IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-6, Issue-11, Nov 2018 E-ISSN: 2347-2693

A Comparative Case Study of Business Process Model with Petri Nets and Process Activity Diagram

Aruna Devi .T[1*], Kumudavalli M.V[2], Sudhamani[3]

[1]Research Scholar, Rayalaseema University, Kurnool, Andhra Pradesh - India
[2] Department of Computer Applications, Dayananda Sagar College, Bangalore - India
[3]Vivekananda College for Women, Bangalore - India

Available online at: www.ijcseonline.org

Accepted: 23/Nov/2018, Published: 30/Nov/2018

Abstract— Business with information technology has bought a revolutionary change in the digital world in terms of the huge amount of data available for processing. Mining techniques are playing a key role in enterprises as it is being used to search vast amounts of data for vital insight and knowledge. The sheer amount of data is posing challenges in terms of representation, analysis etc., which has given emphasis to pictorial representation of the same which for easy visualization and understanding. The mining tools are automated software tools used to achieve business intelligence by finding hidden relations, and predicting future events from vast amounts of data. This uncovered knowledge helps in gaining completive advantages, better customer relationships, etc. To process the data the techniques of process mining is used to discover and analyse the process. Process activity diagrams are often used to model business processes. One of the important modelling artefacts used is the activity diagrams which are further used to model the sequence of actions as part of the process flow. Process mining techniques use Petri nets which are best investigated process modelling language allowing for the modelling of concurrency. This paper emphasizes the comparison of the given process activity model to corresponding petri nets for analysis and verification. The process activity diagram and petri nets are used to demonstrate the applicability of process mining techniques.

Keywords— Business Processes, Process Mining, Process Activity Diagram, Petri Nets

I. INTRODUCTION

Information systems are becoming more and more tangled with the operational processes they support. As a result, masses of events are recorded by today's information systems. Most organizations spend a lot of resources for implementing, analysing and managing their business process models. Organizations have problems to extract value from these data and to analyse the process. Hence the data can be represented as graphical representation for visualization of the data which is clear to analyse. Therefore tools or techniques that can help to reach these goals are required. Process mining is a new research agenda, which helps to gain more insight about their organization's processes. The aim of process mining is to use event data to extract process related information, e.g., to automatically discover a process model by observing events recorded by some enterprise system [1]. Process mining can be considered to be the x-ray or photo copy of the process, which shows the reality that occurs within the organization. In many cases, the process that is executed in an organization can have many differences with the process that is expected to be running. This can be because of several reasons such as management changes, infractions and so on. Process mining extracts valuable knowledge for users and brings transparency for them by analysing event logs that are stored in the information systems of organizations. Process mining techniques often work with event logs as input [2]. The types of objectives that require mining techniques to apply on business processes are extracting the bottlenecks of a process, improving a process, detecting the deviations in a process, analysing the performance of a process, identifying the best and worst employee involved in a process. The other method is represented by UML tool which is considered as an industry standard modelling language with a rich graphical notation, and comprehensive set of diagrams and elements for visualize the process. Business people can build models and diagrams to help put things into proper perspective. UML can be used as an analysis tool in business modelling to help increase the complexity and depth of the event that is being developed. Activity diagram is an important component of the set of diagrams. Activity diagram in synchronous language framework to arrive at executional models which will be useful for analysis. The activity diagrams that can be used to model sequence of actions as part of the process flow. The modelling language focuses on the control flow of process models such as extracting activity orders which can be visualized in different form like BPMN, Petri net, EPCs and UML activity diagram [3, 4, 5].

The research paper is organized as follows, Section I contains the introduction, Section II contains related work, Section III explains the concept of process mining, Section IV contains some of the process models used, Section V deals about unified modelling language, Section VI discuss about petri nets, Section VII and VIII describes the process activity diagram and petri net model, Section IX describes business process case study, Section X compares both process activity diagram and petri net model, Section XI concludes research work.

II. RELATED WORK

Business process modelling provides the conceptual artefacts by supporting the management for organizational processes and their continuous change [6]. Business experts have made various efforts to grow the business process for the organization. It is necessary to update and revise business processes periodically in order to achieve improved organizational performance enabling the organisation to deliver quality products and services as required by its customers. A workflow mining algorithm is used to develop and/or design the existing workflows [7]. The process mining work focuses on discovery of resource queues where the ability to determine the number of cases waiting for an activity to discover the queue lengths [8]. Many organizations and industries apply process mining techniques to analyses the process to discover, examine and progress real processes by extracting knowledge from event logs. The petri net variants are widely used as a work-flow modelling technique and UML activity diagrams are used for the same purpose, even though the syntax and semantics of activity diagrams has not been yet fully worked out [9].

