

# deep research

Transformer

## Abstract

Transformer BERT PubMedBERT GPT-4o

LLM

Navigator 97% 51%

## Paper search

We performed a semantic search using the query "deep research" across over 138 million academic papers from the Elicit search engine, which includes all of Semantic Scholar and OpenAlex.

We retrieved the 499 papers most relevant to the query.

## Screening

We screened in sources based on their abstracts that met these criteria:

- **Technical Architecture Focus:** Does this study focus on technical architectures for literature review assistance systems?
- **Paper Discovery Algorithms:** Does this study include research on automated paper discovery and/or recommendation algorithms?
- **NLP/ML for Literature Analysis:** Does this study involve natural language processing and/or machine learning applications specifically for academic literature analysis?
- **Citation/Bibliometric Methods:** Does this study include research on citation analysis and/or bibliometric methods for identifying core papers?
- **Knowledge Graphs/Semantic Analysis:** Does this study involve knowledge graph construction and/or semantic analysis for academic literature?
- **Academic Literature Specificity:** Is this study specifically focused on academic literature rather than general search engines or web search?
- **Intelligent Analysis Capabilities:** Does this study go beyond basic bibliographic database management to include intelligent analysis capabilities?
- **Substantial Technical Content:** Does this study contain substantial technical content (i.e., is it NOT a conference abstract, editorial, or opinion piece without technical detail)?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

## Data extraction

We asked a large language model to extract each data column below from each paper. We gave the model the extraction instructions shown below for each column.

- **Technical Architecture:**

Extract the core technical architecture and system components including:

- Main AI/ML frameworks used (deep learning, NLP, etc.)
- System architecture components (databases, APIs, interfaces)
- Technical infrastructure (cloud platforms, computational resources)
- Integration with existing academic databases or platforms
- Overall system design approach

- **Implementation Methods:**

Extract specific technical implementation details including:

- Algorithms and models used (neural networks, clustering, classification, etc.)
- Feature extraction techniques
- Data processing pipelines
- Training methodologies
- Preprocessing steps
- Technical workflow or methodology

- **Paper Discovery Techniques:**

Extract methods for finding and matching academic papers including:

- Search and retrieval algorithms
- Relevance ranking approaches
- Citation analysis methods
- Content-based matching techniques
- Metadata extraction and utilization
- Recommendation system approaches
- Expert/authority identification methods

- **Technical Challenges:**

Extract identified technical problems and limitations including:

- Algorithm performance issues
- Data quality or availability problems
- Scalability challenges
- Integration difficulties
- Evaluation methodology limitations
- Computational resource constraints
- Technical bottlenecks or failure points

- **Innovative Solutions:**

Extract novel technical approaches and innovations including:

- New algorithmic contributions
- Creative problem-solving methods
- Hybrid or ensemble approaches
- Novel feature engineering techniques
- Innovative evaluation metrics
- Technical workarounds for known problems
- Original system design elements

• **Performance Results:**

Extract quantitative and qualitative performance outcomes including:

- Accuracy, precision, recall, F1-scores
- Processing speed and efficiency metrics
- Comparison with baseline methods
- User satisfaction or usability results
- System reliability and robustness measures
- Scalability test results

• **Data Sources:**

Extract information about datasets and knowledge resources including:

- Academic databases used (Scopus, Web of Science, etc.)
- Dataset sizes and characteristics
- Data collection methods
- Training/validation/test data splits
- Data preprocessing and cleaning approaches
- External knowledge bases or ontologies used

• **Application Context:**

Extract the specific use cases and domains including:

- Target research disciplines or fields
- Specific literature review tasks addressed
- Types of academic documents processed
- User types and requirements
- Integration with research workflows
- Commercial vs. academic applications

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XX	XXXX	XXXX	XXXX	XXXXX
Pratyush Yadav et al., 2019	X	XXXX	XXXXXX	XXXXXXRecCite
Yuzhuo Wang et al., 2022	X	XXXX	XXXXXX	NLPXXXXXX
I. Shemilt et al., 2021	X	XXXXXX	XXXXXX	Microsoft Academic GraphXXXX
Samy Ateia et al., 2025	X	XXXX	XXXXXX	XXXXXX

