An Internship Report

on

Process Mining Virtual Internship

Submitted in partial fulfilment of the requirements

for the award of the degree of

BACHELOR OF TECHNOLOGY

in

Computer Science and Engineering (Data Science)

by

P.Pavithra   **214G1A3275**

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

(DATA SCIENCE)

SRINIVASA RAMANUJAN INSTITUTE OF TECHNOLOGY
(AUTONOMOUS)

(Affiliated to JNTUA, accredited by NAAC with 'A' Grade, Approved by AICTE, New Delhi & Accredited by NBA (EEE, ECE & CSE))
Rotarypuram village, B K Samudram Mandal, Ananthapuramu-515701.

2023 - 2024

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Certificate

This is to certify that the internship report entitled Process Mining Virtual Internship is the bonafide work carried out by **P.PAVITHRA** bearing Roll Number 214G1A3275 in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering (Data Science)** for three months from May 2023 to July 2023.

Internship Coordinator

Mr. P. Veera Prakash, M. Tech., (Ph.D.),
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Head of the Department

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Associate Professor

Date:

Place: Ananthapuram

EXTERNAL EXAMINER

PREFACE

Brief overview of the company's history:

Process mining has a rich history that dates back to the early 2000s. It emerged as a field of study at the intersection of data mining and business process management. Researchers and practitioners recognized the value of analyzing event data to gain insights into business processes. Over the years, process mining techniques and tools have evolved, leading to advancements in process discovery, conformance checking, and performance analysis. Today, process mining is widely used in various industries to improve operational efficiency, identify bottlenecks, and optimize processes.

- Who founded it

  Professor Wil van der Aalst founded

- What purpose and when

  The purpose of process mining is to gain insights into business processes by analyzing event data. It helps uncover the actual process flows, identify bottlenecks, measure performance, and discover areas for improvement. Process mining is used to optimize processes and make data-driven decisions. It is typically applied when organizations want to understand their processes, improve efficiency, and enhance overall operational performance.

Company's Mission Statement:

The general mission of process mining companies is to provide innovative solutions and tools that enable organizations to gain valuable insights into their business processes, optimize operations, and achieve operational excellence.

Business Activities:

Process mining involves the analysis of event logs to understand and improve business processes. Its business activities include process discovery, conformance checking, and process enhancement. It helps identify inefficiencies, compliance issues, and areas for optimization in various industries like manufacturing, healthcare, and finance.

ACKNOWLEDGEMENT

The satisfaction and euphoria that accompany the successful completion of any task would be incomplete without the mention of people who made it possible, whose constant guidance and encouragement crowned our efforts with success. It is a pleasant aspect that I have now the opportunity to express my gratitude for all of them.

It is with immense pleasure that I would like to express my indebted gratitude to my internship coordinator **Mr. P. Veera Prakash, Assistant Professor & HOD, Department of Computer Science and Engineering**, who has supported me a lot and encouraged me in every step of the internship work. I thank him for the stimulating support, constant encouragement and constructive criticism which have made possible to bring out this internship work.

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I also express our sincere thanks to the Management for providing excellent facilities and support**.**

Finally, I wish to convey my gratitude to my family who fostered all the requirements and facilities that I need.

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LIST OF ABBREVIATIONS

CRM   Customer Relationship Management

EMS   Event Management System

ERP   Enterprise Resource Planning

KPI   Key Performance Indicator

PQL   Process Query Language

SLA   Service Level Agreement

CHAPTER - 1

INTRODUCTION

Process mining is a data-driven technique that extracts valuable insights from event logs of business processes. It visualizes how processes truly unfold, identifies inefficiencies, and helps organizations optimize their operations for better efficiency and decision-making. By bridging the gap between theory and practice, process mining enables businesses to improve processes based on real-world data, fostering agility and informed process enhancement.

1.1 Introduction to Process Mining

Process Mining is a modern way to understand how businesses work using data. It's like a clear and complete picture that helps us see how things are really happening. This helps a lot in making good decisions and improving how things are done.

It's a big deal for making businesses better. When we use data to understand processes, we can do things in a smarter way. This has become really important for making businesses work smoothly and using technology to do things faster and better.

Think of it like a special tool for businesses that use computers and lots of real-time information to make their work even better. This is possible because of computer systems that help collect a lot of useful information. Process Mining saves time and money compared to other methods, which is something even experts agree on.

What is Process Mining?

