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UI Action Logger to Investigate Potential Robotic Process Automation Routines.

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Abstract: **-** Robotic Process Automation (RPA) is a cost-effective technology that emulates human tasks, reduces errors and enhances business performance. However, identifying ideal processes for RPA implementation can be challenging. Process Mining is a strategy that leverages User Interface (UI) logs to delve into processes and generate "process maps." These logs record user actions during processes, necessitating the use of a tool such as UI Action Logger to capture and transmit them to a cloud-based application for logging. Subsequently, Process Mining frameworks like ProM utilize these logs to construct process models, aiding in the identification of repetitive processes suitable for RPA automation. This innovative study shifts the focus of process mining from event logs to UI logs, simplifying the detection of potential routines. Enriched UI logs are valuable for creating RPA bots, conducting in-depth process analysis, task mining, and training RPA bots through machine learning, and selecting processes for automation. In summary, UI Action Logger offers distinctive features, capturing user interactions at a coarse level conducive to RPA implementation.

Keywords*: Action Logger, Petri nets, Process Selection, Robotic Process Automation, Robotic Process Mining, User Interface (UI) Logs, Software Bots*

1. Introduction

In an organization, the majority of business processes are monotonous and repetitive in nature, such as copying data from Excel sheets to other online forms, transferring information from one information system to other Enterprise Resource Planning (ERP) applications, and sending emails to a certain list in an Excel sheet. Some common business processes are Customer Registration, Banking, Purchase-to-Pay (P2P), Order-to-Cash (O2C), Inventory Management, Order Management, Procurement, and Customer Services Processes [1]. These tedious tasks are often performed by humans, and human actions play no role in any strategic decisions in these processes.

Organizations are continuously developing innovative technologies for automation[2]. Organizations reroute requests to humans for further help, such as processing medical claims or authorizing credits. Order processing teams, loan interviewers, back office teams, and fraud checkers perform clerical tasks that have high potential for automation. Automating these tasks in processes provides many benefits , like cost reduction, error reduction, enhanced feedback, and improvements in the performance of processes [3]. An example of a digital mundane task is “Create Question Bank.” This task involves copying a question from an Excel file and updating an Enterprise Resource Planning (ERP) system at a college to create a question bank. This task is typically done by a human user as depicted in Figure 1. The replication of the “Create Bank” process using Robotic Process Automation (RPA) as illustrated in Figure 2. In this scenario, an RPA bot performs the task without requiring human intervention. The UiPath RPA tool facilitates the creation of an RPA script by recording and analyzing user interactions. These scripts are then uploaded onto the organization's primary underlying system, which functions as an “RPA Bot.” Consequently, these repetitive tasks are efficiently executed by the RPA Bot, relieving human users of such responsibilities.

1.1. Robotic Process Automation:

Robotic Process Automation (RPA) is a recent advancement in lifting automation in business processes [3]. RPA creates a virtual workforce for tiresome and everyday tasks that were completed earlier by humans [4]. RPA assists in the automation of processes that are rule-based, standardized, error-free, and repeatable [5]. RPA builds virtual software bots on top of the underlying information system and does not disturb its functionality[6].

