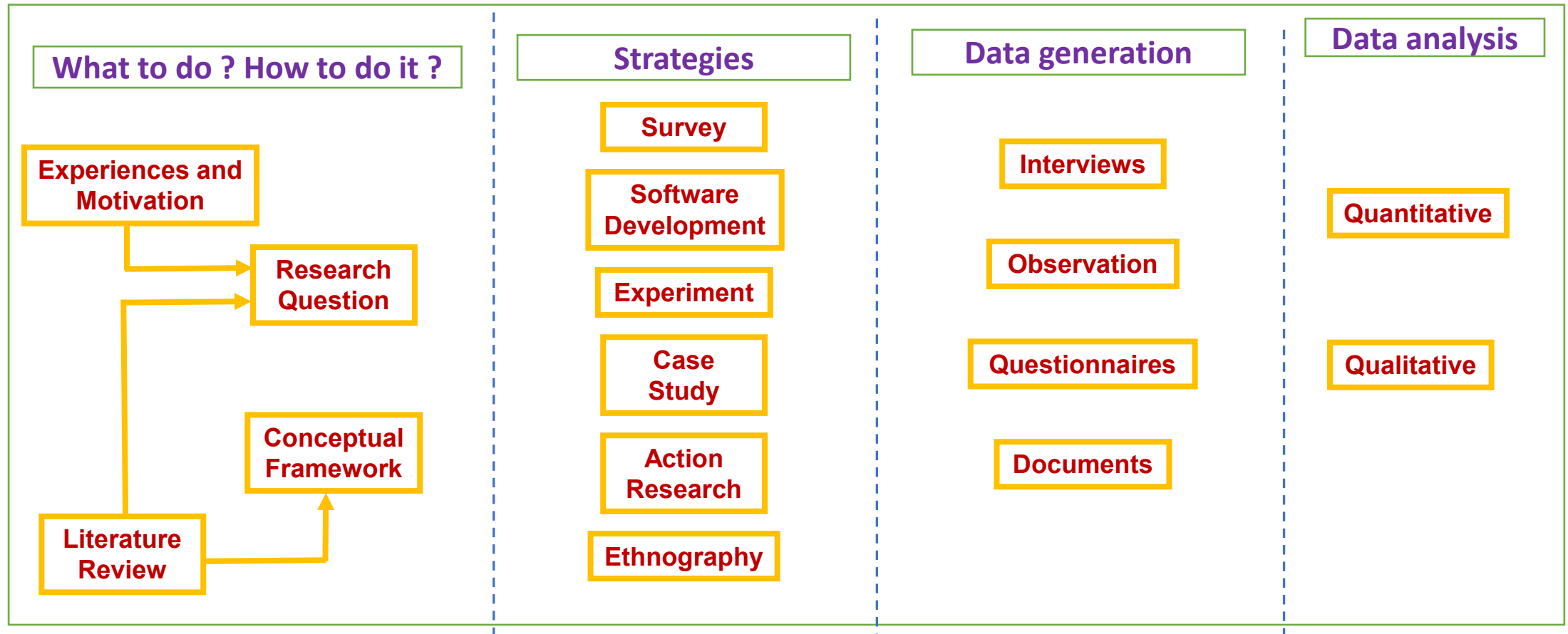


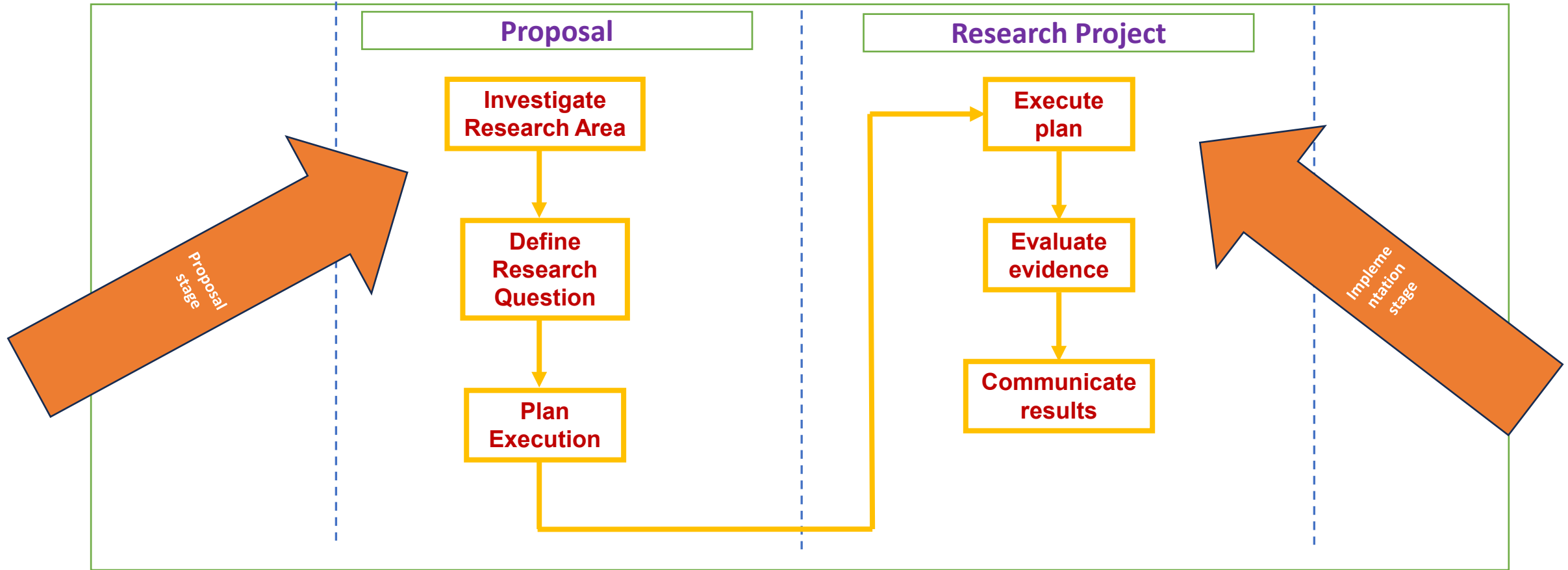
Research Methodology

The research process



(Oates, 2006)

The research process



Identifying the research topic

- What topic to research?
- Where can I get ideas?
 - Your strengths and interests
 - Your work, your job
 - Lecturers' ideas
 - The literature
 - Fit with career ambitions
- Must be rooted in academic theory (you'll compare your findings with previous studies & the academic literature)
- Can you access the data you'll need?

Research aim and objectives

- Most research topics have one overarching aim
 - The broad thing you are trying to achieve
 - Often mirrored in the title of the research
- This aim is then broken down into research objectives (typically 3 or 4)
 - The **things you will do** to achieve the aim

Research aim and objectives

- Example 1

The main aim of this study is to develop a clustering-based image segmentation algorithm that automatically identifies an optimum cluster count to represent the homogenous regions and uses a set of salient features that would work effectively on a large class of images with a more generalized approach and optimum performance.

The main aim of this study is accomplished by setting the following objectives:

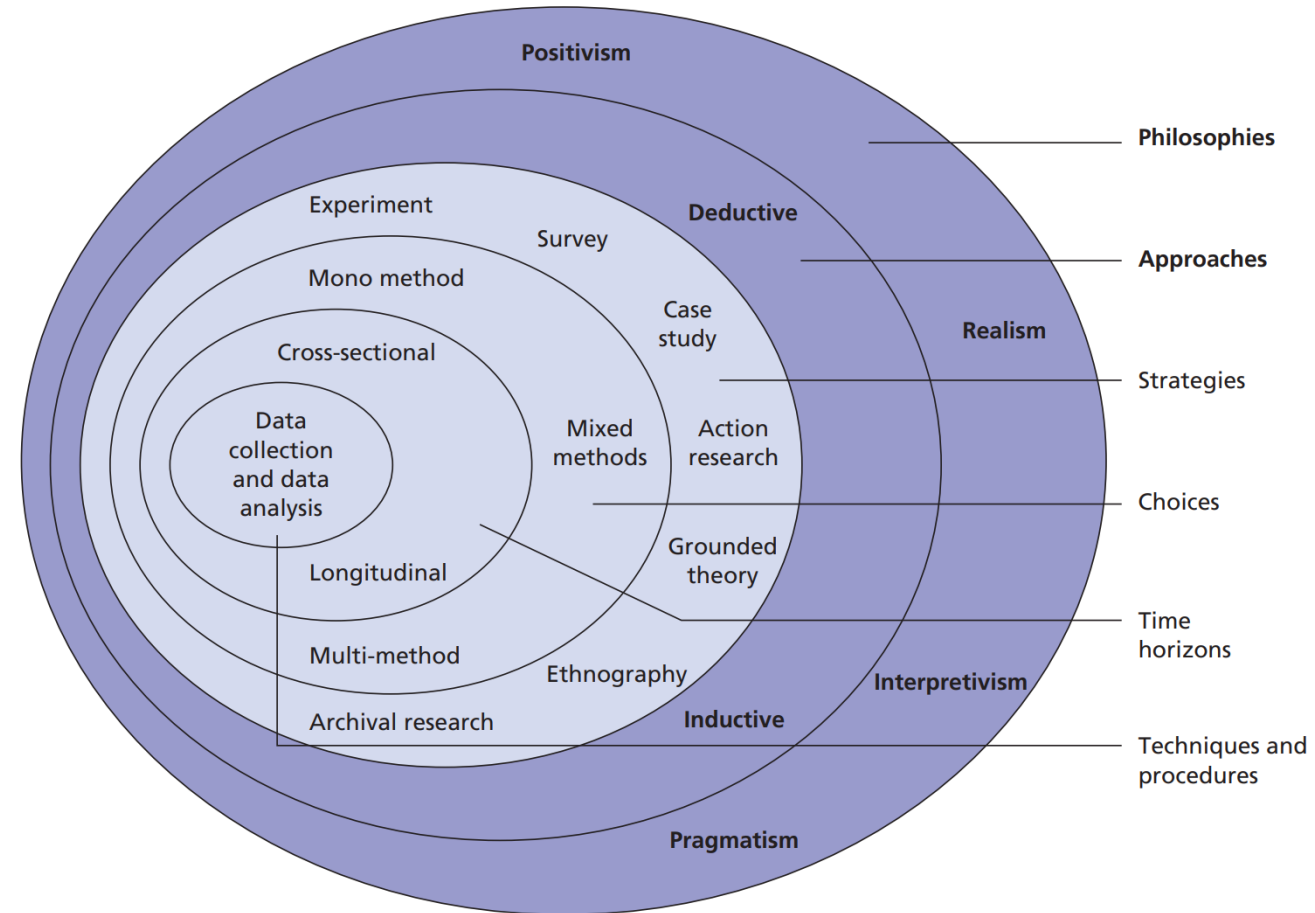
- To conduct a meta-analysis of existing studies on image segmentation methods.
- To develop an effective and efficient clustering-based image segmentation algorithm that automatically identifies an optimum number of clusters and integrates a set of salient features to increase the generalizability of the segmentation method.
- To investigate the effect of image preprocessing on the performance of the newly developed image segmentation algorithm.

Research aim and objectives/Questions

- **Example 2** : Research objectives and questions
 - **Research objective:** To analyse organisations' objectives for software development project teams
 - **Research question:** Why have organisations introduced project teams for software development?
- **Example 3:** Research objectives and questions
 - **Research objective:** To establish suitable effectiveness criteria for software development project teams
 - **Research question:** How can the effectiveness of software development project teams be measured?

Research Design

- Research Onion

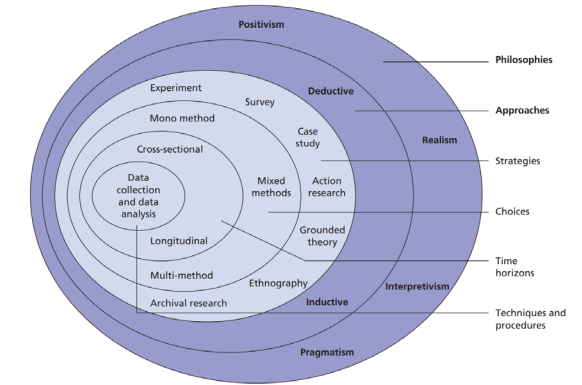


Saunders, et.al, 2009.

