Philosophy of Research Methodology

Philosophy→ love of wisdom (*literally in Greek*)

knowledge that deepen our understanding. We should have a quest to acquire it.

Philosophy is an activity of thinking **seriously, critically**, **rationally** & **comprehensively.**

It is also about logical/ sensible reasoning & Intellectual process that requires analytical abilities & ability of synthesizing knowledge.

Philosophy of science is a discipline of philosophy concerned with:

Foundations, Methods & Applications of science.

Science is the pursuit & application of knowledge & understanding of the world we live in following a systematic methodology based on evidence.

Scientific methodology includes the following:

- Objective observation (without bias)
- Experiment/ observation for testing hypotheses
- Collecting evidence
- **Critical analysis**
- **Reasoning to arrive at conclusions**
- Verification & testing: scrutiny, peer review & assessment

- **Research is a logical & systematic search for new & useful information on a particular topic.**

- Search for knowledge.
- Addition to existing knowledge.
- Discovery of hidden truths.
- Knowing the unknown.

Research methods

Procedures & algorithms (a process or set of rules to be followed) in research.

Methods can be:

- Theoretical
- Experimental
- Numerical
- Statistical

Explanations based on collected facts, measurements, observations & reasoning.

Research Methodology

- Systematic way to solve a problem.
- Explain how research is to be carried out.
- Procedures used by researchers in their work of describing, explaining & predicting phenomena.

The methods section describes:

- Actions to be taken to investigate a research problem.
- Rationale for the application of specific procedures or techniques used to understanding the problem, thereby, allowing the reader to critically evaluate a study's overall validity and reliability.
- The methodology section of a research paper answers two main questions:
- How was the data collected or generated?
- How was it analysed?

You must explain how you obtained & analysed your results for the following reasons:

1. Readers need to know how the data was obtained because the method you chose affects the results & how you interpreted their significance in discussion section of your paper.

2. Methodology is crucial for any branch of scholarship because an unreliable method produces unreliable results & undermines the value of your analysis of the findings.

You must clearly articulate the reasons why you have chosen a particular procedure or technique.

The remainder of your M & M section should describe the following:

- Tools & methods used
- Data processing – statistical methods.
- Specific research tools or strategies that you utilized to study the underlying hypothesis & research questions.

Provide a justification for subject selection and sampling procedure.

For instance:

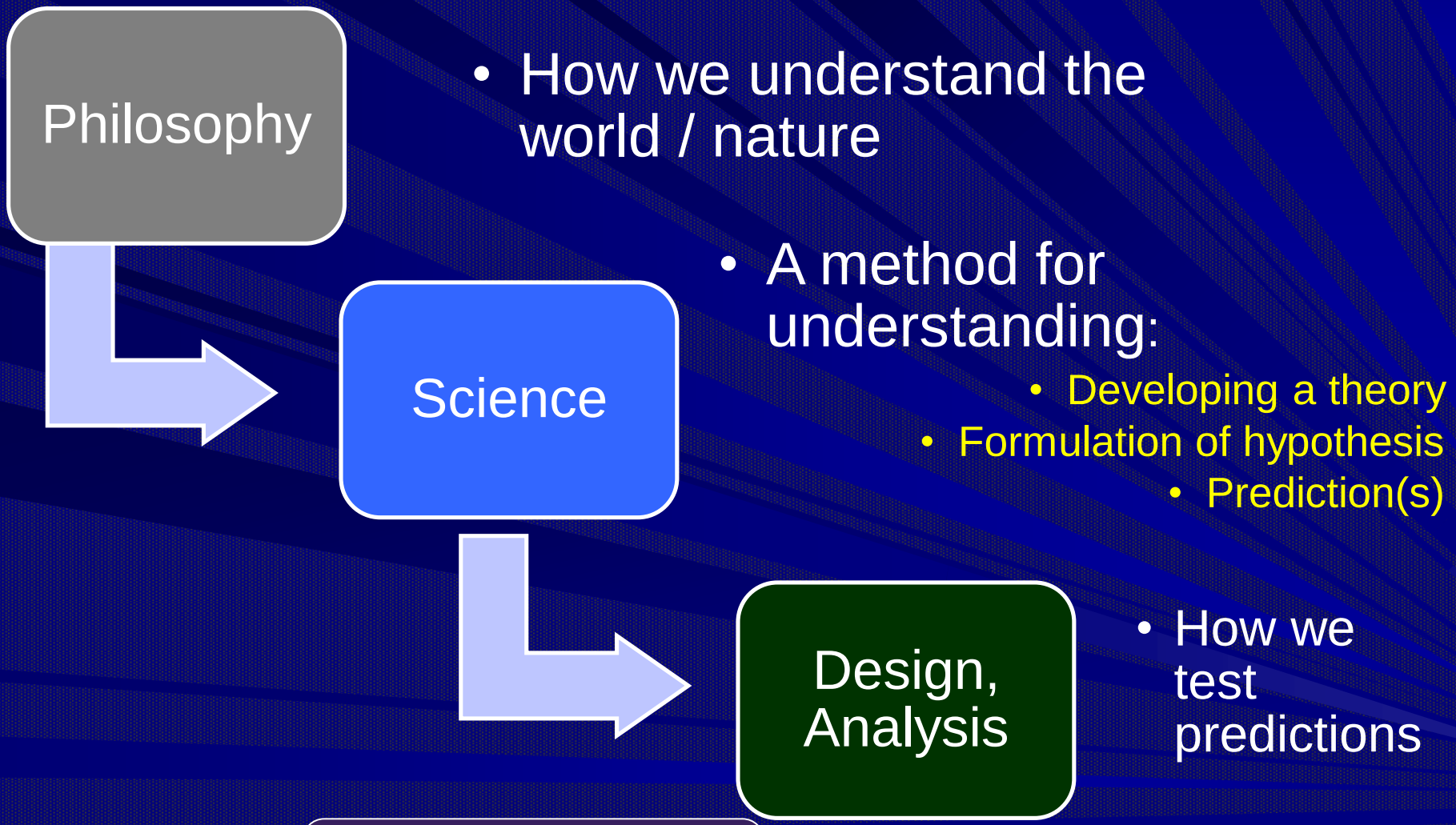
- If you propose to conduct interviews, how do you intend to select the sample population?
- If you are analysing texts, which texts have you chosen, and why?
- If other data sources exist, explain why the data you chose is most appropriate to addressing the research problem.