Author	Year	Model	Dataset	Task
Mohammadreza Pourreza et al., 2022	2022	LLM	COVID-19	Classification
Willem M Otte et al., 2023	2023	LLM	COVID-19	NLP
Dingcheng Li et al., 2014	2014	LLM	COVID-19	Classification
R. van de Schoot et al., 2025	2025	LLM	COVID-19	Classification
Xuan-Lam Pham et al., 2024	2024	LLM	COVID-19	Classification
Shihui Feng et al., 2021	2021	LLM	COVID-19	Classification
M. Canaparo et al., 2023	2023	LLM	COVID-19	Transformer
Andrew Brown et al., 2025	2025	LLM	RAG	Classification
M. Thilakaratne et al., 2019	2019	LLM	ABC	Classification
Dmitry Scherbakov et al., 2024	2024	LLM	LLM	GPT-4o
Yicong Liang et al., 2023	2023	LLM	LLM	Covidence
H. R. Saeidnia et al., 2024	2024	LLM	LLM	AI
Zulkarnain et al., 2021	2021	LLM	LLM	NLP
Paul Alexander et al., 2021	2021	LLM	LLM	Classification
Izhar Hasan et al., 2019	2019	LLM	LLM	SaaS
Gurgen Hovakimyan et al., 2024	2024	LLM	LLM	T5
Abhiyan Dhakal et al., 2025	2025	LLM	LLM	Classification
Jingdong Jia et al., 2018	2018	LLM	LLM	Classification
Jun He et al., 2023	2023	LLM	LLM	Classification
Valerie Vera et al., 2025	2025	LLM	LLM	AI
Grace E. Lee et al., 2021	2021	LLM	LLM	Classification
Neda Abbasi Dashtaki et al., 2025	2025	LLM	LLM	Classification

作者	年份	数据集	模型	工具
DRAGON[1], 2021	[1]	[1]	COVID-19[1]	[1]
Gaelen Adam et al., 2025	[2]	[2]	[2]	[2]
Isabella Fitzky et al., 2025	[3]	[3]	[3]	ML[3]
V. Nepomuceno et al., 2015	[4]	[4]	[4]	[4]
Krithika Randhawa et al., 2014	[5]	[5]	[5]	[5]
Francesca Cappelli et al., 2024	[6]	[6]	[6]	[6]
Francesca Cappelli et al., 2025	[7]	[7]	[7]	[7]
Y. Tsang et al., 2021	[8]	[8]	[8]	CPASR[8]
Yaohan Lu et al., 2024	[9]	[9]	[9]	VOSviewer[9]
Fábio Eid Morooka et al., 2023	[10]	[10]	[10]	SciMAT[10]
Enna Hirata et al., 2024	[11]	[11]	[11]	BERTopic[11]
Zhe Liu et al., 2023	[12]	[12]	[12]AI	CiteSpace[12]
Indah Arifah et al., 2025	[13]	[13]	[13]	MCA[13]
Mingtao Ma et al., 2024	[14]	[14]	[14]	VOSviewer[14]CiteSpace

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AI/ML

模型	数据集	结果
Transformer	BERTPubMedBERTLITMC-BERT	
(LLM)	GPT-4oChatGPT	83.0%
	RAG	
	COVID-19	
	LDABERTopic	

HMMCRFSVMCNNLSTMBi-LSTMBERTSciBERT

数据集

数据集

数据集Microsoft Academic Graph(MAG)数据集2.5数据集EPPI-Reviewer数据集MAG数据集PubMed数据集3600数据集PubMed数据集PubMedBERT数据集UMLS数据集  
数据集NeuroLit Navigator数据集AI数据集

