

Dataset for Laakmann et al.

A Nascent Taxonomy of Machine Learning in Intelligent Robotic Process Automation

A Literature Search

Database	Filter	# Total	# Analysis	# Review
ACM Digital Library	Abstract	23	5	
AIS eLibrary	Peer-reviewed only	54	11	
IEEE Xplore	Subscribed content	130	13	45
ScienceDirect	Engineering, subscribed	52	5	
SpringerLink	IT in Business	180	17	

Excluded at the stage of title and abstract analysis were publications that:

- a) are not research articles from computer science or IS conference proceedings, journals, or specialist books, specifically outlines, workshop papers, and posters, or
- b) do not explicitly associate RPA and ML in the title or abstract, and thus presumably do not primarily focus on the connection between these two technologies, or
- c) take a distinctly company-specific, industry-specific, or country-specific perspective, or
- d) obviously address other AI concepts rather than ML, or
- e) focus only on possible impacts, such as changes in the role of work, without providing a conceptual view on how RPA and ML can be integrated.

B Analyzed Literature

Reference	Short Description
Agostinelli et al., 2019	Classification of RPA tools and identification of key research gaps to enrich RPA with intelligence
Agostinelli et al., 2020	Development of the SmartRPA tool, which aims to build an executable RPA bot from multiple UI logs of various process flows
Baidya, 2021	Development of a ML-based document categorization system where RPA provides and processes the documents
Baviskar et al., 2021	Overview article on the possibilities of automated and AI-based document processing
Beerbaum, 2023	Development of a taxonomy for the ethical application of RPA and AI
Bhattacharyya et al., 2023	Anthology on the convergence of RPA and AI
Chakraborti et al., 2020	Determination of goals and challenges in the transition to IA
Chakraborti et al., 2022	Consideration of configuring RPA bots through natural language
Chugh et al., 2022	Analysis of gray literature to explore the actual current state-of-the-art due to lagging scientific research
Czarnecki and Auth, 2018	Presentation and characterization of the RPA approach and derivation of recommendations for implementation in companies based on case studies
Daase et al., 2020	Conceptualization of integrating chatbots with RPA to make RPA usable for customer interaction processes and bridge the gap between front and back office
Engel et al., 2021	Development of a method to identify use cases for cognitive automation in companies
Engel et al., 2022	Impact of artificial cognitive abilities on automation
Gao et al., 2019	Development of an end-to-end approach to generate an RPA bot based on form interactions
Godbole et al., 2022	Relationship between process complexity and the necessary automation intelligence
Herm et al., 2021	Identification of challenges for the development and operation of intelligent RPA
Hofmann et al., 2020	Fundamental article on RPA, particularly its impact on IT strategy, governance, and management
Hung et al., 2021	Demonstration of combining RPA with a chatbot based on selected business processes
“IEEE Guide for Terms and Concepts in Intelligent Process Automation”, 2017	A guide from an expert board on terms and concepts related to Intelligent Automation to ensure clarity and consistency in their use
Juell-Skielse et al., 2022	Identification of the benefits of cognitive RPA for organizations
Kanakov and Prokhorov, 2022	Analysis of the possibilities for integrating AI and RPA
Kedziora and Hyrynsalmi, 2023	Case study on invoice processing at a Finnish consulting firm using UiPath and a ML model to extract invoice data
Khare et al., 2022	Development of an RPA bot for email management
Kholiya et al., 2021	Introduction of the IA approach
Lacity and Willcocks, 2021	Presentation of 39 action principles for executives on intelligent automation: What do we know about RPA and CA, and how to address challenges?
Leopold et al., 2018	Development of a prototype to identify RPA candidate processes by classifying natural language process descriptions
Mahalakshmi. et al., 2022	Automation of signature matching using RPA and ML
Martínez-Rojas et al., 2022	Development of a method to uncover decision models from event logs
Martins et al., 2020	Application of convolutional neural networks to classify menu interfaces for use in RPA
Moreira et al., 2023	Synthesis of the definition, benefits, challenges, process properties, and research gaps in RPA in a structured literature review
Ng et al., 2021	Overview article on the capabilities, drivers, challenges, and research gaps in IA
Ribeiro et al., 2021	Contributions of RPA and AI to Industry 4.0
Rizk et al., 2020	Development of various approaches to interact with RPA bots via chatbots

Reference	Short Description
Rizk et al., 2022	Concept design for improving and generalizing RPA bots through self-learning approaches
Rohaime et al., 2022	Development of an open-source RPA bot for automatic processing of incoming invoices using OCR and information extraction
Patil et al., 2021	Integration of RPA and ML for automated vehicle insurance fraud detection
Sudharson et al., 2023	Systematization of hyperautomation
Syed et al., 2020	Overview article on RPA, aiming to establish consensus on the term, state-of-the-art, and existing knowledge gaps
Urabe et al., 2021	Use of (shallow) ML approaches for process identification based on UI logs as a basis for selecting automation candidates
van der Aalst, 2021	Design of human-machine collaboration in times of AI/ML and RPA through hybrid intelligence: the best of both worlds
van der Aalst et al., 2018	Fundamental article introducing RPA
van de Weerd et al., 2021	Application of the Task-Technology-Fit model to develop a framework for assigning AI capabilities to RPA tasks and developing use cases
Viehhauser, 2020	Examination of the impact of AI on the capabilities of RPA and the processes that become automatable as a result
Wróblewska et al., 2018	Case study on automating document management using ML and RPA focusing on challenges and developing a general architecture
Yatskiv et al., 2020	Application of AI-supported RPA in software testing