Provide a justification for Case Study selection

A common method of analysing research problems is to select specific cases which you intend to examine as a singular topic of in-depth investigation or multiple topics of investigation studied.

In either method, you should explain why a case was chosen and how they specifically relate to the research problem.

For example: Tilapia for AI application.


Philosophy
How we understand the world / nature
Science
A method for understanding:
Developing a theory
Formulation of hypothesis
Prediction(s)
Design, Analysis
How we test predictions
Statistics: Tools for testing

Ethical & moral considerations

Ethical/Humane treatment of experimental animals:

- Guidelines for many vertebrates exist.
- Invertebrates also deserve attention.

Environmental ethics:

- Common examples: use of solvent in fat extraction
- Discharge of chemical waste
- Drainage of wastewater from farming systems; antibiotic substitutes, nutrient cascading, etc.

Science is about finding facts through verifiable experimentation & establishing truth.

→ requires sampling methods.

Scientific sampling methods

Aimed at collection of data/information that can verify a hypothesis & establish facts.

Sample should be a representative that takes into consideration the variability in the population or a large fraction.

In biological systems, variation is a rule rather than exception.

Basic sampling approaches

1. Random sampling

- Non-discriminately among a large sample or whole.
- Representative- takes into account the variability.

2. Systematic sampling

Develop some kind of an order in selecting samples from randomly collected large sample size based on certain criteria specifically required for investigation.

3. Stratified sampling

Multiple observations from a heterogeneous sample divided into sub-sets.

Example: Macrofauna from a sea floor sample.

Sorting for separate assessment of microfauna, meiofauna & macrofauna.

This is selective for these 3 sub-groups of macrofauna.

Otherwise, the seabed sample was collected randomly.

Moreover, there is a random collection within each sub-group.

4. Non-random sampling

a. Convenience (or accidental) sampling.

- Selected on the basis of availability.

b. Quota sampling: when a certain proportion of some characters is required.

Ex. Proportion of color patterns.

Use of social science in science sampling

- Social science = Branches of study that deal with human social relations.

- In certain scientific problems we need a social science approach in sampling:

  Example: MPAs, marine mammal sightings & aquaculture projects.

Example-1: Dealing with issues related to MPA:

1. Impact of MPA on community.
2. Direct & indirect economic impacts of MPA over time.
3. Relationship between coastal-marine resources resources & indigenous community.
4. Use of marine environment & relationships between various user groups.

Example-2: Aquaculture development.

- Questionnaires to get required info. for increasing scientific input into farming operations.

- Food safety- no use of antibiotics or other harmful chemicals.

Example-3: Marine mammal sightings for conservation measures.

- Based on interviews & questionnaires.

Scientific methods are based on collecting evidence that is:

1. Observable
2. Empirical
3. Measurable
4. Subject to principles of reasoning

Scientific sampling may require instruments – samplers & supporting equipment.

- Water samplers
- Grab samplers
- Plankton nets, other types of nets
- Secchi disk
- Sampler bottles
- GPS, current meters, flow meters, remote sensing facilities
- Water quality meters
- Data loggers

Types of scientific methods

Methods depend on nature of study

Examples:

1. Collection of water samples
2. Collection of sediment samples
3. Collection of plankton samples
4. Collection of fish samples

All require different methods.

Same equipment (Bottom sampler) but different weight.

- Small Grab sampler- when sea is rough, the sample that it will collect will not be a good representative.

- Heavy sampler- winch-operated will be needed for deep sea & rough sea conditions.

- Direct observations- tanks, aquarium, snorkeling & diving.

- Indirect observations- example- gut analysis.

- Technology-assisted devices:
  - Transmitters (ex. Salt marsh experiment)- IR3.0

  - Artificial Intelligence (AI) tools- IR4.0

New tools of study- IR4.0

Artificial intelligence (AI) emerging as a new tool for:

- Study of biology of aquatic animals
- Application (of AI gadgets) in aquaculture

Existing instruments in UMS- Ex. YSI

Disruptive technology tools

1. Sensors
2. IoT & machine learning
3. Big Data Analytics
4. Realtime monitoring systems
5. Automation using robots
6. Drones
7. 3D prints
8. AI – more widespread

Definition of AI

Intelligent system that perceives its environment & takes actions which maximize its chances of successful operations.

Basic AI technique:

- Artificial Neural Networks (ANN).

Artificial neural systems- mathematical models of brain-like systems.