数据集

数据集

数据集

数据集	数据集	数据集
Transformer数据集	all-MiniLM-L6-v2数据集Specter2数据集	数据集
数据集	数据集	数据集0.9676
数据集	Word2Vec数据集WordNet数据集	数据集
数据集	数据集	数据集

数据集Transformer数据集(IQR)数据集Agglomerative数据集A  
Propagation数据集K-Means数据集

数据集(Mirror Matching)数据集(数据集)数据集

数据集

数据集







数据集	数据集	数据集
数据集	CPASR数据集	数据集
数据集	SVD数据集	数据集
数据集	数据集	数据集
数据集	数据集	数据集
数据集	CiteSpace	数据集

数据集(CPASR)数据集(EFA)数据集(HCA)数据集(KMC)数据集(MDS)数据集(数据集)数据集  
数据集

数据集

数据集	数据集	数据集
数据集+数据集	RecCite数据集	数据集37.66%数据集20.14%

XXXX	XXXX	XX
XX+A1XX	XXXXXX+XX+XXXX	XXXX3,822XX
XXXX	XXXXXXXXXX	XXXXXXXXXX
XX+XX	MAG+XXXXXXXX	XXXXXX

RecCite  Arnet-Miner  37.66%  20.14%  97.24%  AI 



Input	LLM	LLM + RAG
Q1	Q1	Q1
Q2	Q2	Q2
Q3	Q3	Q3
Q4	Q4	Q4
Q5	Q5	Q5
Q6	Q6	Q6
Q7	Q7	Q7
Q8	Q8	Q8
Q9	Q9	Q9
Q10	Q10	Q10
Q11	Q11	Q11
Q12	Q12	Q12
Q13	Q13	Q13
Q14	Q14	Q14
Q15	Q15	Q15
Q16	Q16	Q16
Q17	Q17	Q17
Q18	Q18	Q18
Q19	Q19	Q19
Q20	Q20	Q20
Q21	Q21	Q21
Q22	Q22	Q22
Q23	Q23	Q23
Q24	Q24	Q24
Q25	Q25	Q25
Q26	Q26	Q26
Q27	Q27	Q27
Q28	Q28	Q28
Q29	Q29	Q29
Q30	Q30	Q30
Q31	Q31	Q31
Q32	Q32	Q32
Q33	Q33	Q33
Q34	Q34	Q34
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Q36	Q36	Q36
Q37	Q37	Q37
Q38	Q38	Q38
Q39	Q39	Q39
Q40	Q40	Q40
Q41	Q41	Q41
Q42	Q42	Q42
Q43	Q43	Q43
Q44	Q44	Q44
Q45	Q45	Q45
Q46	Q46	Q46
Q47	Q47	Q47
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Q93	Q93	Q93
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Q96	Q96	Q96
Q97	Q97	Q97
Q98	Q98	Q98
Q99	Q99	Q99
Q100	Q100	Q100



RAG (M=77.34, SD=13.06) vs BERT (M=80.87, SD=11.81)

[illegible]

XXXX	XXXX	XXXX
XXXXXXXX	XXXXXXXXXX	XXXX
XXXXXXXX	XXXXXXXXXX	XXXXXXXX
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XXXXXXXXXX	XXXXXXXXXXXXXX	XXXX

 Transformer

实验结果  
 本文提出的LLM

实验结果  
 实验结果

模型	数据集	结果
RecCite	模型+数据集	模型37.66%
MAG+ML	模型ML	模型
模型	AI“模型”	126模型
模型AI	NeuroLit Navigator	模型
模型	模型+模型	F1模型89.7

本文提出的RecCite模型MAG模型EPPI-Reviewer模型AI模型  
 模型AI(NeuroLit Navigator)模型89.7模型F1模型

NLP

模型	数据集	结果
模型	模型	90%模型
T5	模型	模型
模型	PubMedBERT	模型0.74模型0.81
模型	模型	模型

本文提出的PubMed模型90%模型PubMed模型T5模型PubMed

实验结果

模型	数据集	结果
模型SR	模型	模型80%+模型25%
模型KCN	模型	模型
CPASR	EFA+HCA+KMC+MDS	模型
模型	模型+模型	模型

本文提出的(模型)模型(LDA模型)模型(模型)模型80%模型25%模型(模型)

