Technical Report: A Systematic Mapping Study of Machine Learning for Software Traceability

1. Extracted Data

1.1 Extracted Data for RQ1

Index	Title	ML Models	Stage
S1	An extended knowledge representation learning approach for context-based traceability link recovery	Decision Tree (DT) GBDT Naive Bayes (NB) SVM	link generation stage
S2	An Improved Approach to Traceability Recovery Based on Word Embeddings	Word2vec Ranking SVM	preprocessing stage link generation stage
S3	An information theoretic approach for extracting and tracing non-functional requirements	Hierarchical Agglomerative Clustering (HAC)	preprocessing stage
S4	Application of reinforcement learning to requirements engineering requirements tracing	Reinforcement Learning	link generation stage
S5	ATLaS: A Framework for Traceability Links Recovery Combining Information Retrieval and Semi-Supervised Techniques	Word2vec GloVe Label spreading	preprocessing stage link generation stage
S6	Automatic traceability link recovery via active learning	Active Learning	link generation stage
S7	Automatic Traceability Maintenance via Machine Learning Classification	K nearest neighbors (KNN) Naive Bayes (NB) Logistic Regression (LR) SVM Random Forest (RF)	link generation stage
S8	Automating traceability link recovery through classification	Decision Tree (DT) Random Forest (RF) K nearest neighbors (KNN) Naive Bayes (NB)	link generation stage
S9	Clustering for Traceability Managing in System Specifications	K-means	link generation stage
S10	Combining Machine Learning and Logical Reasoning to Improve Requirements Traceability Recovery	Doc2vec Decision Tree (DT) K nearest neighbors (KNN) Random Forest (RF) GBDT	preprocessing stage link generation stage
S11	Detecting, classifying, and tracing non-functional software requirements	Hierarchical Agglomerative Clustering (HAC) K-medoids	preprocessing stage
S12	Enhancing Automated Requirements Traceability by Resolving Polysemy	FNN Word2vec	preprocessing stage
S13	A Machine Learning Approach for Determining the Validity of Traceability Links	Random Forest (RF)	link generation stage

S14	Enhancing Unsupervised Requirements Traceability with Sequential Semantics	Word2vec Doc2vec	preprocessing stage
S15	Estimating the number of remaining links in traceability recovery	Decision Tree (DT) Bagging K nearest neighbors (KNN) Logit Boost Naive Bayes (NB)	link generation stage
S16	Improving the effectiveness of traceability link recovery using hierarchical bayesian networks	Hierarchical Bayesian Network (HBN)	link generation stage
S17	Traceability Link Recovery between Requirements and Models using an Evolutionary Algorithm Guided by a Learning to Rank Algorithm: Train control and management case	FNN RNN RankBoost	link generation stage
S18	Leveraging Historical Associations between Requirements and Source Code to Identify Impacted Classes	Decision Tree (DT) Random Forest (RF) Logistic Regression (LR) Naive Bayes (NB) Bagging	link generation stage
S19	On the effect of incompleteness to check requirement-to-method traces	Decision Tree (DT) Random Forest (RF) Naive Bayes (NB) K nearest neighbors (KNN)	link generation stage
S20	On the relationship between similar requirements and similar software	Doc2vec FastText BERT Universal Sentence Encoder (USE)	preprocessing stage
S21	Tracing with Less Data: Active Learning for Classification-Based Traceability Link Recovery	Active Learning Random Forest (RF)	link generation stage
S22	Semantically Enhanced Software Traceability Using Deep Learning Techniques	Word2vec RNN LSTM Bi-LSTM GRU Bi-GRU	preprocessing stage
S23	Tackling the term-mismatch problem in automated trace retrieval	Decision Tree (DT) Naive Bayes (NB)	link generation stage
S24	Towards feature-aware retrieval of refinement traces	Graph Clustering	link refinement stage
S25	Towards the automatic classification of traceability links	Decision Tree (DT) Random Forest (RF) K nearest neighbors (KNN) Naive Bayes (NB)	link generation stage
S26	Tracing Requirements as a Problem of Machine Learning	SVM Single-link clustering	link generation stage preprocessing stage

1.2 Extracted Data for RQ2

Index	Source Artifact (number)	Target Artifact (number)	Datasets (true link number)
S1	Use Case	Code	eTour
S2	High-level requirement Use case Use case Use case	Low-level requirement Code Interaction Diagrams Test Case	CM1-NASA GANNT eTOUR iTrust EasyClinic
S3	Requirement	Code	SmartTrip ***** SafeDrink ***** BlueWallet *****
S4	Requirement Requirement	Use case Design	Pine CM1SUB
S5	High-level requirements	Design	ARC-IT
S6	High-level requirement Use Case Test Case Test Case Interaction Diagram	Low-level requirement Code Use Case Code Test Case	eAnci SMOS MODIS EasyClinic eTour
S7	High-level requirement Use Case Test Case Test Case Interaction Diagram Interaction Diagram Interaction Diagram	Low-level requirement Code Use Case Code Test Case Code Use Case	eAnci SMOS MODIS EasyClinic eTour iTrust
S8	High-level requirement Use Case Test Case Test Case Interaction Diagram Interaction Diagram Interaction Diagra	Low-level requirement Code Use Case Code Test Case Code Use Case	eAnci SMOS EasyClinic eTour iTrust CM-1
S9	Requirement	Requirement	Dataset1 ***** Dataset2 *****
S10	Use Case	Code	eTour SMOS Albergate eAnci
S11	Requirement	Code	SmartTrip ***** SafeDrink ***** BlueWallet *****
S12	Requirement Requirement	Requirement Design	AIRFLOW ANY23 DASHBUILDER DROOLS IMMUTANT JBTM

			MODIS CM-1
S13	Use Case	Code	eAnci eTour SMOS
S14	Requirement Use Case Use Case Use Case	Requirement Code Test Case Interaction Diagram	GANNT CM1-NASA eTour iTrust EasyClinic
S15	Requirement Use Case Use Case Use Case Use Case Test Case Test Case Interaction Diagram Interaction Diagram Interaction Diagram Interaction Diagram Code Code	Requirement Code Use Case Test Case Interaction Diagram Test Case Code Interaction Diagram Code Test Case Use Case Code Test Case	Selex SI eTour EasyClinic
S16	Requirement Requirement Use Case	Code Test Case Code	Albergate EBT LibEST eTour SMOS iTrust
S17	Requirement	Model	CAF
S18	Requirement	Code	Accumulo Ignite Isis Tika
S19	Requirement	Code	Chess Gantt iTrust JHotDraw
S20	Requirement Requirement	Requirement Code	A * B *
S21	High-level requirement Use Case Test Case Test Case Interaction Diagram Interaction Diagram Interaction Diagram	Low-level requirement Code Use Case Code Test Case Code Use Case	eAnci SMOS MODIS EasyClinic eTour iTrust
S22	Requirement	Design	PTC

S23	Regulatory code	Requirement	Care2x CCHIT ClearHealth Physician iTrust Trial Implementations PatientOS PracticeOne Lauesen WorldVistA
S24	Requirement Use Case Feature	Use Case Test Case Use Case	CM-1 EasyClinic Waterloo
S25	Requirement Use Case Test Case Interaction Diagram Interaction Diagram Test Case Interaction Diagram	Requiremen Code Code Test Case Use Case Use Case Code	CM-1 eAnci eTour SMOS iTrust EasyClinic
S26	Requirement	Use case	Pine

* present that author uses a pseudonym of the name of dataset for confidentiality agreements

1.3 Extracted Data for RQ3

Index	Title	Measures
S1	An extended knowledge representation learning approach for context-based traceability link recovery	Precision Recall F-Measure
S2	An Improved Approach to Traceability Recovery Based on Word Embeddings	Precision Recall F-Measure MAP MRR Running Time
S3	An information theoretic approach for extracting and tracing non-functional requirements	Precision Recall
S4	Application of reinforcement learning to requirements engineering requirements tracing	Precision Recall F-Measure
S5	ATLaS: A Framework for Traceability Links Recovery Combining Information Retrieval and Semi-Supervised Techniques	Precision Recall F-Measure
S6	Automatic traceability link recovery via active learning	Precision Recall F-Measure
S7	Automatic Traceability Maintenance via Machine Learning Classification	Precision Recall

