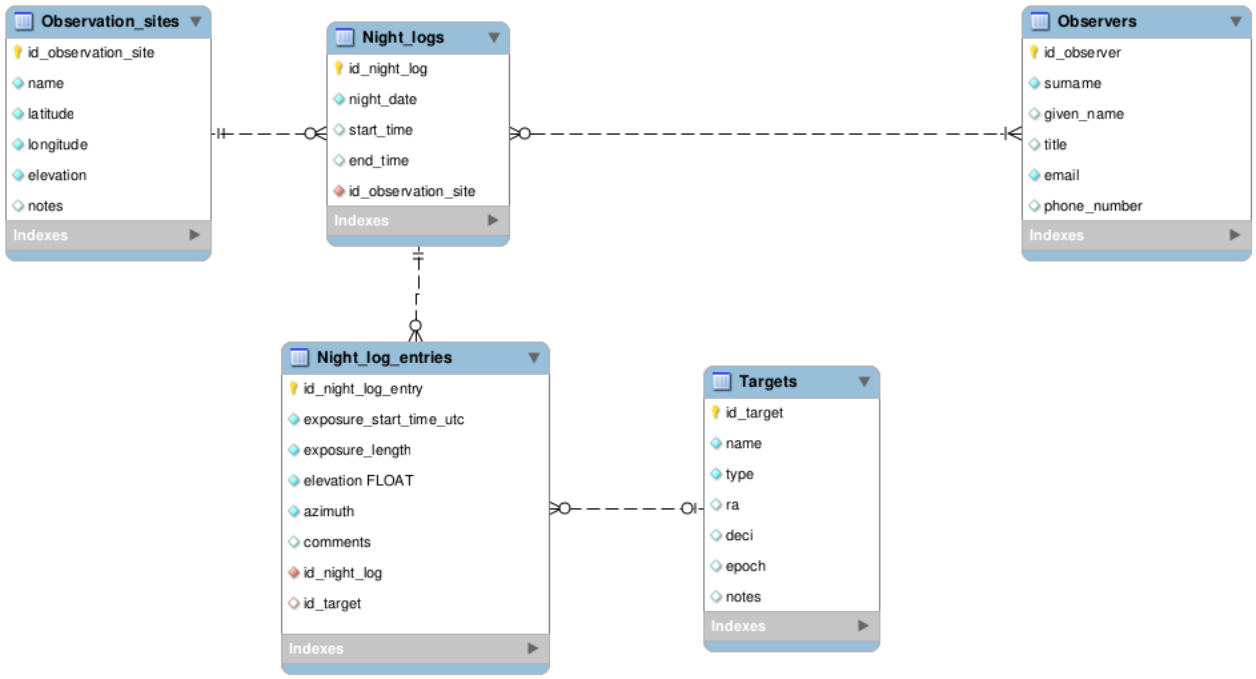
Attributes:

- id_target: INT, Primary Key, Not NULL, Unique, Auto Increment
- name: VARCHAR (300), Not NULL
- type: VARCHAR (45), Not NULL, default: 'star'
- ra: VARCHAR (45)
- deci: VARCHAR (45)
- epoch: VARCHAR (45)
- notes: VARCHAR (300)