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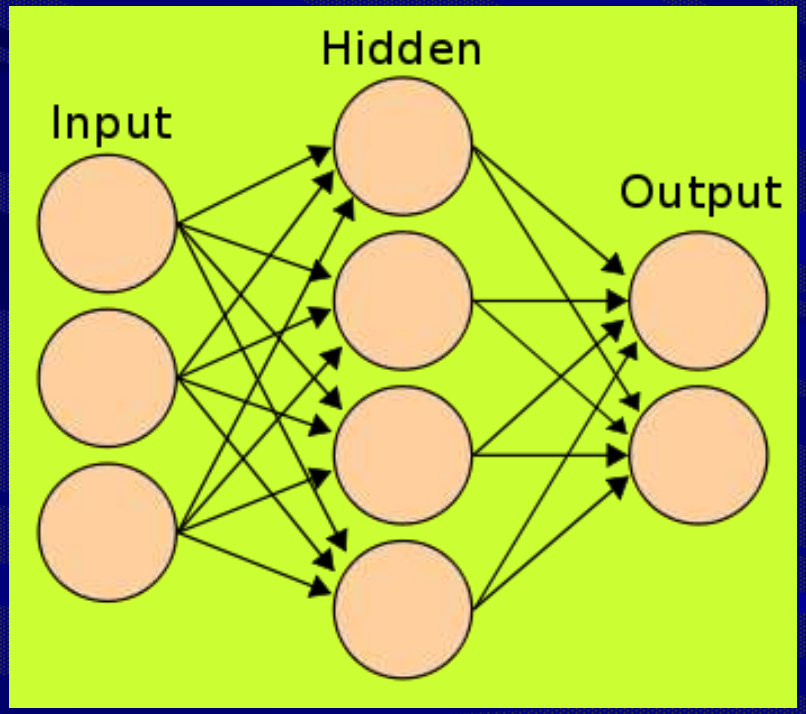
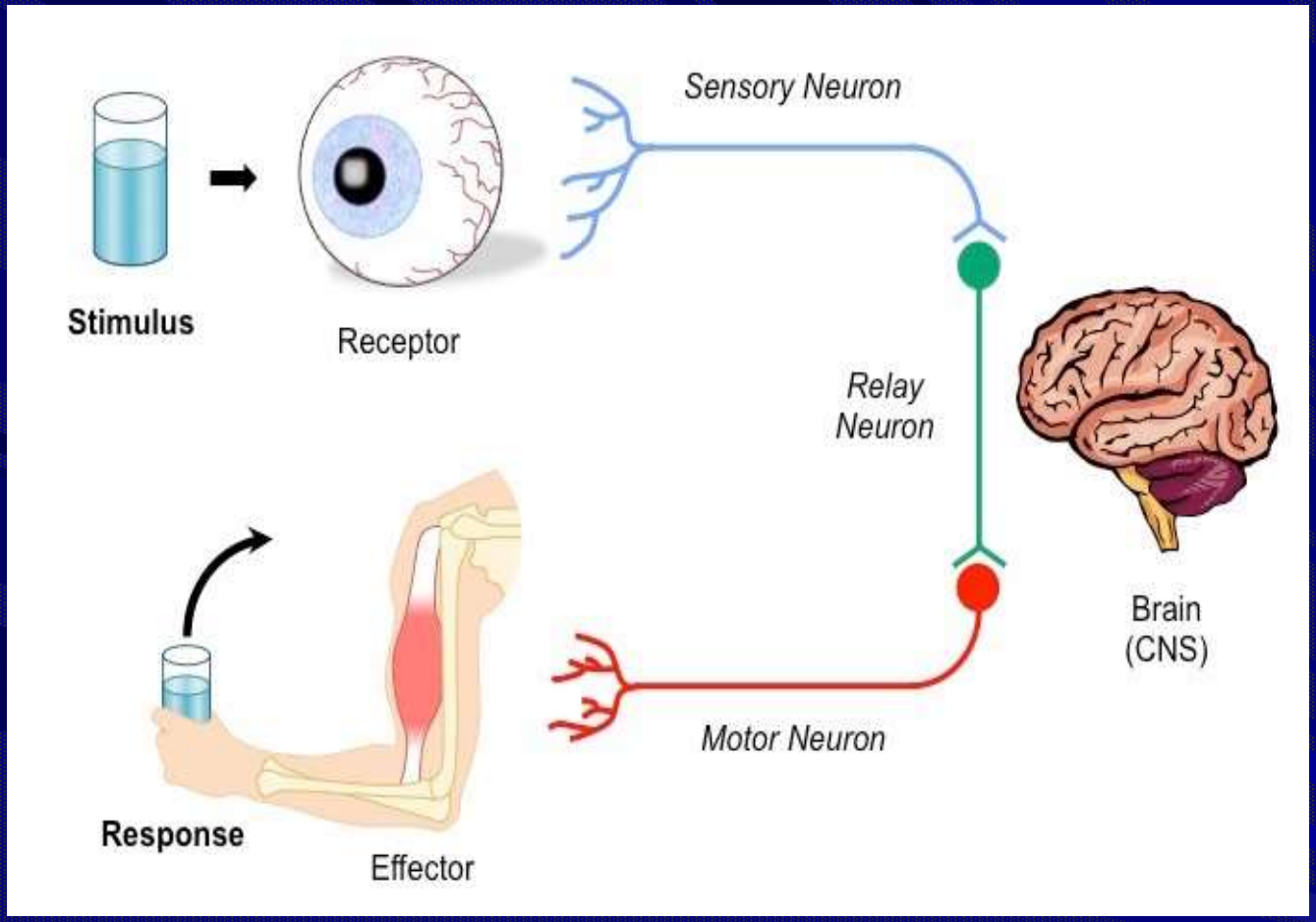
ANN comprises Nodes which in biology are termed as Neurons (or nerve cells)

There are multiple nodes arranged in three layers:



Input (X)→ x Weight (W) +Bias (b) → Output (Y).

Each input (X) is assigned a 'weight' (W) value on the basis of its relative importance to all other inputs.


Sensory Neuron
Stimulus
Receptor
Relay
Neuron
Brain
(CNS)
Response
Effector
Motor Neuron

3D prints

- 3D-coral reef, seagrass
- 3D fish robot equipped with AI- printed by MIT that mimics an actual fish's motions & movements:

A better understanding of an animal in its natural environment could help:

- Improving welfare conditions.
- Providing a more natural experience for the cultured animal used in production.

Can robots manage aquatic farm?

Yes, to some extent!

Farms are crowded places that can exacerbate issues such as diseases & parasites, leading to lower yields & higher production costs.

Using AI & robotics it is possible to actively sort out sick or injured fish as well as those that are ready for harvesting.
→ *iFarm system*.

Future of marine finfish aquaculture could very well lie in giant, autonomous roaming robotic cages in deep sea called aquapods.

- Costly to buy.
- Cheaper in long-term operational cost.
- High efficiency.

Aquapod is a free-floating fish farm that can accommodate a large no. of fish. Image Credit: InnovaSea.

If aquapods grow fish in the open ocean, what happens when repairs are needed?

Companies are developing an underwater robot that will be able to examine & repair these nets, providing a safer and more cost-effective way to manage the operation.