		F-Measure
S8	Automating traceability link recovery through classification	Recall (TPR) FPR
S9	Clustering for Traceability Managing in System Specifications	Precision
S10	Combining Machine Learning and Logical Reasoning to Improve Requirements Traceability Recovery	Precision Recall F-Measure
S11	Detecting, classifying, and tracing non-functional software requirements	Precision Recall
S12	Enhancing Automated Requirements Traceability by Resolving Polysemy	Precision Recall F-Measure
S13	Enhancing software model encoding for feature location approaches based on machine learning techniques	TP FP
S14	Enhancing Unsupervised Requirements Traceability with Sequential Semantics	Precision Recall F-Measure
S15	Estimating the number of remaining links in traceability recovery	MRE MAE
S16	Improving the effectiveness of traceability link recovery using hierarchical bayesian networks	Precision Recall Average Precision (AP)
S17	Traceability Link Recovery between Requirements and Models using an Evolutionary Algorithm Guided by a Learning to Rank Algorithm: Train control and management case	Recall Precision F-Measure Matthews Correlation Coefficient
S18	Leveraging Historical Associations between Requirements and Source Code to Identify Impacted Classes	Precision Recall F-Measure
S19	On the effect of incompleteness to check requirement-to-method traces	Precision Recall F-Measure
S20	On the relationship between similar requirements and similar software	None
S21	Tracing with Less Data: Active Learning for Classification-Based Traceability Link Recovery	F-Measure
S22	Semantically Enhanced Software Traceability Using Deep Learning Techniques	Precision Recall MAP
S23	Tackling the term-mismatch problem in automated trace retrieval	Precision Recall F-Measure MAP
S24	Towards feature-aware retrieval of refinement traces	Precision Recall Average Precision (AP)
S25	Towards the automatic classification of traceability links	Recall FPR
S26	Tracing Requirements as a Problem of Machine Learning	Recall

		Precision F-Measure

1.4 Extracted Data for RQ4

Index\ Factors	Method				Data			Experiment					Score		
	Problem	Research method	Research questions	Pseudo code	Dataset partitioning	Dataset source	Results	Hypothesis and Prediction	Source code	Hardware specifications	Software dependencies	Experiment setup	D1	D2	D3
S1	0	1	1	0	1	1	1	0	1	0	1	1	0.5	1	0.6
S2	1	1	0	0	1	1	0	1	0	1	0	1	0.5	0.66	0.6
S3	1	1	1	0	**0**	0	0	0	0	0	0	0	0.75	0	0
S4	0	1	0	1	1	0	0	1	0	0	0	1	0.5	0.33	0.4
S5	1	1	1	0	1	1	0	0	0	1	1	0	0.75	0.66	0.4
S6	0	0	1	1	1	0	0	1	0	0	0	1	0.5	0.33	0.4
S7	1	1	1	0	1	1	1	0	0	0	0	1	0.75	1	0.2
S8	0	0	0	0	1	0	0	0	0	0	1	1	0	0.33	0.4
S9	1	0	0	0	**0**	0	0	0	0	0	0	1	0.25	0	0.2
S10	1	1	1	0	0	0	0	0	0	0	0	1	0.75	0	0.2
S11	0	1	1	0	**0**	0	0	0	0	0	1	1	0.5	0	0.4
S12	1	1	0	0	**0**	0	0	0	0	0	1	1	0.5	0	0.4
S13	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0.2
S14	1	1	1	0	**0**	1	0	0	0	0	1	1	0.75	0.5	0.4
S15	1	0	1	1	1	1	0	1	1	0	1	1	0.75	0.66	0.8
S16	1	1	1	0	0	1	0	0	1	0	1	1	0.75	0.33	0.6
S17	1	1	0	0	1	1	0	1	1	0	1	0	0.5	0.66	0.6
S18	0	1	1	0	1	0	0	0	0	0	0	1	0.5	0.33	0.2
S19	1	1	1	0	1	1	0	0	1	0	1	0	0.75	0.66	0.4
S20	1	1	1	0	**0**	1	0	0	1	0	1	1	0.75	0.5	0.6
S21	1	0	1	0	1	1	1	0	1	0	1	1	0.5	1	0.6
S22	1	1	1	0	1	0	0	0	1	0	1	1	0.75	0.33	0.6
S23	1	1	0	0	1	1	0	1	0	0	0	1	0.5	0.66	0.4
S24	1	1	0	0	**0**	1	0	1	0	0	0	1	0.5	0.5	0.4
S25	1	0	0	0	0	0	0	0	0	0	1	0	0.25	0	0.2
S26	1	1	0	0	1	0	0	0	0	0	0	1	0.5	0.33	0.2
Num of True	19	19	15	3	15	13	4	7	8	2	15	20			

1.5 The information of Datasets and the studied papers which used the datasets

Dataset Name	Source Artifacts (Number)	Target Artifacts (Number)	True link	Scale (Total)	Source Link	Freq	Primary researches
eTour	Use Case (58)	Code (116)	336	(174)	http://www.coest.org/	12	[S1] [S2] [S7] [S8] [S9] [S11] [S14] [S15] [S16] [S18] [S26] [S35]
	Use Case (58)	Code (116)	308	(174)			
	Use Case (58)	Code (116)	385	(174)			
	Use Case (58)	Code (116)	366	(174)			
	Use Case (Unclear)	Code (Unclear)	365	Unclear			

EasyClinic	Use Case (30)	Code (47)	93	(77)	http://www.coest.org/	9	[S2] [S7] [S8] [S9] [S15] [S16] [S33] [S35] [S26]
	Use Case (30)	Test Case (63)	63	(93)			
	Use Case (30)	Test Case (47)	63	(77)			
	Use Case (30)	Interaction Diagram (20)	26	(50)			
	Use Case (30)	Use Case (30)	53	(60)			
	Test Case (Unclear)	Use Case (Unclear)	63	Unclear			
	Interaction Diagram (20)	Use Case (30)	26	(50)			
iTrust	Use Case (131)	Code (367)	534	(498)	http://www.coest.org/	9	[S2] [S8] [S9] [S15] [S18] [S24] [S26] [S30] [S35]
	Requirement (131)	Code (367)	399	(498)			
	Requirement (131)	Code (332)	535	(463)			
	Requirement (34)	Code (4913)	307	(4947)			
	Use Case (Unclear)	Code (Unclear)	58	Unclear			
SMOS	Use Case (67)	Code (100)	1045	(167)	http://www.coest.org/	8	[S7] [S8] [S9] [S11] [S14] [S18] [S26] [S35]
	Use Case (67)	Code (100)	1044	(167)			
CM-1	High-level requirement (235)	Low-level design document (220)	Unclear	(455)	http://www.coest.org/	7	[S2] [S4] [S9] [S13] [S15] [S33] [S35]
	High-level requirement (22)	Low-level requirement (53)	45	(75)			
	Requirement (22)	Design (46)	46	(68)			
	Requirement (22)	Design (53)	45	(75)			
	Requirement (Unclear)	Use Case (Unclear)	Unclear	Unclear			
eAnci	Use Case (140)	Code (55)	567	(195)	http://www.coest.org/	7	[S7] [S8] [S9] [S11] [S14] [S26] [S35]
	Use Case (Unclear)	Code (Unclear)	554	Unclear			
MODIS	High-level requirement (19)	Low-level requirement (49)	41	(68)	http://promise.site.uottawa.ca/SERepository	4	[S7] [S8] [S13] [S26]
Albergate	Use Case (17)	Code (55)	54	(72)	http://www.coest.org/	2	[S11] [S18]
	Requirement (55)	Code (17)	53	(72)			
GANNT	High-level requirement (17)	Low-level requirement (69)	68	(86)	http://www.coest.org/	2	[S15] [S2]
CCHIT	Requirement (Unclear)	Requirement (Unclear)	1046	Unclear	http://www.coest.org/	1	[S30]
EBT	Requirement (40)	Test Case (25)	51	(65)	http://www.coest.org/	1	[S18]
	Requirement (40)	Code (50)	98	(90)			
LibEST	Requirement (59)	Code (11)	204	(70)	http://sarec.nd.edu/coest/datasets.html	1	[S18]
	Requirement (59)	Test Case (18)	352	(77)			
Selex SI	Requirement (Unclear)	Requirement (Unclear)	138	(2500)	http://www.finmeccanica.com/en/home	1	[S16]
Chess	Requirement (8)	Code (752)	563	(760)	https://github.com/warpwe/java-chess	1	[S24]
Gantt	Requirement (18)	Code (5013)	343	(5031)	https://sourceforge.net/projects/ganttproject	1	[S24]
JHotDraw	Requirement (21)	Code (6520)	439	(6541)	https://sourceforge.net/projects/jhotdraw	1	[S24]
ARC-IT	Requirement (2395)	System Functions (802)	2395	(3197)	https://local.iteris.com/arc-it/index.html	1	[S5]
DASHBUILDE	Requirement (Unclear)	Requirement (Unclear)	Unclear	(85)	https://issues.jboss.org/bro	1	[S13]

