



# Aquarium animal identification system

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A stylized illustration of a shark swimming in the ocean. The shark is white with a dark blue outline and is positioned on the right side of the frame. In the background, there are several small, dark blue fish swimming in a line. The ocean floor is depicted with dark blue and green wavy lines, and there are some red and green coral-like structures in the bottom right corner. The overall color scheme is dark blue with white and light blue accents.

**01**

# Introduction



This project focuses on developing an animal identification system using Convolutional Neural Networks (CNNs) for image classification, specifically targeting marine organisms. The RegNet Y800 model from the SuperGradients library, based on PyTorch, was utilized for training the dataset. The model, optimized for computer vision tasks, demonstrated high efficiency and accuracy in image classification.



However, challenges such as computational complexity and task specialization were identified. The system integrated SQLite for database management and utilized OpenCV for image capture. The web application, built with Flask, facilitated user interaction and information retrieval. Experimental studies validated the model's performance, achieving an accuracy of 86.05% with a Top-5 accuracy of 97.25%.

The project successfully addressed the need for accurate animal identification in aquariums, enhancing visitor experiences and promoting marine life conservation. Future enhancements aim to optimize system performance and expand the marine life database for broader recognition capabilities.



A stylized illustration of an underwater scene. The background is a deep blue with wavy lines suggesting water movement. In the upper left, a school of small, dark blue fish swims. In the lower left, a larger, dark blue shark swims. In the upper right, a white shark with a dark blue outline and a smiling face swims. In the lower right, there are stylized coral reefs in red and green. The text '02 Methodology' is centered on the left side.

**02**

# **Methodology**



# Model



In our project, we use the **RegNet Y800** model of SuperGradients to train our dataset. This model is a machine learning model that can classify images from the Imagenet dataset. It is based on the principles of CNN and uses convolutional layers to process and learn image data.

## Pros:

1. Embedding early-stop function to avoid overfitted

During the model training phase, if the model's performance on the validation set does not improve within 7 consecutive training epochs, training will end early.

2. High efficiency for use

The model design space provides a simple and fast network that performs well under various flipping mechanisms.



Super**Gradients**™



## Cons:

### 1. Numerous parameter for training

The model has many built-in parameters for the training process, which requires a lot of computing power to achieve.

### 2. Specialization to Vision Tasks

While this specialization enables them to perform well in computer vision tasks, it may limit their applicability to other types of problems, such as natural language processing.

# Prediction Showcase

```
image1 = 'https://c.files.bbci.co.uk/875C/production/\_114925643\_54557569.jpg'  
pred_and_plot_image(image_path= image1, subplot=(1, 1, 1))
```

Pred: Sharks | Prob:  
0.681



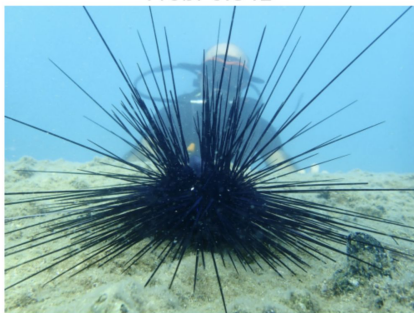
```
image3 = 'https://ichef.bbc.co.uk/images/ic/640x360/p077s2dy.jpg'  
pred_and_plot_image(image_path= image3, subplot=(1, 1, 1))
```

Pred:  
Turtle\_Tortoise |  
Prob: 0.624



```
image5 = 'https://idsb.tmgup.com.tr/ly/uploads/images/2022/07/24/220284.jpg'  
pred_and_plot_image(image_path= image5, subplot=(1, 1, 1))
```

Pred: Sea Urchins |  
Prob: 0.842



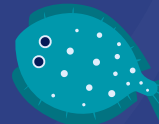
```
image4 = 'https://www.booklife.com.tw/upload\_files/fonlego-rwd/club/04400289jellyfish.jpg'  
pred_and_plot_image(image_path= image4, subplot=(1, 1, 1))
```