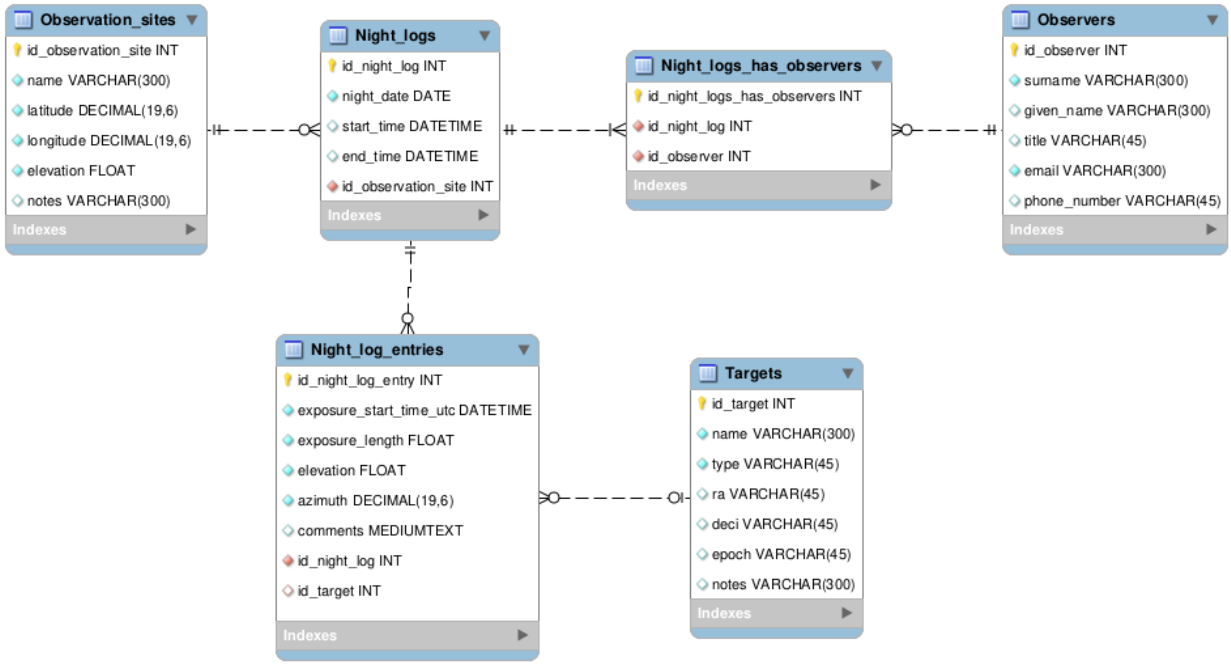
Relationships:

- 1:M Relationship with Night_log_entries. Each target can have many night log entries associated with it.

Entity Relationship Diagram



Database Schema



Sample Data

Observation_sites:

id_observation_site	name	latitude	longitude	elevation	notes
1	Lowell - NURO	35.096944	-111.535833	2163	Reflecting telescope, primary mirror=0.79m
2	Subaru Telescope	19.8256	-155.4761	4139	Ritchey–Chrétien
3	IRTF	19.8263	-155.473	4205	NULL

Observers:

id_observer	surname	given_name	title	email	phone_number
1	Neugarten	Andrew	Mr.	1@example.com	+1 (555) 555-5555
2	Worms	Katherine	Mrs.	2@example.com	+1 (555) 555-5555
3	Inconnue	Femme	Mme	3@example.com	+33 5 55 55 55 55
4	Doe	John	NULL	4@example.com	+1 (555) 555-5555

Targets:

id_target	name	type	ra	deci	epoch	notes
1	AZ Vir	Binary Star	13 43 25.65	+04 36 57.0	J2000.0	10.74 - 11.37 V
2	KID 11405559	Binary Star	19 32 54.15	+49 14 33.3	J2000.0	W Ursae Majoris-type eclipsing binary.

3	Saturn	Planet	NULL	NULL	NULL	Lots of rings!
4	Virgo	Star	02 31 49.09	+89 15 50.8	J2000.0	NULL

Night_logs:

id_night_log	night_date	start_time	end_time	id_observation_site
1	2023-10-01	2023-10-01 18:00:00	2023-10-02 06:00:00	1
2	2023-10-02	2023-10-02 18:00:00	2023-10-03 06:00:00	1
3	2023-10-05	2023-10-06 00:00:00	2023-10-06 06:05:00	2
4	2023-10-08	2023-10-08 19:00:00	2023-10-09 00:00:00	2
5	2023-10-09	NULL	NULL	3

