

5-2 Milestone Four: Enhancement Three: Databases

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CS 499: Computer Science Capstone

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Artifact Overview

This milestone centered on integrating a PostgreSQL database into the Grazioso Salvare Dog and Monkey application, shifting from in-memory data handling to a robust database-driven approach. The original application managed animal data through local lists, which posed limitations in scalability and reliability. By implementing a PostgreSQL database, we enhanced the application's strength and future growth potential.

Key enhancements included significant modifications to `driver.py`, where in-memory data structures for dogs and monkeys were replaced with processes designed to communicate with the new database. Additionally, the `initialize.py` module was overhauled to encompass essential database functions, such as connecting to the database, creating tables, and retrieving data. These updates allowed the application to dynamically access and manage data, improving efficiency and accuracy.

A major new feature was the introduction of a secure login system through the addition of the `security.py` module. This system provided controlled access and established a more secure environment for users. By restricting database access, we significantly improved the security and integrity of the application's data.

To further enhance user experience, a graphical user interface (GUI) was developed using Tkinter. This interface transitioned users from a terminal-based system to a more interactive experience, incorporating tabs for easier navigation. The GUI also included a dark theme option, which can be toggled for user comfort, alongside a dynamic company logo banner that adapts to the theme.

Justification for Inclusion

This artifact was chosen for my portfolio to showcase my ability to integrate advanced database technologies into existing applications, significantly enhancing their performance and scalability. Transitioning from in-memory data structures to a PostgreSQL database necessitated extensive modifications to the codebase, highlighting my proficiency in database management and software architecture.

Multiple changes emerged during this enhancement. First, the `initialize.py` module was revamped to encapsulate all essential database functions, allowing for seamless connection and data retrieval. Second, the new `security.py` module introduced a secure login system, consolidating essential login functions. This modular design not only promotes maintainability but also facilitates future extensions or modifications. By centralizing these operations, the application adheres to best practices in modularity and separation of concerns.

The final, and another significant addition was the integration of a graphical user interface (GUI) using Tkinter. This transition from a terminal-based system to an interactive GUI greatly improved user experience, providing intuitive navigation through tabs and features. The GUI also included a dark theme option and a dynamic company logo banner, enhancing visual appeal and usability.

Screenshots of Graphical User Interface

Main Landing with Dogs Selected

Rescue Animal Dashboard

Dogs Monkeys

Name	Breed	Gender	Age	Weight	Acquisition Date	Acquisition Country	Training Status	Reserved	Service Country
Bailey	German Shepard	Female	2	30	09-03-2024	United States	Phase I	False	United States
Charlie	Doberman	Male	2	4	02-19-1988	Canada	Phase III	False	Guam
Obie	Rottweiler	Female	1	30	06-18-1992	United Kingdom	Phase IV	False	Mexico
Abby	Alaskan Husky	Female	1	15	06-18-1988	Mexico	Phase I	False	Mexico
Cash	American Bully	Male	2	20	06-18-1989	Canada	Phase II	True	United States
Erle	Australian Shepherd	Female	3	10	06-18-1990	United States	Phase III	False	Sweden
Josie	Border Collie	Male	4	25	06-18-1991	Argentina	Phase IV	True	Canada
Sophie	Bloodhound	Male	2	15	06-18-1993	Spain	In Service	True	United States
Ace	Alaskan Husky	Female	3	20	06-18-1994	France	Phase I	False	Sweden
Catcher	American Bully	Male	4	10	06-18-1995	Mexico	Phase II	True	Canada

Training Status: All Apply Training Status Filter Reserved: All Apply Reserved Filter Service Country: All Apply Service Country Filter

Add New Dog Edit Selected Dog

Toggle Theme

Main Landing with Monkeys Selected with Theme Toggled

Rescue Animal Dashboard

Dogs **Monkeys**

Name	Species	Gender	Age	Weight	Tail Length	Height	Body Length	Torso Length	Skull Length	Neck Length	Acquisition Date	Acquisition Country	Training Status	Reserved	Service Country
Helga	Guenon	Female	4	20	4	5	2	5	3	1	01-13-1989	Tibet	Phase III	False	Sweden
Becky	Macaque	Female	5	32.3	10	2	3	2	3	1	01-11-2017	China	In Service	True	Mexico
BillyBob	Macaque	Female	4	55.0	3.0	6.0	4.0	4.0	1.0	1.0	01-13-1989	China	In Service	True	Tibet
Madeline	Capuchin	Female	3	10.0	2.5	2.0	1.0	0.5	0.5	0.2	08-23-2024	Tibet	Phase I	False	United States
Chunky	Capuchin	Male	2	35.6	12	6	6	1	2	1	12-12-2020	India	Phase V	False	Canada
Gortherm	Guenon	Male	3	20	20	20	20	20	20	20	01-23-2014	Venezuela	Phase III	False	Mexico
Gregory	Capuchin	Male	2	20	20	20	20	20	20	20	02-19-1988	United States	Phase II	False	United States