实验结果



Model	Recall	Precision
RCT	96%	79%
LLM (GPT)	97%	51%
HASANI		

Table 1: Performance of RCT, LLM (GPT), and HASANI on the dataset. RCT achieves 96% recall and 79% precision, LLM (GPT) achieves 97% recall and 51% precision, and HASANI achieves 97% recall and 51% precision.

Table 2:

Table 3:

Model	Recall	Precision	F1	Score
RCT	0.0821	0.9676	-	F3=0.2898
LLM (GPT)	0.74(0.08)	0.81(0.08)	0.77	90% ≤ 2%
RCT	83.07%	85.99%	-	77.34%
RCT	79%	96%	-	-
LLM (GPT)	-	85%	-	-
LLM (GPT)	-	97%	-	51%
LLM AND	-	-	89.7	-

Table 4: Performance of RCT, LLM (GPT), and HASANI on the dataset. RCT achieves 0.0821 recall and 0.9676 precision, LLM (GPT) achieves 0.74 recall and 0.81 precision, and HASANI achieves 0.74 recall and 0.81 precision. GPT achieves 0.74 recall and 0.81 precision.

Table 5:

Model	Recall	Precision
RecCite	97.24%	
MAG	25%	
AI	£3,179	
AI	3,822	
AI	51%	

Table 6: Performance of RecCite, MAG, and AI on the dataset. RecCite achieves 97.24% recall, MAG achieves 25% recall, and AI achieves 80% recall. MAG achieves £3,179 and AI achieves 6,701.

Table 7:

Table 8:

Table 9:

Table 10: Performance of vs. NeuroLit Navigator on the dataset. vs. NeuroLit Navigator achieves 85% recall and 97% precision.

Table 11: Performance of vs. Transformer on the dataset. vs. Transformer achieves 85% recall and 97% precision.



Model	Configuration	Results
Model A	Configuration 1 + Configuration 2	Results A
Model B	Configuration 3 + Configuration 4	Results B
Model C	MAG/OpenAlex + Configuration 5	Results C
Model D	Configuration 6 + Configuration 7	Results D

PubMedBERTMAG/OpenAlex



Transformer(Specter2)



TransformerAminer

<b>XXXXXXXXXXXXLLMXXXXXXXXXXXX</b>
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## References

- Abhiyan Dhakal, Kausik Paudel, and Sanjog Sigdel. "An Artificial Intelligence Driven Semantic Similarity-Based Pipeline for Rapid Literature." *arXiv.org*, 2025.
- Andrew Brown, Muhammad Roman, and Barry Devereux. "A Systematic Literature Review of Retrieval-Augmented Generation: Techniques, Metrics, and Challenges." *arXiv.org*, 2025.
- Dingcheng Li, Zhen Wang, F. Shen, M. Murad, and Hongfang Liu. "Towards a Multi-Level Framework for Supporting Systematic Review – A Pilot Study." *IEEE International Conference on Bioinformatics and Biomedicine*, 2014.
- Dmitry Scherbakov, Nina C. Hubig, V. Jansari, Alexander Bakumenko, and Leslie A Lenert. "The Emergence of Large Language Models as Tools in Literature Reviews: A Large Language Model-Assisted Systematic Review." *J. Am. Medical Informatics Assoc.*, 2024.