Sensors for smarter gadgets

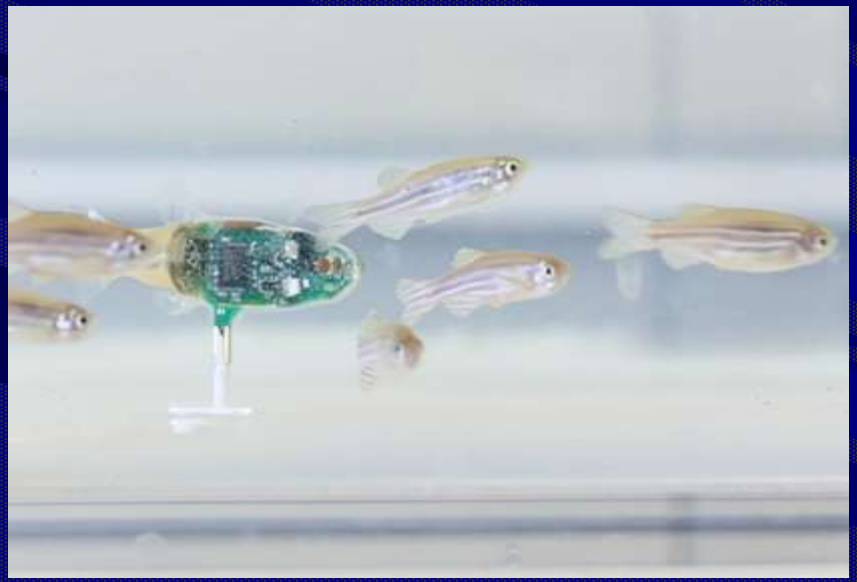
Underwater drones & robots use sensors to collect data such as pH, salinity, oxygen levels, turbidity & pollutants.

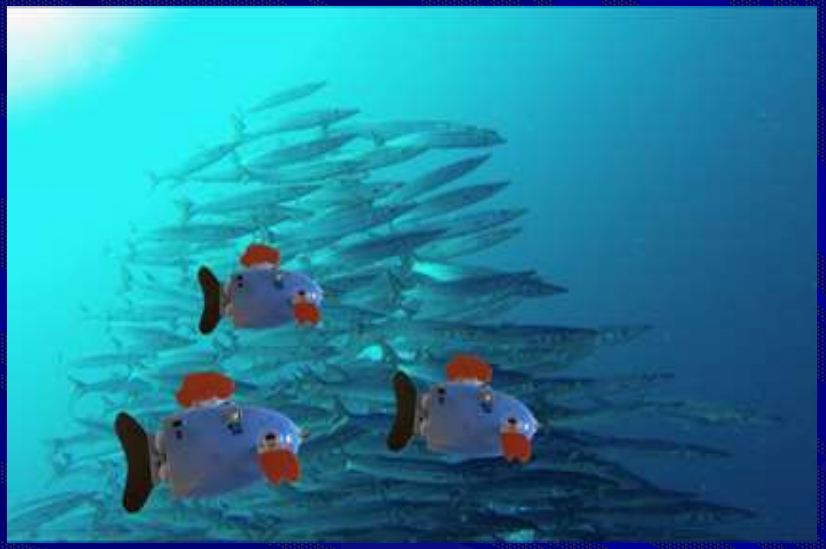
Modern buoys: Real-time marine environmental monitoring.

Researchers have developed a miniature robot that can integrate perfectly into schools of zebrafish (*Danio rerio)*

This is a kind of ‘secret agent’ that can infiltrate schools of fish.

The robot is seven centimeters long with the same shape & proportions.





When researchers compared their results with observations made on schools of five zebrafish swimming under the same conditions, but without the robot:

Their findings were:

1) Fish accepted the robot into their schools without any problem.

2) Robot was able to mimic the fish's behavior, prompting them to change direction or swim as required.

This will help in:

- Training the fish for improving recapture rates in a sea ranching program.
- Aggregate them in a pond for feeding (to save diet from wastage & to maintain water quality).

Requires AI

Example: Driverless car where the system knows surroundings to find direction without hitting until it reaches destination following the GPS device.

A robotic aquatic animal can likewise mix around with a group of fish & work its way as it moves.
Algorithm – to modulate the activity of robotic animal: speed of swimming, direction, when to stop, etc.

A driverless car must have an artificial intelligence system that:

- Senses its surroundings.
- Processes the visual data to determine how to avoid collisions.
- Operates car machinery like the steering and brake.
- Uses GPS to track the car's current location and destination.

Without an AI, cars cannot be truly driverless.

What about cues?

Visual cues OK, but others?

‘AI’ in biodiversity monitoring

Sampling for treasures of deep sea - using robots

- Deep sea is a resource for strange types of marine natural products.
- Ocean floor is deep, unique & inhospitable.
- Extreme conditions prevail in this most difficult to access part of ocean (abyssal zone):
  - Very high hydrostatic pressure
  - Absolute darkness
  - Freezing cold ($0^{o}C$ or less)

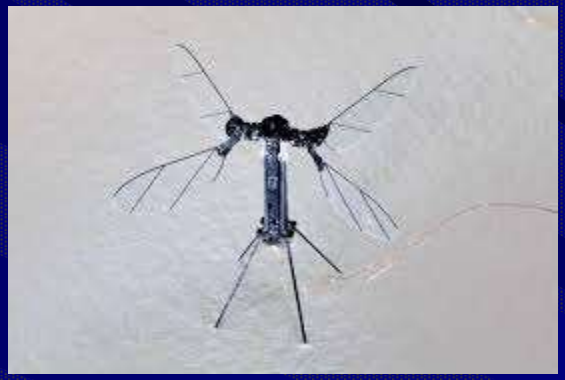
Different requirements- underwater sampling

Underwater sampling- robots in deep sea trench

Robots equipped with AI can also manage agriculture farms & livestock.