Training Status: Phase V Apply Training Status Filter Reserved: All Apply Reserved Filter Service Country: All Apply Service Country Filter

Add New Monkey Edit Selected Monkey

Toggle Theme

Example of Filters

Rescue Animal Dashboard



Rescue Animal Dashboard

Dogs

Monkeys

Name	Breed	Gender	Age	Weight	Acquisition Date	Acquisition Country	Training Status	Reserved	Service Country
Sophie	Bloodhound	Male	2	15	06-18-1993	Spain	In Service	True	United States
Bacon	Rottweiler	Male	2	60.0	02-19-1988	Italy	In Service	False	Sweden
Spark	Bloodhound	Male	4	20	06-18-1999	United Kingdom	In Service	True	Canada
Spencer	Bloodhound	Male	2	10	06-18-2005	Argentina	In Service	True	United States
Spirit	Bloodhound	Male	4	25	06-18-2011	United States	In Service	True	Canada
Spring	Bloodhound	Male	2	30	01-13-1989	Canada	In Service	False	United States
Star	Bloodhound	Male	4	15	01-13-1995	Mexico	In Service	False	Canada
Storm	Bloodhound	Male	2	20	01-13-2001	France	In Service	False	United States
Strider	Bloodhound	Male	4	10	01-13-2007	Spain	In Service	True	Canada
Summer	Bloodhound	Male	2	25	01-13-2013	United Kingdom	In Service	True	United States

Training Status

In Service

All

Phase V

Phase II

In Service

Phase III

Phase IV

Phase I

Apply Training Status Filter

Reserved

All

Apply Reserved Filter

Service Country

All

Apply Service Country Filter

Add New Dog

Edit Selected Dog

Toggle Theme

Add New Dog

Intake New Dog

Name

Breed

Gender

Age

Weight

Acquisition Date

Acquisition Country

Training Status

Reserved

In Service Country

Submit

Add New Monkey

Intake New Monkey

Name

Species

Gender

Age

Weight

Tail Length

Height

Body Length

Torso Length

Skull Length

Neck Length

Acquisition Date

Acquisition Country

Training Status

Reserved

In Service Country

Submit

Example of Animal Edit Before

Rescue Animal Dashboard

Dogs Monkeys

Name	Breed	Gender	Age	Weight	Acquisition Date	Acquisition Country	Training Status	Reserved	Service Country
Spring	Bloodhound	Male	2	30	01-13-1989	Canada	In Service	False	United States
Apollo	Alaskan Husky	Female	3	15	01-13-1990	United States	Phase I	True	Sweden
CICI	American Bully	Male	4	20	01-13-1991	Argentina	Phase II	False	Canada
Gator	Australian Shepherd	Female	1	10	01-13-1992	United Kingdom	Phase III	False	Mexico
Kira	Border Collie	Male	2	25	01-13-1993	Spain	Phase IV	True	United States
Piper	Rottweiler	Female	3	30	01-13-1994			True	Sweden
Star	Bloodhound	Male	4	15	01-13-1995			False	Canada
Aspen	Alaskan Husky	Female	1	20	01-13-1996			False	Mexico
Cody	American Bully	Male	2	10	01-13-1997			False	United States
Georgia	Australian Shepherd	Female	3	25	01-13-1998			False	Sweden

Training Status ☐ Apply Training Status Filter Reserved ☐ All Apply Reserved Filter

Add New Dog Edit Selected Dog

Edit Dog

Name Apollo

Training Status Phase I

Reserved True

In Service Country Sweden

Submit

Example of Animal Edit After

Rescue Animal Dashboard

Dogs Monkeys

Name	Breed	Gender	Age	Weight	Acquisition Date	Acquisition Country	Training Status	Reserved	Service Country
Abby	Alaskan Husky	Female	1	15	06-18-1988	Mexico	Phase I	False	Mexico
Ace	Alaskan Husky	Female	3	20	06-18-1994	France	Phase I	False	Sweden
Addie	Alaskan Husky	Female	1	10	06-18-2000	Spain	Phase I	False	Sweden
Adele	Alaskan Husky	Female	3	25	06-18-2006	United Kingdom	Phase I	False	Sweden
Annie	Alaskan Husky	Female	1	30	06-18-2012	Argentina	Phase I	True	Mexico
Apollo	Alaskan Husky	Female	3	15	01-13-1990	United States	Phase II	True	Mexico
Aspen	Alaskan Husky	Female	1	20	01-13-1996	Canada	Phase I	False	Mexico
Bacon	Rottweiler	Male	2	60.0	02-19-1988	Italy	In Service	False	Sweden
Bailey	German Shepard	Female	2	30	09-03-2024	United States	Phase I	False	United States
Bailey	Alaskan Husky	Female	3	10	01-13-2002	Mexico	Phase I	True	Sweden

Training Status ☐ All Apply Training Status Filter Reserved ☐ All Apply Reserved Filter Service Country ☐ All Apply Service Country Filter

Add New Dog Edit Selected Dog

By integrating the PostgreSQL database, the system changed how data is retrieved and manipulated. The implementation of functions like `fetch_all_dogs` and `fetch_all_monkeys` allow the application to query the database directly, leading to more efficient data handling, reduced redundancy, and improved performance. This enhancement underscores my ability to optimize data access patterns, ensuring the application remains scalable and responsive as the dataset grows.

Achievement of Course Outcomes

For this course, I am striving to reach five key course outcomes. They are as follows:

- Employ strategies for building collaborative environments that enable diverse audiences to support organizational decision making in the field of computer science.
- Design, develop, and deliver professional-quality oral, written, and visual communications that are coherent, technically sound, and appropriately adapted to specific audiences and contexts.
- Design and evaluate computing solutions that solve a given problem using algorithmic principles and computer science practices and standards appropriate to its solution, while managing the trade-offs involved in design choices.
- Demonstrate an ability to use well-founded and innovative techniques, skills, and tools in computing practices for the purpose of implementing computer solutions that deliver value and accomplish industry-specific goals.
- Develop a security mindset that anticipates adversarial exploits in software architecture and designs to expose potential vulnerabilities, mitigate design flaws, and ensure privacy and enhanced security of data and resources.

With Enhancement One, I transitioned the code from Java to Python and restructured the Grazioso Salvare Animal Rescue database to improve modularity and documentation, meeting algorithmic and structural goals. In Enhancement Two, I optimized the application's performance by transitioning from lists to dictionaries, which improved search functionality and scalability, and implemented input validation to enhance security. In Enhancement Three, I achieved four key outcomes.

First, I employed strategies for building collaborative environments that enable diverse audiences to support organizational decision-making in the field of computer science by moving all data to a centralized PostgreSQL database and providing a user-friendly Tkinter dashboard. This allows multiple users to access a consistent dataset and view real-time updates through the dashboard, enhancing collaboration and efficiency.

Second, I designed and evaluated computing solutions that solve a given problem using algorithmic principles and computer science practices and standards appropriate to its solution while managing the trade-offs involved in design choices by implementing the PostgreSQL database, secure login system, and Tkinter dashboard. These enhancements balanced the need for security and performance while ensuring that the application remained scalable and user-friendly.

Third, I demonstrated an ability to use well-founded and innovative techniques, skills, and tools in computing practices for the purpose of implementing computer solutions that deliver value and accomplish industry-specific goals by integrating the PostgreSQL database, developing the Tkinter GUI, and implementing bcrypt for password encryption. These innovations enhanced both the functionality and security of the application, aligning it with industry standards.

Finally, I developed a security mindset that anticipates adversarial exploits in software architecture and designs to expose potential vulnerabilities, mitigate design flaws, and ensure privacy and enhanced security of data and resources by implementing a robust secure login system using bcrypt hashing and salt generation. This system protected the application from unauthorized access and ensured that the data remained secure.

Reflection on the Enhancement Process

Integrating a PostgreSQL database into the Grazioso Salvare Dog and Monkey application was both challenging and rewarding. This required a solid understanding of database management and its application in software development. I utilized resources like GeeksforGeeks (2019 & 2022) to effectively implement PostgreSQL interactions in Python, ensuring the integration followed best practices.

Originally, the application used local lists then dictionaries to store animal data, limiting collaboration. By switching to a remote PostgreSQL database, multiple users could access and maintain it. I also implemented a security system for user login. After extensive research, I learned to convert strings to bytes, generate salts, and encrypt passwords with hashing, significantly enhancing security. Implementing the system required researching password hashing libraries. I ultimately chose bcrypt for its effectiveness in handling both hashing and validation, utilizing resources like Pypi (2024) to understand how to leverage it.

Another major challenge was refactoring the initialize.py module to replace in-memory data handling with database-driven processes. This underscored the importance of modular design and clear separation of concerns. Modifying driver.py to replace lists with database queries required meticulous attention to performance and accuracy, reinforcing my understanding of software design trade-offs.

To enhance user experience, I developed a GUI using Tkinter, moving away from a terminal-only interface. This involved creating tabs and managing data retrieval with lambda functions, which proved difficult. I faced challenges like ensuring real-time updates and correctly pulling unique IDs for editing. Debugging was essential to resolve issues with dropdown filtering and data selection. Through this process, I had to research Tkinter extensively, leveraging documentation from multiple sources such as RealPython (2023) and CodersLegacy (2021). This

research led to me implementing quality-of-life features like a dark theme using `sv_ttk` and a dynamic company logo banner.

Overall, this enhancement significantly boosted my technical skills in database integration and software architecture, emphasizing the importance of continuous learning and adaptation with new technologies. This experience was challenging but immensely rewarding.

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