C Concept Matrix

The following concept matrix is organized as follows: The reviewed literature is initially divided into the three previously described types: *Practitioner reports* (abbreviated: P), *Conceptions* (abbreviated: C), and *Frameworks* (abbreviated: F). For each publication, the corresponding characteristics are marked in the respective row. While the characteristics of the described artifacts are presented for application reports, the characteristics in concepts and frameworks are marked if the respective characteristic is mentioned in the source. The focus here is less on identical terminology and more on the intended meaning. Additionally, table cells are marked green in the matrix if the publication itself classifies RPA-ML integration based on the marked dimension. The absolute frequencies of the occurrence of characteristics are shown for each publication type and for the proposed dimensions in total.

Publication		RPA-ML integration						RPA-ML interaction		
		Arch.	Cap.	Data	Level	Depth	Area	Phase	User	
Reference	Type	External integration Integration platform Out-of-the-box	Computer vision Data analytics Nat. lang. proc.	Structured Unstructured UI logs	Symbolic Intelligent Hyperautomation	High code Low code	Analytics Back office Front office	Process selection Robot development Robot execution Robot improvement	Attended Unattended Hybrid	
Baidya, 2021	P	x	x x	x	x	x	x	x	x	x
Hung et al., 2021	P	x	x	x	x	x	x	x	x	x
Kedziora and Hyrynsalmi, 2023	P	x	x	x	x	x	x	x	x	x
Khare et al., 2022	P		x	x	x	x	x	x	x	x
Mahalakshmi. et al., 2022	P	x	x	x	x	x	x	x	x	x
Martins et al., 2020	P	x	x	x	x	x	x	x	x	x
Patil et al., 2021	P	x	x	x	x	x	x	x	x	x
Rohaime et al., 2022	P	x	x	x	x	x	x	x	x	x
Wróblewska et al., 2018	P	x	x x x	x	x	x	x	x	x	x
Practitioner reports	9	5 2 1	6 3 3	1 8 0	1 8 0	5 4	1 8 0	0 1 8 1	5 4 0	
Agostinelli et al., 2020	C	x	x	x	x	x	x	x	x	
Chakraborti et al., 2022	C	x	x	x	x	x	x	x	x	x
Daase et al., 2020	C	x	x	x	x	x	x	x	x	x
Gao et al., 2019	C		x	x	x	x	x	x	x	x
Leopold et al., 2018	C	x	x	x	x	x	x	x	x	x
Martínez-Rojas et al., 2022	C	x	x	x	x	x	x	x	x	x
Rizk et al., 2020	C	x x	x	x	x	x	x x	x	x	x
Rizk et al., 2022	C	x	x	x	x	x	x	x	x	x
Urabe et al., 2021	C	x	x	x	x	x	x	x x	x	x
Yatskiv et al., 2020	C		x		x x x					
Conceptions	10	7 2 0	1 5 4	0 4 5	1 3 8	5 2	2 4 3	2 5 2 1	4 2 2	
Agostinelli et al., 2019	F				x	x x		x x x	x x x	x
Baviskar et al., 2021	F	x	x	x	x	x	x	x	x	x
Beerbaum, 2023	F	x	x x	x	x	x	x	x	x	x
Bhattacharyya et al., 2023	F		x x	x	x x			x x		
Chakraborti et al., 2020	F		x x		x x		x x	x x		
Chugh et al., 2022	F				x x x				x x	
Czarnecki and Auth, 2018	F		x x					x		
Engel et al., 2021	F		x	x x	x					
Engel et al., 2022	F	x	x		x			x		
Godbole et al., 2022	F		x x		x x x					
Herm et al., 2021	F		x x		x x			x x		
Hofmann et al., 2020	F	x	x		x x x					
IEEE Guide [...], 2017	F				x x x					
Juell-Skielse et al., 2022	F		x x	x	x		x			
Kanakov and Prokhorov, 2022	F		x				x x	x		
Kholiya et al., 2021	F		x	x	x		x x			
Lacity and Willcocks, 2021	F	x	x	x	x					
Moreira et al., 2023	F				x x x					

Publication		Arch.	Cap.	Data	Level	Depth	Area	Phase	User
Reference	Type	External integration Integration platform Out-of-the-box	Computer vision Data analytics Nat. lang. proc.	Structured Unstructured UI logs	Symbolic Intelligent Hyperautomation	High code Low code	Analytics Back office Front office	Process selection Robot development Robot execution Robot improvement	Attended Unattended Hybrid
Ng et al., 2021	F		x x x	x	x x x		x		
Ribeiro et al., 2021	F	x x	x x x	x	x	x		x	
Sudharson et al., 2023	F			x	x	x		x	
Syed et al., 2020	F	x x	x x	x	x x x		x x	x x	
van der Aalst, 2021	F				x x x				x x x
van der Aalst et al., 2018	F			x	x x x			x x	
van de Weerd et al., 2021	F		x x x	x	x x		x x		
Viehhauser, 2020	F	x	x x x	x	x x				
Frameworks	26	1 7 2	14 5 15	1 13 1	11 22 14	1 4	4 5 4	6 4 8 3	3 4 2
Dimensions		2	4	1	8	1	1	1	4

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