Research Onion

- Research Onion – an illustrative model for guiding the researchers on constructing a research design.
- widely accepted for research design
 - Mainly developed for business research
 - Popular in all discipline- used as framework for designing research
- Information system - > social science and natural science (mathematics, Engineering and Computer Science)

Research Philosophy and Paradigm

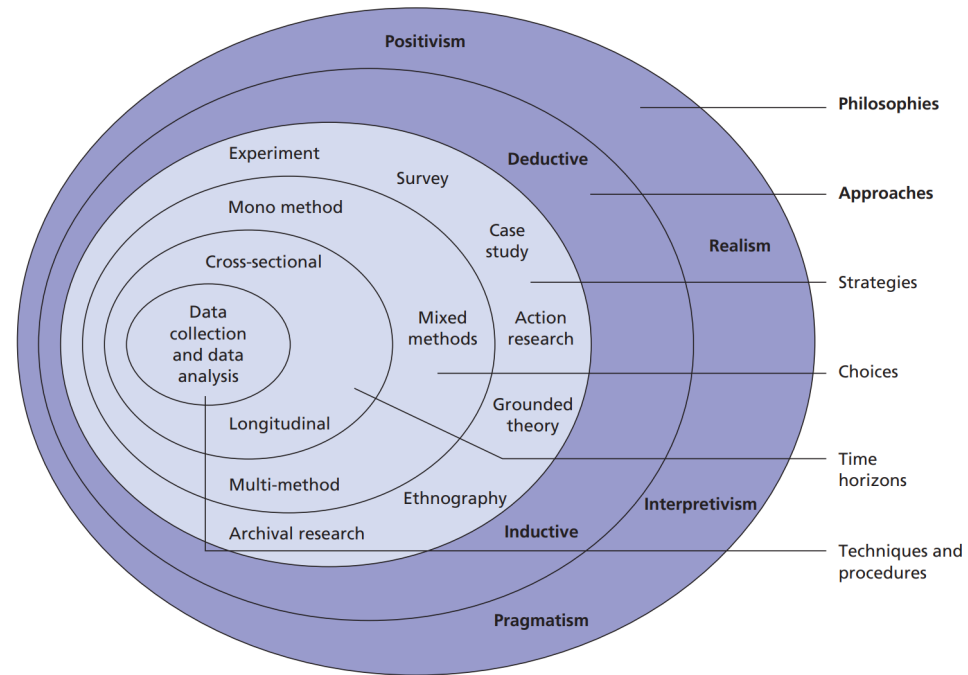


- Research philosophy and Paradigm
 - the set of beliefs, assumptions, and principles that underlie the way you approach your study.
 - System of assumption or belief about the development of knowledge
 - Research philosophy : set of beliefs concerning the nature of the reality being investigated.
 - Research Paradigm – from the Greek word ‘Paradeigma’ meaning pattern
 - Research philosophy – the researcher themselves
 - Research paradigm – the approach to the study

The research philosophy and the research paradigm form the foundation of your research study.

Research philosophy and Paradigm

- Positivism
- Interpretivism
- Realism
- Pragmatism



Research philosophy and Paradigm

- Research paradigm – Positivism

- Knowledge can be obtained through objective observations and measurements
- Empirical evidence
- Assumes that answers can be found by carefully measuring and analysing the data, particularly numerical data.
 - Experimental research design
 - Example 1 : In the domain of artificial intelligence (AI), positivist researchers may conduct experiments to test the performance of machine learning algorithms for image recognition. Researchers collect large datasets, define specific metrics for evaluating algorithm accuracy, and use statistical analysis to assess performance objectively.
 - Example 2 : investigate the relationship between a particular dietary supplement and weight loss.

Research philosophy and Paradigm

- **Research paradigm – interpretivism**

- Assumption is that the reality is subjective , and is socially constructed, i.e. it is constructed by the observer through their experience.
- Subjective interpretation
- Rely on qualitative methodology – interviews, observations, textual data
- Example 1 : in human computer interaction, researchers use the qualitative methods such as interviews and observation to explore user's experience and perceptions of digital interfaces.
- Example 2 : understanding the experience of individuals suffering from chronic pain... Conducting a depth interview with a group of participants and ask open ended questions about the pain, coping strategies, its impact on their lives etc.
 - insight can be obtained through engaging in conversation with and exploring the subjective experiences of people

Research philosophy and Paradigm

Research paradigm – Realism

- Realism is a research paradigm that emerged in the social sciences as a response to the limitations of positivism and interpretivism.
- Realism seeks to understand the underlying structures and mechanisms that shape social phenomena while acknowledging the role of both objective reality and subjective interpretation.
- It's about recognizing that there's a complex web of factors shaping the outcomes we observe.
- Example:
 - Realism can be applied in computer science to understand complex socio-technical phenomena such as bias in machine learning algorithms. Realists advocate for a critical examination of the underlying structures and mechanisms that produce biased outcomes, with the aim of developing a deeper understanding of the societal implications of technology.

Research philosophy and Paradigm

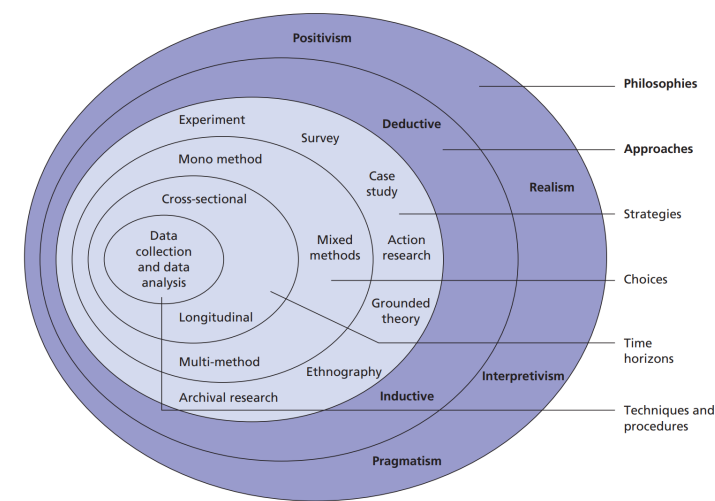
- **Research paradigm – Pragmatism**

- Pragmatism combines elements of both positivism and interpretivism, recognizing the value of empirical evidence as well as subjective interpretations depending on the research context and objectives. Pragmatist researchers prioritize practical outcomes and solutions.
 - Example 1 : In software engineering research, pragmatist approaches are prevalent. Researchers may adopt a mixed-methods approach, combining quantitative metrics (e.g., lines of code, bug fix rates) with qualitative insights (e.g., developer interviews, usability testing) to evaluate software development practices.
 - Example 2: Investigate the effectiveness of the new teaching methods in improving students learning outcome; One part of your project could involve comparing standardised test results from an intervention group (students that received the new teaching method) and a control group (students that received the traditional teaching method; person interview from both groups to gather qualitative data regarding their perceptions and preferences on the respective teaching methods.

Research philosophy and Paradigm

- Positivism : knowledge can be acquired by means of objective observations and measurements since reality exists independently of the observer.
- Interpretivism: adopts the (opposing) stance that reality is not an independent entity, but is instead subjectively created by the observer by their experience of it.
- Pragmatism : practical approach to solving problem; finding practical solutions based on observation and experiments.

Research Approach



- **Deductive**

- This involves developing a theory and hypothesis, and designing a research strategy to test that hypothesis
- e.g. You hypothesise that your new piece of software is better (faster, more usable, has more features) than an existing piece of software

- **Inductive**

- This involves collecting data, analysing it, then developing theory
- e.g. You develop a description of how businesses use Facebook for advertising based upon a survey of local businesses

Research Approach

- Deductive
 - Scientific principles
 - Moving from theory to data
 - The need to explain causal relationships between variables
 - The collection of quantitative data
 - A highly structured approach
 - Researcher independence of what is being researched
 - Large sample size to allow generalisations
- Inductive
 - Gaining an understanding of the meanings humans attach to events
 - A close understanding of the research context
 - The collection of qualitative data
 - A more flexible structure to permit changes of research emphasis as the research progresses
 - A realisation that the researcher is part of the research process
 - Less concern with the need to generalise
 - The inductive approach involves moving from specific observations to broader generalizations or theories

Research Approach – Best one ? Deductive or inductive ?

- Deduction:

- Is suitable when your research topic has a wealth of literature from which you can define a theoretical framework and a hypothesis
- Is about using theory to identify what data you need to collect

- Induction:

- Is suitable when the topic is new, has much debate and/or there is little existing literature
- Is about gathering data and trying to generate theories from it

Activity : Deductive or Inductive ?