Pred: Jelly Fish |  
Prob: 0.786





# Database creation (SQLite)



	Name	Introduction
	过滤	过滤
1	Clams	Clams, commonly found in marine habitats worldwide, are ...
2	Corals	Coral, a diverse marine organism, forms intricate reefs vit...
3	Crabs	Crabs are crustaceans with a broad, flattened body, a tou...
4	Dolphin	Dolphins are intelligent marine mammals known for their ...
5	Eel	Eels are long, snake-like fish found in both freshwater and...
6	Fish	Fish are diverse aquatic vertebrates with gills for breathin...
7	Jellyfish	Jellyfish, or jellies, are gelatinous marine creatures with ...
8	Lobster	Lobsters are large marine crustaceans with a hard ...
9	Nudibranchs	Nudibranchs, or sea slugs, are colorful and diverse marine...
10	Octopus	Octopuses are highly intelligent cephalopods with soft ...
11	Otter	Otters are semi-aquatic mammals with streamlined bodies...
12	Penguin	Penguins are flightless birds found in the Southern ...
13	Puffers	Pufferfish are fish that inflate their bodies to deter ...
14	Sea Rays	Sea Rays are a type of marine stingray known for their ...
15	Sea Urchins	Sea urchins are spiny marine creatures that belong to the ...
16	Seahorse	Seahorses are unique and enchanting marine fish with ...
17	Seal	Seals are marine mammals that are adapted for both land ...
18	Sharks	Sharks are apex predators of the ocean, characterized by ...
19	Shrimp	Shrimp are small, decapod crustaceans found in both ...
20	Squid	Squid are cephalopods with elongated bodies, a soft ...
21	Starfish	Starfish, also known as sea stars, are marine invertebrate...
22	Turtle/Tortoise	Turtles and tortoises are reptiles belonging to the order ...
23	Whale	Whales are magnificent marine mammals characterized by...

1. Collect the required information about marine organisms based on the model training database and organize it into a CSV file named “sea\_animal\_introduction”.
2. Next, we import this information into SQLite to generate a DB file.

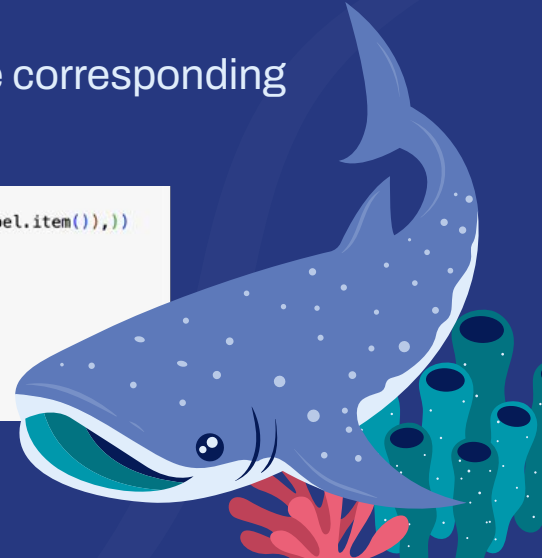
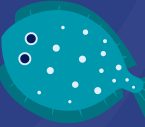


# Database creation (SQLite)

3. In Python, we import the required sqlite3 libraries for SQLite and read the DB file through Python. In this way, we can create a cursor object for performing SQL query operations.
4. Then, we perform model identification and get the results, storing them in the variable "prediction".
5. Finally, we use the cursor object to perform a query to get the corresponding marine life description.

```
cursor = conn.cursor()
cursor.execute("SELECT Introduction FROM sea_animal WHERE name = ?", (str(target_image_pred_label.item()),))
result = cursor.fetchone()
print(result)

if result is not None:
    introduction = result[0]
    print("Sea animals introduction:", introduction)
else:
    print("Couldn't find a corresponding marine life presentation.")
```



The background is a deep blue gradient with wavy lines. In the top left, a school of small dark fish swims. In the bottom left, a large dark shark swims. In the bottom right, there are stylized coral reefs in red and teal. A large white shark is swimming towards the right in the upper right quadrant.

