A Bibliometric Analysis

The Impact of Artificial Intelligence and Machine Learning on the Banking Sector

Research Questions

1. **How have AI/ML been applied in the banking sector to address key challenges?**
2. **What are the emerging trends in AI/ML research in banking?**
3. **What gaps exist in the current literature on AI/ML applications in banking?**
4. **How can bibliometric and thematic analyses contribute to identifying future research directions?**

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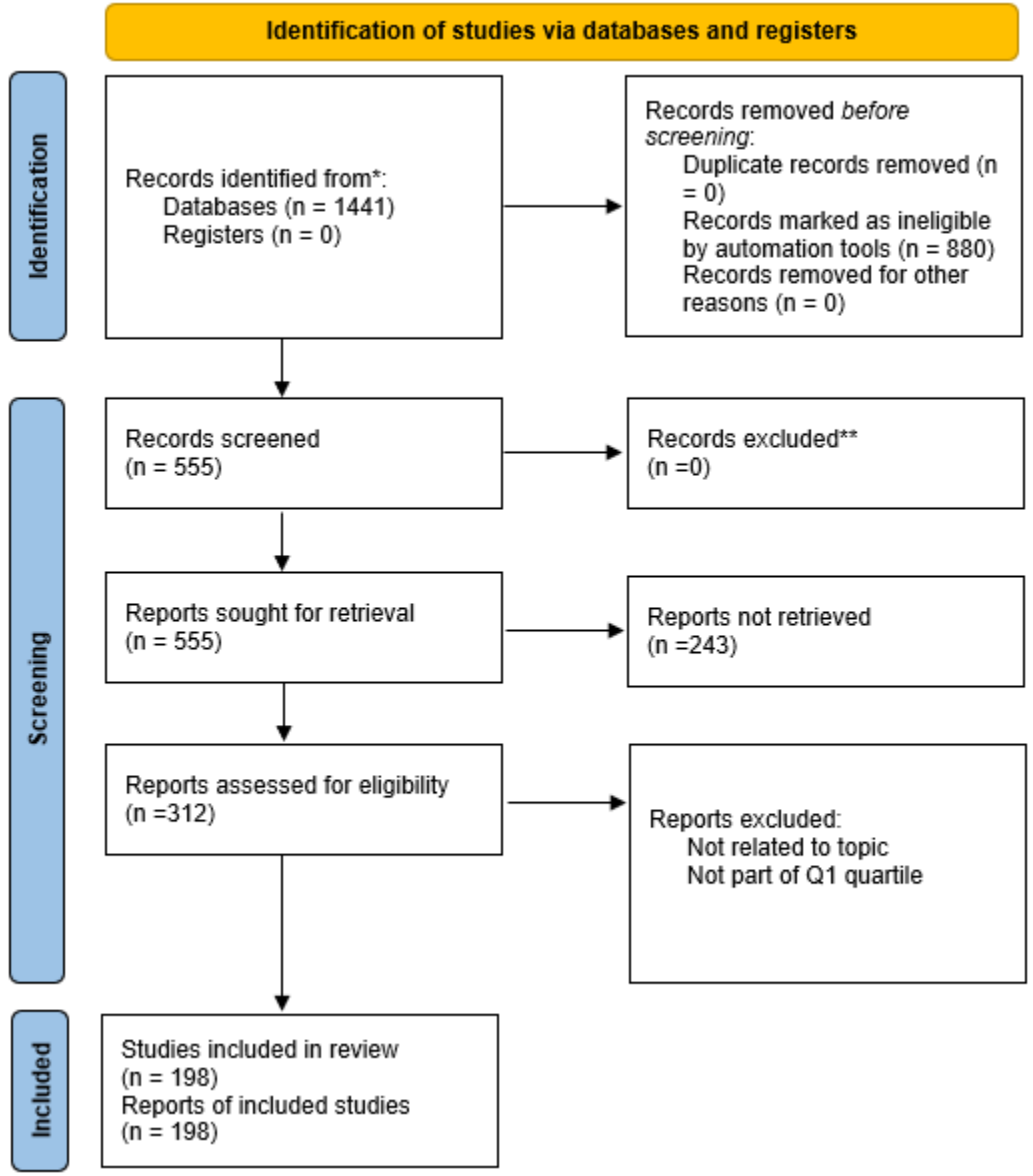
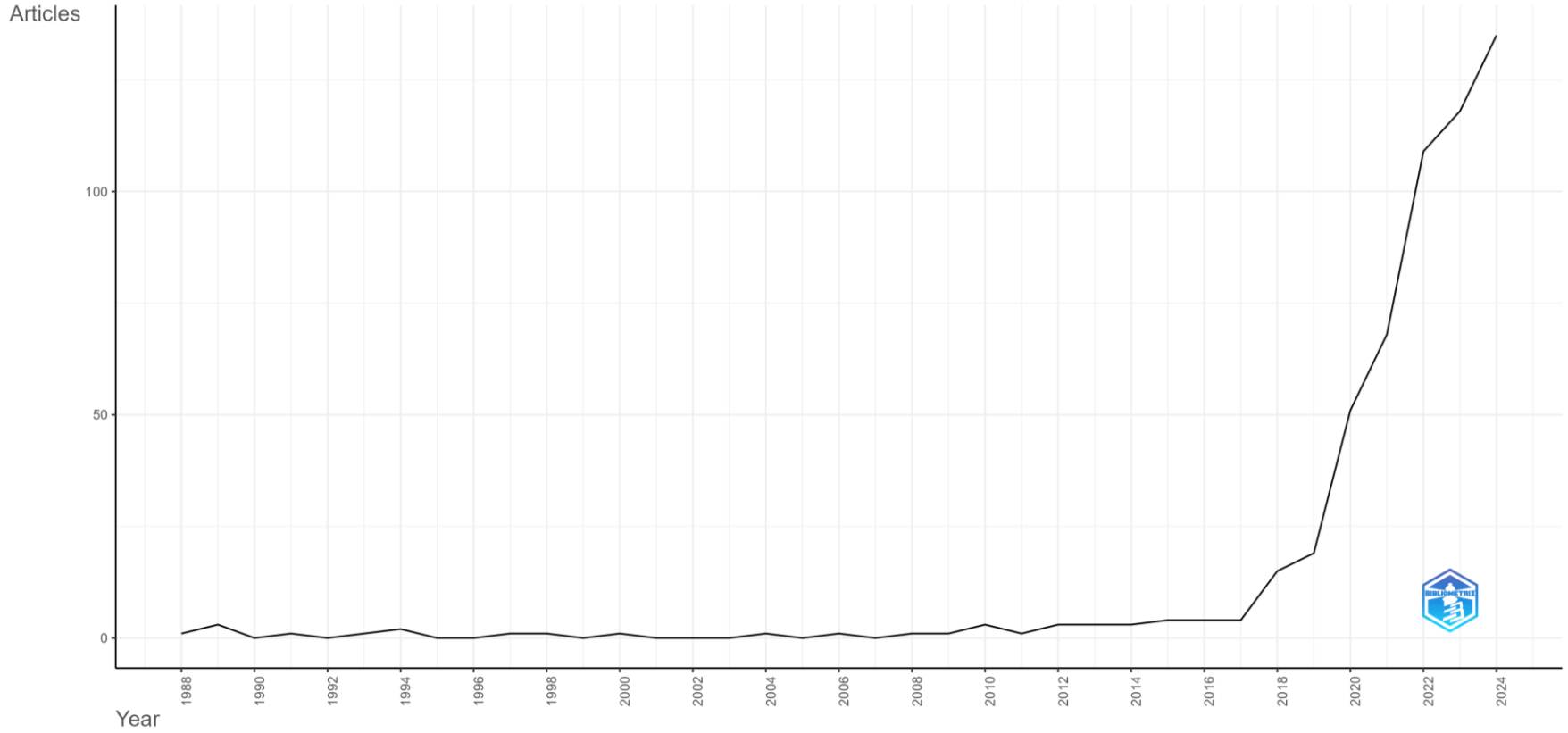
Study Selection Process (PRISMA Flow Diagram)

- Initial pool: 1,441 records identified.
- Automated screening removed 880 irrelevant/duplicate entries.
- 243 records unavailable, leaving 312 reports for eligibility assessment.
- Final selection: 198 high-quality studies based on topic relevance and Q1 quartile.



