Descriptive Research
In Computer Science

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ABSTRACT

Descriptive research answers the question ”what?”, having its focus on finding facts and accurately describing the way things are, with the help of surveys or observations. It classifies, describes, compares, and measures data. It provides a foun- dational understanding of technologies and behaviors.

This paper explores descriptive research in computer science, focusing on defining it, its methods, ethical aspects, benefits, and limitations. It examines methods, tools, techniques, and discusses the importance of ethical practices such as protecting participant privacy and ensuring data security. While highlighting the strengths of descriptive research in providing comprehensive insights, the paper also acknowledges its limitations.

The conclusion emphasizes that despite these limitations, descriptive research remains an essential tool in computer science, contributing significantly to the field’s advancement and understanding. .

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Chapter 1

Introduction

The greatest art of a scientist is to discover new questions to explore. As Dr. Albert Szent-Gyorgyi, Nobel Prize winner said: *"Research is to see what everybody else has seen and think what nobody has thought"*. It is fundamental to understanding the world, providing evidence-based information and data, crucial for making deci- sions. It leads to discovery of new technologies and solutions to problems. It is the backbone of technological advancement, and it greatly contributes to the quality of life.

As a field defined by rapid innovation and technological breakthroughs, computer science continually presents new challenges and opportunities for research. This means that the more the field advances, the more diverse and creative research methods are needed. These methods are pivotal in shaping the direction and the impact of the field. This paper focuses on descriptive research, its challenges, importance and impact on the field.

1.1 Overview of Descriptive Research

Descriptive research is a straightforward and essential type of research used to describe what is happening or what exists. It focuses on answering questions like ”what is” or ”how many” rather than ”why” something happens. This approach is often used to gather information about a situation, a group of people, or an area of interest without changing the environment or condition. Descriptive research sets the stage for the other types of research, representing the first step in any project.

Descriptive research is useful because it gives a clear, factual base for understanding a topic, like taking a snapshot of a particular subject. These snapshots can help in many areas, like understanding consumer behavior in business, or study- ing social trends. They can also be a starting point for other types of research that explore why things happen.

In short, descriptive research is about collecting facts and details as they are. It helps to know more about different subjects in a simple and structured way. It collects insights with the help of different methods, it organizes the information and analyzes the data. This information is valuable for making decisions and understanding the world better.

1.2 Importance of descriptive research

If the raw data was simply presented in its original form, it would be hard to visualize what the data was showing, especially if there is a big quantity of it. Descriptive research therefore allows to present the data in a more meaningful way, which allows simpler interpretation of the data. It can help identify or better understanding patterns within the data, finding interesting relations among the variables. The following list presents examples of impact of this research:

- **Understanding User Behavior**: In computer science, understanding how users interact with technology is vital. Descriptive research can collect data on user experiences, preferences, and challenges, which provides insights into how people use the technology, and helps to create a better and more user-friendly system or application.
- **Trend Analysis**: It helps in identifying and analyzing trends within the field of computer science, which is essential for predicting future changes in computer science. For example, the Stack Overflow annual survey helps developers to be up to date to popular or potential new technologies.
- **Decision Making**: Data gathered through descriptive research assists in making informed and strategic decisions within organizations and industries related to technology. For example, understanding the current state of IT infras- tructure can guide investment and development decisions.
- **Benchmark and Standard Setting**: It helps establish benchmarks in areas like system performance, giving a standard that future technologies can aim to meet or exceed. By providing detailed data on current practices and technologies, this research contributes to the development of industry standards.
- **Education Improvement**: In computer science education, descriptive research can be used to assess the effectiveness of teaching methods, curricula, and student engagement strategies. This research can inform educators on how best to train the next generation of computer scientists.

1.3 Objectives of the paper

This paper aims to present descriptive research in the field of computer science, including its methodologies, tools and techniques. The objective is to highlight the role and the impact that this research has on this field and to explore its applicability in different subfields like software development, human-computer interaction and data analytics.