Night_log_entries:

id_night_log_entry	exposure_start_time_utc	exposure_length	elevation	azimuth	comments	id_night_log	id_target
1	2023-10-01 18:00:00	60	90.400	45.000	NULL	1	1
2	2023-10-01 18:01:30	60	89.767	46.000	Aborted due to clouds	1	1
3	2023-10-01 18:03:00	60	88.995	46.900	NULL	1	1
4	2023-10-02 18:00:00	45	60.554	45.612	Unusable, headlights.	2	2

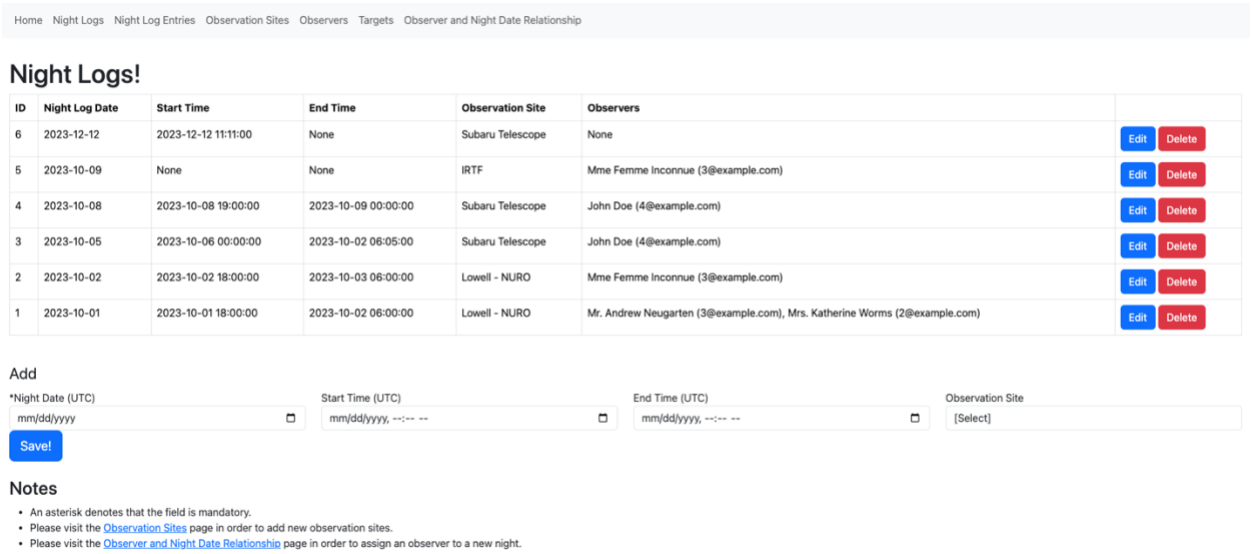
5	2023-10-06 00:00:00	600	54.635	77.568	NULL	3	4
6	2023-10-08 19:00:00	18000	30.123	45.586	NULL	4	3

Night_logs_has_observers:

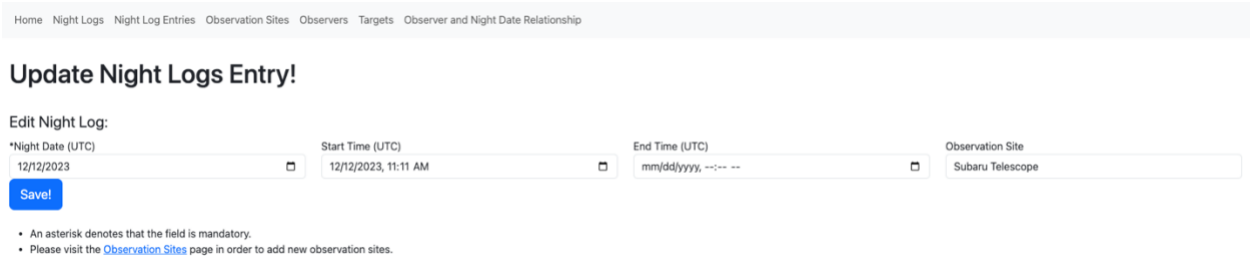
Id_night_logs_has_observers	id_night_log	id_observer
1	1	1
2	1	2
3	2	3
4	3	4
5	4	4
6	5	3

UI Screen Captures

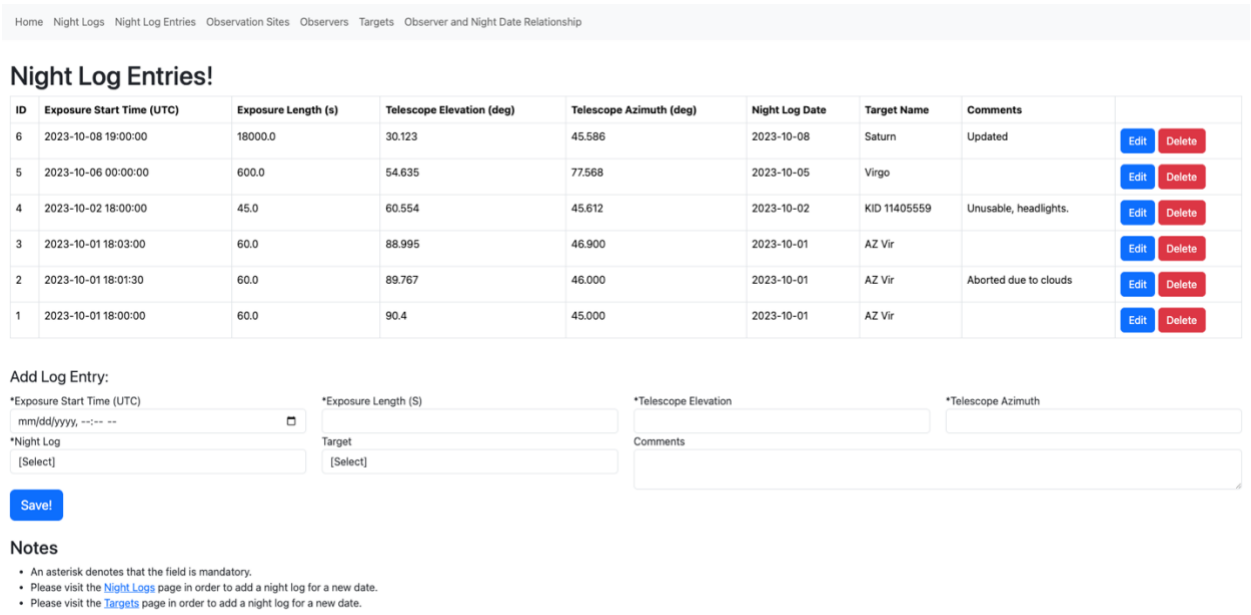
Night_logs (CREATE/READ/DELETE (M:N Relationship with Observers)):



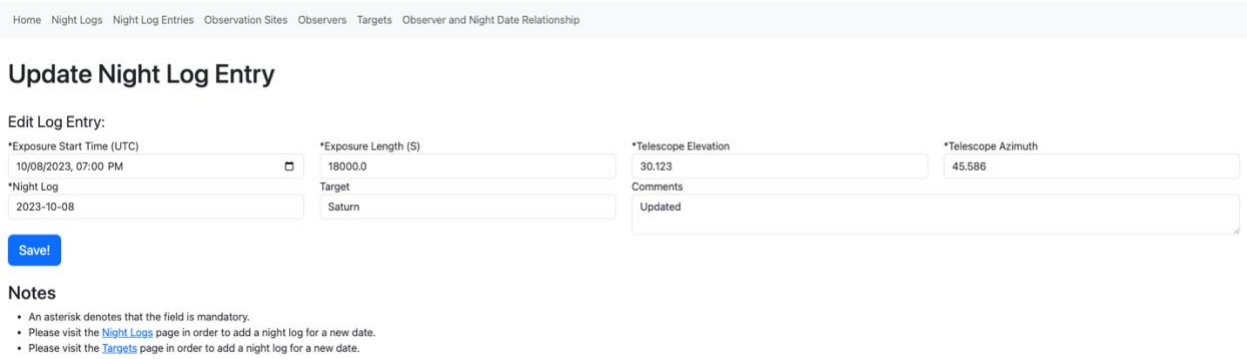
Night_logs (UPDATE (M:N Relationship with Observers)):



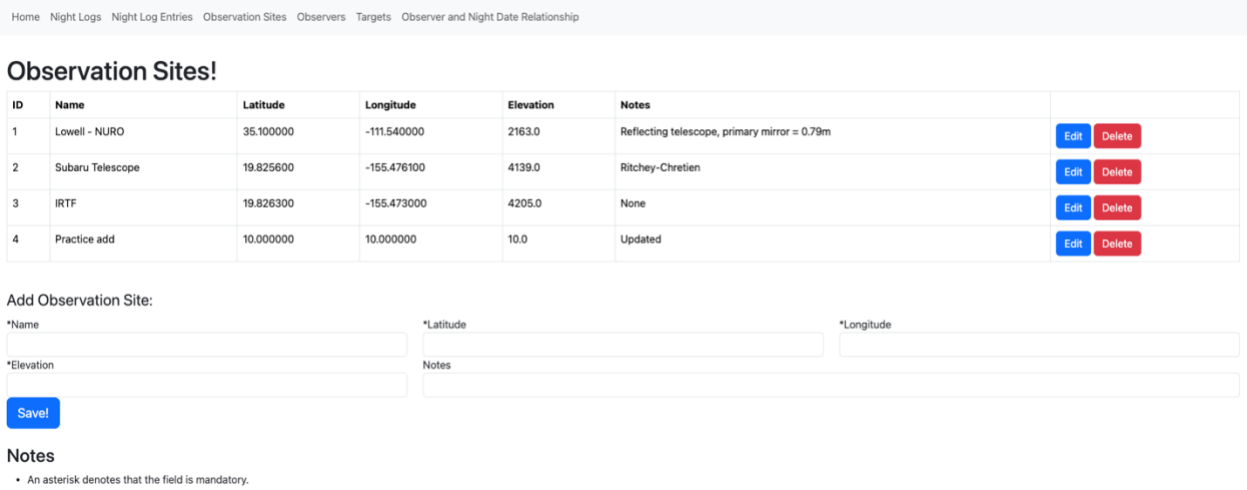
Night_log_entries (CREATE (Target is FK and NULLABLE)/READ/DELETE):



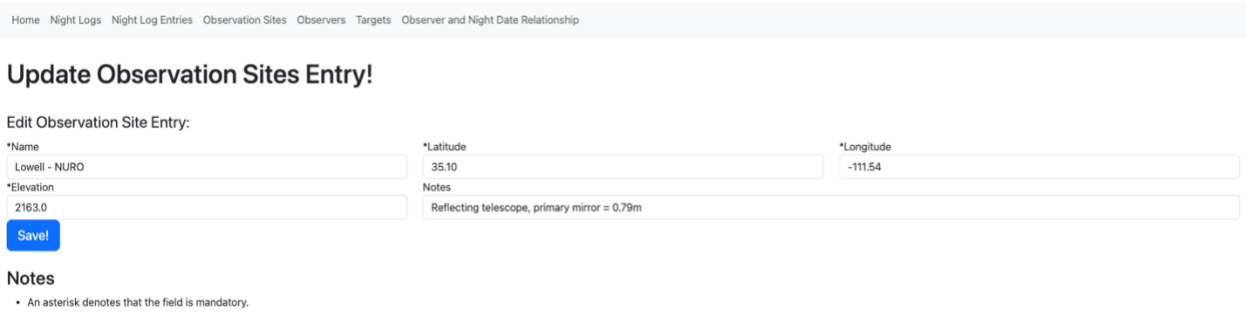
Night_log_entries (UPDATE (Target is FK in this table and is NULLABLE):



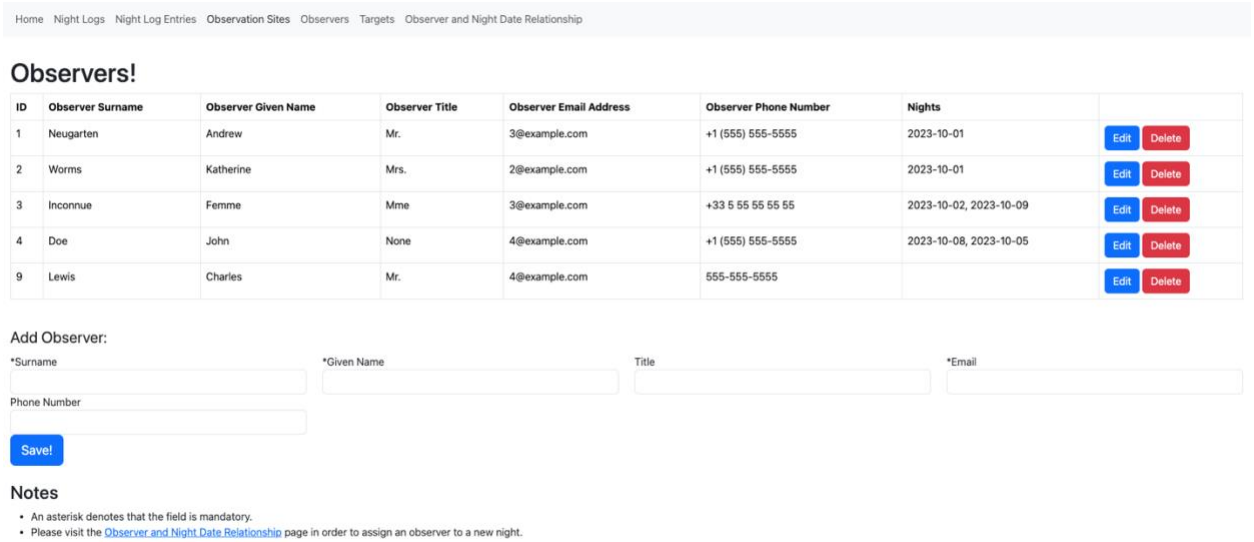
Observation_sites (CREATE/READ/DELETE):



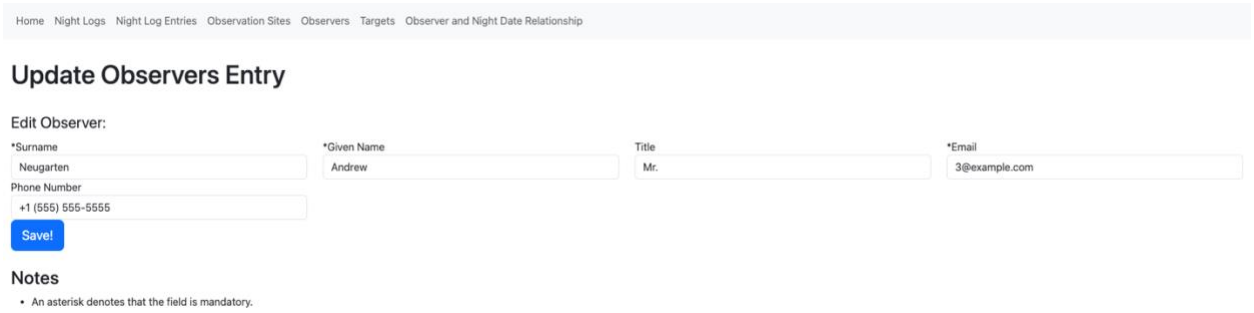
Observation_sites (UPDATE):



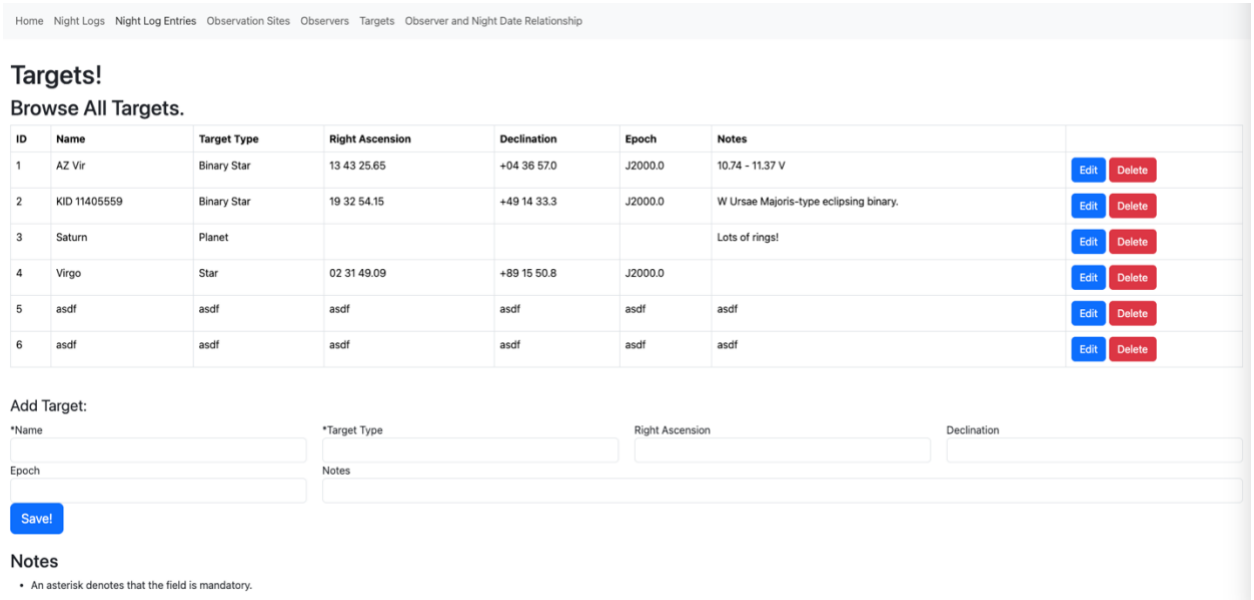
Observers (CREATE/READ/DELETE (M:N Relationship with Night_logs)):



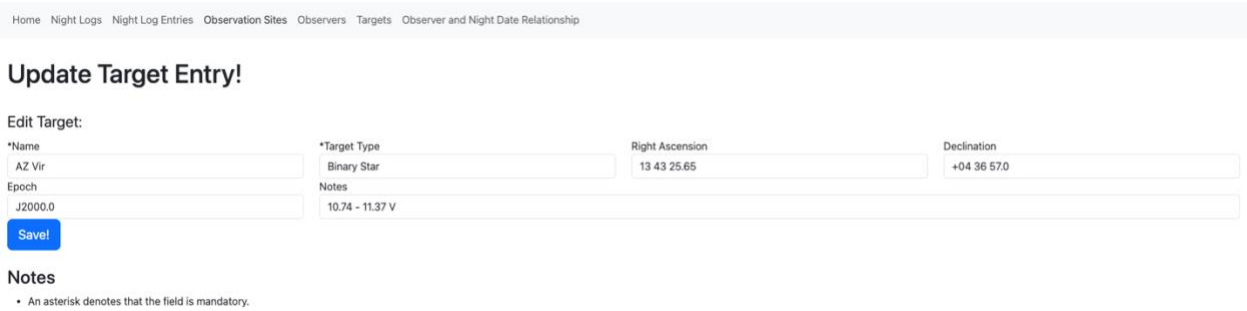
Observers (UPDATE (M:N Relationship with Night_logs)):



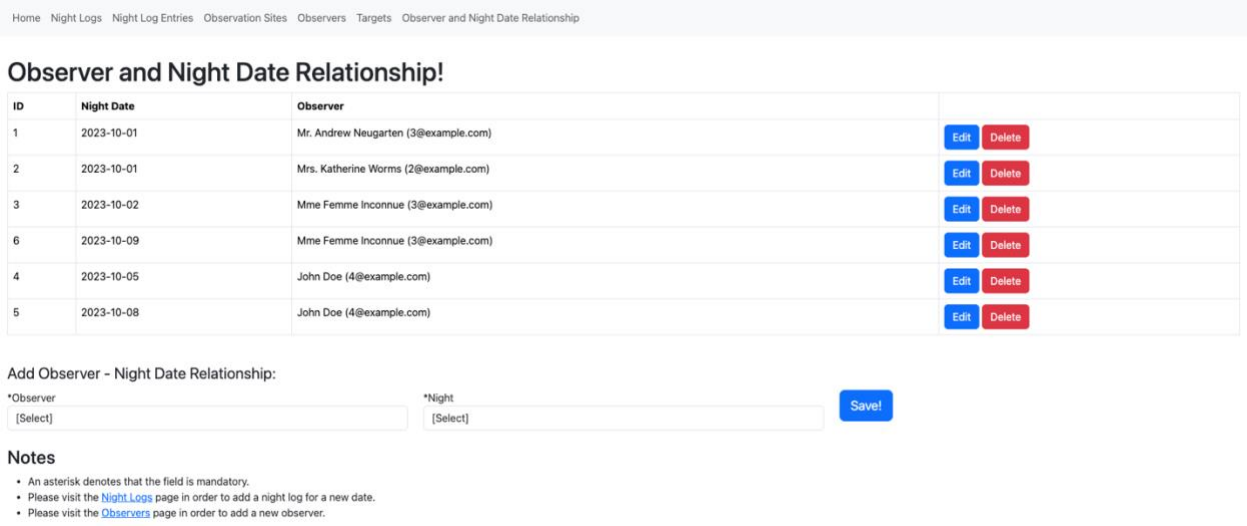
Targets (CREATE/READ/DELETE):



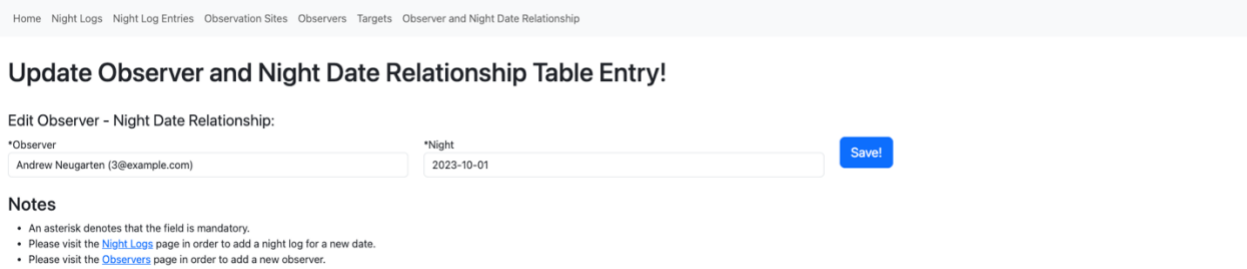
Targets (UPDATE):



Night_logs_has_observers (CREATE/READ/DELETE) (Intersection table for Night_logs and Observers M:N Relationship):



Night_logs_has_observers (UPDATE) (Intersection table for Night_logs and Observers M:N Relationship):



Sources Cited

The general layout and structure of the included web application came co-author Neugarten, who has been developing Flask web applications using this (factory function and blueprints) structure for over four years. Initially, back in 2019, Migual Grinberg's Flask Mega Tutorial (URL: https://blog.miguelgrinberg.com/post/the-flask-mega-tutorial-part-i-hello-world) was used to learn Flask.

An understanding of the specific syntax for the Flask-MysqlDB module for python, particularly how to use store configuration variables in a configuration class, was taken from the official documentation (URL: https://pypi.org/project/Flask-MySQLdb/) on 2023-11-12.

The knowledge to use the form.process() method to set the default values of our forms' drop-down menus was adapted from the official documentation (URL: https://wtforms.readthedocs.io/en/2.3.x/forms/) on 2023-11-16.