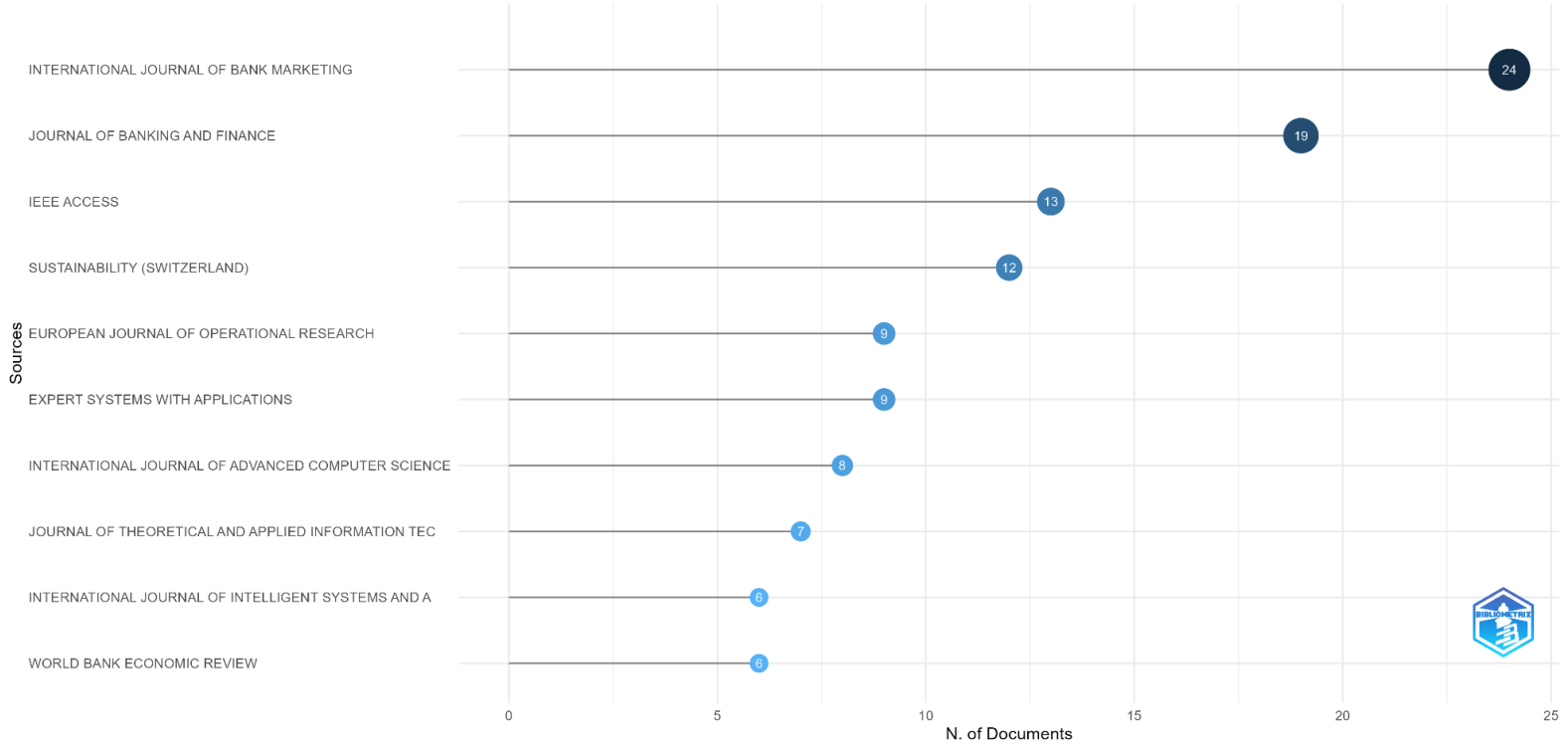
Annual Scientific Production

- Research output remained low and stable from 1988 to 2016.
- A sharp increase in publications from 2017 onward.
- Reflects growing interest and advancements in AI/ML for banking applications.