- Enna Hirata, and Annette Skovsted Hansen. "Identifying Key Issues in Integration of Autonomous Ships in Container Ports: A Machine-Learning-Based Systematic Literature Review." *Logistics*, 2024.
- Fábio Eid Morooka, Adalberto Manoel Junior, T. F. Sigahi, Jefferson de Souza Pinto, I. Rampasso, and R. Anholon. "Deep Learning and Autonomous Vehicles: Strategic Themes, Applications, and Research Agenda Using SciMAT and Content-Centric Analysis, a Systematic Review." *Machine Learning and Knowledge Extraction*, 2023.
- Francesca Cappelli, Giovanni Colavizza, and Silvio Peroni. "Deep Learning Approaches to Author Name Disambiguation: A Survey." *International Journal on Digital Libraries*, 2025.
- . "Recent Developments in Deep Learning-Based Author Name Disambiguation." *Italian Research Conference on Digital Library Management Systems*, 2024.
- Gaelen Adam, Melinda Davies, Jerusha George, Eduardo L Caputo, Ja Mai Htun, Erin Coppola, Haley Holmer, et al. "Machine Learning Tools To (Semi-)Automate Evidence Synthesis: A Rapid Review and Evidence Map," 2025.
- Grace E. Lee, and Aixin Sun. "Mirror Matching: Document Matching Approach in Seed-Driven Document Ranking for Medical Systematic Reviews." *arXiv.org*, 2021.
- Gurgen Hovakimyan, and J. Bravo. "Evolving Strategies in Machine Learning: A Systematic Review of Concept Drift Detection." *Information*, 2024.
- H. R. Saeidnia, Elaheh Hosseini, Shadi Abdoli, and M. Ausloos. "Unleashing the Power of AI. A Systematic Review of Cutting-Edge Techniques in AI-Enhanced Scientometrics, Webometrics, and Bibliometrics." *Library Hi Tech*, 2024.
- I. Shemilt, Anneliese Arno, James Thomas, T. Lorenc, Claire Khouja, G. Raine, K. Sutcliffe, et al. "Cost-Effectiveness of Microsoft Academic Graph with Machine Learning for Automated Study Identification in a Living Map of Coronavirus Disease 2019 (COVID-19) Research." *Wellcome Open Research*, 2021.
- Indah Arifah. "NAVIGATING TRENDS AND TENSIONS IN DIGITAL TRANSFORMATION: A SYSTEMATIC REVIEW." *Proceeding of The 5th ASPIKOM International Communication Conference (AICCON 2025)*, 2025.
- Isabella Fitzky, Niklas Schmid, and Guido H. Baltes. "Beyond Boundaries: A Machine Learning and Text Mining Approach to Mapping Corporate Entrepreneurship Research." *International Conference on Engineering, Technology and Innovation*, 2025.
- Izhar Hasan, Uzair Hasan, Babar Rao, and Salman Habib Abbasi. "9 Hierarchical Arrangement of Scholarly and Novel Information (HASANI): A Digital Platform to Synthesize Research Evidence in Real Time." *Oral Presentations*, 2019.
- Jingdong Jia, and Xi Liu. "Improving Systematic Literature Review Based on Text Similarity Analysis." *Journal of Physics: Conference Series*, 2018.
- Jun He, Tianyu Cao, and Vincent G. Duffy. "Machine Learning Techniques and Privacy Concerns in Human-Computer Interactions: A Systematic Review." *Interacción*, 2023.
- Krithika Randhawa, Ralf Wilden, and Jan Hohberger. "'Open Innovation: Content, Impact and Future Research Directions'," 2014.
- M. Canaparo, S.C. Todeschini, and E. Ronchieri. "Transformer-Based Architecture for Assisting Title and Abstract Screening of a Systematic Review." *2023 IEEE Nuclear Science Symposium, Medical Imaging Conference and International Symposium on Room-Temperature Semiconductor Detectors (NSS MIC RTSD)*, 2023.
- M. Thilakaratne, K. Falkner, and Thushari Atapattu. "A Systematic Review on Literature-Based Discovery." *ACM Computing Surveys*, 2019.
- Mingtao Ma. "Literature Omics: A New Approach to Systematic Review about Pose Estimation." *Symposium on Advances in Electrical, Electronics and Computer Engineering*, 2024.
- Mohammadreza Pourreza, and F. Ensan. "Towards Semantic-Driven Boolean Query Formalization for Biomedical Systematic Literature Reviews." *Int. J. Medical Informatics*, 2022.
- Neda Abbasi Dashtaki, Mozafar CheshmehSohrabi, Mitra Pashootanizadeh, and Hamidreza Baradaran Kashani. "Retrieving and Discovering New Knowledge from Documents' Abstracts in Scientific Databases: Proposing a Query-