III. PROCESS MINING

Process mining is to discover, monitor and improve real processes by extracting knowledge from event logs readily available in today's systems. Process mining techniques which include three main types i) Process discovery (automated discovery of process model from event log), ii) Conformance checking (detecting deviations by comparing process model and the corresponding event log), iii) Organizational mining (including several techniques such as social network analysis, prediction and recommendation systems) [1]. Process mining techniques often work with event logs as input. Each event data to be usable should have at least three properties: a) data should have timestamps, b) activity labels should be present and c) case id of each record should be specified (case id is the id of each process instance).

A. Process Discovery

Process discovery is the main type and one of the most challenging tasks of process mining. A process discovery technique takes an event log of an information system as input and generates a model without using any a-priori information [2]. Process discovery can be investigated from various perspectives, e.g., the control-flow perspective, the organizational perspective, the case perspective and the time perspective. The control-flow perspective focuses on the control-flow of process models such as extracting activity order in terms of a modelling language (e.g., BPMN, Petri net, EPCs and UML activity diagram). The organizational or resource perspective focuses on organizational resource (e.g., human, monetary, raw materials and capital) information that can be extracted from event logs. The time view is related with timing and frequency of events. Process discovery through each of these perspectives can give different valuable insight to the organization.

B. Conformance checking

Conformance checking is the second type of process mining [2]. Conformance checking is used for deviation detection, prediction, decision making and recommendation systems. In conformance checking, an event log is compared with its existing corresponding process model and it reveals that if process model conforms to reality and vice versa. One of the most widely used methods for conformance checking is replaying all cases of event log using a token on its corresponding process model [10, 11]. Based on this method, the fitness of the event log in light of the process model is calculated.

C. Organizational mining

Organizational mining is the third type of process mining activity, which brings more insight for organizations and can, led to added value. Using organizational mining, the bottlenecks of processes is analysed and new improvements are proposed. The most widely used technique for this purpose is social network analysis [11]. The resources are represented by nodes and the relations by links. The thickness of a link shows the amount of relationships between two nodes [11]. Also, the nodes or links may have weight which shows their importance. So far, many metrics for analysing social networks have been proposed such as closeness, between-ness, centrality, and shortest distance among others [2].

IV. PROCESS MODELS ARE USED FOR

- Insight: The model is to visualize the process from various perspectives.
- Discussion: The stakeholders use models to structure discussions.
- Documentation: Processes are documented for instructing people.
- Verification: Process models are analyzed to find errors in systems or procedures (e.g., deadlocks).
- Performance analysis: Techniques like simulation can be used to understand the factors influencing response times, service levels, etc.

- Animation: Models enable end users to "play out" different scenarios and thus provide feedback.

V. UNIFIED MODELING LANGUAGE

The Unified Modelling Language (UML) is huge and growing rapidly. This tool becomes a modelling standard to follow changes [9]. UML makes it possible to model any system from different perspectives. Modelling a system from different perspectives allows to clearly picking the vision of what you want to do. This is because UML is a modelling language that holds its own specific rules, semantic, and syntax. It defines several types of diagrams to view the static and dynamic aspects of a system. The diagrams include the use case diagram, class diagram, sequence diagram, state chart diagram, activity diagram, component diagram, and deployment diagram. One of these diagram types is the activity diagram which is used to visualize the workflow of the process [12]. These diagrams are suitable for system analysis, design. The UML model of the domain is a process-oriented tool. It is graphically structured for the construction of diagrams or flowcharts. These diagrams show the number of steps required by an entity as it moves into the system. With its help business people can build models and diagrams to help put things into different perspective. It shows UML can be used as an analysis tool in business modelling to assist in knowing the process.

VI. PETRI NETS

Process mining is to discover, monitor and improve real processes by extracting knowledge from event logs. Process discovery can be investigated from various perspectives. The main type of process discovery is control flow perspective. The control-flow perspective focuses on the control-flow of process models such as extracting activity orders in terms of a modelling language as Petri net [4]. Petri nets are best investigated process modelling language allowing for the modelling of concurrency. Although the graphical notation is intuitive and simple, Petri nets are executable and many analysis techniques can be used to analyze them. Petri nets are used to formalize the behavior of some component, system or application, namely those that have a complex behavior. Since Petri nets are a formal model, they do not carry any ambiguity and are thus able to be validated. The Petri net based approach is used to model and analyze the systems. There are several reasons for modelling a system, e.g. to create and evaluate a design of a new system, to compare alternative designs and to investigate possible improvements in a real system. Model building forces us to organize, evaluate and examine the validity of our thoughts. This way modelling reveals errors and possible improvements. The outcome of any modelling process is a process model.

The classic or basic Petri net is a directed bipartite graph with two node types called places and transitions. The nodes are connected via directed arcs. Connections between two nodes of the same type are not allowed. Places are represented by circles and transitions by bars. Places can have zero or more tokens which is represented as black dots. The number of tokens may change during the execution of the net. A place 'p' is called an input place of a transition't' if there exists a directed arc from 'p' to't'. A place p is called an output place of a transition t if there exists a directed arc from't' to 'p'. Each transition puts a weight to each of its input and output places, i.e. each arc are labelled with a weight positive integer. A transition is called enabled if each of its input places contains at least a number of tokens equal to its weight. In other words, a transition is enabled if all input places contain (at least) the specified number of tokens. An enabled transition can fire. Firing a transition't' means consuming tokens from the input places and producing tokens for the output places, i.e. 't' occurs. The number of tokens produced for each of the output places is equal to the weight of the corresponding arc. A state of a Petri net is a distribution of tokens over the places.

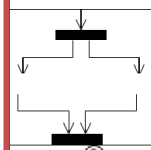
Table 1. Elements of Petri Nets Diagram

Notation	Description
	Place
	Transition
	Arc
	Token

VII. PROCESS ACTIVITY DIAGRAM

UML defines several types of diagrams to view the static and dynamic aspects of a system. One of these diagram types is the activity diagram which is used to visualize the workflow of the process [12]. Process activity diagram is primarily a flow chart to represent the flow form one activity to another activity. It is prepared to have an idea of how the system will work when processed. The activity can be described as process of the system. So the control flow is drawn from one process to another. Process activity diagram consists of activities and links. Activity diagram is some time considered as the flow chart. Although the diagrams looks like a flow chart but it is not. This process flow can be sequential, branching or concurrent. Process activity diagrams deals with all type of flow control by using different elements like fork, join etc. Activity is a particular operation of the system. The activity diagrams are not only used for visualizing dynamic nature of a system but they are also used to construct the executable system.

Table 2. Elements of a Process Activity Diagram

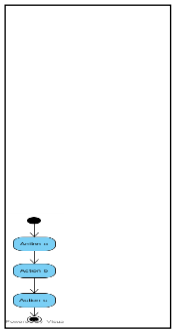
Notation	Description
	Initial Node - Portrays the beginning of a set of actions or activities.
	Activity - Is used to represent a set of actions.
	Control Flow - Shows the sequence of execution.
	Decision Node - Represent a test condition to ensure that the control flow only goes down one path.
	Fork Node - Split behaviour into a set of parallel or concurrent flows of activities. Join Node - Bring back together a set of parallel or concurrent flows of activities.
	Activity Final Node - Stop all control flows in an activity.

VIII. PROCESS ACTIVITY DIAGRAM AND PETRI NET MODEL

The process Activity Diagram is behaviourally equivalent to Petri Nets models. Transformations among these models are processed manually. The result of applying these ideas to some event log is processed.

A. Depiction of one process activity to another process activity

The process activity diagram represented in Figure 1. a) represents an interaction. There are three actions and two control flows between them. Petri Nets in Figure 1. b) associates a transition for message in the activity diagram.



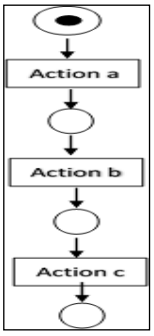
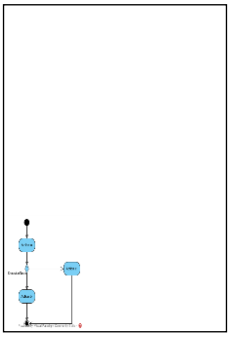


Figure 1. a) Process Activity Diagram b) Petri Net Model

B. Depiction of one process Activity to other using decision

The process activity diagram represented in Figure 2. a) shows that If condition Action 'a', then perform Action 'b', else do Action 'c'. This indicates If-Else statement. Its corresponding Petri Net is shown in Figure 2. b).