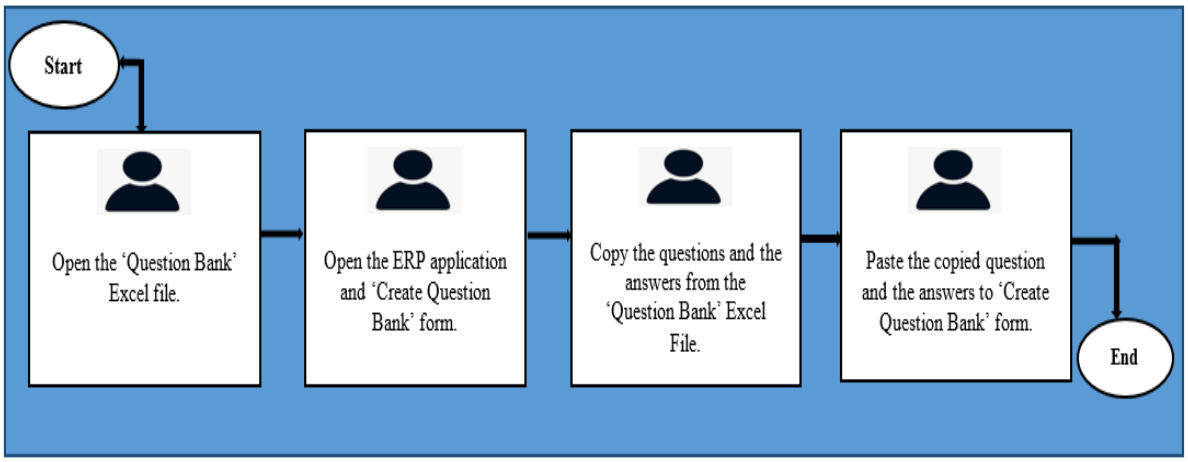

Figure 1: "Human User" performing routine tasks in the Question Bank system, Source: Self

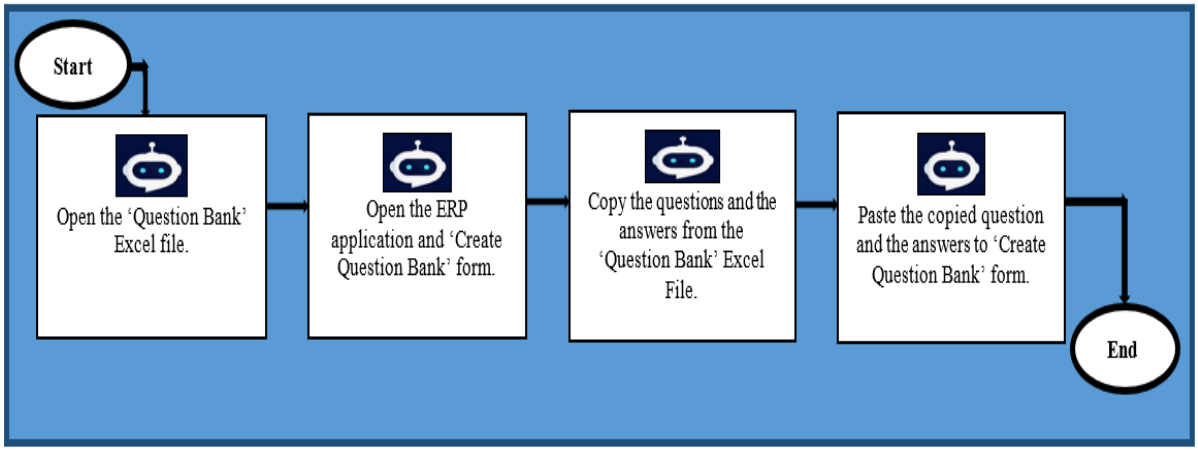

Figure 2: "RPA Bot" performing the same routine tasks of the Question Bank system, Source: Self

RPA mimics the behaviour of human-user interactions[7]. Big industries are nowadays harnessing the power of RPA, which includes education, healthcare, e-commerce [8], banking, finance, insurance, marketing, Fast-Moving Consumer Goods (FMCG), and Information Technology (IT)[9]. RPA utilizes advanced techniques of Machine Learning[10] and Artificial Intelligence: like Natural Language Processing (NLP)[11], Optical Character Recognition (OCR), face recognition[12], and image recognition as shown in Figure 3 to increase the cognitive abilities of "virtual software bots". The top RPA providers were Blue Prism, Automation Anywhere, and UiPath as per market share in 2020 [13]. Besides several advantages of RPA, every business process is not suitable for automation, if they are not standardized, more prone to errors, and required cognitive intelligence.