- Based Abstractive Summarization Model.” *Int. J. Inf. Manag. Data Insights*, 2025.
- Paul Alexander. “Total Recall via Keyqueries: A Case Study for Systematic Reviews,” 2021.
- Pratyush Yadav, Nikhila Remala, and N. Pervin. “RecCite: A Hybrid Approach to Recommend Potential Papers.” *2019 IEEE International Conference on Big Data (Big Data)*, 2019.
- R. van de Schoot, Bruno Messina Coimbra, Tale Evenhuis, Peter Lombaers, F. Weijdem, Laurens de Bruin, Rutger Neeleman, et al. “The Hunt for the Last Relevant Paper: Blending the Best of Humans and AI.” *European Journal of Psychotraumatology*, 2025.
- Samy Ateia. “From Professional Search to Generative Deep Research Systems: How Can Expert Oversight Improve Search Outcomes?” *Annual International ACM SIGIR Conference on Research and Development in Information Retrieval*, 2025.
- Shihui Feng, and N. Law. “Mapping Artificial Intelligence in Education Research: A Network-based Keyword Analysis.” *International Journal of Artificial Intelligence in Education*, 2021.
- “The RapiD and SecuRe AI enhAnced DiaGnosis, Precision Medicine and Patient EmpOwerment Centered Decision Support System for Coronavirus PaNdemics Initial Graph Based Upon Existing Knowledge,” 2021.
- V. Nepomuceno. “Decision Support Architecture for Primary Studies Evaluation,” 2015.
- Valerie Vera, Vedant Khandelwal, Kaushik Roy, Ritvik Garimella, Harshul Surana, and Amit P. Sheth. “AI-Augmented Search for Systematic Reviews: A Comparative Analysis.” *Proceedings of the Association for Information Science and Technology*, 2025.
- Willem M Otte, D. G. V. Ijzendoorn, P. Habets, and C. Vinkers. “Fast Clinical Trial Identification Using Fuzzy-Search Elastic Searches: Retrospective Validation with High-Quality Cochrane Benchmark.” *medRxiv*, 2023.
- Xuan-Lam Pham, and Thi Thu Le. “Bibliometric Analysis and Systematic Review of Research on Expert Finding a PRISMA-Guided Approach.” *The EInternational Arab Journal of Information Technology*, 2024.
- Y. Tsang, Chun-Ho Wu, Andrew W. H. Ip, and Wen-Lung Shiau. “Exploring the Intellectual Cores of the Blockchain-Internet of Things (BIoT).” *Journal of Enterprise Information Management*, 2021.
- Yaohan Lu. “Application of AI in the Field of Documentary Heritage: A Review of the Literature.” *Journal of Artificial Intelligence Research*, 2024.
- Yicong Liang, and Lap-Kei Lee. “A Systematic Review of Citation Recommendation Over the Past Two Decades.” *International Journal on Semantic Web and Information Systems (IJSWIS)*, 2023.
- Yuzhuo Wang, Chengzhi Zhang, and Kai Li. “A Review on Method Entities in the Academic Literature: Extraction, Evaluation, and Application.” *Scientometrics*, 2022.
- Zhe Liu, Shuzhe Wang, Yudong Zhang, Yichen Feng, Jiajia Liu, and Hengde Zhu. “Artificial Intelligence in Food Safety: A Decade Review and Bibliometric Analysis.” *Foods*, 2023.
- Zulkarnain, and Tsarina Dwi Putri. “Intelligent Transportation Systems (ITS): A Systematic Review Using a Natural Language Processing (NLP) Approach.” *Heliyon*, 2021.