R					wse/DASHBUILDE		
JBTM	Requirement (Unclear)	Requirement (Unclear)	Unclear	(1575)	https://issues.jboss.org/browse/JBTM	1	[S13]
Accumulo	Requirement (145)	Code (593)	3412	(738)	http://isis.apache.org	1	[S23]
Ignite	Requirement (41)	Code (668)	15569	(709)	https://ignite.apache.org/	1	[S23]
Isis	Requirement (252)	Code (2424)	11850	(2676)	http://isis.apache.org	1	[S23]
Tika	Requirement (49)	Code (72)	248	(121)	http://tika.apache.org	1	[S23]
Care2x	Requirement (Unclear)	Requirement (Unclear)	44	Unclear	http://www.care2x.org	1	[S30]
ClearHealth	Requirement (Unclear)	Requirement (Unclear)	44	Unclear	e http://www.clear-health.com	1	[S30]
Physician	Requirement (Unclear)	Requirement (Unclear)	147	Unclear	hmss.org/content/files/CTC_use_Case.pdf	1	[S30]
Trial Implementations	Requirement (Unclear)	Requirement (Unclear)	100	Unclear	http://healthit.hhs.gov	1	[S30]
PatientOS	Requirement (Unclear)	Requirement (Unclear)	90	Unclear	http://www.patientos.org	1	[S30]
PracticeOne	Requirement (Unclear)	Requirement (Unclear)	34	Unclear	http://www.practiceone.com	1	[S30]
WorldVistA	Requirement (Unclear)	Requirement (Unclear)	66	Unclear	http:/worldvista.org	1	[S30]
Pine	Requirement (49)	Use case (51)	250	(100)		2	[S4] [S36]
	Requirement (49)	Use case (51)	246	(100)			
SafeDrink *	Functional requirement (170)	Code (173)	Unclear	(343)		2	[S3] [S12]
SmartTrip *	Functional requirement (214)	Code (266)	Unclear	(480)		2	[S3] [S12]
BlueWallet *	Functional requirements (184)	Code (374)	Unclear	(558)		2	[S3] [S12]
Drools	Requirement (Unclear)	Requirement (Unclear)	Unclear	(486)		1	[S13]
Lauesen	Requirement (Unclear)	Requirement (Unclear)	116	Unclear		1	[S30]
PTC	Requirement (1651)	Design (466)	1387	(2117)		1	[S27]
A *	Requirement (112)	Requirement (142)	Unclear	(254)		1	[S25]
B *							
Waterloo	Feature (Unclear)	Use Case (Unclear)	Unclear	Unclear		1	[S33]
AIRFLOW	Requirement (Unclear)	Requirement (Unclear)	Unclear	(629)		1	[S13]
ANY23	Requirement (Unclear)	Requirement (Unclear)	Unclear	(182)		1	[S13]
IMMUTANT	Requirement (Unclear)	Requirement (Unclear)	Unclear	(404)		1	[S13]
CAF	Requirement (Unclear)	Model (Unclear)	Unclear	Unclear		1	[S19]
Dataset1 *	Requirement (762)	Requirement (521)	367	(1283)		1	[S10]
Dataset2 *	Requirement (2060)	Requirement (4188)	817	(6248)		1	[S10]

* present that author uses a pseudonym of the name of dataset for confidentiality agreements

2. Search process record

Database	Number of searches	Number of repetitions in each database	Number of each database (After deleting repetitions)	Remove irrelevant contents (After deleting repetitions)
ACM	51	10	49	26

Springer	265	54	223	185
Science Direct	99	13	63	61
EI	302	43	265	159
IEEE	193	77	113	86
Total	**910**	**197**	**713**	**517**

Exclude inclusion/exclusion criteria

Database	***Title Screening***	***Full Paper Reading***	**Snowballing**	**Final**
ACM	**211**	**25**	**1**	**26**
Springer				
Science Direct				
EI				
IEEE				
Total				

1.6 Search records

Digital Libraries：

Database	**Website**
ACM	https://dl.acm.org/
Springer	https://www.springer.com/
Science Direct	https://www.sciencedirect.com/
EI	https://www.engineeringvillage.com/
IEEE	https://ieeexplore.ieee.org/

Search terms：

P1	requirement traceability	**I1**	machine learning
P2	requirement trace	**I2**	ML
P3	requirement tracing	**I3**	supervised learning
P4	requirement traceability recovery	**I4**	unsupervised learning
		I5	semi-supervised learning
		I6	reinforcement learning

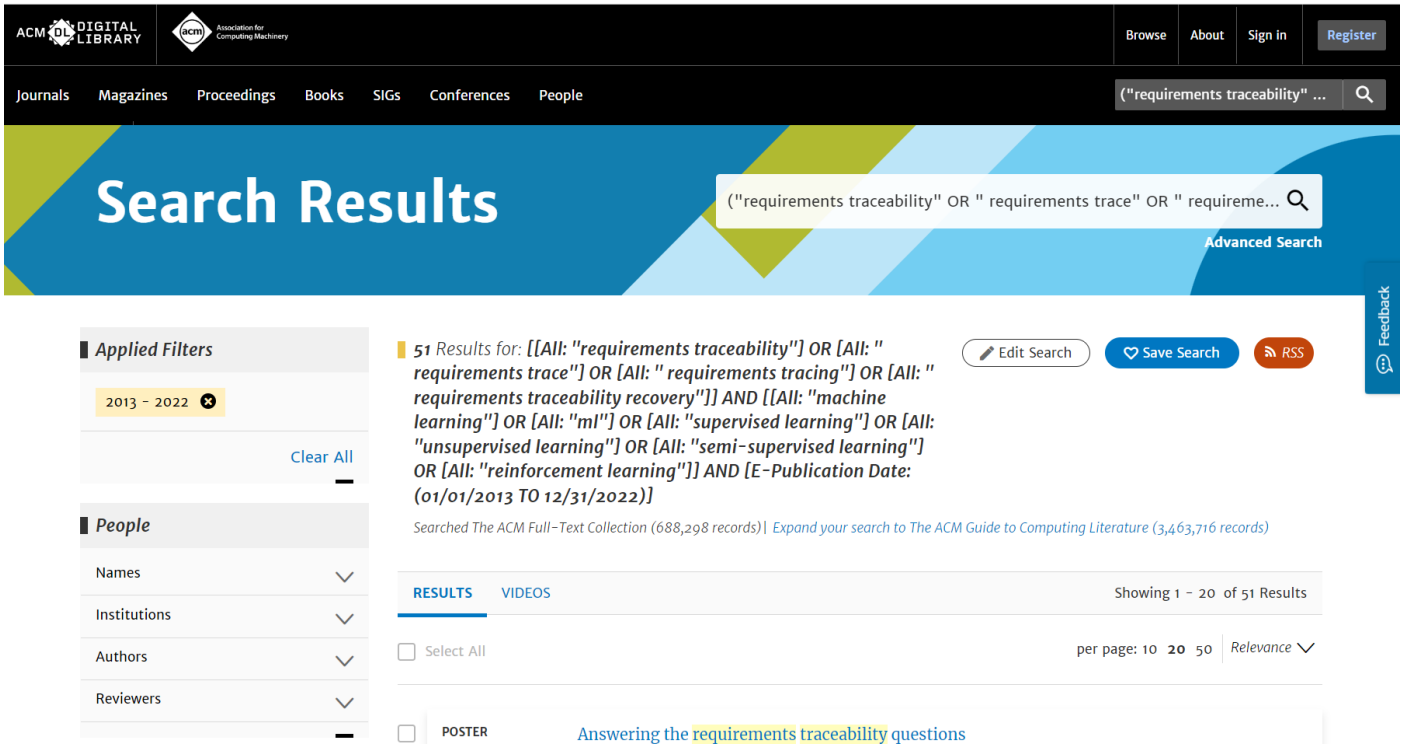
(1) ACM

	Anywhere
(P1 OR P2 OR P3 OR P4) AND (I1 OR I2 OR I3 OR I4 OR I5 OR I6)	51

Advanced search:

("requirements traceability" OR " requirements trace" OR " requirements tracing" OR " requirements traceability recovery") AND ("machine learning" OR "ML" OR "supervised learning" OR "unsupervised learning" OR "semi-supervised learning" OR "reinforcement learning")

Screenshot of search process in ACM:



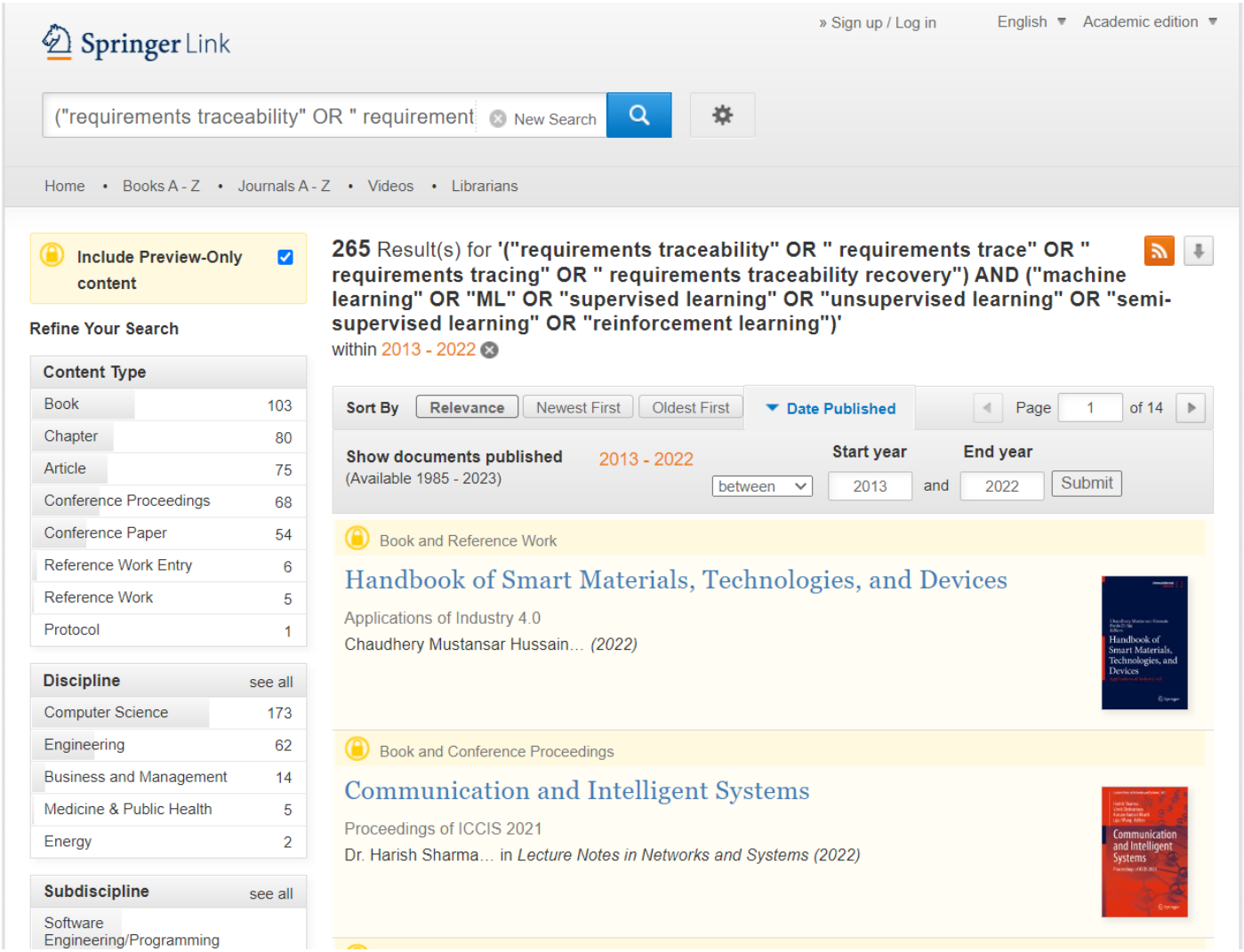
(2) Spinger

	Keywords+Title+Abstract
(P1 OR P2 OR P3 OR P4) AND (I1 OR I2 OR I3 OR I4 OR I5 OR I6)	265

Advanced search:

("requirements traceability" OR " requirements trace" OR " requirements tracing" OR " requirements traceability recovery") AND ("machine learning" OR "ML" OR "supervised learning" OR "unsupervised learning" OR "semi-supervised learning" OR "reinforcement learning")

Screenshot of search process in Springer:



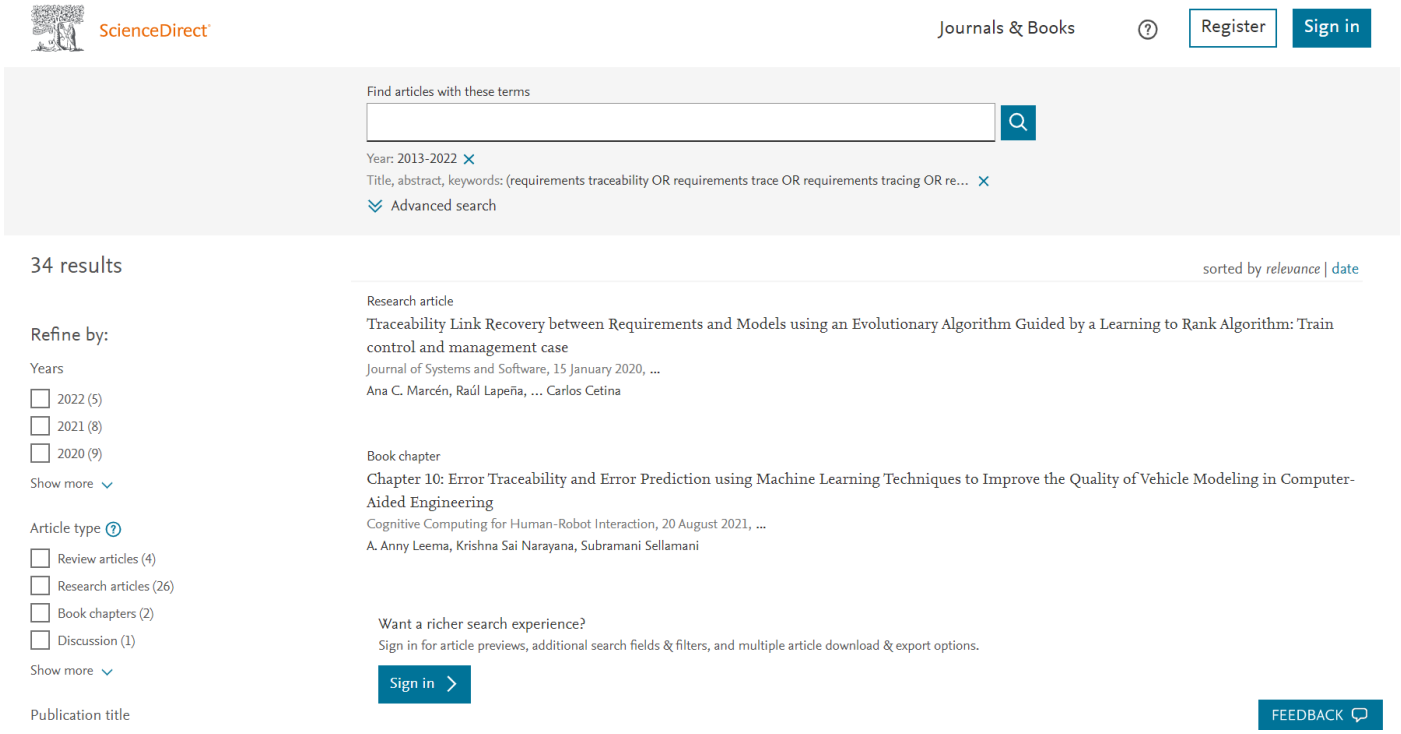
(3) Science Direct

	Title+Abstract+Keywords
(P1 OR P2 OR P3 OR P4) AND (I1)	34
(P1 OR P2 OR P3 OR P4) AND (I2)	55
(P1 OR P2 OR P3 OR P4) AND (I3)	3
(P1 OR P2 OR P3 OR P4) AND (I4)	2
(P1 OR P2 OR P3 OR P4) AND (I5)	1
(P1 OR P2 OR P3 OR P4) AND (I6)	4
Total	99

■ **Advanced search((P1 OR P2 OR P3 OR P4) AND (I1)):**

(requirements traceability OR requirements trace OR requirements tracing OR requirements traceability recovery) AND (machine learning)

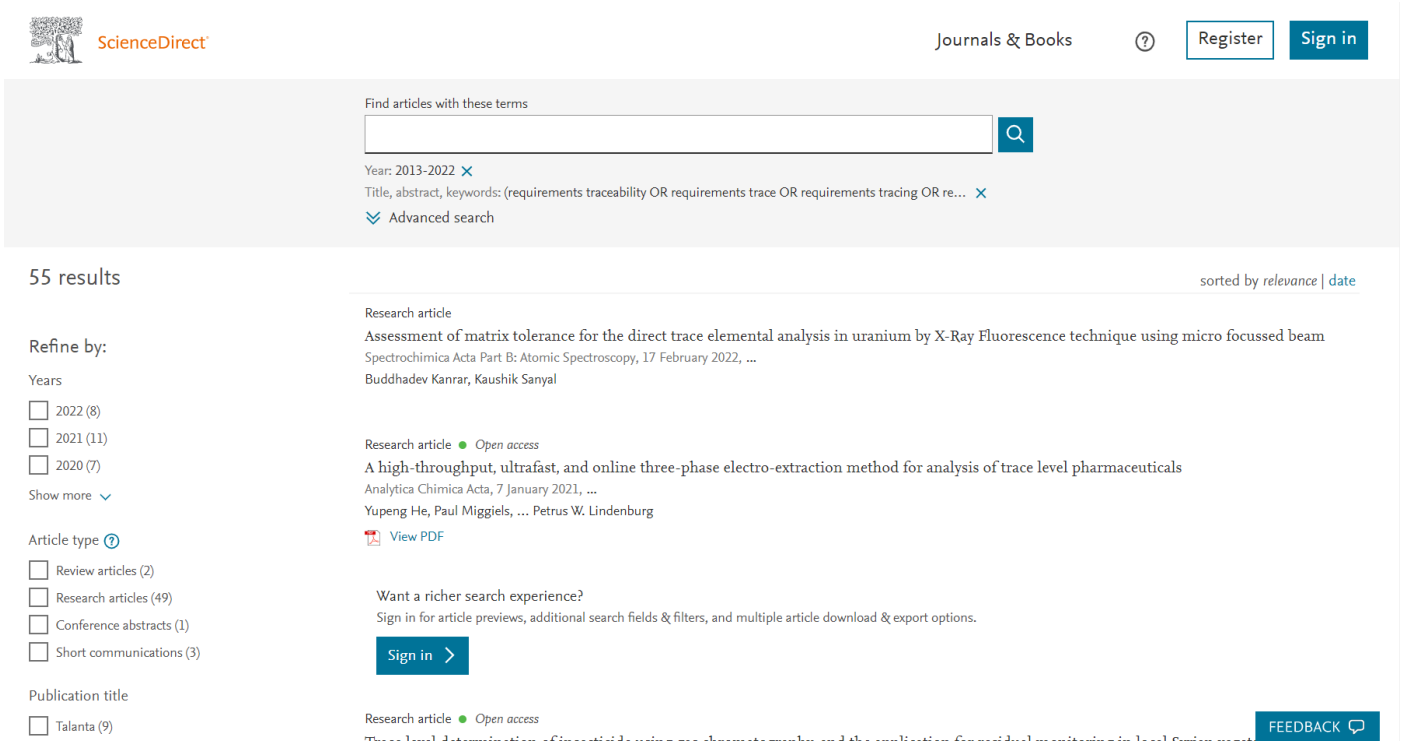
Screenshot of search process in Scienct Direct:



■ **Advanced search((P1 OR P2 OR P3 OR P4) AND (I2)):**

(requirements traceability OR requirements trace OR requirements tracing OR requirements traceability recovery) AND (ML)

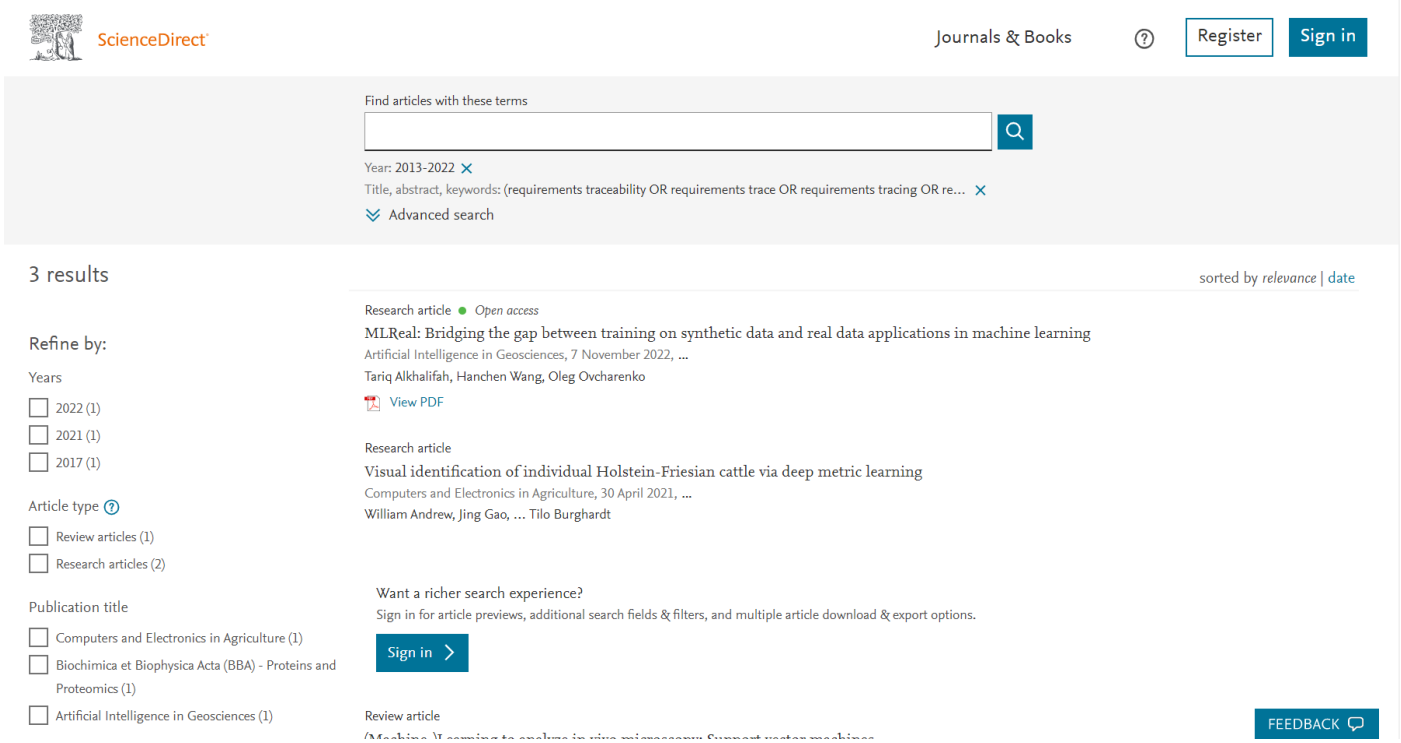
Screenshot of search process in Scienct Direct:



■ **Advanced search((P1 OR P2 OR P3 OR P4) AND (I3)):**

(requirements traceability OR requirements trace OR requirements tracing OR requirements traceability recovery) AND (supervised learning)

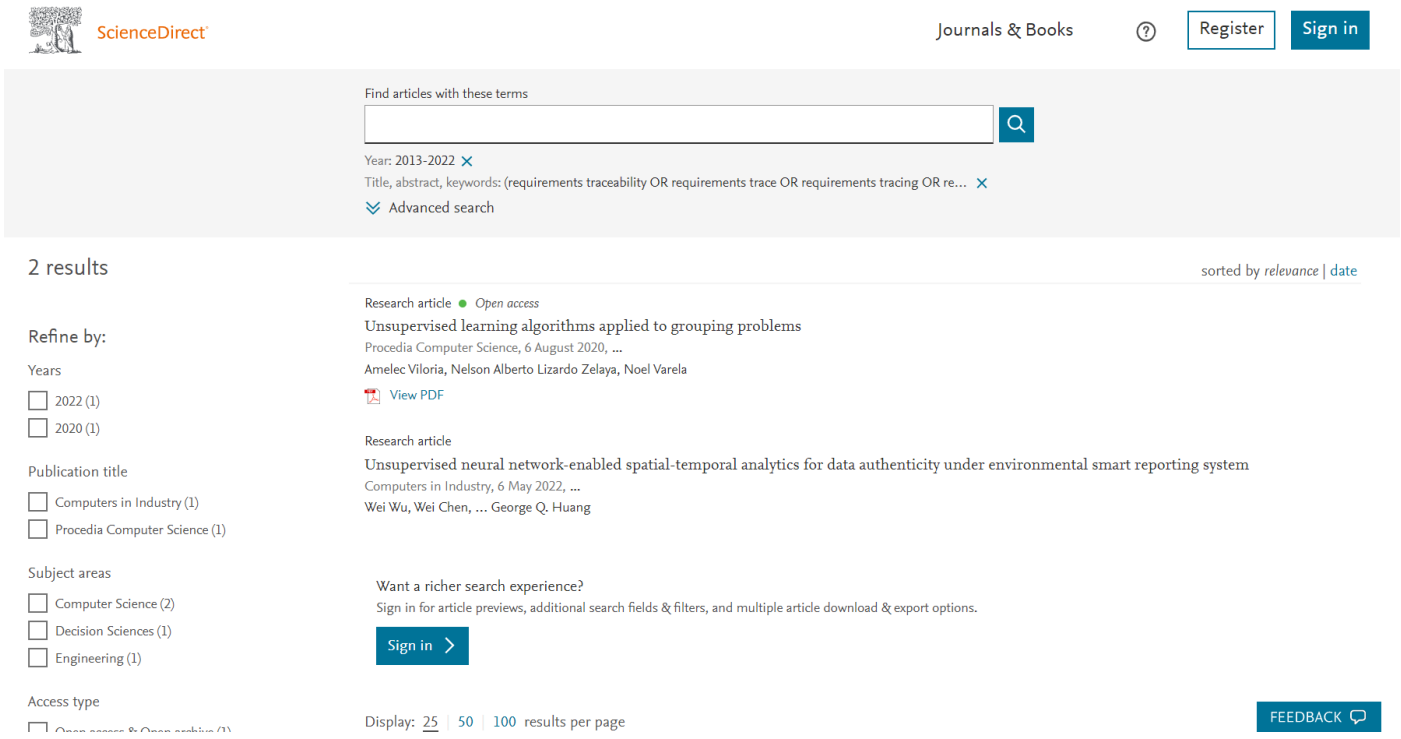
Screenshot of search process in Scienct Direct:



■ **Advanced search((P1 OR P2 OR P3 OR P4) AND (I4)):**

(requirements traceability OR requirements trace OR requirements tracing OR requirements traceability recovery) AND (unsupervised learning)

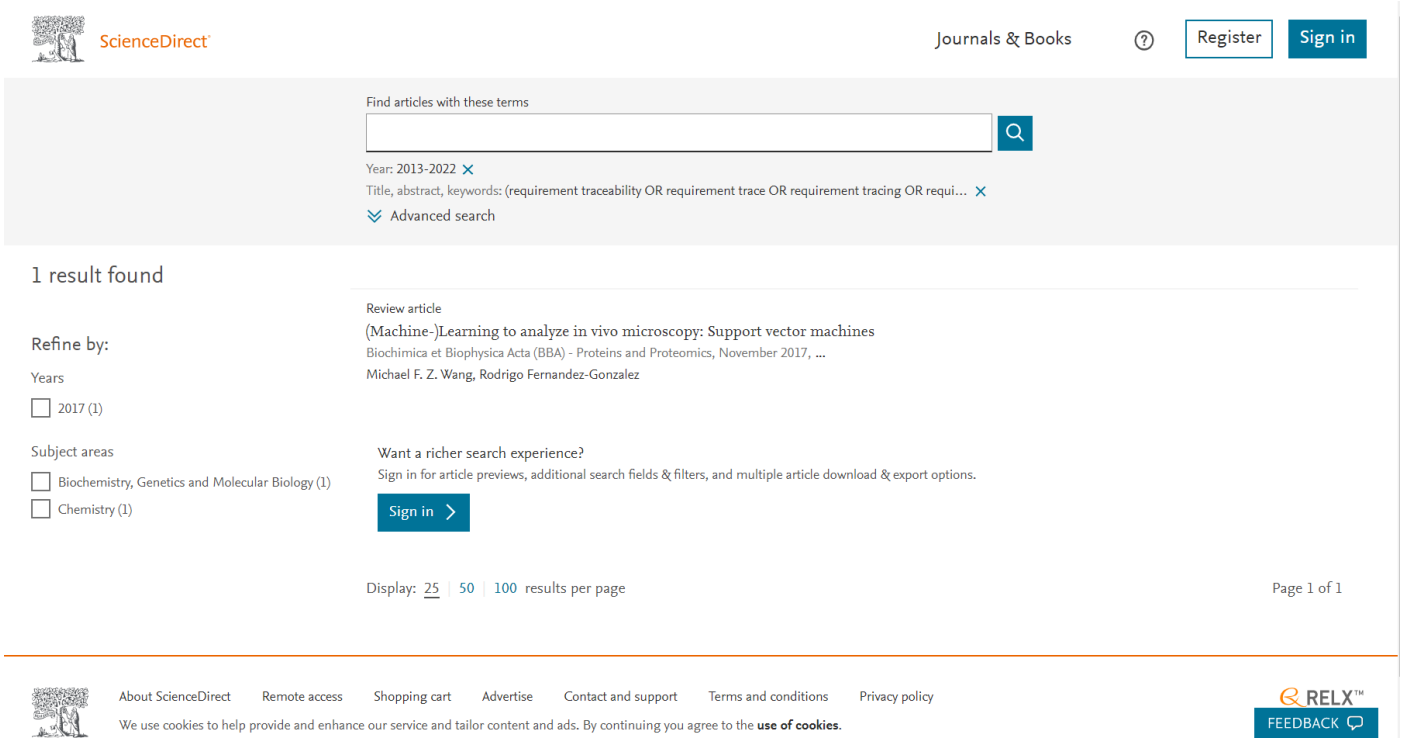
Screenshot of search process in Scienct Direct:



■ **Advanced search((P1 OR P2 OR P3 OR P4) AND (I5)):**

(requirements traceability OR requirements trace OR requirements tracing OR requirements traceability recovery) AND (semi-supervised learning)

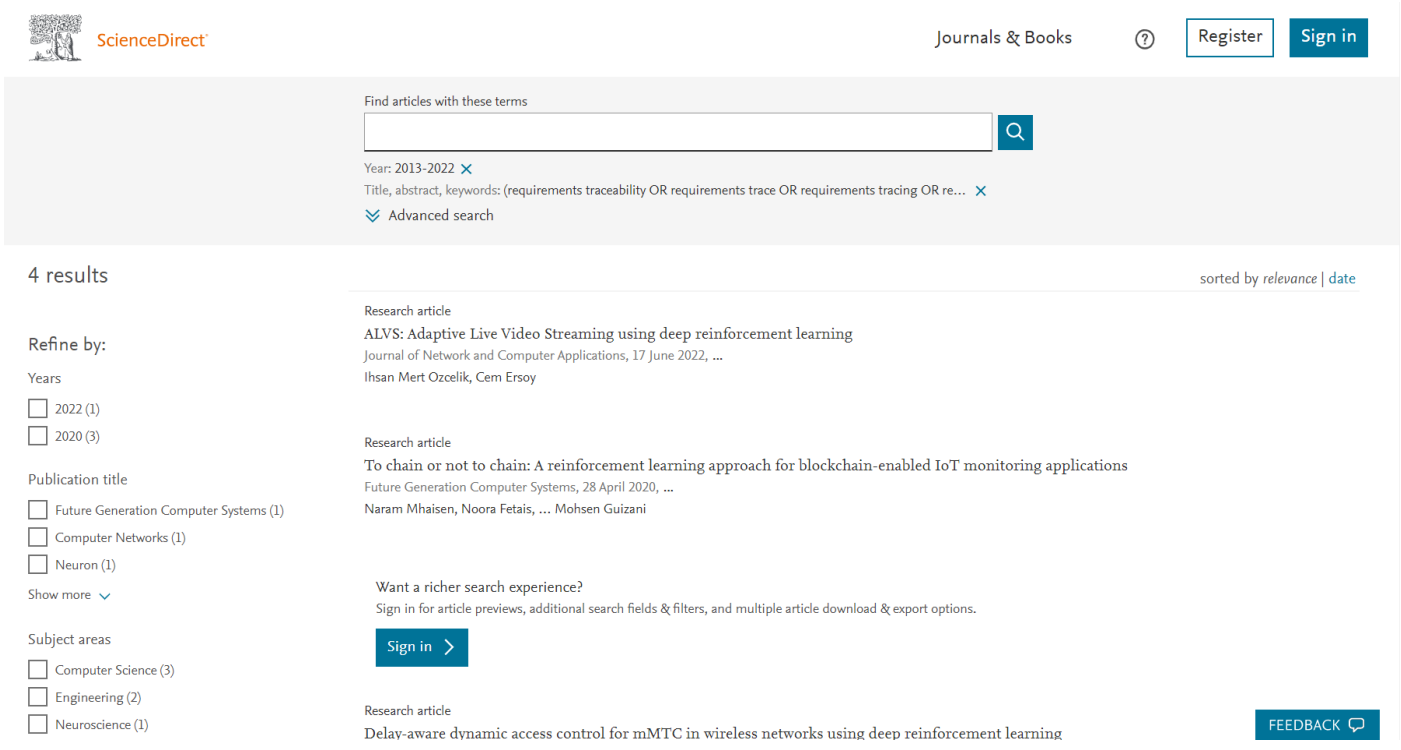
Screenshot of search process in Scienct Direct:



■ **Advanced search((P1 OR P2 OR P3 OR P4) AND (I6)):**

(requirements traceability OR requirements trace OR requirements tracing OR requirements traceability recovery) AND (reinforcement learning)

Screenshot of search process in Scienct Direct:



(4) EI

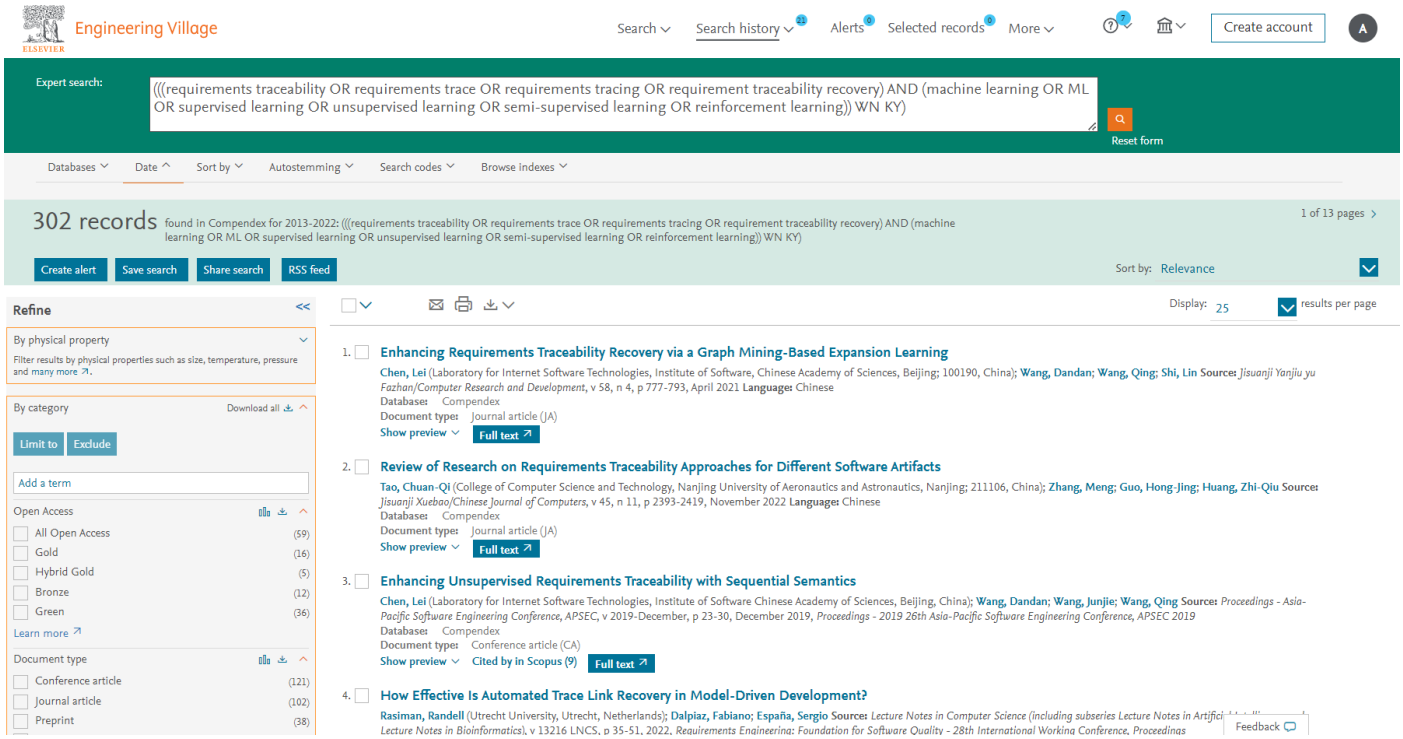
	Subject/Title/Abstract
(P1 OR P2 OR P3 OR P4) AND	302

(I1 OR I2 OR I3 OR I4 OR I5 OR I6)	

Expert search:

(((requirements traceability OR requirements trace OR requirements tracing OR requirement traceability recovery) AND (machine learning OR ML OR supervised learning OR unsupervised learning OR semi-supervised learning OR reinforcement learning)) WN KY)

Screenshot of search process in EI:



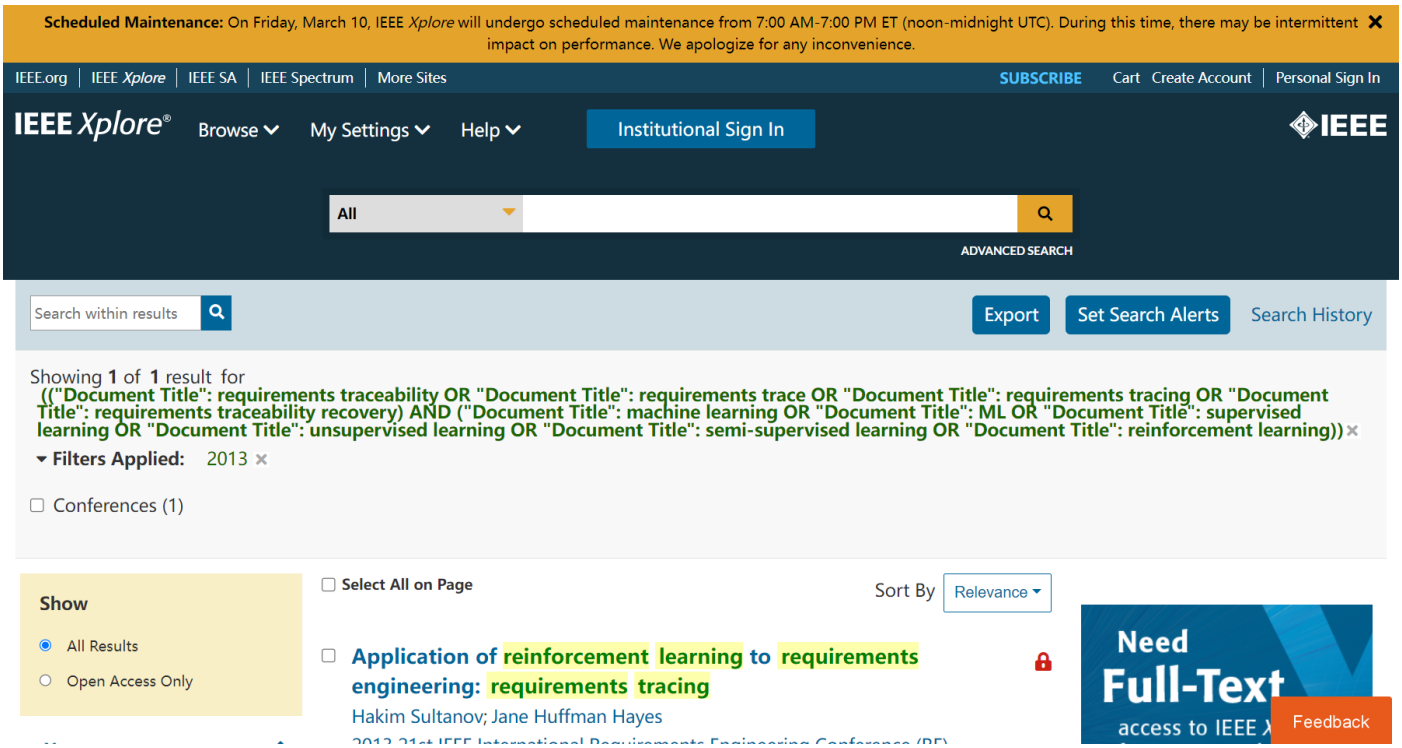
(5) IEEE

	Title	Abstract	Index terms
(P1 OR P2 OR P3 OR P4) AND (I1 OR I2 OR I3 OR I4 OR I5 OR I6)	1	150	42
Total	193		

■ **Command Search(Title):**

("Document Title": requirements traceability OR "Document Title": requirements trace OR "Document Title": requirements tracing OR "Document Title": requirements traceability recovery) AND ("Document Title": machine learning OR "Document Title": ML OR "Document Title": supervised learning OR "Document Title": unsupervised learning OR "Document Title": semi-supervised learning OR "Document Title": reinforcement learning)

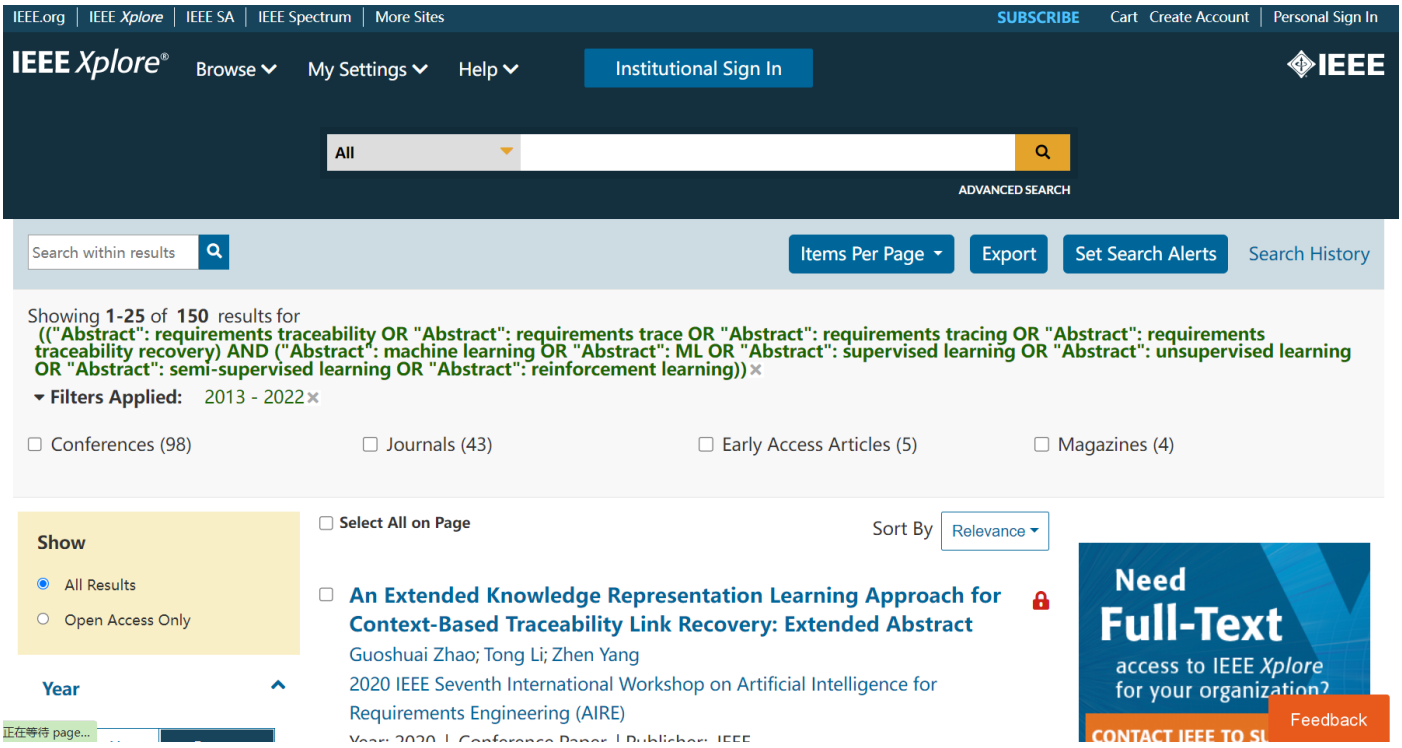
Screenshot of search process in IEEE:



■ **Command Search(Abstract):**

("Abstract": requirements traceability OR "Abstract": requirements trace OR "Abstract": requirements tracing OR "Abstract": requirements traceability recovery) AND ("Abstract": machine learning OR "Abstract": ML OR "Abstract": supervised learning OR "Abstract": unsupervised learning OR "Abstract": semi-supervised learning OR "Abstract": reinforcement learning)

Screenshot of search process in IEEE:



■ **Command Search(Index Terms):**

("Index Terms": requirements traceability OR "Index Terms": requirements trace OR "Index Terms": requirements tracing

OR "Index Terms": requirements traceability recovery) AND ("Index Terms": machine learning OR "Index Terms": ML OR "Index Terms": supervised learning OR "Index Terms": unsupervised learning OR "Index Terms": semi-supervised learning OR "Index Terms": reinforcement learning)

Screenshot of search process in IEEE: