**BIOI4870 DB SEARCH AND PATTERN DISCOVERY IN BIOINFORMATICS**

**MySQL Course Project Report**

**Simplified Primary Database of Poisonous Plants Native to Nebraska**

| **Abstract** |
| --- |
| Within Nebraska, there are hundreds of plants that are harmful to humans and livestock. Exposure for livestock is closely monitored but there is no easily accessible way to view exposure protocols for human exposure to potentially harmful plants. PoPDb, Poison Plants Database, is an accessible, primary relational database for poisonous plants commonly found in Nebraska that utilizes MySQL, HTML and PHP. Users enter a corresponding PlantID and PoPDb outputs geographical information and exposure information about the subject plant.  Keywords: ExposureProtocols, Ecology, MySQL, Relational Database |

**Background**

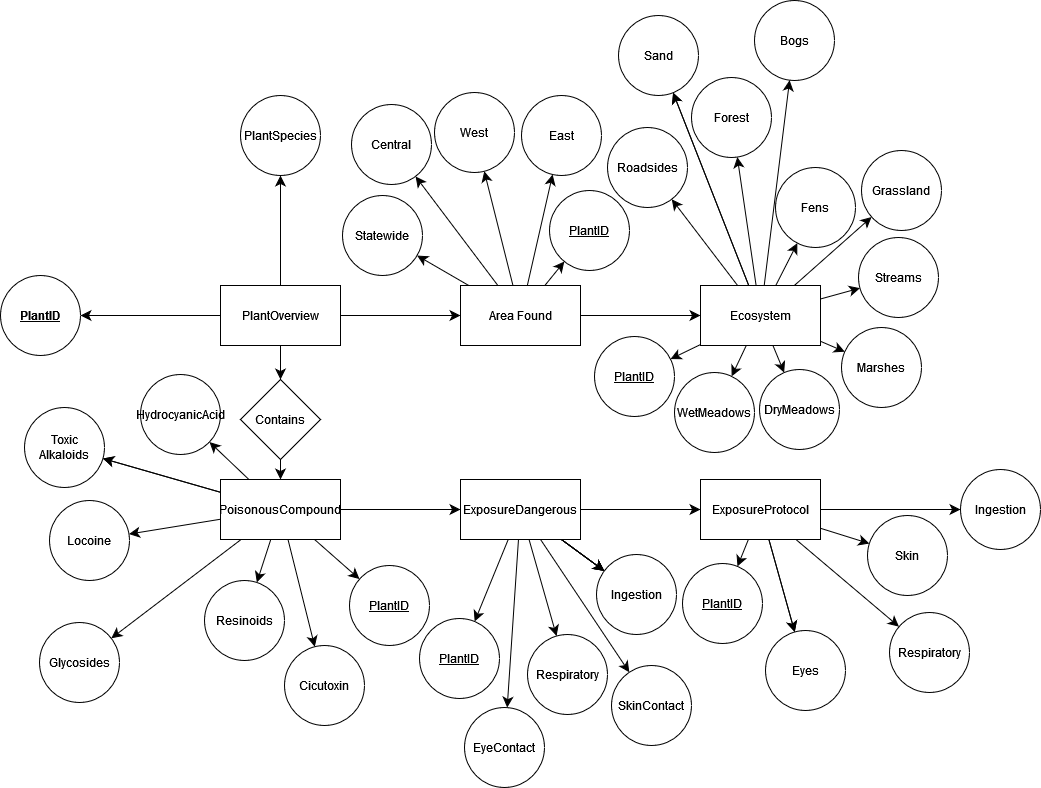
As of 2007, there were over 100,000 toxic plant exposures in the United states alone (Froberg). The United States maintains organizations like the Department of Health and Human Services’ Health Resources and Services Administration which dedicate a portion of their resources to preventing, tracking, and dealing with various types of poisoning. Most Poison control hotlines commonly deal with chemical exposures, drug overdoses, and ethanol poisoning; This means poisonous plant exposure is often overlooked even though common plants can be highly poisonous to humans, wildlife, and domesticated animals (Wendt).

The Nebraska Regional Poison Center only exhibits common substances, such as medication and house cleaners, that individuals may accidentally ingest or overdose on. Nebraska has a vast landscape with diverse flora, some of which are highly dangerous. As a native Nebraskan, I grew up exposing myself to many different plants and I did not know if they were harmful or not. A database that specifically lists harmful plants that I would be more likely to come across within my area would be extremely helpful. A proper database that specifically pertains to poison plants of Nebraska does not exist. The University of Nebraska Lincoln published guides and documents of plants that are poisonous to livestock, but only published a webpage with information related to humans (Volesky).

Most substances that are dangerous to livestock are also dangerous for humans. For example, poisonous glycosides are dangerous to both humans and livestock but common species of milkweed contain (Roberts)(Groen)(Milkweed Can Cause Serious Poisoning). Despite the dangers of some species of milkweed, the plant is still a vital part of the local ecosystem so it should not be removed; individuals need to be educated on the possible dangers presented by exposing themselves to poisonous substances.

At a point in time, the Food and Drug Administration did maintain a poison plants database but it was decommissioned in the 2000’s (FDA). Most up-to-date information regarding poisonous plants targets individuals who farm or the information is on a case by case basis from academic articles, national park websites, or blogs. My database, Poison Plants Database (PoPDb), aims to present useful information about poisonous plants that at native to Nebraska in an accessible format.

**ER Diagram**



\*\*\*PlantID in PlantOverview is bolded to indicate a primary key

**Methods**

Code

1. DDL: the DDL for this project is normalized to the best of my ability. Each table shares PlantID as a foreign key so individual plants can be referenced by their ID number instead of their name; this leaves less room for error when referencing various plants.

| **DDL for PoPDb** | |
| --- | --- |
| Creates a MySQL table with a plant species name and a unique ID number. | CREATE TABLE PlantOverview(  PlantID INT(5),  PlantSpecies VARCHAR(20),  PRIMARY KEY(PlantID)  ); |
| Creates a MySQL table that states if a plant (identified by PlantID) contains a poisonous compound or not. | CREATE TABLE PoisonousCompound(  PlantID INT(5),  HydrocyanicAcid BOOLEAN,  ToxicAlkaloids BOOLEAN,  Locoine BOOLEAN,  Glycosides BOOLEAN,  Resinoids BOOLEAN,  Cicutoxin BOOLEAN,  FOREIGN KEY(PlantID) REFERENCES PlantOverview(PlantID)  ); |
| Creates a MySQL table that states where a plant (identified by PlantID) can be found in the state | CREATE TABLE AreaFound(  PlantID INT(5),  Statewide BOOLEAN,  Central BOOLEAN,  West BOOLEAN,  East BOOLEAN,  FOREIGN KEY(PlantID) REFERENCES PlantOverview(PlantID)  ); |
| Creates a MySQL table that states is a plant (identified by PlantID) can be found in a specific habitat | CREATE TABLE Ecosystem(  PlantID INT(5),  WetMeadows BOOLEAN,  DryMeadows BOOLEAN,  Marshes BOOLEAN,  Streams BOOLEAN,  Grassland BOOLEAN,  Fens BOOLEAN,  Bogs BOOLEAN,  Forest BOOLEAN,  Sand BOOLEAN,  Roadsides BOOLEAN,  FOREIGN KEY(PlantID) REFERENCES PlantOverview(PlantID)  ); |
| Creates a MySQL table that states how dangerous a plant (identified by PlantID) can be when it comes in contact with eyes, inhaled, skin contact, or ingested on a scale of 1 to 4 | CREATE TABLE ExposureDangerous(  PlantID INT(5),  EyeContact SET('1', '2', '3', '4'),  Respiratory SET('1', '2', '3', '4'),  SkinContact SET('1', '2', '3', '4'),  Ingestion SET('1', '2', '3', '4'),  FOREIGN KEY(PlantID) REFERENCES PlantOverview(PlantID)  ); |
| Creates a MySQL table that gives the exposure protocol for a plant (identified by PlantID) | CREATE TABLE ExposureProtocol(  PlantID INT(5),  Eyes VARCHAR(40),  Respiratory VARCHAR(40),  Skin VARCHAR(40),  Ingestion VARCHAR(40),  FOREIGN KEY(PlantID) REFERENCES PlantOverview(PlantID)  ); |

1. Data Dictionary

| **Table: PlantOverview** | | |
| --- | --- | --- |
| Column | Data Type | Description |
| PlantID | Int(5) | Primary key for table; unique identifier for each plant |
| PlantSpecies | VARCHAR(20) | Common name for plant |

| **Table: PoisonousCompound** | | |
| --- | --- | --- |
| Column | Data Type | Description |
| PlantID | Int(5) | Foreign key that references PlantOverview; unique identifier for each plant |
| HydrocyanicAcid | BOOLEAN | Type of toxic compound; not required |
| ToxicAlkaloids | BOOLEAN | Type of toxic compound; not required |
| Locoine | BOOLEAN | Type of toxic compound; not required |
| Glycosides | BOOLEAN | Type of toxic compound; not required |
| Resinoids | BOOLEAN | Type of toxic compound; not required |
| Cicutoxin | BOOLEAN | Type of toxic compound; not required |

| **Table: AreaFound** | | |
| --- | --- | --- |
| Column | Data Type | Description |
| PlantID | Int(5) | Foreign key that references PlantOverview; unique identifier for each plant |
| Statewide | BOOLEAN | Area of Nebraska where the plant can be found; not required |
| Central | BOOLEAN | Area of Nebraska where the plant can be found; not required |
| West | BOOLEAN | Area of Nebraska where the plant can be found; not required |
| East | BOOLEAN | Area of Nebraska where the plant can be found; not required |

| **Table: Ecosystem** | | |
| --- | --- | --- |
| Column | Data Type | Description |
| PlantID | Int(5) | Foreign key that references PlantOverview; unique identifier for each plant |
| WetMeadows | BOOLEAN | An ecosystem where a plant may be found; not required |
| DryMeadows | BOOLEAN | An ecosystem where a plant may be found; not required |
| Marshes | BOOLEAN | An ecosystem where a plant may be found; not required |
| Streams | BOOLEAN | An ecosystem where a plant may be found; not required |
| Grassland | BOOLEAN | An ecosystem where a plant may be found; not required |
| Fens | BOOLEAN | An ecosystem where a plant may be found; not required |
| Bogs | BOOLEAN | An ecosystem where a plant may be found; not required |
| Forest | BOOLEAN | An ecosystem where a plant may be found; not required |
| Sand | BOOLEAN | An ecosystem where a plant may be found; not required |
| Roadsides | BOOLEAN | An ecosystem where a plant may be found; not required |

| **Table: ExposureDangerous** | | |
| --- | --- | --- |
| Column | Data Type | Description |
| PlantID | Int(5) | Foreign key that references PlantOverview; unique identifier for each plant |
| EyeContact | SET('1', '2', '3', '4') | A collection of integers that creates a scale of 1 to 4 that will indicate how dangerous a compound would be if they come in contact with eyes; not required |
| Respiratory | SET('1', '2', '3', '4') | A collection of integers that creates a scale of 1 to 4 that will indicate how dangerous a compound would be if inhaled; not required |
| SkinContact | SET('1', '2', '3', '4') | A collection of integers that creates a scale of 1 to 4 that will indicate how dangerous a compound would be if they come in contact with skin; not required |
| Ingestion | SET('1', '2', '3', '4') | A collection of integers that creates a scale of 1 to 4 that will indicate how dangerous a compound would be if ingested; not required |

| **Table: ExposureProtocol** | | |
| --- | --- | --- |
| Column | Data Type | Description |
| PlantID | Int(5) | Foreign key that references PlantOverview; unique identifier for each plant |
| Eyes | VARCHAR(40) | A string that demonstrates the exposure protocol if a plant comes in contact with eyes; not required |
| Respiratory | VARCHAR(40) | A string that demonstrates the exposure protocol if a plant is inhaled; not required |
| Skin | VARCHAR(40) | A string that demonstrates the exposure protocol if a plant comes in contact with skin; not required |
| Ingestion | VARCHAR(40) | A string that demonstrates the exposure protocol if a plant is ingested; not required |