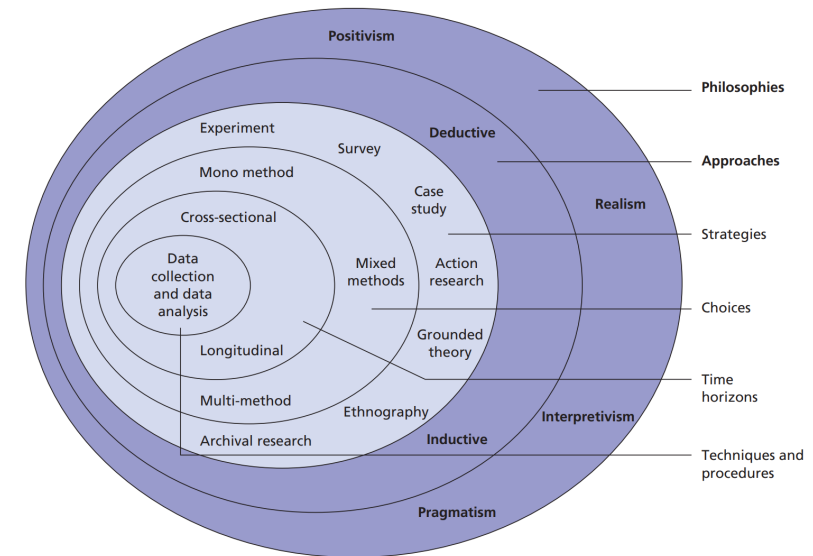
For each of the nine projects, identify a suitable approach for the study. Is it obvious which one you 'should' use or could you perform the study in more than one way?

- Investigating the factors responsible for network outages
- Finding out how to make a website easier to use
- Analyse how companies use social media for advertising
- Investigating the Impact of Financial Literacy Programs on Personal Savings Rates
- Examining the Relationship Between Exercise and Weight Loss
- Testing the Effectiveness of a New Drug for a Specific Medical Condition
- Exploring Patterns of Behavior in Online Gaming Communities
- Studying Leadership Styles in Innovative Companies
- Exploring Emerging Patterns in Social Media Usage Among Teenagers

Research strategy

Research strategy : A roadmap for researchers; A research strategy provides a framework for organizing the research process, collecting and analyzing data, and interpreting findings.

- Experiment
- Survey
- Case study
- Action research
- Grounded theory
- Ethnography
- Archival research



Research strategy

Experiment

- Experimentation sets out to examine the relationship between two factors (or variables) by manipulating one whilst measuring changes in the other

Hypothesis

- Your big question
- It must be phrased in a testable form

Experimental variables

- The factors you are going to investigate
- Independent variable (IV) – the thing you're going to control or manipulate
- Dependent variable (DV) – the thing you're going to measure
- Aim for: changes in the IV cause changes in the DV
- Examples:
 - We may test out three different e-commerce website designs and measure the effect on usability.
 - A computer scientist conducts an experiment to evaluate the performance of different machine learning algorithms for sentiment analysis. The researcher manipulates variables such as algorithm type, training dataset size, and feature selection methods. By measuring accuracy, precision, and recall on a standardized dataset, the researcher can determine which algorithm performs best under various conditions.

Research strategy

Survey

- An investigation into opinions through questionnaires or interviews
- Surveys involve collecting data from a sample of individuals through standardized questionnaires or interviews. Surveys are used to gather information about attitudes, opinions, behaviors, or characteristics of a population.
- The design of questionnaires and interviews is complex and must be prototyped before use
- All questions must be written with great care
- Respondents are questioned either verbally, in writing or via computer and their responses noted
- May be able to generalise from small samples to large populations
- Good for getting large amounts of subjective data in a short amount of time
- Good for 'what' and 'how' questions
- Example
 - A marketing researcher conducts a survey to assess customer satisfaction with a new product. The survey asks participants to rate their satisfaction levels on a scale and provide feedback on various aspects of the product.
 - A software developer conducts a survey to gather feedback from users about the usability of a mobile application

Research strategy

Case Study

- Case studies involve in-depth examination of a single individual, group, organization, or event.
- Involves gathering very detailed data and using it to explain what is happening
- Can be very time-consuming and requires good access to the phenomenon of interest
- Example:
 - visiting schools to investigate the use of iPads in the classroom.
 - cybersecurity analyst conducts a case study on a data breach incident to understand the root causes and mitigation strategies. The analyst examines the sequence of events, vulnerabilities exploited, and responses taken by the affected organization.

Research strategy

Action research

- Action research is a process where the researcher is simultaneously trying to investigate and solve a problem.
- The investigator should be part of the community impacted by the results of the research
- Collaboration between researchers and practitioners to address practical problems or improve practices in real-world settings. It typically follows a cyclical process of planning, action, observation, and reflection.
- Often used in education and business
- Example:
 - An educator collaborates with teachers to implement a new teaching method aimed at improving student engagement in the classroom. The educator observes the method in action, collects feedback from teachers and students, and adjusts the approach based on the results.
 - A network administrator collaborates with system users to address performance issues in a company's IT infrastructure. The administrator implements network monitoring tools to identify bottlenecks and performance bottlenecks.

Research strategy

Grounded theory

- Develop theories or explanations based on systematic analysis of qualitative data.
- Researchers collect and analyze data to identify patterns, themes, and categories, which are then used to develop theoretical frameworks.
- Example
 - A researcher conducts interviews with individuals who have experienced workplace discrimination. Through iterative analysis of the interview data, the researcher identifies key themes related to the nature, causes, and consequences of discrimination, leading to the development of a grounded theory of workplace discrimination.
 - A human-computer interaction researcher conducts grounded theory research to develop a framework for understanding user interactions with virtual reality interfaces. The researcher collects qualitative data through user observations and interviews. By analysing the qualitative data, the researcher develops a theoretical framework that explains users' behaviors, preferences, and challenges in interacting with virtual environments.

Research Strategy

Ethnography

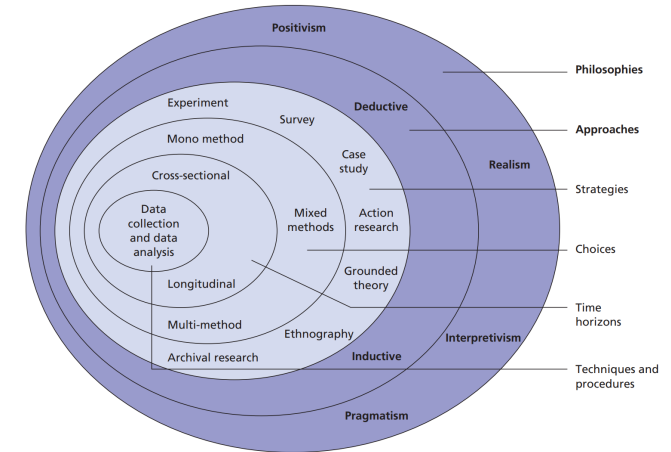
- Ethnography involves immersive, long-term fieldwork in naturalistic settings to study cultural phenomena from the perspective of participants.
- Ethnography is a qualitative research method where the researcher embeds themselves into an organisation to study how that organisation works.
- Researchers engage in participant observation, interviews, and document analysis to understand the cultural context and practices of a group or community.
- Example:
 - An anthropologist conducts ethnographic research in a rural village to study traditional farming practices. The researcher lives among the villagers, participates in daily activities, and documents agricultural techniques, rituals, and social dynamics.
 - A computer scientist conducts ethnographic research to study the culture and practices of software development teams in a large technology company

Research Strategy

Archival Research

- Archival research involves the systematic examination of historical documents, records, or artifacts to answer research questions or gain insights into past events, behaviors, or phenomena.
- Example:
 - A historian conducts archival research in a national archive to study the political dynamics of a historical period. The researcher examines government documents, newspapers, letters, and other primary sources to reconstruct the events and decisions of the era.
 - A computer historian conducts archival research to study the evolution of programming languages over time. The historian examines historical documents, technical specifications, and code repositories to trace the development of programming languages such as Fortran, C, and Java.