- **Robot dog herds sheep in New Zealand**


ROCOS



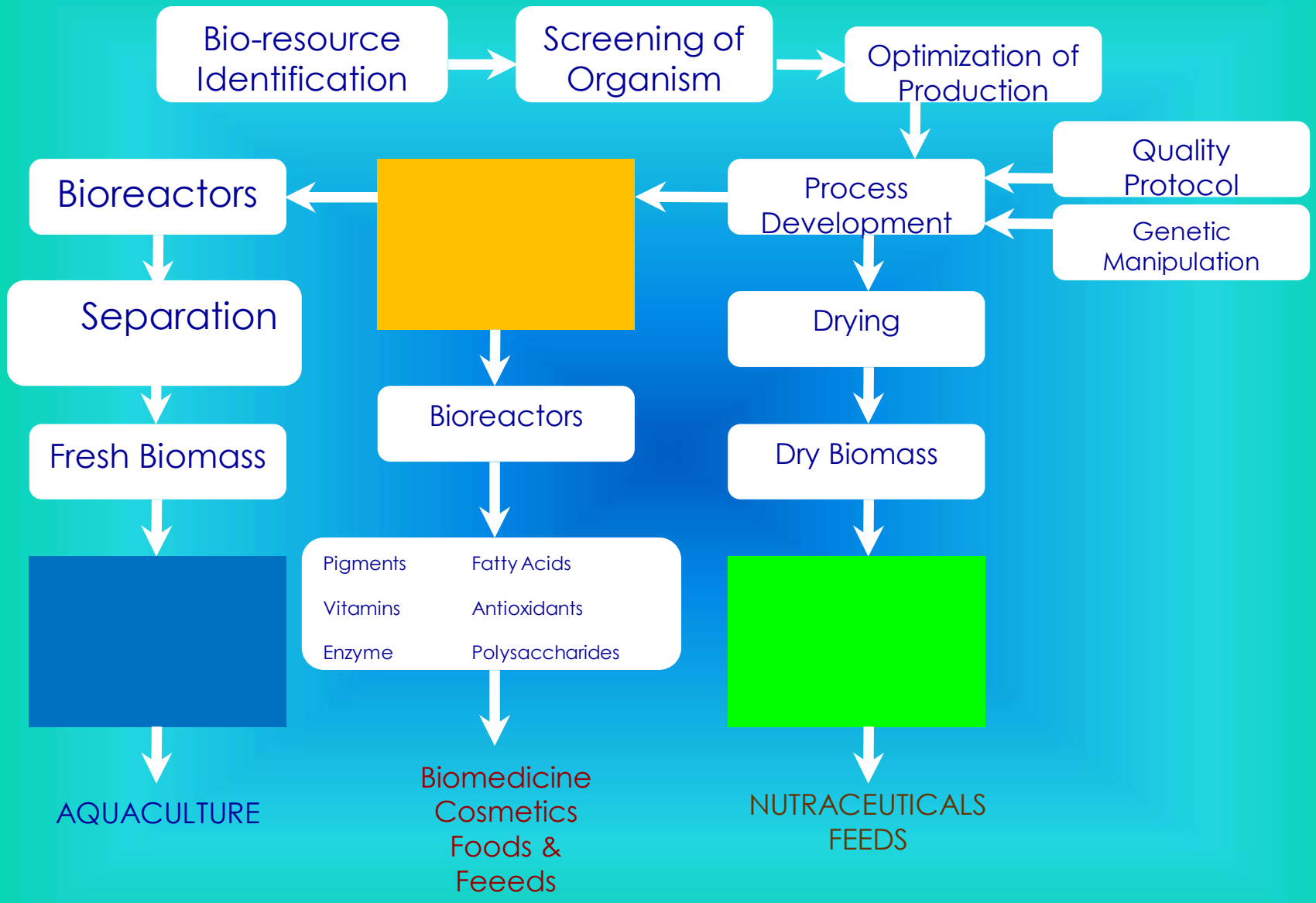
Bioprospecting & sample processing for product development

- Biotech research involves bioprospecting but does not end with bioprospecting.

- It begins with bioprospecting & progresses towards product development:
  - Many stages of samplings are needed-
    Population samplings, tissues sampling, etc.

Structured methodology for establishing a marine biotechnology development program.

Developing a marine biotechnology project based on a certain organism from marine life must follow a structured methodology:



Flow chart of Marine Biotechnology Developmental

Respect traditional knowledge but subject it to trials.

Ex. Natural products traditionally known for therapeutic qualities (to get clues)

- Should not dismiss traditional knowledge out of hand.
- Should not have blind faith.
- Moral obligation to correct baseless public perceptions.

Recap: Philosophy of science & scientific methods:

- A thought-process aimed at understanding the truth & gaining knowledge of processes that shape our world.
- Scientists must develop a culture of critical thinking: asking questions, examining information & evidence, & figuring out conclusions.
- Ability of thorough interpretation of data & expressing it properly.

- Use technology that helps- IR3.0 or IR4.0
- Culture of innovation →try going where no one has gone before.
- Absence of evidence is not evidence of absence.
- Invest in knowledge management- diversified forms of knowledge: modern as well as traditional knowledge.
- Be rational in pursuing & implementing a research topic.

- Culture of thinking is linked to innovations & can contribute to nurturing an innovation ecosystem.
- There is a great deal of concealed/ hidden information in addition to data that you get to extract to achieve the study objectives.
- That hidden information can lead to innovation/ disruptive innovations/ breakthroughs.
- Absence of evidence is not evidence of absence:

- Case of virus surviving outside host: in the air, dry surfaces, who knows in swimming pool– nucleoprotein body in search of cytoplasm.

Literature Review

Literature review involves survey of books, scholarly articles, & any other sources relevant to a particular area of research.

By doing so:

Provides a description, summary & critical evaluation of these works in relation to the research problem being investigated.

- Literature reviews are designed to:
  - Provide an overview of sources you have explored while researching a particular topic.
  - Demonstrate how your research fits within a larger field of study.

IMPORTANCE OF LITERATURE REVIEW

A literature review may consist of:

- **Summary of key sources**
- **Organizational pattern that combines both summary & synthesis**

Summary is a recap of the important information of the source.

Synthesis is a re-organization, or a reshuffling, of that information in a way that informs how you are planning to investigate a research problem.

The purpose of a literature review is to:

- Place a problem in the context of its contribution to understanding the research problem being pursued.

- Describe the relationship of each work to the others under consideration.

- Reveal any knowledge gaps that exist in the subject.

- Resolve conflicts amongst seemingly contradictory previous studies.
- Place your own research within the context of existing literature [very important].

THREE layers of knowledge in a literature review:

1. Primary studies that researchers conduct & publish.

2. Reviews of those studies that summarize & offer new interpretations built from & often extending beyond the primary studies.

3. Perceptions, conclusions, opinion, and interpretations that are shared by blogs, magazines & even some journals.

In composing a literature review, bear in mind that sometimes this third layer of knowledge is cited as "true" even though it often has only a loose relationship to the primary studies & secondary literature reviews.