1. DML

| **DML (Input Statements)** | |
| --- | --- |
| Inputs plant ID and common name of plant into PlantOverview | INSERT INTO PlantOverview(PlantID, PlantSpecies)  VALUES(10, "Arrowgrass"),  (11, "Deathcamas"),  (12, "Dwarf milkweed"),  (13, "Lambert crazyweed"),  (14, "Larkspurs"),  (15, "Nebraska lupine"),  (16, "Nightshades"),  (17, "Poison hemlock"),  (18, "Riddell groundsel"),  (19, "Showy milkweed"),  (20, "Water hemlock"),  (21, "Chokecherry"); |
| Inputs a TRUE or FALSE if a plant does or does not contain a poison pound into PoisonousCompound | INSERT INTO PoisonousCompound(PlantID, HydrocyanicAcid, ToxicAlkaloids, Locoine, Glycosides, Resinoids, Cicutoxin)  VALUES(10, 1, 0, 0, 0, 0, 0),  (11, 0, 1, 0, 0, 0, 0),  (12, 0, 0, 0, 1, 1, 0),  (13, 0, 0, 1, 0, 0, 0),  (14, 0, 1, 0, 0, 0, 0),  (15, 0, 1, 0, 0, 0, 0),  (16, 0, 1, 0, 0, 0, 0),  (17, 0, 1, 0, 0, 0, 0),  (18, 0, 1, 0, 0, 0, 0),  (19, 0, 0, 0, 1, 1, 0),  (20, 0, 0, 0, 0, 0, 1),  (21, 1, 0, 0, 0, 0, 0); |
| Inputs a TRUE or FALSE if a plant is or is not found in a part of Nebraska into AreaFound | INSERT INTO AreaFound(PlantID, Statewide, Central, West, East)  VALUES(10, 0, 1, 0, 0),  (11, 1, 0, 0, 0),  (12, 0, 1, 1, 0),  (13, 0, 1, 1, 0),  (14, 1, 0, 0, 0),  (15, 0, 1, 1, 0),  (16, 0, 1, 0, 0),  (17, 1, 0, 0, 0),  (18, 0, 1, 1, 0),  (19, 1, 0, 0, 0),  (20, 1, 0, 0, 0),  (21, 1, 0, 0, 0); |
| Inputs a TRUE or FALSE if a plant can or cannot be found in a specific ecosystem into Ecosystem | INSERT INTO Ecosystem(PlantID, WetMeadows, DryMeadows, Marshes, Streams, Grassland, Fens, Bogs, Forest, Sand, Roadsides)  VALUES(10, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0),  (11, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0),  (12, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1),  (13, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0),  (14, 1, 1, 0, 0, 1, 0, 0, 1, 1, 0),  (15, 0, 1, 0, 0, 1, 0, 0, 0, 1, 1),  (16, 1, 0, 0, 1, 1, 0, 0, 1, 1, 1),  (17, 1, 0, 1, 1, 1, 0, 0, 0, 0, 1),  (18, 0, 1, 1, 0, 1, 0, 0, 0, 1, 0),  (19, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1),  (20, 1, 0, 1, 1, 1, 1, 1, 0, 0, 0),  (21, 1, 0, 0, 1, 1, 0, 0, 0, 0, 0); |
| Inputs a score of 1 to 4 according to how dangerous a plant is when it comes in contact with eyes, lungs, skin, or is ingested into ExposureDangerous | INSERT INTO ExposureDangerous(PlantID, EyeContact, Respiratory, SkinContact, Ingestion)  VALUES(10, 2, 2, 1, 3),  (11, 4, 4, 4, 4),  (12, 2, 1, 2, 2),  (13, 2, 2, 2, 3),  (14, 2, 2, 1, 4),  (15, 2, 2, 2, 4),  (16, 1, 2, 1, 3),  (17, 2, 1, 1, 4),  (18, 2, 1, 2, 2),  (19, 2, 1, 2, 2),  (20, 2, 2, 2, 4),  (21, 2, 2, 2, 4); |
| Inputs an exposure protocol into ExporsureProtocol | INSERT INTO ExposureProtocol(PlantID, Eyes, Respiratory, Skin, Ingestion)  VALUES(10, "Rinse With Clean Water", "Move to Fresh Air", "Wash Area With Soap and Water", "Seek Medical Attention"),  (11, "Seek Medical Attention", "Seek Medical Attention", "Seek Medical Attention", "Seek Medical Attention"),  (12, "Rinse With Clean Water", "Move to Fresh Air", "Wash Area With Soap and Water", "Seek Medical Attention"),  (13, "Seek Medical Attention", "Seek Medical Attention", "Wash Area With Soap and Water", "Seek Medical Attention"),  (14, "Rinse With Clean Water", "Seek Medical Attention", "Wash Area With Soap and Water", "Seek Medical Attention"),  (15, "Rinse With Clean Water", "Seek Medical Attention", "Wash Area With Soap and Water", "Seek Medical Attention"),  (16, "Rinse With Clean Water", "Seek Medical Attention", "Wash Area With Soap and Water", "Seek Medical Attention"),  (17, "Rinse With Clean Water", "Move to Fresh Air", "Wash Area With Soap and Water", "Seek Medical Attention"),  (18, "Rinse With Clean Water", "Move to Fresh Air", "Wash Area With Soap and Water", "Seek Medical Attention"),  (19, "Rinse With Clean Water", "Move to Fresh Air", "Wash Area With Soap and Water", "Seek Medical Attention"),  (20, "Rinse With Clean Water", "Seek Medical Attention", "Wash Area With Soap and Water", "Seek Medical Attention"),  (21, "Rinse With Clean Water", "Seek Medical Attention", "Wash Area With Soap and Water", "Seek Medical Attention"); |

1. Data analysis
   1. After data was accumulated (see Data Provenance for how information was accumulated), I created an excel file with the general information regarding each plant of interest.
   2. Excel was used to map commonalities between each plant (i.e what harmful substance each plant contained) and keep track of which tables were necessary for the final database.
   3. The data was simplified using a boolean system for PoisonousCompound, AreaFound, and Ecosystem tables. The TRUE (1) indicates a compound is found there (for AreaFound and Ecosystem) or if a plant contains a certain poisonous compound.
   4. ExposureDangerous and ExposureProtocol are dependent on each other in a subjective way. ExposureDangerous operates on a scale of 1 to 4; 1 = 'Not Dangerous', 2 = 'Slightly Dangerous', 3 = 'Moderately Dangerous' and 4 = 'Highly Dangerous'. When I created ExposureProtocol, I took the numbers from the subjective scale from ExposureDangerous into account along with their growing conditions.
2. **For code license, please refer to GitHub**

**Data Provenance**

Data for PoPDb was accumulated by hand from various resources including but not limited to: government websites, national parks, academic papers, indigenous scholars, and others. (see references for a full list of sources)

Dr. Volesky’s “Poisonous Range and Pasture Plants” article served as the main starting point for this project. In the article, Volesky lists out twelve poisonous plants, where they are found and their toxic compounds. I took that information and normalized it (making each column their own MySQL table), along with adding more information from other sources to do the foundation of my project.

The scale for exposureDangerous was loosely based on a Thoughtscapism article titled “Measures of Toxicity” written by Dr Ruishalme and Dr Berstein. I was originally skeptical of the article because Thoughtscapism is a blog but after I checked into the authors’ credentials and the sources used to create the article, I found them creditable. The exact concentrations of the poisonous compounds within each plant was difficult to source or had not been studied, so the toxicity scale for PoPDb is completely subjective based on found literature and reports from poison control websites. The acute toxicity scale provided by Thoughtscapism served as the basis for what the cut off should be for how dangerous a plant is.

The last major datasource for this project was the “Poisoning by Plants” article by Wendt et al. This article served as a recent example of how plant poisonings impact communities and the symptoms associated with plant poisonings. Not all of the information in the article was relevant because the literature review was focused on plant species common in Germany and their specific health system but it demonstrated a clinical need to understand and recognize the symptoms associated with plant poisonings.

**Webpage**

Visit [http://odin.unomaha.edu/~ggoodwin/POPDB/tryPoPDb.php](http://odin.unomaha.edu/~ggoodwin/POPDB/popdb.php) to view PoPDb!

Code Repository: <https://github.com/gabstergoodwin/PoPDb>

**Results**

PoPDb did not turn out exactly as I anticipated. I originally was going to create a user guide to correspond with the database to make it easier for use and access but that was unnecessary. The user interface of PoPDb is simple enough that it does not need further explanation through a user guide. I wanted to focus on accessibility and usability so the overall design of PoPDb is very simple; users enter a PlantID and then get information about the plant in question.

I originally wanted to use a dropdown with the name of the plant so users would just select the plant they wanted to learn about but, I could not get the drop down to work appropriately. I had issues with assuring the input value was actually sent to the MySQL database. As a result, I went back to the drawing board and decided to create a table of possible input values that the user input themselves. As a result, I was able to get the database working and it is still user friendly.

**Discussion/Conclusion**

A major challenge I encountered was finding specific information about each individual plant I wanted to include in my database. As previously mentioned, exact concentrations of known poisonous compounds were not available for each plant, hence why some sections of the database were left to my discretion instead of exact lethal or harmful doses. To address this, I gathered as much information as I could about each plant and their respective poisonous compound(s) and made an informed guess on how dangerous I thought they were.

I also attempted to normalize my database to the best of my ability to prevent errors if someone else decided to use the code and update the database. The boolean data type only allows for a true or false, ‘1’ or ‘0’, input so there is less confusion. There is no debate on whether a new entry should use True, or 1, or yes because there is only one option.

My attempt at normalization made this project more complicated. I could have used a string for the poisonous compounds so there would be a list of which compounds are in a plant instead of an individual table. I also could have simplified ExposureDangerous and ExposureProtocol into the same table. For example, if something was ranked a ‘1’ for exposure dangerous, that could have automatically output a specific exposure protocol from ExposureProtocol; instead I left them separate because some chemicals have differing exposure protocols but similar rankings on how dangerous exposure to them would be.

In my initial project proposal, I wanted to create an actual map that corresponded with the various plant ecosystems covered in PoPDb. I could not gain access to ArcGIS within a suitable time frame to create the map. Other alternatives to ArcGIS were not compatible with my workspace so I cut that portion of the project.

Overall, this project turned out fairly well for my first attempt at creating a relational database. I set out to create a database containing information about poison plants, and I did so.

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