**03**

# **Market Application**



**Due to the mobility of aquatic animals, it is difficult for tourists to connect specific animals with their corresponding introductions.**



# Cv2 is the Python interface of OpenCV

open-source computer vision and image processing library. It provides rich functions and tools for processing image and video data, including image processing, feature detection, object recognition, target tracking, and other functions.

```
import cv2

# 初始化摄像头
cap = cv2.VideoCapture(0) # 0 通常是默认的摄像头

# 检查摄像头是否成功开启
if not cap.isOpened():
    print("无法打开摄像头")
    exit()

# 捕获一张图片
ret, frame = cap.read()

# 检查是否成功捕获
if ret:
    # 设置图片保存路径和名称
    save_path = '/Users/qiusiying/Downloads/images/use/seafood.jpg'

    # 保存图片
    cv2.imwrite(save_path, frame)
    print(f'图片已保存到 {save_path}')
else:
    print("无法捕获图像")

# 释放摄像头资源
cap.release()
```

Python

```
image1 = '/Users/qiusiying/Downloads/images/use/seafood.jpg'
pred_and_plot_image(image_path= image1, subplot=(1, 1, 1))
```

Python

```

else:
    print("Couldn't find a corresponding marine life presentation.")

plt.show()

image1 = 'https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcTl_NDhZ9R8tqj-zZcaFxeWhiRfyrNLG1E5TJ1JR8et8w@s'
if IN_COLAB:
    parent_dir = "/content/drive/MyDrive/Colab Notebooks/figures/dataset"
    db_path = parent_dir + '/sea_animal_introduction.db'
else:
    db_path = './sea_animal_introduction.db'

pred_and_plot_image_SQL(image_path=image1, subplot=(1, 1), db_path=db_path, model=best_full_model)

```



Pred: Squid | Prob: 0.2452



Species Predicted: Squid, Probability: 0.24520131945610046

Sea animals introduction: Squid are cephalopods with elongated bodies, a soft mantle, and a distinct head equipped with large eyes and tentacles. They are highly intelligent a

## pred\_and\_plot\_image\_SQL

When the analysis and scanning results match the corresponding marine species, corresponding marine biological information will pop up.



## Welcome to the knowledge collection of Clams!

Clams are a type of bivalve shellfish that live in oceans, freshwater, and swamps. Clams have a flat oval shape and their shells are usually composed of two shells, which can be opened and closed by muscle contraction. Clams contain rich meat inside their bodies and are one of the favorite ingredients among people.

Clams are a part of the marine food chain, mainly feeding on plankton and organic waste, while also providing food sources for other marine organisms. Clams play an important role in clearing water bodies and maintaining ecological balance in marine ecosystems.

Clams have unique characteristics, such as being able to perceive changes in the surrounding environment and being sensitive to light and temperature.



## Web pages and their redirects

We designed a page introduction of the 23 types of marine life we predicted and stored it in the template folder of the Flask application for Python and JavaScript to implement web page jumps.