It is left to the intellectual efforts of the researchers to produce a convincing explanation.

Examples:

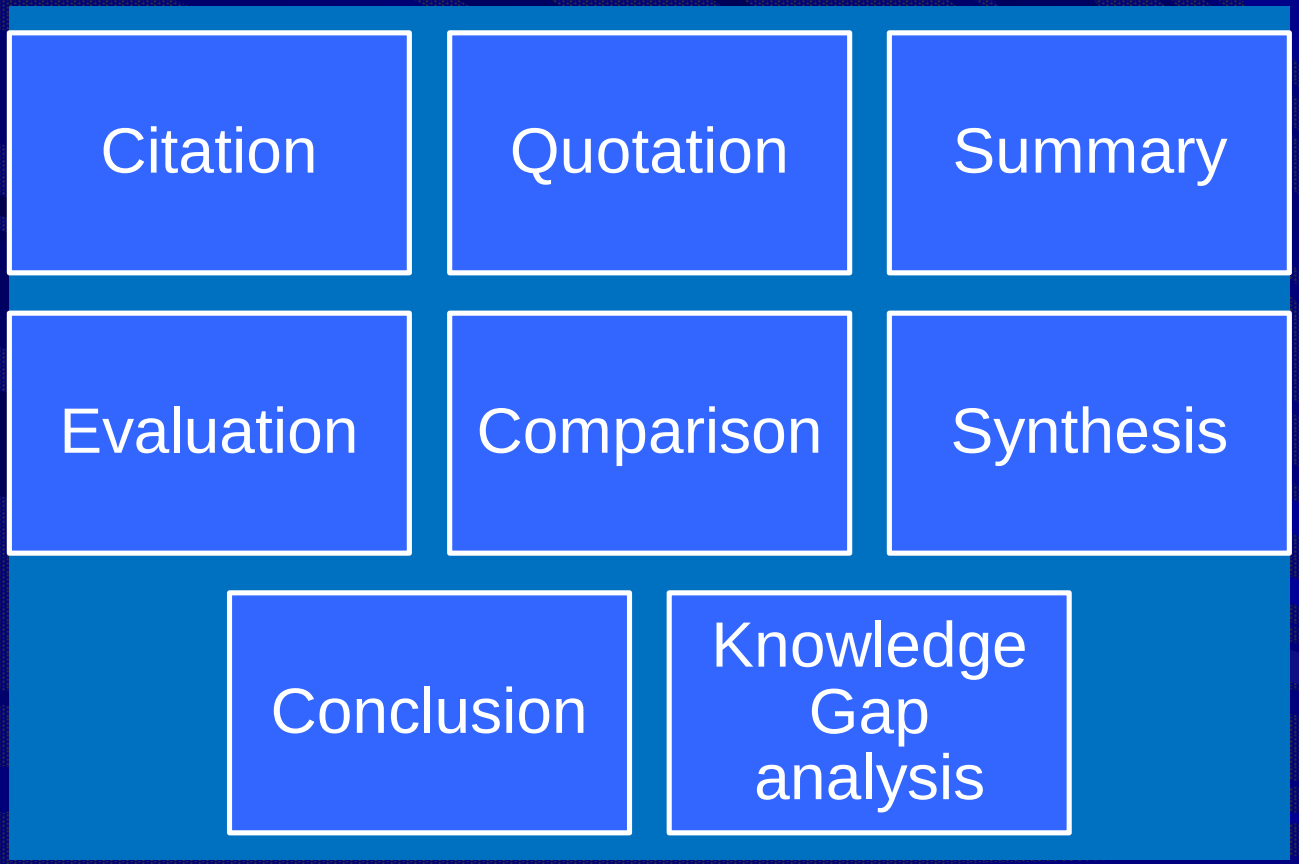
- Opinions without quantitative data.
- Often, Hypothesis accepted as Facts.

Problem at hand- Species redundancy & functional redundancy.

Serious question marks in the context of marine ecosystem.


06
Create New Knowledge
01
Explore Background
05
Use & Cite Sources
The Research Process
Develop Topic
02
Evaluate Sources
04
Find Sources
03

Different kinds of Literature Survey, and, depending on what kind you are doing, you may have to include one or more of the following:



Sources of information(Primary, Secondary & Tertiary)

Primary sources

- Original work; direct & first-hand evidence; observations; results of experiment; in blogs or communications; creative writing; video recording; original ideas .

- They are first formal appearance of results in print or electronic literature.

- Primary sources: present original thinking, report discoveries, generate new information.

- They present information in its original form, not interpreted or modified by other writers while evaluating their merit.

Examples of Primary Sources:

- Scientific journals containing articles reporting research results.
- Proceedings of conferences, seminar, etc.
- Technical reports.
- Dissertations or theses (may also be secondary)
- Newspaper articles (may also be secondary)

Primary sources:

- Government documents
- Speeches
- Interviews, surveys & fieldwork
- Letters & correspondence
- Photographs
- Internet communications (email)

Secondary sources

- Less easily defined than primary sources.

- Secondary sources describe, discuss, interpret, comment upon, analyze, evaluate, summarize, and process primary sources.

- These can be articles that discuss or evaluate someone else's original research.

- Secondary sources are those which simplify the process of finding & evaluating the primary literature.

They tend to be works which repackage, reorganize, reinterpret, summarize, index or otherwise add value to new info. reported in primary literature.

Examples of secondary sources:

- Textbooks
- Book reviews
- Scripts & commentaries
- Bibliographies
- Encyclopedias (may also be tertiary)
- Dissertations or theses
- Handbooks & data compilations (may also be tertiary)

Tertiary Sources

Works which list primary & secondary resources in a specific subject area.

- These are sources that index, abstract, organize, compile, or digest other sources.

Examples of tertiary sources:

- - Encyclopedias (may also be secondary)- Example: SDG14
- - Wikipedia- a free online encyclopedia, created and edited by volunteers & hosted by the Wikimedia Foundation.
- - Bibliographies
- - Directories, guidebooks, manuals, handbooks, and textbooks (may be secondary),
- - Indexing and abstracting sources.

Types of Literature Reviews

Integrative Review

Considered a form of research that reviews, critiques, & synthesizes knowledge on a topic in an integrated way such that new frameworks & perspectives on the topic are generated.

The body of literature includes all studies that address related or identical hypotheses or research problems.

A well-done integrative review meets the same standards as primary research in regard to clarity, rigor, and replication.
Examples:
Critique of Neutral & Classic theories of biodiversity (New perspectives on marine biodiversity-Ambio)
Critique of biochemical techniques for measuring protein nitrogen.

Historical Review

Focus on examining research over a period of time, often starting with the first time an issue, concept, theory, phenomena emerged in the literature, then tracing its evolution within the discipline.

The purpose is to place research in a historical context to show familiarity with the developments & to identify the likely directions for future research.

Systematic Review

This form consists of an overview/ summary of existing evidence pertinent to a specific research problem.

Investigates ‘cause-and-effect’ relations that have been left as question marks.

Theoretical Review

The purpose of this is to examine the theories in regard to an issue, concept, phenomena.

It helps to establish what theories already exist, the relationships between them, to what degree the existing theories have been investigated, and to develop new hypotheses to be tested.

Often this form is used to help establish a lack of appropriate theories or reveal that current theories are inadequate for explaining new or emerging research problems.

At the time of developing literature review: Consider it in 4 stages:

1. Problem formulation- Clarity very important.
2. Literature search - finding materials relevant to the subject being explored.
3. Evaluation - determining which literature makes a significant contribution to the understanding of the topic.
4. Analysis and interpretation - discussing the findings and conclusions of pertinent literature.

Clarity

If your topic is not very specific about what form your literature review should take, seek clarification from your supervisor by asking these questions:

1. Roughly how many sources should I include?

2. What types of sources should I review (books, journal articles, websites; blogs; scholarly versus popular sources)?

3. Should I summarize, synthesize, or critique sources?

4. Should I evaluate the sources?

5. Should I provide sub-headings and other background information?

Find samples/ models/ examples

To examine how authors in your area of interest have composed their literature review sections.

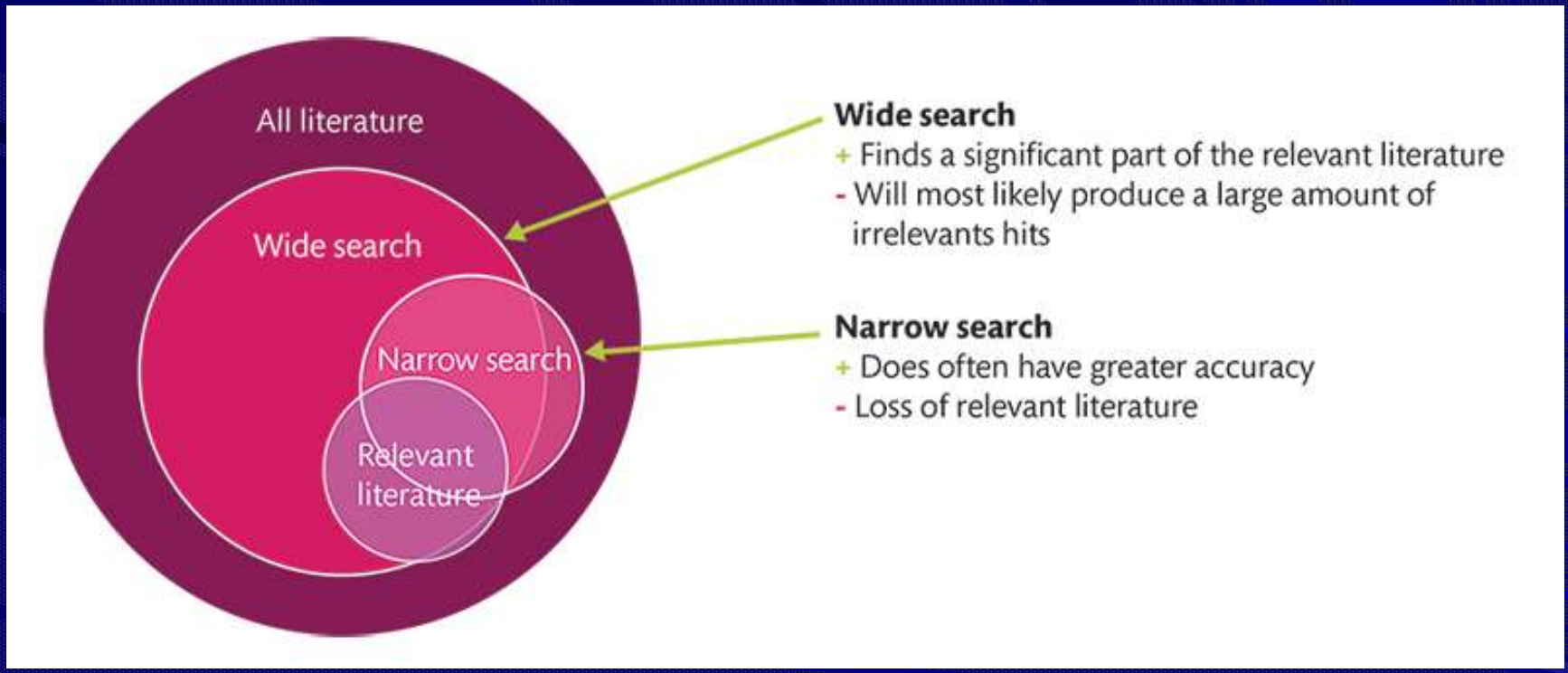
Narrow the Topic

The narrower your topic, the easier it will be to limit the number of sources you need to read in order to obtain a good survey of relevant resources.

Not expected to read everything that's available about the topic, but you'll make your job easier if you first limit scope of the research problem.

You can also review the indexes of books to find references to specific issues that can serve as the focus of your research.

Avoid information overload. Be focused!!!



Consider Whether Your Sources are recent

In science, you should use information that is as current as possible. This is research conducted becomes obsolete very quickly as new discoveries are made.

However, a survey of the history of the literature may be required. Know how knowledge and perspectives have changed over time.

You can also use this method to explore what is considered by scholars to be a "hot topic" and what is not.

Be Selective

Select only the most important points in each source to highlight in the review.

Type of information you select should relate directly to the research problem.

Points to remember:

- Summarize
- Extract most relevant & important information.
- But then synthesize it by rephrasing the study's significance & relating it to your own work.

Use Caution When Paraphrasing

- When paraphrasing a source that is not your own, be sure to represent the author's information or opinions accurately and in your own words.

- Even when paraphrasing an author’s work, you still must provide a citation to that work to avoid plagiarism.

Common mistakes to avoid:

1. Sources in your literature review do not clearly relate to the research problem.

2. You have not defined & identified the most relevant sources to use in the literature review related to the research problem.

3. Relied exclusively on secondary analytical sources rather than including relevant primary research studies or data.

4. Presuming another researcher's hypothesis and interpretations which are question marks as valid, rather than examining critically all aspects of the research design & analysis.

5. Even if other researchers treat their preliminary findings as facts & publish them in predatory journals, you need to critically examine them.

6. Not describing the search procedures that were used in identifying the literature to review;

7. Exclusively including research that validates assumptions while not considering contrary findings & alternative interpretations found in the literature.

Citing blogs

- A blog is a discussion or informational website published on the World Wide Web (WWW).
- Often informal text entries.
- When working for your research, using web-based information, be careful of unreliable sources since anyone can publish on internet.
- You can accept a blog source if it is reliable & on authentic platform.

- Citing a well-known author/writer with expertise in a field would be fine.
- If a “fact” stated in your thesis comes from a blog it is probably wise to verify from a more concrete source.
- Currently, blogs, like Wikipedia, should only be cited to demonstrate a level of knowledge that is conversed about at the popular level.
- But basing real research on blogs is not a good idea.

Many agencies allow Blogs on their websites:

- World Resources Institute (WRI)
- World Ocean Council

Blogs from credible agencies such as WRI contain references of original published work that you can access & verify.

I have verified WRI Blogs many times & found the information to be correct.

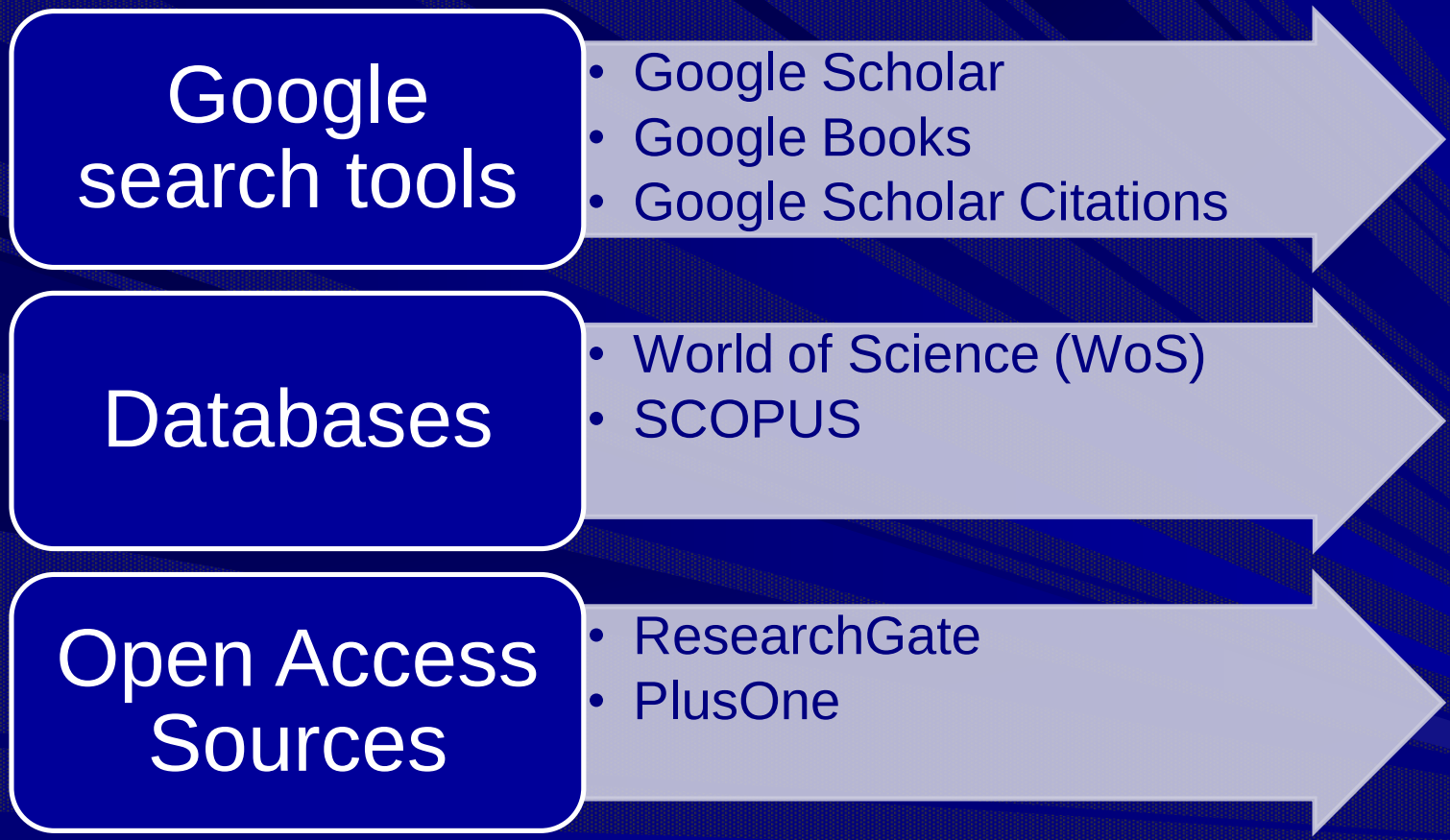
I prefer giving reference to the work cited in the Blog.

Example of WRI Blog: The Paris Deal at 5. Is it Working?

by Andrew Steer - December 14, 2020

In 2020, more than 50 countries committed to achieve net-zero emissions by mid-century, & more than 100 stated they will announce such commitments soon. Since 2015, more than 1,000 companies have signed up to Science-Based Targets, committing to decarbonize throughout their value chains and be transparent in reporting progress.

DIGITAL LITERATURE REVIEW



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Terima kasih