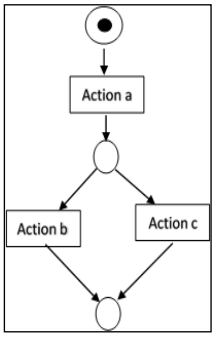
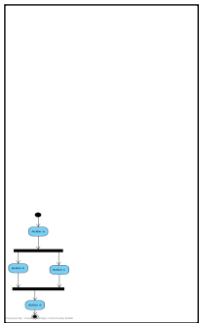


Figure 2. a) Process Activity with decision b) Petri Net Model

C. Depiction of one process Activity to Parallel process Activities using fork

Figure 3. a) represents a parallel interaction and after Action 'a' two transitions namely Action 'b' and Action 'c' occurs parallel. The obtained Petri Nets is shown in Figure 3. b).



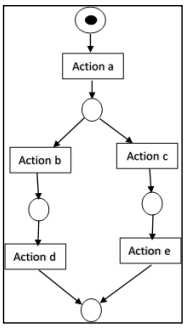


Figure 3. a) Process Activity Diagram with Fork and Join. b) Petri Net Model.

IX. BUSINESS PROCESS CASE STUDY

A case study on compensation requests is considered for visualizing process activity diagram and petri net models. Information is extracted from an event log. The minimal requirements for process mining are that any event can be related to both a case and an activity and that event within a case are organized. Process mining technique is used to discovery and transforms the information into process models as petri nets Figure 4. b) and process activity diagram Figure 4. a). each case is represented by a sequence of activities also referred to as trace. For clarity, the activity names have been transformed into single-letter labels, e.g., 'a' denotes activity register details. A compact representation of log is denoted with nine activities or process as in Figure 4 b), a= register details, b = record entreat, c= careful scrutinize, d = informal scrutinize, e = check ticket, f = reinitialize entreat, g= decision taken, h= fee recompense, I = reject entreat. Activity diagram for complains request shows the flow of activity from one activity to another. It is mainly to understand the flow of activities which is used by the

business users. Petri Net models are generated using process mining techniques to analyses the process.

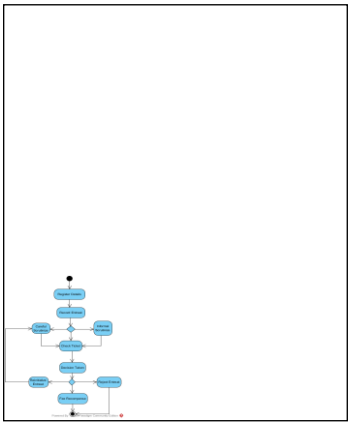


Figure 4. a) Process Activity Diagram

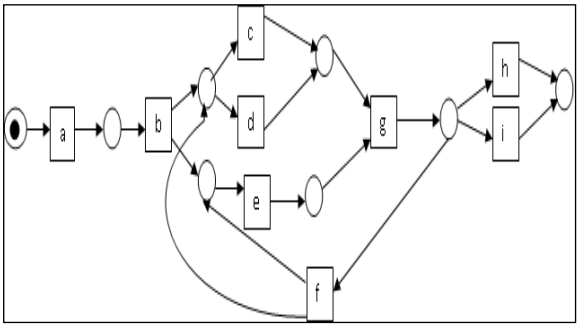


Figure 4. b) Petri Net Model

X. COMPARATIVE STUDY OF PROCESS ACTIVITY DIAGAM AND PETRINETS MODEL

Process activity diagram are visualized as a flow chart which is easy to understand. It depicts the flow of process activity to another activity. Process activity diagram is not suited for huge data from information systems as it involves more manual process. Decision and analysis is complex in case of process activity. Process mining technique is used to discovery and transforms the information into process models as petri nets. The process mining tool is used to input an event log and get an output to visualize as a petri net model. Large amount of data is analysed in this case. No manual process. The efficiency is more in case of Petri net as it can handle large data set it also reduces the time complexity.

Table 3. Comparison of Process activity diagram and Petri Nets Model

S. No.	Parameters	Process Activity Diagram	Petri Nets Model
1	Description	Activity diagram is like a flow chart to represent the flow form one activity to another activity.	The control-flow perspective focuses on the control-flow of process models such as extracting activity orders in terms of a modelling language as Petri net model
2	Data	Real time data with different activities	Event logs from information systems
3	When to use it	Real-life data with not too many different events	For huge complex event logs
4	Processing	Not easy to process for analysis with huge data.	Easy to Process data for analysis with huge data.
5	Output	Process Activity Diagram or a Flow Chart	Petri Nets Model
6	Tools	UML Tool	ProM tool
7	Behaviour	One activity to another activity	One process to another process
8	Format	Flow chart	Control flow diagram
9	Usability	For few data points	Few/huge data points

XI. CONCLUSION

With increasing amount of data in today's databases, there is need for techniques that can handle such huge amount of data. In an organization due to many reasons actual work can deviate from process definitions. Therefore, it becomes irresistible for organizations to discover these deviations in order to improve their processes. Process mining allows identification of processes from event logs and the discovery of differences between the prescriptive process model and the real world process executions. In this paper we have briefly reviewed the state of the art techniques and tools related to processes diagrams and presented the comparison of approaches used for depicting the process discovery model for extracting the order of process activity in modelling language as process activity diagram and petri net model.

ACKNOWLEDGMENT

One of the authors Mrs. Aruna Devi T., acknowledges Dayananda Sagar Institutions, Bangalore, Karnataka and Rayalaseema University, Andhra Pradesh, India for providing the facilities for carrying out the research work.

REFERENCES

[1]. Van der Aalst, W.M.P. "Business Process Management: A Comprehensive Survey", ISRN Software Engineering, pp 1–37 (2013).

[2]. W. M. P. van der Aalst, "Process Mining - Data Science in Action", Second Edition. Springer 2016, ISBN 978-3-662-49850-7, (2016), pp. 3-452.

[3]. W.M.P. van der Aalst, "The Application of Petri Nets to Workflow Management", The Journal of Circuits, Systems and Computers, 8(1):21–66, 1998.

[4]. K. Salimifard and M. Wright, "Petri net-based modelling of workflow systems: An overview", Eur. J. Oper. Res., vol. 134, pp. 664-676, (2001).

[5]. W. M. P. van der Aalst, "Formalization and verification of event driven process chains", Information and Software Technology 41(10)639–650, (1999).
[6]. Mendling, J, "Metrics for Process Models", Springer, Berlin Heidelberg, 2008.
[7]. Boleslaw Mikolajczak, Jian-Lun Chen, "Workflow Mining Alpha Algorithm –AComplexity Study", Intelligent Information Processing and Web Mining dvances in Soft Computing, 451, 2005.
[8]. Arik Senderovich, Sander J.J. Leemans, Shahar Harel, Avigdor Gal, Avishai Mandelbaum, Wil M.P. van der Aalst, "Discovering Queues from Event Logs with Varying Levels of Information", In Business Process Intelligence 2015, Innsbruck, Austria.
[9]. R. Eshuis and R. Wieringa, "A real-time execution semantics for UML activity diagrams", In H. Hussmann, editor, Proc. Fundamental Approaches to Software Engineering (FASE 2001), LNCS 2029. Springer, 2001.
[10] A. Rozinat and W.M.P. van der Aalst, "Conformance Checking of Processes Based on Monitoring Real Behavior", Information Systems, 33(1):64–95, (2008).
[11] W.M.P., van der Aalst, M., Song, "Mining Social Networks Uncovering interaction patterns in business processes", In: Desel, J., Pernici, B., Weske, M. (eds.) BPM 2004. LNCS, vol. 3080, pp. 244–260. Springer, Heidelberg (2004).
[12] A. Teilans, A. Kleins, Y. Merkuryev, and A. Grinbergs, "Design of UML models and their simulation using Arena," WSEAS Transactions on Computer Research, vol.3, no.1, pp.67‐73, 2008.

Authors Profile

Mrs. Aruna Devi. T received B.Sc., degree, Masters in Computer Applications from Madras University in 1998 and 2001 respectively and M.Phil, Computer Science from Alagappa University in 2008. Pursing Ph.D in Rayalaseema University. She has published good no of research papers in referred journals pertain to subject of study. Also authored Computer Graphics book. Currently working as Assistant Professor with 16 years of teaching experience in the Department of Computer Science and Applications, Dayananda Sagar College, Bangalore, India.

Dr. Kumudavalli M.V is working as an Associate Professor in the Department of Computer Applications at Dayananda Sagar College, Bangalore, India. She is a member of CSI. Her domains of interests are Bioinformatics, Networks and Operations Research.

Dr. Sudhamani received M.Sc. degree from Bangalore University, MBA (Computer Science) from AIUMT- California and PhD Computer Science from AIUMT-California. She is Principal in Vivekananda College for Women, Bangalore with 30 years of teaching experience in various institutions in India. She has good no of publications in National and International Journals. She is the author of Software Engineering Text book useful for UG and PG students. She been awarded prestigious "Life time achievement award" from National Compendium, New Delhi, 2003 - 2004.