Research Methodology



- Methodological choice : Deals with the type of data that will be collected and analysed.
 - Qualitatively (Mono method)
 - Quantitatively (Mono method)
 - Mixed method - Combination of qualitative and quantitative methods
 - Multi method – one method either qualitative or quantitative; twice or more during the course of the research

Research methodology

- ***Qualitative research*** involves the collection of (soft) data that are open to interpretation, for example, people's opinions which cannot be generalised in numerical terms.
- ***Quantitative research*** – research that produces statistics (hard data)

Time Horizons

Longitudinal

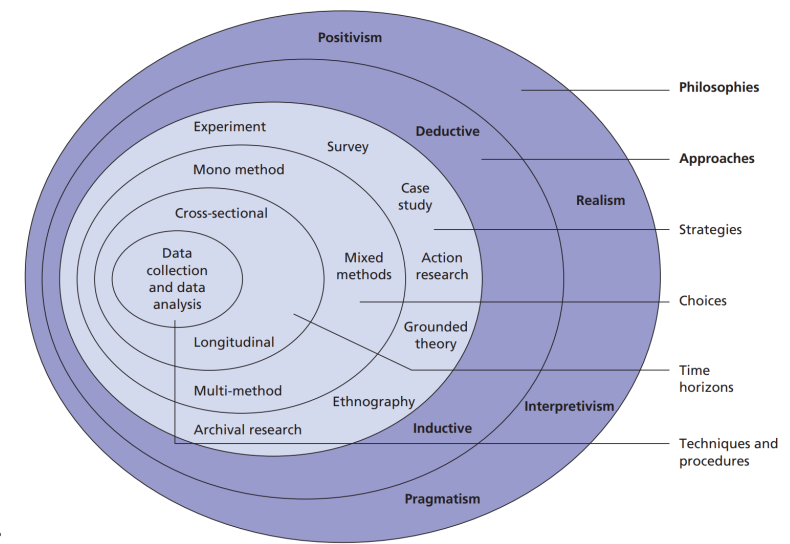
Cross-sectional studies

Longitudinal research extends over a substantial period of time and involves studying changes over time.

- Longitudinal research involves collecting data from the same group of subjects or participants over an extended period.
- Example
 - A longitudinal study tracking a cohort of children from birth to adulthood to investigate the long-term effects of early childhood interventions on academic achievement, socio-emotional development, and health outcomes.
 - tracking changes in software development practices or technology adoption over time within development teams or organizations

Cross-sectional research takes a 'snapshot' of a situation in time

- Cross-sectional research involves collecting data from a sample of subjects at a single point in time.
- Example
 - A cross-sectional study surveying adults of different age groups to examine the prevalence of mental health disorders and identify potential demographic, socioeconomic, or cultural factors associated with higher rates of mental illness.
 - assess current trends and preferences in areas such as programming languages or technology usage among software developers at a specific point in time



Research techniques and procedures

Data collection and analysis

- Data collection refers to the process of gathering information or data relevant to the research study. This can involve various methods depending on the research design and objectives, including questionnaires, interviews, observations, experiments, document analysis, or existing datasets.
 - **Research Design:** Data collection methods should align with the research objectives and chosen research design (e.g., qualitative, quantitative, mixed-methods).
 - **Sampling:** Researchers must carefully select the sample population or data sources to ensure they are representative of the target population and provide valid and reliable data.
 - **Data Quality:** Steps should be taken to ensure the accuracy, reliability, and validity of the collected data. This may include pilot testing instruments, using standardized measures, and implementing quality control procedures during data collection.

Research techniques and procedures

Data collection and analysis

- Data analysis involves the systematic examination and interpretation of collected data to derive meaningful insights, identify patterns or trends, and draw conclusions relevant to the research questions or objectives.
 - **Data Cleaning:** Raw data may need to be cleaned and organized to remove errors, inconsistencies, or missing values that could compromise the analysis.
 - **Statistical Analysis:** Quantitative data may be analyzed using statistical techniques such as descriptive statistics, inferential statistics (e.g., t-tests, ANOVA, regression analysis), or multivariate analysis to test hypotheses, identify relationships, or make predictions.
 - **Qualitative Analysis:** Qualitative data may be analyzed using techniques such as thematic analysis, content analysis, or grounded theory to identify patterns, themes, or categories within the data and generate explanations or theories.
 - **Interpretation:** Researchers interpret the findings of the data analysis in light of the research questions, existing literature, and theoretical frameworks. They draw conclusions, make recommendations, and discuss the implications of the findings for theory, practice, or policy.

Selecting your Methodology

Philosophy	Positivism			Phenomenology		
Approach	Deductive			Inductive		
Strategies	Experiment	Software Development	Document Review	Action Research	Ethnography	Case Study Survey

Reference

- Saunders, M., Lewis, P. and Thornhill, A., 2009. *Research methods for business students*. Pearson education.
- Oates, B.J., 2006. Researching Information Systems and Computing.