The paper is divided into 7 chapters, each addressing different aspects of the research. The next chapter presents the theoretical foundation of this research type, discussing its characteristics, history, evolution, and comparisons with other research methods. Chapter 3 then explains the research methods, tools, and techniques used. Chapter 4 focuses on the practical side of the research, demonstrating how to conduct it and offering a case study. Chapter 5 highlights the importance of ethical research practices, while Chapter 6 provides a list of benefits and drawbacks. Finally, the last chapter concludes the paper.

Chapter 2

Theoretical Background

2.1 Characteristics

In this section, there are presented the characteristics studied at reference [Adi23]

2.1.1 Quantitative Nature

Descriptive research in computer science often focuses on collecting data that can be measured and analyzed with numbers. This is called quantitative research. For example, it might involve counting how many times users click a certain button on an app or measuring how long it takes to complete a specific task on a computer. The idea is to gather information that can be expressed in numbers and then use statistics to understand what those numbers mean for a larger group of people. This approach is particularly useful for getting a clear and precise picture of user behaviors, technology usage patterns, or other measurable aspects of computer science.

2.1.2 Uncontrolled Variables

The researcher observes and records information without changing the environment or influencing the variables being studied. This means the researcher doesn't manipulate or control any aspect of the research setting or the subjects being observed. The goal is to see and record things as they naturally and normally occur. This approach is important because it gives a true picture of the situation or behavior being studied, without any alterations caused by the researcher's involvement.

2.1.3 Cross-sectional studies

This type of research often involves looking at different groups or sections of a population at one specific point in time. The aim is to get a broad overview of a situation or phenomenon by studying various aspects within a group. For instance, a researcher might study different age groups using a particular computer program to see how usage varies among them.

2.1.4 Foundation for Further Research

The information collected through descriptive research can be a starting point for more detailed or specific studies in the future. Researchers use this initial data to identify areas that need more exploration. The findings can suggest new questions to ask or new aspects of computer science to investigate more deeply.

2.2 Historical context and evolution in computer science

The use of descriptive research in computer science has a rich historical context, reflecting the evolution of the field itself. To understand its impact and development, it is important to explore how descriptive research has been intertwined with the growth of computer science over the years.

2.2.1 Early Beginnings

In the early days, when computers were a novel invention, much of the research was descriptive, aimed at documenting and understanding the capabilities and lim- itations of these new machines. Researchers focused on cataloging the functionali- ties, design, and operational aspects of computers.

2.2.2 The Rise of Computing Technology

As the technology evolved, descriptive research expanded to include the study of software, algorithms, and programming languages. Researchers began to systematically record and analyze the development and performance of various programming languages and software, leading to improved designs and more efficient computational methods.

2.2.3 Expansion into Human-Computer Interaction

With the advent of personal computing, the focus of descriptive research broad- ened to include human-computer interaction (HCI). This period marked the study of how individuals interact with computers, leading to insights that significantly influenced the design and usability of software and hardware.

2.2.4 The Internet Era

The explosion of the internet brought a new dimension to descriptive research in computer science. Researchers began to explore and document the rapidly evolving landscape of online communication, e-commerce, and digital information exchange. This era saw a significant shift towards studying network architectures, data trans- mission methods, and user behavior online.

2.2.5 Big Data and Machine Learning

The rise of big data and machine learning in recent years has further expanded the scope of descriptive research. Studies now encompass data patterns, algorithm effectiveness, and the impact of artificial intelligence on various sectors. This shift reflects the growing complexity and integration of computer science in everyday life.

2.2.6 Current Trends and Future Directions

Today, descriptive research in computer science continues to evolve, focusing on emerging technologies like quantum computing, blockchain, and the Internet of Things (IoT). Researchers are not only documenting the development and applica- tion of these technologies but are also exploring their societal impact and potential future developments.

Chapter 3

Comparison with other research methodologies

Descriptive research in computer science, while distinct, shares the landscape with several other research methodologies, each with its unique approach and pur- pose. The paper [Has16] identifies 4 other research methods and each of it will be compared to the subject of this paper.

3.1 Descriptive vs. Correlational Research

Descriptive research focuses on describing the current state of a phenomenon. It aims to accurately capture and present the characteristics of a specific situation or population without establishing cause-and-effect relationships.

Correlational Research seeks to identify relationships between variables. Unlike descriptive research, correlational studies go a step further to explore how one variable may be associated with changes in another. However, like descriptive research, it does not infer causation.

3.2 Descriptive vs. Exploratory Research

Descriptive research is more structured than exploratory research. It aims at presenting an accurate picture of an aspect of the world as it currently exists.

Exploratory Research is more open-ended and is often used in areas where there is little existing knowledge. It is used to explore new areas of inquiry, asking 'what' or 'how' questions without aiming for definitive answers as descriptive research does.

3.3 Descriptive vs. Explanatory Research

Descriptive research is about the 'what' of a subject. It does not delve into explaining why things are the way they are.

As the name suggests, explanatory Research aims to explain the reasons behind a phenomenon. It goes beyond description to explore cause-and-effect relationships, which is not a focus of descriptive research.

3.4 Descriptive vs. Analytical Research

Descriptive research involves observing and describing the state of affairs as they are, without looking to make any inferences or predictions

Analytical Research aims involves a deeper examination of data or content to understand underlying reasons, motives, or patterns. Analytical research often starts with what is known (sometimes derived from descriptive research) and then goes on to analyze the data to reach a deeper understanding or conclusion.

In summary, while descriptive research is pivotal in providing a foundational understanding and a clear picture of current phenomena in computer science, each of these other methodologies serves a different purpose in the broader research landscape. They range from understanding relationships (correlational), exploring new areas (exploratory), explaining phenomena (explanatory), to analyzing underlying patterns (analytical), each complementing the others in contributing to the comprehensive understanding of the field.

Chapter 4

Methodologies in Descriptive Research

4.1 Methods

Descriptive research in computer science utilizes a variety of methods to collect and analyze data [DW23] [LZ23]. Each method has its unique strengths and is chosen based on the specific requirements of the study. This subchapter outlines the methods used in descriptive research within the field of computer science.

4.1.1 Surveys and Questionnaires

Surveys and questionnaires are a straightforward yet powerful tool in descriptive research, especially in computer science. Surveys and questionnaires are sets of questions given to a group of people to answer. These questions are usually designed to find out people's opinions, experiences, or behavior related to a specific topic. They can be used for the following reasons:

- **User Feedback**: They can be used to get feedback from users about a new software or app. For example, after releasing a new version of an app, developers might use a survey to ask users about their experience with the new interface, any bugs or issues they encountered, or suggestions for improvement. This feedback is crucial for iterative design processes, where user input directly influences the following versions of the software.
- **Preference Studies**: Surveys can find out what kinds of technologies people prefer. For instance, a survey might ask users to rank different features of a smartphone in order of importance, like battery life, camera quality, screen size, etc.

- **Behavioral Studies**: They can also be used to understand how people use technology in their daily lives, like how often they use certain types of apps or software. Surveys can collect data on how frequently users engage with certain types of software, their typical usage patterns, or their attitudes towards emerging technologies like AI or VR. By analyzing this data, researchers can gain insights into how different user groups interact with technology, which can inform everything from user interface design to the development of new tech products.

These methods are useful since they can be sent to a large number of people over email or the internet, making it easy to get responses and to get a broad view of what a group thinks. Also, it is cheaper than other methods like interviews or experiments.

4.1.2 Observational Method

The observational method can be split in two categories:

- **Quantitative Observations**: This method is about counting things and recording numbers. For example, in a study about a new app, it might be counted how many times people click a certain button. This method is good for getting clear, number-based information. These numbers can be used to understand things like which features of a program are most popular or how long it takes to do a task on a computer.
- **Qualitative Observations**: Instead of numbers, this is about watching and noting what people do and how they behave. For example it can be observed how someone uses a new website and note if they seem confused or if they find it easy to use. Sometimes the person doing the study just watches without getting involved (complete observer), or they might partly join in (observer as participant). Other times, they might join in fully, either letting people know they're studying them (participant as observer) or not (full participant).

One of the best things about this method is that you can see how people naturally interact with technology, like how they really use a computer program in their daily work or how they shop for gadgets in a store. This can give you a real insight of what people like, don't like, or need in technology, which is very useful for making better tech products.

4.1.3 Case Study Method

The case study method in computer science is a focused, in-depth investigation of a specific instance or scenario. The case study method and the observational method in computer science research have distinct focuses and approaches, even though they might occasionally overlap in their use of observation as a data collection technique. The observational method is mainly about watching how people behave and interact with technology in real-life situations. The researcher just observes and takes notes, without changing anything or getting involved. On the other hand, the case study method is a bit different. It involves looking closely at a specific example, like how a particular software is used in a company. This method doesn't just rely on watching; it also uses other ways to gather information, like interviews or looking at documents. So, while both methods can involve watching and noting down things, the case study method goes deeper, using more ways to understand a particular situation.

4.2 Tools

A variety of tools and techniques are employed to collect, analyze, and interpret data. Some of the data collection tools include:

- **Online survey platform**s - enable researchers to design and distribute surveys efficiently .Examples: SurveyMonkey, Google Forms;
- **Observation software** – helpful in studies that require tracking and analyzing user interactions with technology. Examples: Heatmap Tools, Mouseflow (User Interaction Tracking Software), OBS Studio (Video Analysis Softwa
  Google Analytics for Mobile), EyeLink (Eye-Tracking Software), WAVE(Accessibility Evaluation Tools)
- **Interview Recording and Transcription Tools** - Digital recorders and transcription software (like Otter.ai or Rev) facilitate the recording of interviews and their transcription, which is essential for qualitative data analysis.
- **Database Management Systems**: Databases are crucial for storing and managing large volumes of data collected through various means. Tools like SQL databases, NoSQL databases, or cloud-based data storage solutions are commonly used.

When it comes to analyzing the data collected in descriptive research, especially in computer science, several straightforward techniques and tools are commonly used:

- **Statistical Analysis Software** - Programs like SPSS or Excel are used for working with numbers. They help in organizing data, doing calculations, and making graphs. After the responses from a survey are collected, these tools can be used to find out the average answer or see how answers are spread out.
- **Qualitative Data Analysis Software** - For information that's more about words than numbers, software like NVivo or ATLAS.ti is used. These programs help to sort through lots of text from interviews or observations, categorizing dif- ferent parts to find patterns or common themes.
- **Data Visualization Tools** - Tools like Tableau or Microsoft Power BI turn data into charts, graphs, and maps, making it easier to see patterns or explain findings to others. For instance, if a visualization of how many people use a certain type of software is required, a chart can make this clear and easy to understand.
- **Big Data Analytics Tools** - For really big sets of data, tools like Apache Hadoop or Spark are necessary. They can handle and analyze huge amounts of data much faster than traditional software, which is useful when dealing with data from sources like large-scale user interaction logs.

4.3 Techniques

Ensuring that the findings of descriptive research are reliable and valid is critical, especially in a field as precise as computer science. The following list contains techniques that are commonly used to reinforce the reliability and validity of research findings:

- **Pilot Testing**: Before starting the main research, a smaller version of the study, known as a pilot test, is often conducted. This helps to identify any issues in the research design, such as unclear survey questions or technical problems with data collection tools. For example, a pilot test might involve running a survey with a small group before sending it out to a larger population.
- **Inter-Rater Reliability Checks**: In studies where data is analyzed or interpreted by researchers (like observational studies), having more than one person analyze part of the data is helpful. This is to check if different people come to similar conclusions. For instance, two researchers might independently analyze the same set of user interaction videos and then compare their findings to ensure consistency.

- **Triangulation**: This involves using multiple methods or data sources to verify the results. If different approaches lead to the same findings, the results are more likely to be accurate. An example could be combining survey data with observational data to understand user behavior; if both data sets tell a similar story, the findings are more credible.
- **Regular Data Audits**: Periodically reviewing the data collection and analysis processes helps maintain the quality of the research. These audits can identify any errors or inconsistencies in the data. For example, periodically checking the data entered into a database for accuracy or consistency can help catch errors early in the research process.
- **Use of Established Research Tools and Methods**: Employing well-established and widely recognized tools and methods can also enhance the reliability and validity of the research. These tools and methods have been tested and refined over time, offering a degree of assurance in their effectiveness.

The tools and techniques in descriptive research in computer science are diverse, ranging from data collection to analysis and visualization. They serve to enhance the efficiency, accuracy, and integrity of the research, ensuring that the findings are reliable and valuable. The choice of tools and techniques depends on the research question, the nature of the data, and the specific requirements of the study.

Chapter 5

How to conduct Descriptive Research

Based on the reference [Edu23], conducting descriptive research in computer science involves several key steps, each crucial for ensuring the study is effective, accurate, and has valuable insights.

The process of conducting descriptive research begins with the careful selection of a research topic. Researchers choose a subject that sparks their interest, ensuring it is relevant and achievable for investigation. The next phase involves a review of existing studies, allowing researchers to deepen their understanding of the subject, find gaps in current knowledge, and refine their research questions. This review of literature guides the direction for the next step.

Then, the method for data collection is determined from the methods mentioned in the "Methodologies in Descriptive Research" chapter. Once the methodology is set, researchers focus on selecting a representative sample from a larger population.

During the data collection phase, researchers carefully gather information using the method they've chosen. They need to be very precise and accurate when recording the data. This data can be collected in different ways, like face-to-face, online, or using special computer tools. Once they have all the data, they organize it neatly so it's ready for the next step, which is analyzing it.

Analyzing the collected data is a key step in the research process. In this phase, researchers look at the data closely to figure out what it means and how it answers their original questions. They then make conclusions based on what they've found, considering how these fit with what's already known from another research. The final step is putting all of these findings into a report. This report starts with an introduction, goes over what other research has found (literature review), explains how the research was done (methods), what was discovered (findings), and what it all means (conclusions). The report often includes charts, graphs, and pictures to make the information clearer and easier to understand.

5.1 Case Study

A real-world case study in computer science is the analysis of user experience on a new e-commerce platform. A review of existing studies on e-commerce platforms is first conducted, helping in understanding the typical user experience challenges and expectations, and identifying gaps, particularly in the context of newer tech- nologies like augmented reality in shopping. The researchers then decide to use a mixed-method approach, combining surveys for quantitative data and user inter- views for qualitative insights.

The research team then focuses on creating a diverse sample that accurately represented the varied user base of the e-commerce site. This includes users from different age groups, geographic locations, and technological proficiency levels, and also attention is given to include both frequent online shoppers and those less accustomed to digital purchasing, as their experiences and perceptions could significantly differ. Data is collected through online surveys and virtual interviews. The survey questions are carefully designed to include user satisfaction, ease of navigation, and overall experience. The interviews provide deeper insights into user preferences and challenges encountered.

The survey data is analyzed using statistical software to identify common trends and patterns. The interview responses are qualitatively analyzed to draw out themes related to user experience.

The analysis aims to understand how the platform meets user needs and where it falls short, aligning these findings with existing literature on e-commerce user experience. After all this steps, a report is made with the findings.

Chapter 6

Ethical Considerations

These considerations ensure that the research is carried out responsibly, respecting the rights and well-being of all participants involved, and maintaining the integrity of the data collected.

Researchers must ensure that all participants in the study provide informed consent. This means participants are fully aware of the study's purpose, what it involves, and any potential risks or benefits. For online surveys or digital data collection, this often involves providing a clear and concise information sheet and obtaining consent electronically before participation. Respecting the privacy of participants is crucial.

Personal information must be securely stored and only accessible to the research team. Identifiable information should be anonymized or pseudonymized in research reports or publications. Researchers must ensure that it's impossible to trace back any data to individual participants. Compliance with legal and regulatory standards, especially regarding data protection laws like GDPR, is mandatory. Researchers must stay informed about and adhere to these regulations throughout the research process.

Ensuring the security of the data collected is a significant ethical responsibility. This involves safeguarding digital data using secure servers, encryption, and password protection, especially when handling sensitive information. Regular audits and checks should be in place to prevent data breaches or unauthorized access.

Researchers should be transparent about the aims and methods of their research. Deception or misleading participants about the study's nature, unless absolutely necessary and ethically justifiable, should be avoided.

Researchers must assess and minimize any potential harm or discomfort that might arise from the research. This includes psychological distress or discomfort due to the nature of questions asked or observations made. Special care should be taken when the research involves vulnerable groups or sensitive topics.

When presenting or publishing findings, researchers have an ethical obligation

to report their findings accurately and responsibly. This involves avoiding misinterpretation or exaggeration of the data.

For certain types of research, especially those involving human participants, obtaining ethical approval from an institutional review board or ethics committee is often required before commencing the study.

Chapter 7

Benefits and drawbacks

Descriptive research in computer science offers unique advantages but also comes with certain limitations. Understanding these benefits and drawbacks is essential for researchers to effectively utilize this methodology in their studies. Benefits include:

- **Providing a Detailed Overview**: Descriptive research is excellent for giving a clear and detailed picture of current conditions. It's particularly useful in understanding user behavior, system performance, and technology usage patterns.
- **Foundation for Further Research**: It lays the groundwork for future studies. By establishing a baseline understanding of a topic, it paves the way for more in-depth exploratory, correlational, or experimental research.
- **Flexibility in Data Collection**: This method offers flexibility in terms of data collection, which can include surveys, observations, and case studies, allowing researchers to gather a wide range of information.
- **Helpful in Developing Hypotheses**: Insights gathered from descriptive studies can lead to the formulation of hypotheses for further research, making it an integral part of the scientific process in computer science.
- **Applicability in Real-world Scenarios**: Descriptive research is particularly valuable for studying real-world scenarios, providing insights that are immediately applicable to solving practical problems.

Drawbacks of Descriptive Research include:

- **Lack of Control Over Variables**: Since this research does not manipulate variables, it's challenging to establish cause-and-effect relationships. It can describe what is happening, but not why it is happening.

- **Limited in Scope**: While descriptive research is great for providing a snapshot of the current state of affairs, its scope is limited to describing, rather than explaining or predicting phenomena.
- **Risk of Bias**: There's a risk of bias in data collection and interpretation, especially in qualitative descriptive studies like observational research or case studies.
- **Not Generalizable**: Findings from descriptive research, especially those based on case studies or specific samples, may not be generalizable to the broader population.
- **Potential for Misinterpretation**: Without the context of causality, there's a risk that the findings from descriptive research can be misinterpreted or oversimplified.

Despite these drawbacks, descriptive research remains a valuable tool in computer science, especially in the initial stages of investigating a new area or phenomenon. By being aware of its limitations and using it in conjunction with other research methods, researchers can significantly contribute to the understanding and development of the field.

Chapter 8

Conclusions

This paper described the role and methods of descriptive research in computer science, illustrating its importance in the field. Descriptive research, with its various methods like surveys, observational studies, and case studies, plays a key role in providing a detailed understanding of different aspects of computer science, from how people use technology to the performance of systems and software.

The discussion on ethical considerations, such as ensuring data privacy and obtaining informed consent, highlights the responsibility researchers have in conducting their studies ethically and with integrity. These ethical practices are crucial in maintaining the trustworthiness and reliability of the research.

In summary, descriptive research is an invaluable asset in the field of computer science. It provides fundamental insights that guide further research and contribute significantly to our understanding of technological phenomena. By using descrip- tive research methods responsibly, computer science researchers can continue to un- cover important findings that drive the field forward.

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