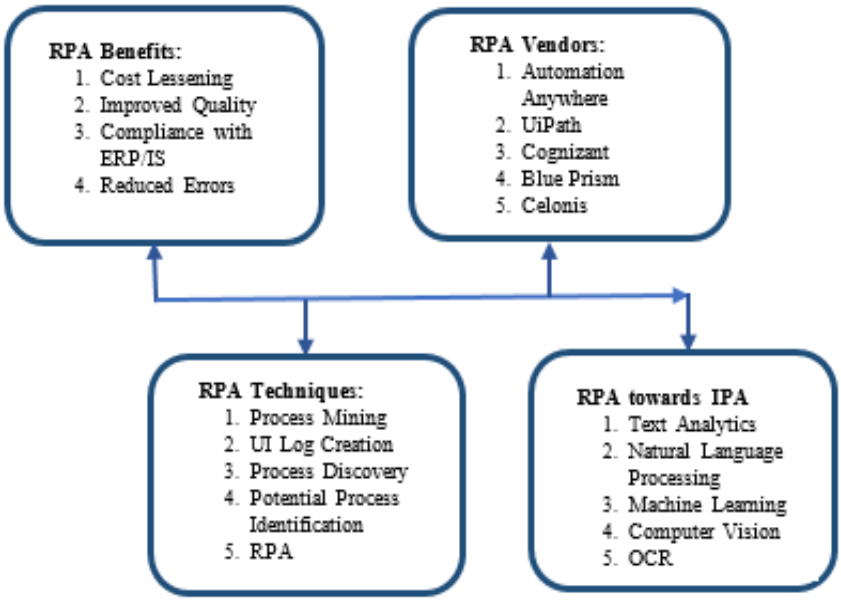

Figure 3: RPA Benefits, Vendors, Techniques, and use of AI/ML in RPA, Source: self

Creating RPA is quite expensive, so organizations generally pay more attention to the analysis phase of bot creation. A deep understanding of the tasks happening in a process, the use of the underlying IT system, and the interaction of a user with the system (UI logs) are required for creating a virtual workforce. The proposed methodology is based on Robotic Process Mining (RPM). Creating UI logs for RPM is the starting point to start the automation process. Robotic Process Mining is an ensemble approach used to deliver powerful insights into a business process[14]. Process mining extracts the execution sequence of a business processes from the underlying IT systems. These tasks are recorded in event logs, CRM logs and ERP logs to improve the business processes [15]. Event Logs includes case ID, timestamp, application name, coordinates of the clicks, etc. Numerous commercial tools are available for process mining that includes ProM, Celonis Process Mining, Disco, ProcessGold Enterprise Platform, Apramore, etc. A Process Model is a graphical representation of a process revealed in event logs, often known as User Interface (UI) logs [16].

2. Objectives

The RPA Technology had its early appearance in the 2000s. RPA is a set of software tools intended to automate repetitive and fixed rules-based business processes[17]. The phrase “ROBOTIC AUTOMATION” was coined in 2012 by Phil Fersht of Horses for Sources (HfS). Blue Prism's solutions are referred to as Robotic Process Automation (RPA) by Patrick Geary, the company's Chief Marketing Officer. Adoption of RPA initiatives not only saves money but also improves project agility and excellence [18].

Different key logger tools were discussed in the literature to record the behavior of a human interacting with the underlying system [19] . Furthermore, RPA vendors such as UI Path [20], Automation Anywhere, and BluePrism provide logging capabilities to capture process tasks so that they can be replicated during RPA bot generation. However, these logs are only compatible with and readable on the systems given. Volodymyr et al. [21] gave the closest possible proposal. The authors provide an action logger in this work to generate UI logs. These UI logs were mined for RPA achievements using process mining techniques. This approach does not consider the varied platforms used by RPA to produce RPA scripts for automation. An open-source approach is provided by [22] to solve the multiplatform issues. This tool captures the user interaction and stores it centrally. Jimenez-Ramirez [23] stressed in improving the analysis and design phases of a process for RPA. Logs are produced for mouse-keyboard events, and actions on screen with their timestamps. The image analysis approach is used to convert these data into UI logs. The study makes use of two BPO use cases. The future scope of this research is to remove the noise in the UI Logs and to accelerate further stages of RPA.

The literature presents two well-known approaches for identifying automatable routines. One approach is based on process characteristics, while the other relies on process mining. Aguirre et al. [24] highlight that RPA is effective for large, standardized operations with a propensity for human error. Bosco et al. [25] propose a method to locate automatable processes using recorded UI logs, considering routines with the longest sequence of deterministic activities as candidates for automation. Agostinelli et al. [26] introduce "SmartRPA," a cross-platform program based on Python and Flask frameworks that generates RPA scripts from UI logs, enabling the creation of software robots. V. Leno et al. [27] develop "Robidium," a tool that automatically generates RPA scripts from UI logs, assisting in the identification of automatable and non-automatable procedures. Robidium can be utilized as a Software as a Service (SaaS) tool for automating routine process operations.

Within a university faculty, a spreadsheet containing a student's internal grades is maintained as an Excel file. The total marks obtained by the student, determined by class tests and instructor evaluations, and are recorded in the Excel file illustrated in Figure 4(a).To generate the final mark sheet, these marks need to be uploaded onto the University's ERP Portal, as shown in Figure4 (b) Currently, a faculty member manually performs this task by copying the data from the Excel sheet and pasting it into the respective form fields provided by the ERP Portal for each subject. This becomes a repetitive task for faculty members handling multiple subjects. To address this issue, RPA technology offers the capability to automate this manual process using software bots. In order to assess the feasibility of automating the process depicted in Figure 4 all occurrences must be recorded. The task involves various User Interface (UI) operations, such as opening the Excel application, copying excel cells, creating a web form on the ERP site, and pasting data into the appropriate input fields (e.g., text boxes and checkboxes), among others. Previous research has proposed numerous approaches to determine the suitability of a process for automation. The proposed methodology in this context relies on Robotic Process Mining (RPM) to prioritize processes for automation. The UI Action Logger tool plays a vital role in generating logs that aid in further discovering the process model of the business process.

4	Branch/ SEM: B.Tech IIIrd Semester					
5	NAME OF FACULTY: Som Nath Dutta					
6						
7	S.NO	ROLL NO.	STUDENT NAME	CLASS TEST (30)	TEACHER'S ASSESSMENT (20)	TOTAL (50)
8	1	2000320140001	AANCHAL	10	20	30
9	2	2000320140002	ABHAY DEV	13	19	32
10	3	2000320140003	DHEERAJ DHIMAN	18	20	38
11	4	2000320140004	TIYA SETH	16	19	35
12	5	2000320140005	ISHA SHARMA	12	19	31
13	6	2000320140006	ADITYA NATH	7	20	27
14	7	2000320140007	AKANKSHA CHOUDHARY	14	20	34
15	8	2000320140008	AKARSHITA	12	19	31
16	9	2000320140009	DIVYA KUMARI	15	19	34
17	10	2000320140010	SHEENU KUMAR BHARDWAJ	17	20	37

Figure 4(a): Spreadsheet contains Student Records, Source: Self

Select Course MCA Select Branch Computer Science and Engineering(CSE) Select Semester I

Select Subject C Programming Select Subject MR01

Sr. No.	Roll. No.	Name	Total Marks	Maximum Marks	Remarks
1	2000320140001	AANCHAL		50	
2	2000320140002	ABHAY DEV		50	
3	2000320140003	DHEERAJ DHIMAN		50	
4	2000320140004	TIYA SETH		50	
5	2000320140005	ISHA SHARMA		50	
6	2000320140006	ADITYA NATH		50	
7	2000320140021	AKANKSHA CHOUDHARY		50	
8	2000320140021	AKARSHITA		50	
9	2000320140021	DIVYA KUMARI		50	
10	2000320140021	SHEENU KUMAR BHARDWAJ		50	

Submit your Marks

Figure 4(b): New Record Creation, Source: Self

Figure 4: A new record creation from spreadsheet data through an online form.

RPA has proven to be quite effective for existing business processes, but there are two key bottlenecks: (i) developing a UI logger tool and (ii) identifying acceptable RPA procedures. The back-office team of business organizations works on digital processes via peripheral companies' Information Systems (IS). Creating a UI log to observe the behavior of such a distributed team is quite challenging. So, a centralized and distributed cloud-based logging technique is required. The present research addresses this issue by presenting a cloud-based UI logger that can operate in a distributed environment. Furthermore, these enhanced user interface records can be used in process mining to identify suitable business processes for RPA implementation. This extensible tool attempts to make RPA more accessible to researchers and practitioners.

3. Methods

3.1 The Proposed Tool: User Interface (UI) Action Logger: Robotic Process Mining (RPM) leverages UI logs to uncover process models, enabling the identification of automation potential within a business process. However, existing tools for recording UI logs are inadequate and fail to capture task execution at a detailed level. Addressing this gap, this paper introduces a tool called “UI Action Logger for Robotic Process Automation.” Figure 5 illustrates the components of the UI Action Logger, which incorporates a cloud-based central repository to capture and store UI logs generated by various applications.

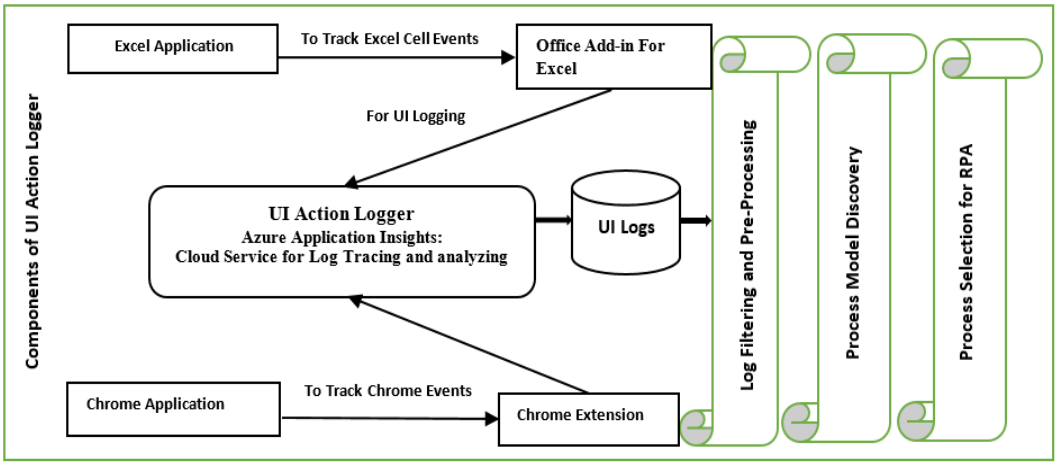

Figure 5: Components of UI Action Logger, Source: Self

3.1.1 Components of UI Logger: Three different components are used to make this UI Action Logger Tool. An Excel application, a Chrome application, and a logger application are the three different components of this tool. The description of all the components of this tool is covered in this section.

3.1.2 OfficeAdd-in for Excel: To interact with the content of the excel application an Office Add-ins (Excel tasks-pane add-in) platform is used. Office Add-in for excel files is used to track all the information about tasks or activities (Name of the cell which is selected and copied, data associated with it, name of the workbook, name of the worksheet, etc.) done by the user in an excel application. This add-in is created by web technology that includes HTML, CSS, JavaScript, and Node JS technology. The JSON data collected from this add-in is sent to the cloud service application (UI Action Logger) for creating the User Interaction logs.

3.1.3 Cloud Logging Server: We have created a WEB API in .net CORE which receives UI and Chrome Extension data logs and upload the same to the azure application insight cloud service for trace and log analytics. The endpoint is used by both the plug-in applications (Excel and Chrome Application) to post the UI Logs. The logger cloud service generates the UI logs as Comma Separated Values (CSV) files.

Steps to create CSV log files by the logger application:

i. The SendLog function (WEB API) issued in both Office-Add-in and Chrome extensions to post the logs in the cloud. Every interaction of a user with both applications is captured and the same is sent to the endpoint.
ii. One endpoint is created in .net core to communicate with application insights azure cloud service. The endpoint is used by both the plug-in applications (Excel and Chrome Application) to post the UI Logs.
iii. The endpoint is protected by a secure hash. The request payload which receives data from an excel file and chrome extension is in the form of properties in order to save the same in azure application insights. In the web API respective data model are created for the mapping purpose.
iv. The logger cloud service generates the UI logs as Comma Separated Values (CSV) files. Each log comprises precisely one (long) trace of UI actions accomplished in a single training session by a single user. Here we can extract log data and use it for further processing.

3.1.4 The Chrome Extension Recorder: The UI Recorder Chrome Extension as shown in Figure 6 showcases the UI Recorder Chrome Extension, designed to monitor and record events occurring on Chrome web pages. The UI Recorder utilizes a Manifest V3 (MV3) framework, consisting of HTML, CSS, and JavaScript, to act as an event listener. Through minimal executable JavaScript code, browser events at the Document Object level are tracked, and this code is then transmitted to the primary UI Action Logger program as JSON Objects for storage of UI logs.

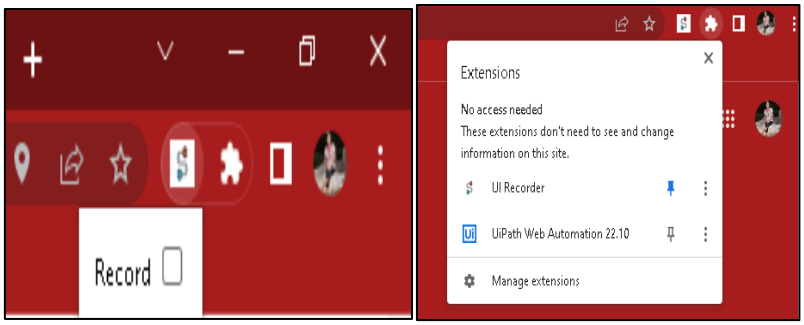

Figure 6 : UI Recorder

Exact Steps to record the UI Logs by Central Logging Server

i. Load the Office Add-in Application comprising the internal marks of a student→ Load the Task Pane and click on it.
ii. Load the Google Form→ Check the UI Recorder with the name "Record" to start recording the chrome browser events
iii. Copy and paste each value from the spreadsheet to the Google form. Submit the form.
iv. Stop the Recorder by checking the Record Checkbox on the Chrome recorder.
v. Once done, the Action Logger tool creates a CSV file of all the traces.
vi. These CSV files will be used to discover Petri nets.

4 Results

This section describes the results and outcome of this work. The UI logs created by the distributed cloud based UI Action Logger logs the results in a Comma Separated Values (CSV) file. This CSV file is then supplied to a process mining tool (ProM) and a process model is generated. This process model helps in identifying the candidate process for automation.

4.1 UI Logs: UI Logs serve as crucial inputs for Robotic Process Mining (RPM). They represent a chronological sequence of activities recorded during task execution, involving interactions with web applications or other information systems. Figure 7 illustrates the UIs and associated data captured by the UI Action Logger tool, which are stored in a CSV file.

4.2 Generation of Process Model and Candidate Routine Discovery:

ProM: Process Mining (ProM) is an extensible tool that offers a wide-ranging set of tools for the detection and analysis of process models from UI Event Logs [28]. It supports numerous Notations i.e. Petri nets, fuzzy models, BPMN, C-nets, etc. ProM is able to load and visualize the Business Process Model Notation (BPMN) models for process discovery. ProM is a tool that takes UI logs as inputs. The stored UI logs (stored as CSV) can be transformed into an eXtensible Event Stream (XES) extension. This extension is used in ProM to visualize the process model from UI Logs. The execution of individual tasks in an activity of a process is called a task trace. In our current example, the collection of executable task traces is called routines. The main aim of RPM is to recognize a monotonous sequence of UIs by considering the collection of task traces for automation.

Process Model (Petri nets) Discovery: Process Model is the graphical representation of a discovered process from event logs (UI Logs). Petri nets as shown in Figure 8 are useful for closer examination because they show differences between the observed and desired behavior of a process [29]. A Process Model is the graphical representation of a discovered process from event logs (Here in our case these are UI Logs). The main aim of building a process model is to provide insights into the process behavior. It is also called a Data Flow Diagram (DFD) that provides information about the flow of data or information within a system.A process model provides a differentiation between the actual process execution and the target process execution. Petri nets can be used for additional scrutiny; it also provides the deviations between the recorded and the intended behavior of a process [30].

	A	B	C	D	E	F	G	H	I	J	K	L
1	timeStamp	userID	targetApp	eventType	url	content	workbookName	sheetName	id	value	tagName	type
2	2023-01-16T05:47:16.126000		Chrome	paste	http://127.0.0.1:550(	12			t6		INPUT	text
3	2023-01-16T05:47:09.072000		Chrome	editField	http://127.0.0.1:5500/MarksFeedingDashboard.html				t6	14	INPUT	text
4	2023-01-16T05:47:08.408000		Chrome	paste	http://127.0.0.1:550(	14			t6		INPUT	text
5	2023-01-16T05:47:08.094000		Chrome	clickTextField	http://127.0.0.1:5500/MarksFeedingDashboard.html				t6		INPUT	text
6	2023-01-16T05:47:07.055000		Excel	editCell			Book 2.xlsx	JavaMarks	D15	14		
7	2023-01-16T05:47:01.185000		Chrome	paste	http://127.0.0.1:550(	7			t5		INPUT	text
8	2023-01-16T05:47:00.959000		Chrome	clickTextField	http://127.0.0.1:5500/MarksFeedingDashboard.html				t5		INPUT	text
9	2023-01-16T05:46:59.904000		Excel	editCell			Book 2.xlsx	JavaMarks	D14	7		
10	2023-01-16T05:46:53.944000		Chrome	editField	http://127.0.0.1:5500/MarksFeedingDashboard.html				t4	12	INPUT	text
11	2023-01-16T05:46:53.109000		Chrome	paste	http://127.0.0.1:550(	12			t4		INPUT	text
12	2023-01-16T05:46:52.718000		Chrome	clickTextField	http://127.0.0.1:5500/MarksFeedingDashboard.html				t4		INPUT	text
13	2023-01-16T05:46:51.856000		Excel	editCell			Book 2.xlsx	JavaMarks	D13	12		
14	2023-01-16T05:46:45.584000		Chrome	editField	http://127.0.0.1:5500/MarksFeedingDashboard.html				t3	16	INPUT	text
15	2023-01-16T05:46:44.768000		Chrome	paste	http://127.0.0.1:550(	16			t3		INPUT	text
16	2023-01-16T05:46:44.487000		Chrome	clickTextField	http://127.0.0.1:5500/MarksFeedingDashboard.html				t3		INPUT	text

Figure 7: UI Logs generated using UI Action Logger Tool, Source: UI Action Logger

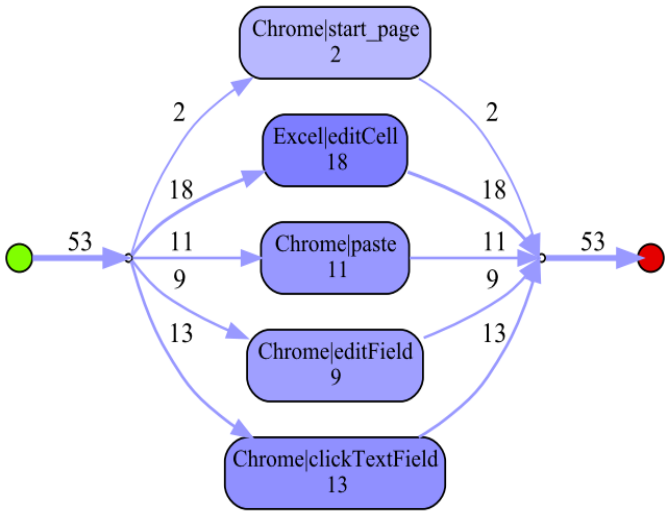

Figure8: Discovered Process Models (Petri nets) from the CSV UI Logs created by the UI Action Logger Tool, Source: ProM Software.

This process model is an input to the automation software's of RPA like UI path and Automation Anywhere. After following these process models, RPA scripts can be generated and one can easily identify an automatable and non- automatable routines. This tool hence helps in identifying the candidate routines in a process. Therefore, the process model and candidate routine discovery in this study are derived from this tool, which aids in the identification of potential routines within a process.

5 Discussion

One way to find tasks that can be done by robots is by asking employees for ideas. But that can be time –consuming and might not always get the best suggestions. Robotic Process Mining (RPM) is a better way to figure this out. It looks at how tasks are done in a company and finds which ones can be automated. RPM uses records of what people do on computer screens (UI logs). To start using RPM, you need these UI logs. This paper talks about a tool called the UI Action Logger. It keeps track of what people do on their computers when they're working. The tool does two main things: i) It records different actions people do and sends that information to a main computer and ii)The main computer then turns that information into organized files (CSV format). These files are made for programs that do Process Mining (like ProM). They help find tasks that happen a lot and could be done by robots. The UI Action Logger spots patterns in what people do on their screens and says which tasks could be done by robots. After that, special "software bots" can be made to do those tasks. This helps pick out the right tasks for robots to do. Right now, the goal is to use UI Path Studio to make robots do the tasks found in the UI logs. But sometimes, these logs have extra stuff that's not useful (noise).

In the future, it could be helpful to find ways to clean up these logs. Also, it would be good to use this technology for more than just tracking what people do in programs such as MS Excel or Chrome. It could be used for other programs such as ERP systems, payment systems,and sign-up systems too.

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