Process mining is a data-driven approach that reveals how business processes truly work by analyzing digital footprints. It uncovers inefficiencies, bottlenecks, and deviations, aiding optimization and informed decision-making. It's like a digital detective, showing the real story behind operations.
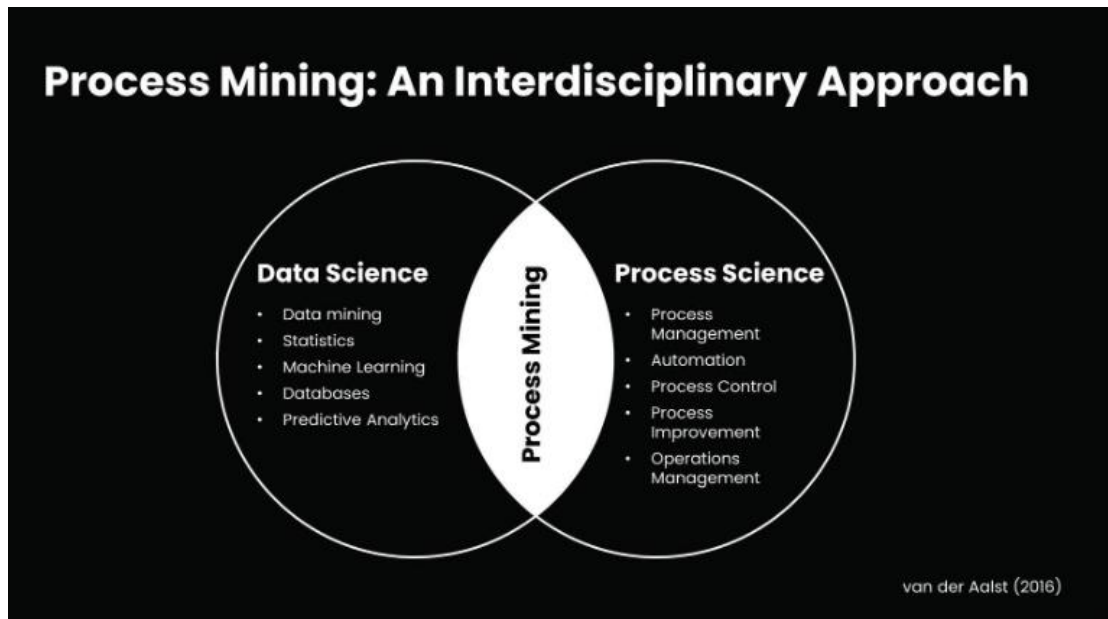
Fig. 1.1: Process Mining uses Data Science techniques to address Process Science problems

Importance of Process Mining

In a world driven by data, process mining emerges as a game-changer. It's the key to understanding how your processes really function, providing insights that drive informed decisions. With process mining, you can identify bottlenecks, optimize workflows, and enhance efficiency. It bridges the gap between theoretical models and practical execution, empowering you to streamline operations with precision.

From the fundamentals that lay the groundwork to the rising star technical insights.In the **Process Mining Fundamentals** section, we'll walk you through the essentials. Starting with the basics, you'll gain a solid understanding of what process mining is and how it works. We'll demystify event logs, process models, and the key concepts that underpin process mining.

This **Rising star technical** section is designed to equip you with the skills to handle the intricacies of process mining from a technical standpoint.Discover the art of extracting and preparing event data from diverse sources.Delve into the world of data transformation, event log formats, and integration techniques.

CHAPTER - 2

TECHNOLOGY

Process mining technology is an advanced approach that involves using data from various sources within an organization to understand, analyze, and improve its business processes. It's a data-driven methodology that unveils the actual flow of activities, decisions, and interactions within processes, providing insights to enhance efficiency and effectiveness.

✧ Process mining is a discipline that uses data to discover, analyze, and improve real-world processes. It can be used to:

1. **Discover** the actual process from event data. This can be used to create a visual representation of the process, which can help to improve understanding of the process and identify potential problems.

2. **Analyze** the process to identify bottlenecks, inefficiencies, and deviations from the desired process. This can be used to improve the efficiency and effectiveness of the process.

3. **Monitor** the process to track its performance over time and identify areas for improvement.

4. **Enhance** the process by making changes to improve its efficiency and effectiveness.

Process mining technology is the software and tools that are used to perform process mining. There are a number of different process mining technologies available, each with its own strengths and weaknesses.

Some of the most popular process mining technologies include:

1. **Celonis:** Celonis is a leading process mining software company that offers a suite of tools for discovering, analyzing, and improving business process.

2. **Minit:** Minit is a process mining software company that offers a cloud-based solution for discovering and analyzing business processes.

3. **Process Gene:** Process Gene is a process mining software company that offers a process mining platform that can be used to discover, analyze, and improve business processes.

4. **Disco:** Disco is a process mining software company that offers a process mining platform that can be used to discover, analyze, and improve business processes.

➢ The choice of process mining technology will depend on the specific needs of the organization. **Some factors to consider when choosing a process mining technology include:**

1. The size and complexity of the processes to be analyzed.

2. The level of detail required in the analysis.

3. The budget available for the project.

4. The skills and experience of the users.

❖ **Process Mining Technology involves**

1. **Event log:** An event log is a data source that process mining algorithms use to discover, analyze, and enhance process models. It typically contains information about the activities that were performed, the resources that were used, and the time that was spent on each activity.
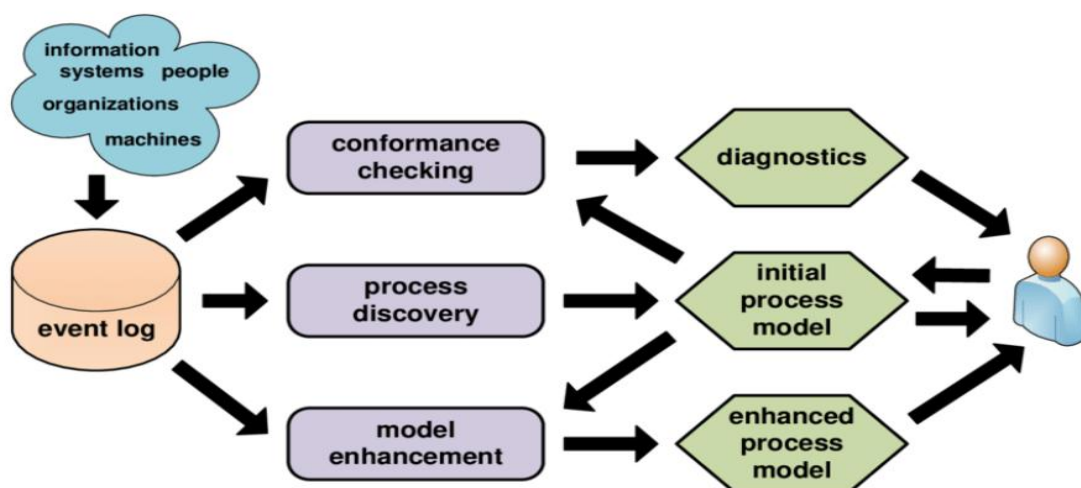
Fig. 2.1:Event log diagram in Process Mining Technology

2. **Process model:** A process model is a graphical representation of the process. It can be used to communicate the process to stakeholders, identify problems, and track the performance of the process.
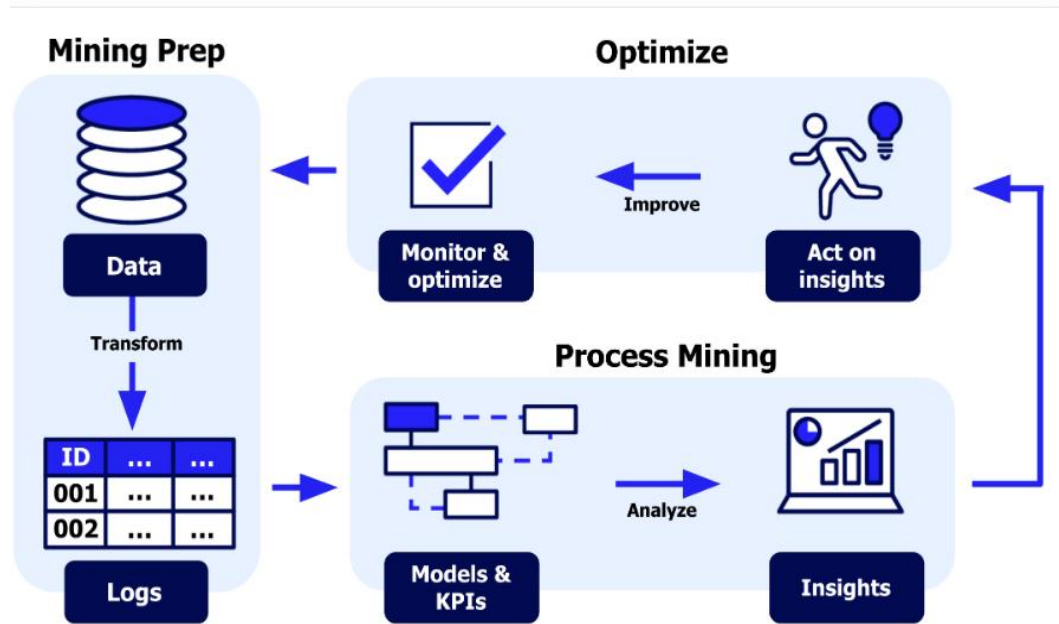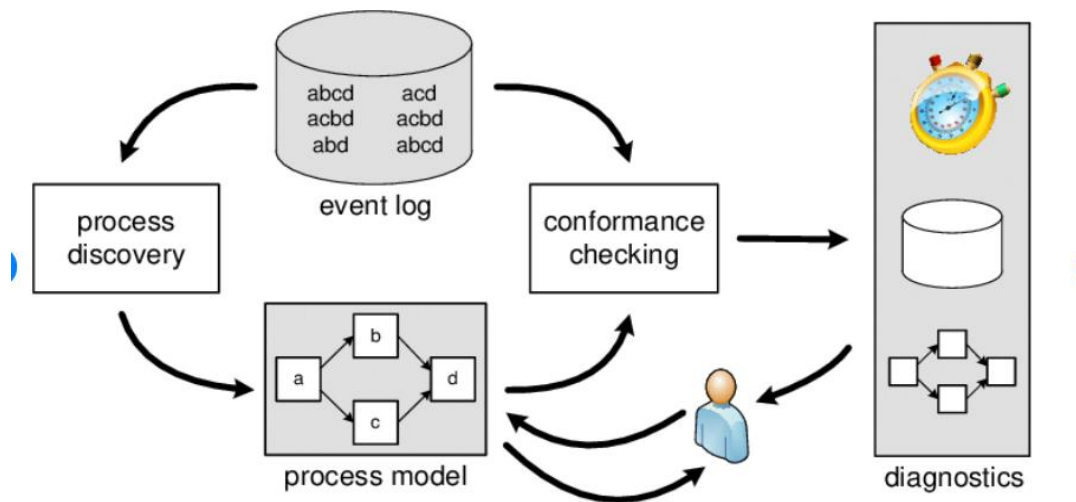

Fig. 2.2:Process Model Diagram in Process Mining Technology

3. **Metrics:** Metrics are used to measure the performance of the process. They can be used to identify areas for improvement and track the effectiveness of changes that have been made.

4. **Process discovery:** Process discovery is the process of finding the underlying process model from event data. This can be done using a variety of algorithms, such as the alpha algorithm, the heuristic miner, and the inductive miner.

5. **Conformance checking:** Conformance checking is the process of checking whether the actual process conforms to the desired process model. This can be done using a variety of algorithms, such as the conformance checking algorithm and the deviation detection algorithm.

Positioning process mining techniques.

Fig. 2.3:Enhancement diagram in Process Mining Technology

6. **Enhancement:** Enhancement is the process of improving the process model based on the analysis of event data. This can be done by adding new activities, removing unnecessary activities, and changing the order of activities.

CHAPTER - 3

APPLICATIONS

Process mining is a powerful tool that can be used to improve the efficiency and effectiveness of business processes. It can be used for a variety of applications, including:

1. **Discovering and documenting processes:** Process mining can be used to discover the actual process from event data. This can be used to create a visual representation of the process, which can help to improve understanding of the process and identify potential problems.

2. **Analyzing processes:** Process mining can be used to analyze the process to identify bottlenecks, inefficiencies, and deviations from the desired process. This can be used to improve the efficiency and effectiveness of the process.

3. **Monitoring processes:** Process mining can be used to monitor the process to track its performance over time and identify areas for improvement.

4. **Enhancing processes:** Process mining can be used to enhance the process by making changes to improve its efficiency and effectiveness.

5. **Compliance checking:** Process mining can be used to check whether the process complies with regulations.

6. **Root cause analysis:** Process mining can be used to identify the root causes of problems in the process. This can be used to take corrective action to improve the process.

7. **Fraud detection:** Process mining can be used to detect fraud by identifying patterns of behavior that are inconsistent with the expected process.

8. **Risk assessment:** Process mining can be used to assess the risk of a process by identifying potential problems and areas for improvement.

9. **Resource allocation:** Process mining can be used to allocate resources more efficiently by identifying bottlenecks and inefficiencies in the process.

10. **Customer experience improvement:** Process mining can be used to improve the customer experience by identifying areas where the process can be made more efficient and effective.

11. **Supply chain management:** Process mining can be used to improve supply chain management by identifying bottlenecks and inefficiencies in the supply chain.

Fig. 3.1: Process mining applications Diagram

These are just a few of the many applications of process mining. The specific applications that are used will depend on the specific needs of the organization.

CHAPTER - 4

MODULES

4.1 Process Mining Fundamentals

Process mining is a method that uses data to understand and improve how a business works. It looks at event data, like when tasks are done and by whom, and turns it into visual models that show how processes flow. By comparing these models with what's actually happening, companies can find ways to make their operations smoother and more efficient. Process mining also helps spot problems and gives insights for making better choices. It's like a map that guides businesses to work better, save time, and serve customers well.

Process mining is a discipline that uses data mining techniques to extract knowledge from event logs of business processes. The goal of process mining is to discover, analyze, and improve real-world processes by analyzing event data.

The three main types of process mining are:

➢ **Process discovery:** This is the process of creating a model of a process from event data. The model can be used to understand the process, identify bottlenecks, and improve the process.

➢ **Conformance checking:** This is the process of comparing a model of a process to the actual execution of the process. This can be used to identify deviations from the process and to improve compliance.

➢ **Enhancement:** This is the process of adding information to a model of a process. This can be used to improve the understanding of the process or to make the model more accurate.

The three main attributes of process mining are:

➢ **Event data:** This is the data that is used to create the process model. Event data typically includes information about the activities that are performed in the process, the resources that are used, and the time at which the activities are performed.

➢ **Process model:** This is a representation of the process. The process model can be used to understand the process, identify bottlenecks, and improve the process.

➢ **Process mining techniques:** These are the techniques that are used to extract knowledge from event data and to create process models.

4.1.1 Celonis Analyses

Celonis Analysis uses the Celonis platform to understand how a business operates. It starts by collecting data from different parts of the company, like sales and customer service. This data is organized and turned into a timeline of activities called event logs. Celonis then uses these logs to create pictures of how the business works, showing how things happen and where there might be problems.

It helps companies see if they're doing things the way they planned. For example, if a process isn't working well, Celonis can figure out why and show what needs fixing. It also keeps track of important numbers in real-time, so businesses can catch issues early. Celonis is like a helpful tool that guides businesses to make better decisions, improve the way they work, and make their customers happier.
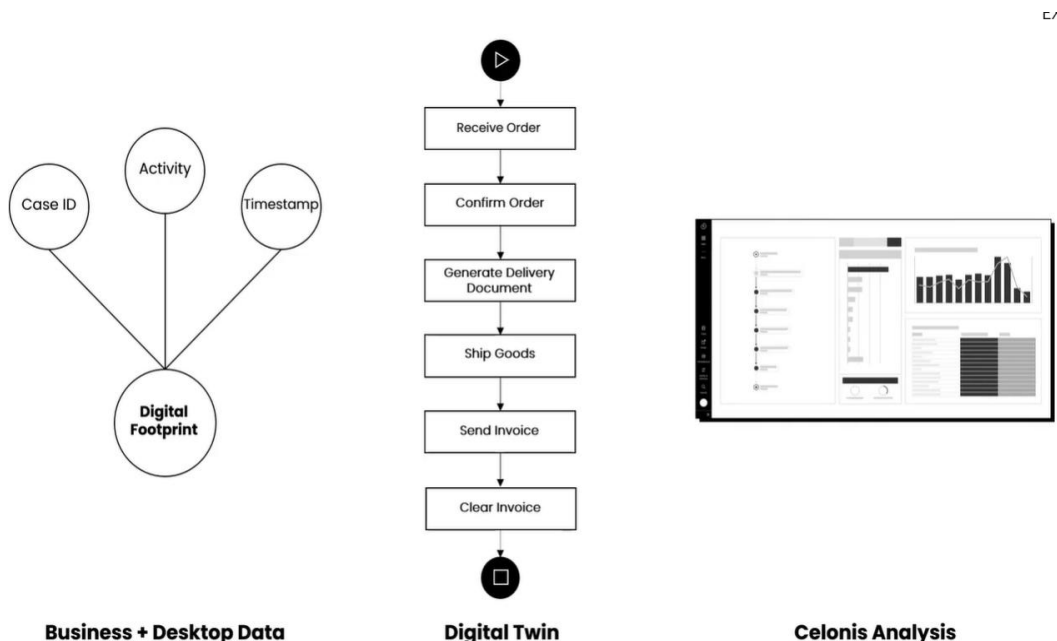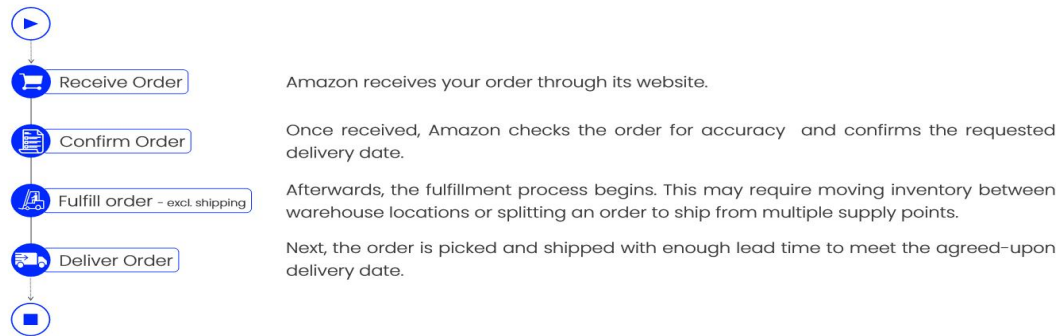

Fig. 4.1: Celonis Analysis

Fig. 4.2: Example for Celonis Analysis

4.1.2 Variability and Variant analyses:

Variability and variant analyses in Celonis are used to understand the different ways that a process can be executed. This can be done by identifying the different paths that a case can take through the process, as well as the different activities that can be performed at each step.

➤ **Process Variability:** Defining process variability as the existence of different paths in a process due to exceptions or choices.

➤ **Variant Analysis:** Explaining how variant analysis helps understand the frequency and implications of different process paths.

Here are some of the benefits of using variability and variant analyses in Celonis:

➤ **Improved understanding of processes:** Variability and variant analyses can help to identify the different ways that a process can be executed. This information can be used to improve the understanding of the process and to identify areas for improvement.

➤ **Identification of bottlenecks:** Variability and variant analyses can help to identify the paths through the process that are taking the longest or are causing the most problems. This information can be used to improve the process by removing or streamlining these paths.

➤ **Identification of opportunities for improvement:** Variability and variant analyses can help to identify the variants of the process that are causing the most problems or that can be improved. This information can be used to improve the process by making changes to the way it is executed.

4.2 Rising Star - Technical

"Rising Star Technical" likely refers to emerging and promising advancements in technical aspects within a particular context, such as process mining. It signifies a growing trend where innovative technologies, tools, or methodologies are gaining prominence and enhancing the capabilities of existing processes.

✧ Rising Star Technical mainly consists of two types :

1. **PQL Queries:**

➢ Basic Queries in PQL

➢ Joining and agregating data

2. **Get Data into EMS:**

➢ set up your Data pipeline

➢ Refine your Data pipeline

4.2.1 PQL Queries

✧ **Basic Queries in PQL**

In process mining, Process Query Language (PQL) is used to retrieve and analyze data from event logs to gain insights into business processes.The intention of Celonis PQL is to provide a query language for performing process mining tasks on large amounts of event data.The event and business data as well as all results (including the mined process models)are represented as relational data.

Currently, the supported data types comprise STRING, INT, FLOAT, and DATE. Boolean values are not directly supported, but can be represented as integers. Each data type can hold NULL values. In general, Celonis PQL treats NULL values as non-existing and ignores them in aggregations. Also, row-wise operations like adding the values of two columns will return NULLif one of its inputs is NULL.

some basic PQL queries:

➢ **SELECT * FROM Activities:** This query will select all activities in the process model.

➢ **SELECT ActivityName, AverageDuration FROM Activities:** This query will select the activity name and the average duration of all activities in the process model.

➢ **SELECT ActivityName, AverageDuration WHERE ActivityName = 'Order Placed':** This query will select the activity name and the average duration of all activities named "Order Placed" in the process model.

➢ **SELECT * FROM Activities WHERE ActivityName IN ('Order Placed', 'Order Approved', 'Order Shipped'):** This query will select all activities named "Order Placed", "Order Approved", or "Order Shipped" in the process model.

➢ **SELECT * FROM Activities WHERE ActivityName LIKE '%Placed%':** This query will select all activities whose name contains the word "Placed" in the process model.
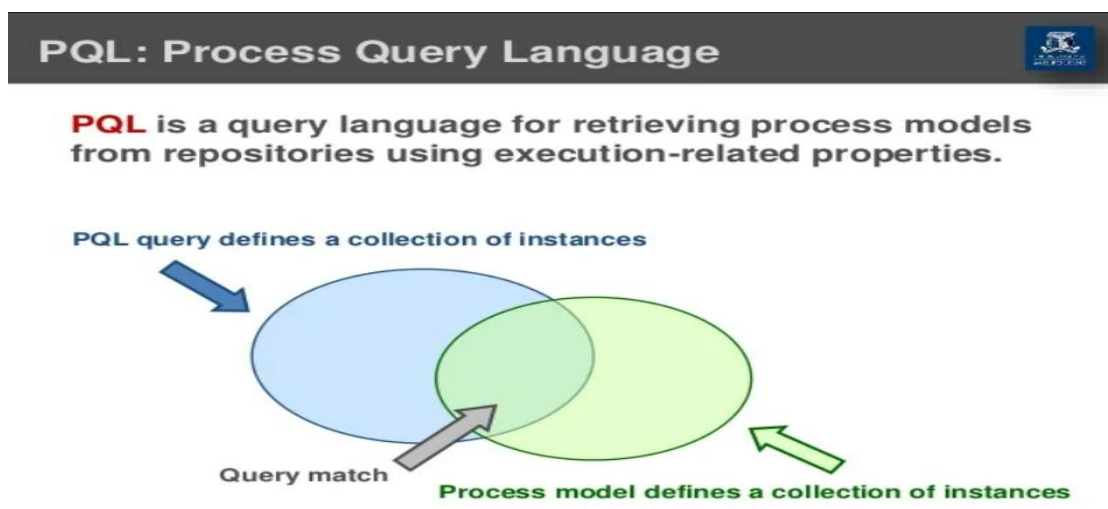

Fig. 4.3: Process Query Language

✧ **Design goals of PQL**

The first version of Celonis PQL was an extension to SQL. While it had several convenient process mining functions, the actual queries evaluated on the database were complicated. Furthermore,it was difficult to extend the language with new functionality. To overcome these issues, the query language was redesigned based on previous experiences, with the following design goals in mind:

➢ **Simplicity:** The query language should be easy to use for business users. Providing an easy way to translate complex process questions into data queries should make process mining accessible for business users.

➢ **Flexibility:** The query language should not include specialized functions. Instead, the goal is to provide a set of generic functions and operators that can be combined in a wide range of queries. This flexibility is very important, since the users should be able to formulate all their questions in the query language, regardless of the processes they address.

➢ **Event log-centered:** In contrast to SQL, the language should be designed to support dedicated process mining functionality. This should be reflected in the query language by process functions, which operate on the given event log.

➢ **Business focus:** Event data can be augmented with additional business information. It is therefore important to combine process mining and business intelligence (BI) capabilities within one query language.

➢ **Frontend interaction:** To simplify the use of the query language, the user should be able to formulate queries with support of a GUI. Consequently, the goal is to design a language that provides easy integration via GUI components. The simple query creation using a GUI is a key factor for the usability of a product, which results in high acceptance, usage, and adoption by the users.
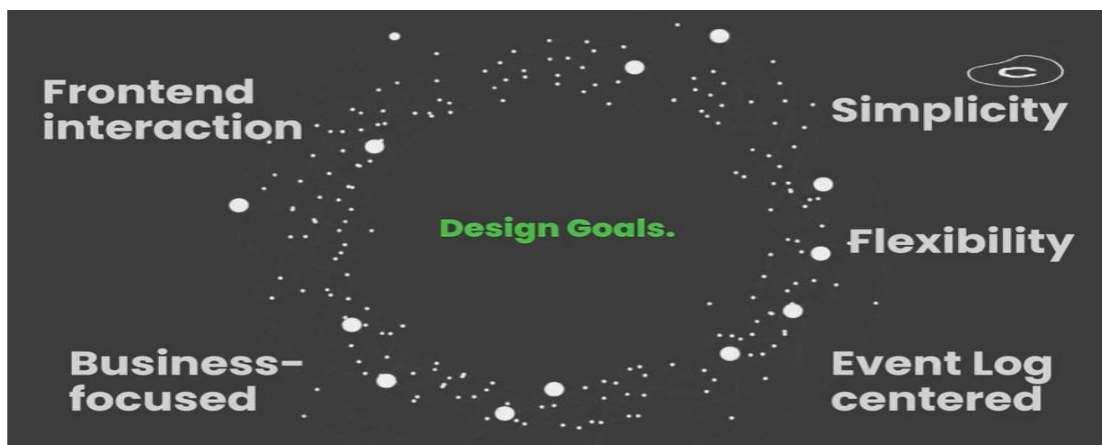

Fig. 4.4: Design goals of PQL

✧ Joining and Aggregating Data

➢ Joining Data in Celonis PQL:

Joining data involves combining information from different tables or sources. In Celonis PQL, you would typically use the JOIN clause to connect data based on common attributes.

For **example**, if you have event data in one table and customer information in another, you might join them to gain insights into customer-related process activities.

SELECT *

FROM EventLog

JOIN CustomerData ON EventLog.customer_id = CustomerData.customer_id;

➢ Aggregating Data in Celonis PQL:

Aggregating data involves summarizing information to extract meaningful insights. Celonis PQL provides functions for aggregation, such as COUNT, SUM, AVG, and more. You can use these functions to analyze patterns and trends in your process data.

For **example**, to count the occurrences of each activity in your event log:

SELECT activity, COUNT(*) AS activity_count

FROM EventLog

GROUP BY activity;

➢ To calculate the average duration of activities:

SELECT activity, AVG(duration) AS avg_duration

FROM EventLog

GROUP BY activity;

4.2.2 Get Data into EMS

As a data engineer or analyst working in Data Integration (formerly known as Event Collection), you're responsible for bringing in clean, real-time process data into the EMS. In other words, you build the data pipeline.

Without this data, no other activities can take place within the EMS and you won't be able to mine, improve, act on, or automate your processes.
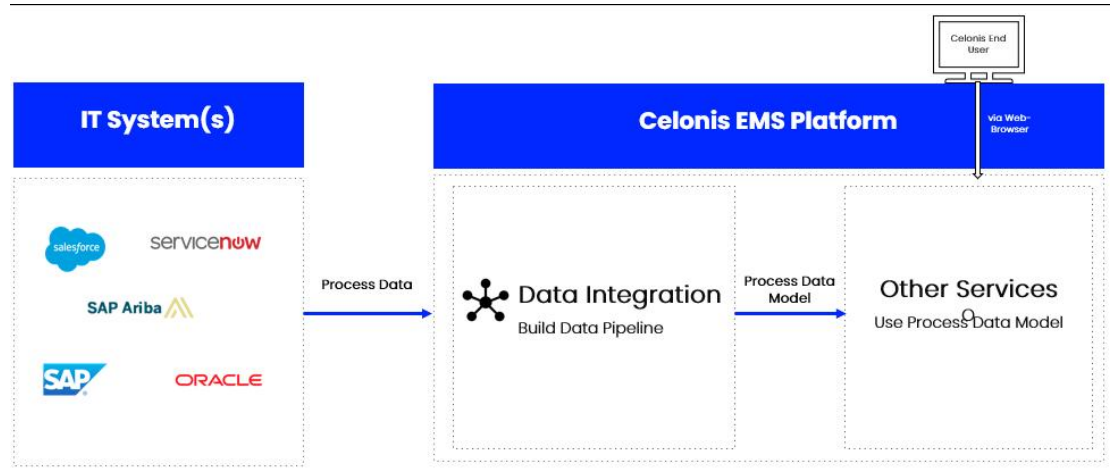

Fig. 4.5: Celonis EMS Platform

✧ Set up your Data pipeline

Data Integration helps you connect to source systems, extract the relevant data, transform it to your needs, and load it into a polished Data Model. You can think of the Data Model as the fuel to all other work in your EMS. Once it's ready, your team picks it up and can get started on analyzing it and acting on it.
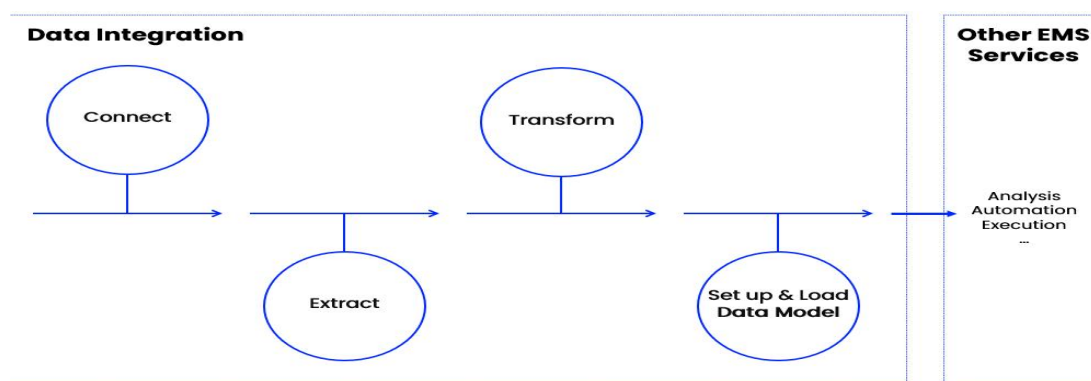

Fig. 4.6: Build up your Data pipeline Diagram

✧ Refine your Data pipeline

A data pipeline in the context of an Event Management System (EMS) involves the structured flow of event data from various sources through a series of processes to ultimately make the data usable for analysis, visualization, and decision-making in process mining.

Here's an overview of a refined data pipeline within an EMS:

➢ **Data Source Integration:** Gather event data from diverse sources such as applications, systems, sensors, and logs.Utilize connectors, APIs, or data ingestion tools to extract data in real-time or batch mode.

➢ **Data Ingestion:** Ingest the raw event data into the EMS environment.Ensure data quality and consistency through validation and cleansing processes.

➢ **Data Storage:** Store the ingested data in a structured format, such as a database or a data lake.Organize data based on timestamps, event types, or other relevant attributes.

➢ **Data Transformation:** Apply transformations to raw data to enhance its quality and usability.Convert data into a standardized format if required for analysis.

➢ **Data Enrichment:** Augment raw data with additional contextual information, such as customer details, product information, or geographical data.Enriched data provides a richer context for process analysis.

➢ **Event Correlation:**Group related events into sequences or cases based on timestamps or unique identifiers.Construct process instances that represent end-to-end process executions.

➢ **Data Aggregation:** Aggregate event data to create higher-level summaries and metrics.Calculate activity frequencies, average durations, and other relevant KPIs.

➢ **Data Storage and Management:** Store the transformed and enriched data in a structured manner for efficient retrieval.Implement proper data governance and access controls.

➢ **Process Mining Integration:** Connect the refined event data to a process mining platform for analysis.Utilize process mining tools to visualize and analyze process flows, bottlenecks, and variations.

➢ **Analysis and Insights:** Conduct process discovery, conformance checking, and performance analysis using the refined data.Generate insights to optimize processes, enhance efficiency, and improve customer experiences.

➢ **Visualization and Reporting:** Present process insights through dashboards, reports, and visualizations.Communicate findings to stakeholders for informed decision-making.

➢ **Continuous Monitoring and Improvement:** Establish a feedback loop to continuously monitor and improve the data pipeline and process mining insights.

CHAPTER - 5

Real Time Examples

Real-time examples for process mining:

➢ **Fraud detection:** Process mining can be used to detect fraud by identifying patterns of activity that are unusual or suspicious. For **example**,if a customer is trying to withdraw a large sum of money from their bank account, process mining can be used to identify if this is a legitimate transaction or if it is a fraudulent attempt.

➢ **Compliance monitoring:** Process mining can be used to monitor compliance with regulations by identifying deviations from the expected process flow. For **example**, a company that is regulated by the Food and Drug Administration (FDA) can use process mining to identify if any of its manufacturing processes are not compliant with FDA regulations.

➢ **Customer experience improvement:** Process mining can be used to improve the customer experience by identifying bottlenecks and inefficiencies in the customer journey. For **example**, a company that provides customer support can use process mining to identify if there are any long wait times or if customers are having to repeat themselves frequently.

➢ **Risk management:** Process mining can be used to identify risks by identifying potential problems in the process flow. For **example**, a company that operates a nuclear power plant can use process mining to identify if there are any potential safety hazards in the plant's operating procedures.

➢ **Resource optimization:** Process mining can be used to optimize resources by identifying ways to improve the efficiency of the process. For **example**, a company that operates a fleet of vehicles can use process mining to identify if there are any ways to reduce the amount of time that vehicles are idle.

➢ **Financial Services:** Digital banking—from mobile devices in particular—has become the norm. Ensuring that new customers are onboarded effectively and the experience of existing customers have is optimized requires visibility into user behavior. Process mining provides an up-to-date and continuous view of the whole process,giving customer experience teams the ability to tell precisely where processes can be improved.

➢ **Healthcare:** As data about patient experiences and outcomes continues to grow, the risks around maintaining population health and individual patient journey outcomes also increases. For healthcare organizations faced with an exponential increase in data, process mining helps deliver efficient and high quality end-to-end patient journeys, from before an initial doctor consultation through treatment regimens to closed treatment cases.

Fig. 5.1: Real Time Examples for Process Mining

CHAPTER - 6

Outcomes

❖ Outcomes of process mining:

1. An understanding of the different types of process mining

2. An understanding of the process mining lifecycle

3. An understanding of the different tools and techniques that can be used for process mining

4. The ability to identify potential applications for process mining in your organization

5. The ability to import data into Celonis

6. The ability to create process models in Celonis

7. The ability to analyze process data in Celonis

8. The ability to identify and improve process bottlenecks in Celonis

CHAPTER - 7

CONCLUSION

Process Mining helps us to optimize   service costs.It Interpret process visualizations and   analyses to identify process inefficiencies It Process the Huge data.Through the application of methods and techniques from the field of business process management,organisations can identify, model, analyse, deploy, and diagnose their business processes.

Process mining is a continuous process that can be used to continuously improve business processes. Process mining can be used to achieve a number of benefits, such as improved efficiency, reduced costs, improved customer experience, increased compliance, and enhanced decision-making. However, there are some challenges associated with process mining, such as data quality, process complexity, and lack of process knowledge.

Despite these challenges, process mining is a valuable tool that can be used to improve business processes. By overcoming these challenges, organizations can use process mining to achieve a number of valuable benefits.

INTERNSHIP CERTIFICATE

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