SDU
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# AI Solutions for Enhancing Situational Awareness in the Sea

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- **Challenges include:**
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- AI can synthesize diverse data into actionable insights.
- This presentation focuses on:
  - **Retrieval-Augmented Generation (RAG)**
  - **Multi-modal information retrieval** for enhancing situational awareness.

# Retrieval-Augmented Generation (RAG)

- **RAG combines:**
  - **Information Retrieval:** Locating relevant documents and datasets.
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- **Key Features**
  - **Dynamic Knowledge Integration:** Combines static pre-trained knowledge with real-time, retrieved data.
  - **Precision and Relevance:** Provides focused insights by filtering through massive datasets.
  - **Versatility:** Can process structured, semi-structured, and unstructured data, making it ideal for marine contexts.

# RAG in Marine Situational Awareness

**APPLICATIONS:**

Leveraging RAG to extract critical insights from:

- Scientific publications on marine biodiversity and ecosystem dynamics.
- Reports on climate change impacts on oceans.
- Emergency response documentation for oil spills and maritime disasters.

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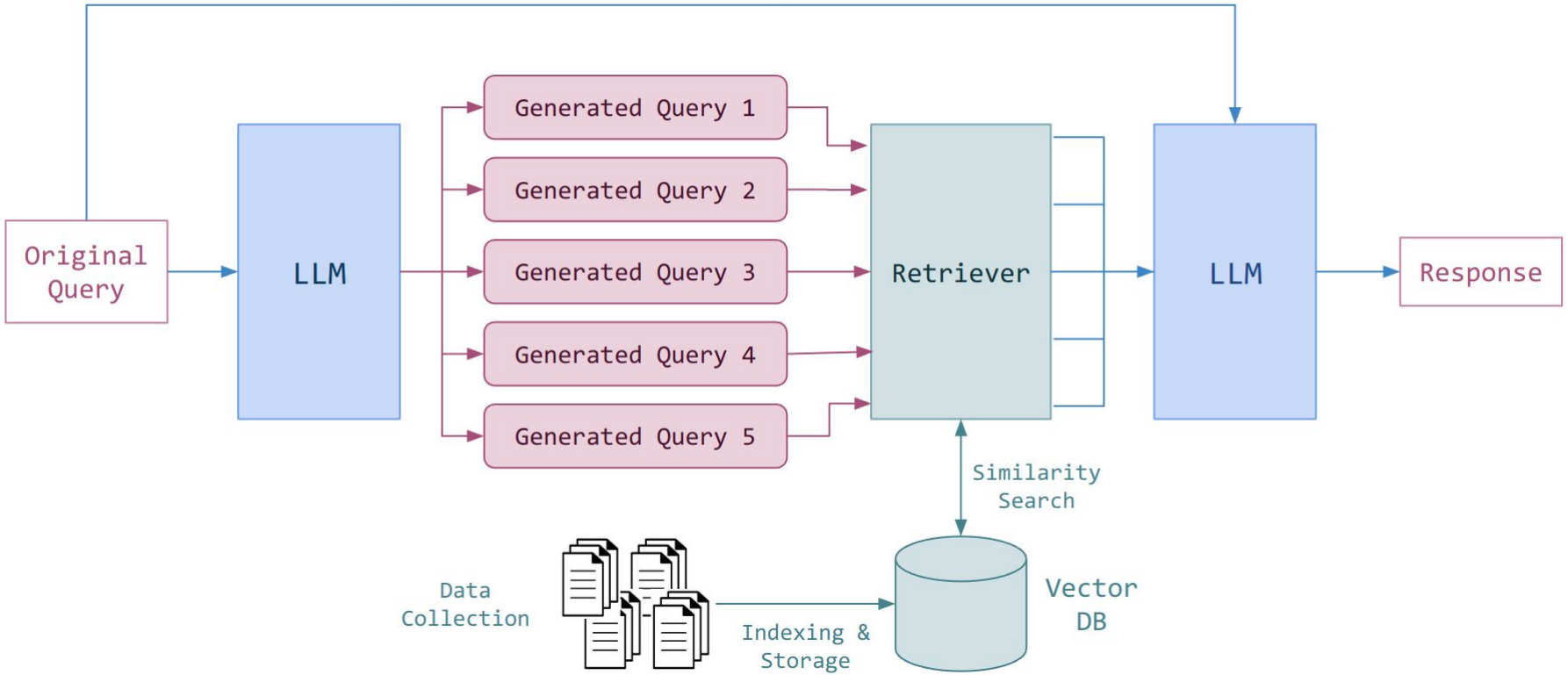
**BENEFITS**

- **Efficiency:** Rapid processing of vast repositories.
- **Contextual Understanding:** Tailored responses to specific queries.
- **Scalability:** Handles diverse, unstructured data types.

# RAG in Marine Situational Awareness



# Multi-Modal Retrieval

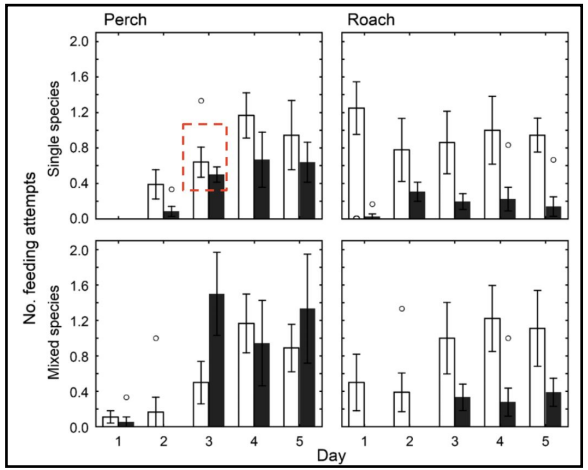
Marine data appears in various formats:

- Text (research findings, reports)
- Tables (e.g., population counts)
- Figures and images (e.g., satellite maps)

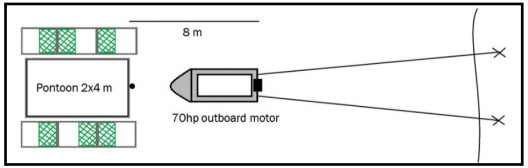
Multi-modal retrieval integrates insights from:

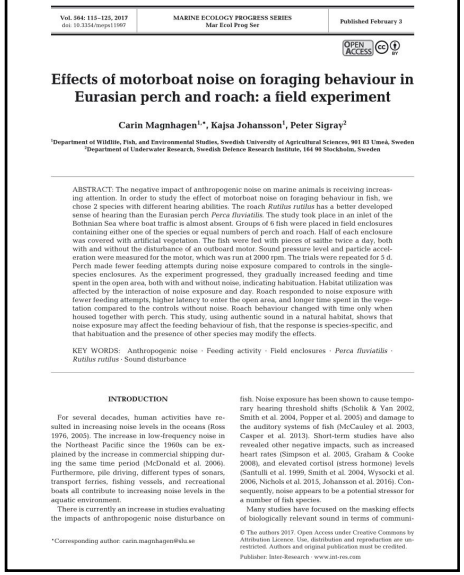
- Textual data: Trends, metadata, methodologies.
- Tables: Data extraction for numerical analysis.
- Images and Maps: Geo-referenced visuals for spatial awareness.

**Fig. 3.** Mean **(±SE) number of feeding attempts** of perch **Perca fluviatilis** and roach Rutilus rutilus in single- and mixed-species enclosures when subjected to either silent (control) conditions (open bars) or noise exposure (filled bars). Scores show the average **number of feeding attempts** for 6 individuals in the single-species enclosure and 3 individuals in the mixed-species enclosure.




| Single-species Variable | Perch Wald $\chi^2$ | Perch p | Roach Wald $\chi^2$ | Roach p |
|---|---|---|---|---|
| Feeding attempt | | | | |
| Exposure | **8.704** | **0.003** | **16.671** | **<0.001** |
| Day | **52.086** | **<0.001** | 0.434 | 0.510 |
| Exposure × day | 1.241 | 0.265 | 0.749 | 0.387 |
| Latency to enter the open area | | | | |
| Exposure | 0.086 | 0.770 | 3.624 | 0.057* |
| Day | **9.101** | **0.003** | 0.001 | 0.972 |
| Exposure × day | 0.560 | 0.454 | 0.648 | 0.421 |
| Time in the open area | | | | |
| Exposure | 0.559 | 0.455 | 3.482 | 0.062* |
| Day | **14.556** | **<0.001** | 1.059 | 0.303 |
| Exposure × day | 0.105 | 0.746 | 0.375 | 0.540 |



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## Effects of motorboat noise on foraging behaviour in Eurasian perch and roach: a field experiment


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ABSTRACT: The negative impact of anthropogenic noise on marine animals is receiving increasing attention. In order to study the effect of motorboat noise on foraging behaviour in fish, we chose 2 species with different hearing abilities. The roach *Rutilus rutilus* has a better developed sense of hearing than the Eurasian perch *Perca fluviatilis*. The study took place in an inlet of the Bothnian Sea where boat traffic is almost absent. Groups of 6 fish were placed in field enclosures containing either one of the species or equal numbers of perch and roach. Half of each enclosure was covered with artificial vegetation. The fish were fed with pieces of saithe twice a day, both with and without the disturbance of an outboard motor. Sound pressure level and particle acceleration were measured for the motor, which was run at 2000 rpm. The trials were repeated for 5 d. Perch made fewer feeding attempts during noise exposure compared to controls in the single-species enclosures. As the experiment progressed, they gradually increased feeding and time spent in the open area, both with and without noise, indicating habituation. Habitat utilization was affected by the interaction of noise exposure and day. Roach responded to noise exposure with fewer feeding attempts, higher latency to enter the open area, and longer time spent in the vegetation compared to the controls without noise. Roach behaviour changed with time only when housed together with perch. This study, using authentic sound in a natural habitat, shows that noise exposure may affect the feeding behaviour of fish, that the response is species-specific, and that habituation and the presence of other species may modify the effects.



KEY WORDS: Anthropogenic noise · Feeding activity · Field enclosures · *Perca fluviatilis* · *Rutilus rutilus* · Sound disturbance


### INTRODUCTION

For several decades, human activities have resulted in increasing noise levels in the oceans (Ross 1976, 2005). The increase in low-frequency noise in the Northeast Pacific since the 1960s can be explained by the increase in commercial shipping during the same time period (McDonald et al. 2006). Furthermore, pile driving, different types of sonars, transport ferries, fishing vessels, and recreational boats all contribute to increasing noise levels in the aquatic environment.

There is currently an increase in studies evaluating the impacts of anthropogenic noise disturbance on fish. Noise exposure has been shown to cause temporary hearing threshold shifts (Scholik & Yan 2002, Smith et al. 2004, Popper et al. 2005) and damage to the auditory systems of fish (McCauley et al. 2003, Casper et al. 2013). Short-term studies have also revealed other negative impacts, such as increased heart rates (Simpson et al. 2005, Graham & Cooke 2008), and elevated cortisol (stress hormone) levels (Santulli et al. 1999, Smith et al. 2004, Wysocki et al. 2006, Nichols et al. 2015, Johansson et al. 2016). Consequently, noise appears to be a potential stressor for a number of fish species.

Many studies have focused on the masking effects of biologically relevant sound in terms of communi-


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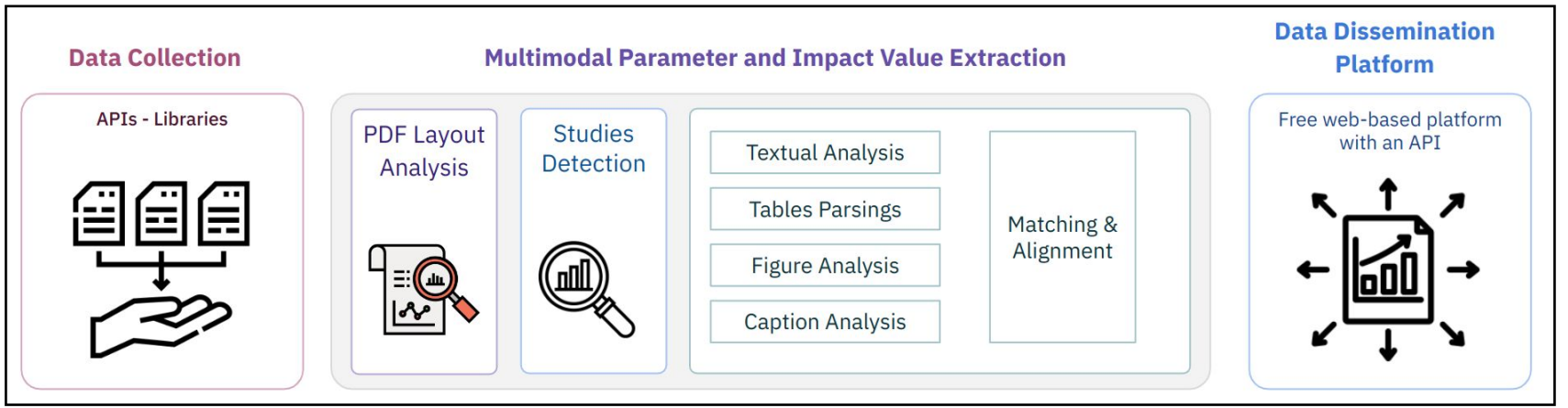

# Advantages of RAG and Multi-Modal Systems

**Overcoming Challenges**

- Data Overload: Processes extensive scientific literature efficiently.
- Unstructured Data: Integrates diverse formats into coherent insights.

**Real-World Impact**

- Automates extraction of actionable insights for marine stakeholders.
- Supports informed decision-making in crises and long-term planning.

# Challenges and Opportunities

## Challenges

- Ensuring accuracy in multi-modal data extraction.
- Ensuring robustness with noisy or incomplete datasets.
- Managing computational demands of RAG models.

## Opportunities

- Automating insights from marine literature.
- Integrating AI with real-time marine data streams (e.g., satellite imagery, IoT sensors).
- Empowering interdisciplinary collaboration.

# Thanks for your Attention

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