## Welcome to the knowledge collection of Corals!

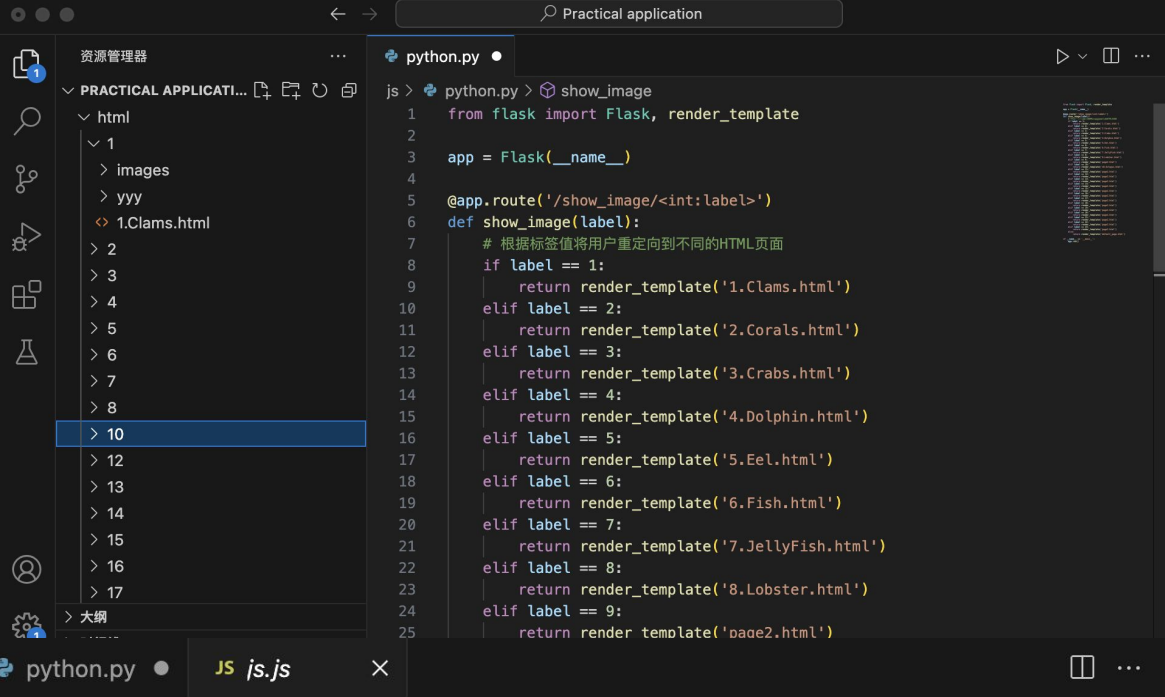
Coral is a type of invertebrate that grows in the ocean. They usually form hard exoskeletons made of calcium, which accumulate together to form coral reefs. Coral reefs are one of the oldest and most diverse ecosystems on Earth, and are home to many marine organisms.

Corals have various colors and forms, such as pink, orange, blue, etc. They grow together and form a colorful coral reef landscape. Coral is not only beautiful, but also has important ecological functions. They play important roles in providing habitats for marine organisms, protecting coastlines, and purifying seawater.

Coral is a constituent element of coral reef ecosystems, coexisting with microalgae to provide nutrients to coral through photosynthesis and feeding on plankton at night. Coral is also a food source for many marine organisms, such as anemone fish and sea turtles.

However, coral currently faces serious threats, including climate change.





# Web pages and their redirects

We use python and JavaScript to implement web page jumps. The Python code creates jumps to marine life with different labels, and will jump to the corresponding web page according to different types of marine life.



The background is a deep blue gradient with subtle wavy lines. In the top left, a school of small dark fish swims. In the bottom left, a large dark shark swims. In the bottom right, there are stylized coral reefs in red and teal. A large white shark is swimming towards the right in the upper right quadrant.

**04**

# **Experimental Study**

# Experimental procedure

## Install Super gradients Deep learning library

uses the pre-trained  
model "regnetY 800"

## Split the data

80%training,10%validation  
and 10% testing.

## Plot random images

check the distribution of the number  
of each marine animal category.

## Augmentation

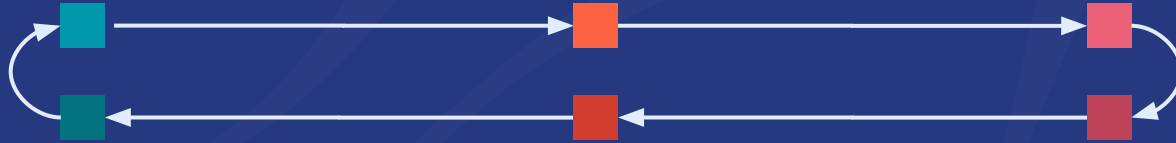
define a series of transformations to be  
applied to the training set to improve the  
generalization ability of the model

## Train model

get best model

## Plot predictions

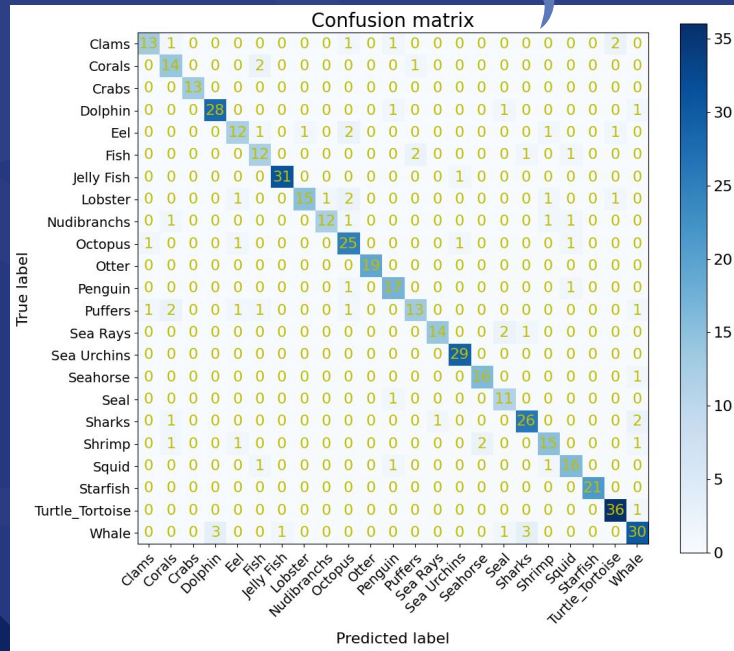
Predict on images from  
internet



# Evaluation method

We randomly selected five photos of marine life from the Internet to evaluate the accuracy of the deep learning model.

In addition, we also use a **confusion matrix**, which shows the relationship between the **actual categories** and the **model-predicted categories**. We find that values along the diagonal represent the number of correct classifications by the model, while values off the diagonal represent the number of incorrect predictions. The confusion model not only shows the accuracy of each class but also visualizes the classification performance of each class, which helps evaluate the model.



# Analysis of results



## ▼ Evaluate on test set

```
full_model_trainer.test(model=best_full_model,  
                        test_loader=test_dataloader,  
                        test_metrics_list=['Accuracy', 'Top5'])
```

```
Testing: 60%|██████████| 3/5 [00:04<00:02, 1.22s/it]  
{'CrossEntropyLoss': 1.4647442,  
 'Accuracy': 0.8527131676673889,  
 'Top5': 0.9670542478561401}  
Testing: 100%|██████████| 5/5 [00:05<00:00, 1.13s/it]
```

The results show that the model performed well on the test set, with an accuracy of about 86.05%. It is worth mentioning that the Top-5 accuracy is as high as 97%, which means that even if the first choice of the model is incorrect, the correct answer It will still be among the top five most likely choices

The background is a deep blue gradient with wavy lines. In the top left, a school of small dark fish swims. In the bottom left, a large dark shark swims. In the bottom right, there are stylized coral reefs in red and teal. A large white shark is swimming in the upper right.

**05**

# Conclusion

# Conclusion and future work



The aim of our project is to **help them accurately identify specific animals among many unfamiliar animal species** in an aquarium through our system **so that they can recognize and understand various animals more easily.**

Combining computer vision and deep learning algorithms, after nearly **30 rounds of training**, our model **reached a high level of accuracy.**

The system helps **improve visitors' knowledge and awareness** of sea animals and promotes awareness for sea life conservation. **For researchers and conservation organizations**, the system can also **provide valuable data and insights for animal population monitoring, behavioral studies, and the development of conservation measures.**

In the future, we can further improve and optimize the performance of the system to **increase accuracy and response time.** As well as **expanding our marine life database** to recognize a greater diversity of marine organisms.

# Workload Distribution

	Train Model Experiment Study	SQL query Template	Market Application Interface	Report	Slide
Zhu Xiaoyu 23422041	√			√	√
Luo Fan 23425968	√		√	√	√
Zhang Sining 23451637		√		√	√
Pan Yier 23462671		√		√	√
Qiu Siying 23467274			√	√	√
Jiang Nanhezi 23473452			√	√	√



# Thanks!

Do you have any questions?

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