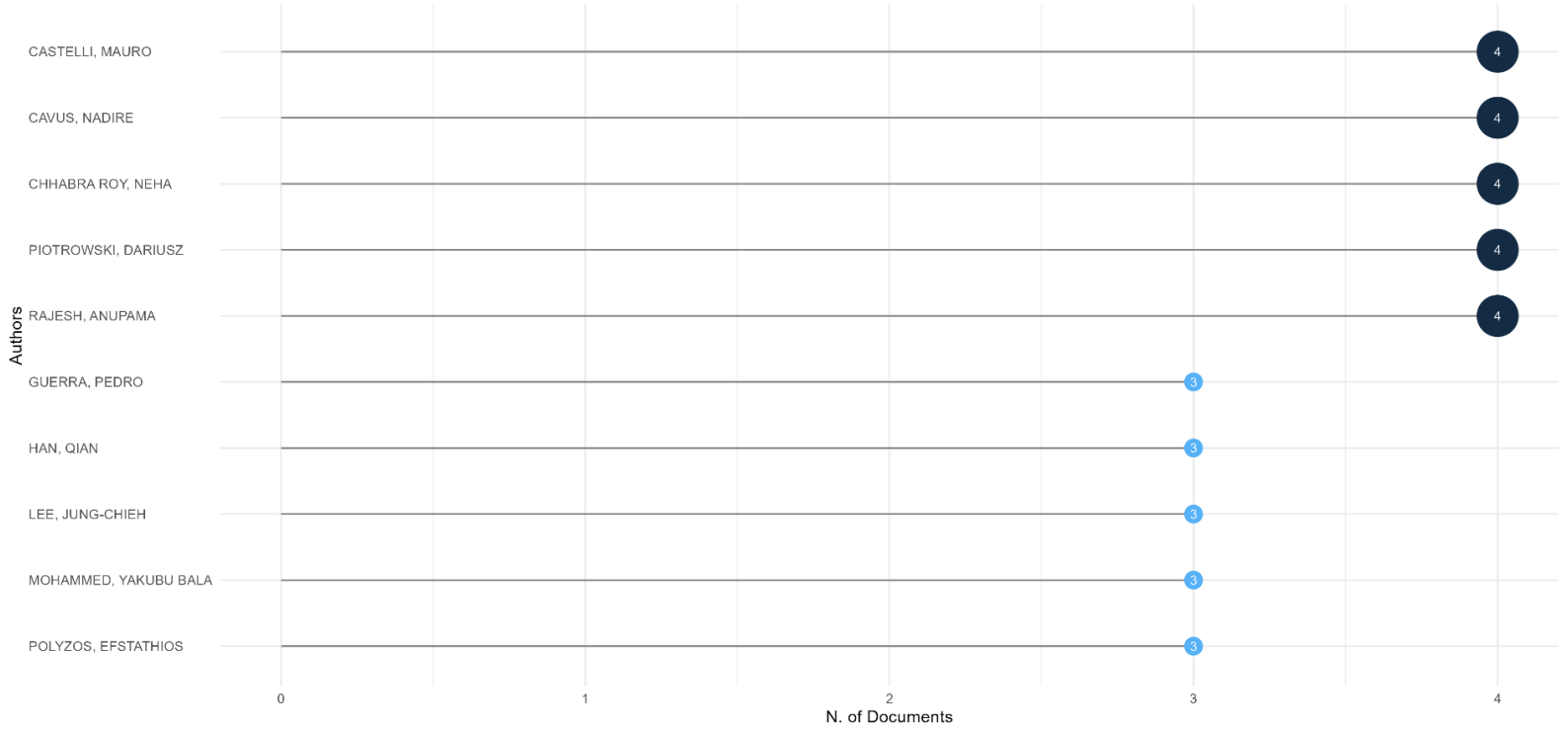
Most Relevant Sources

- **Top journals publishing AI/ML research in banking**:
  - International Journal of Bank Marketing (24 articles).
  - Journal of Banking and Finance (19 articles).
  - IEEE Access (13 articles).
- Highlights the interdisciplinary nature of research.



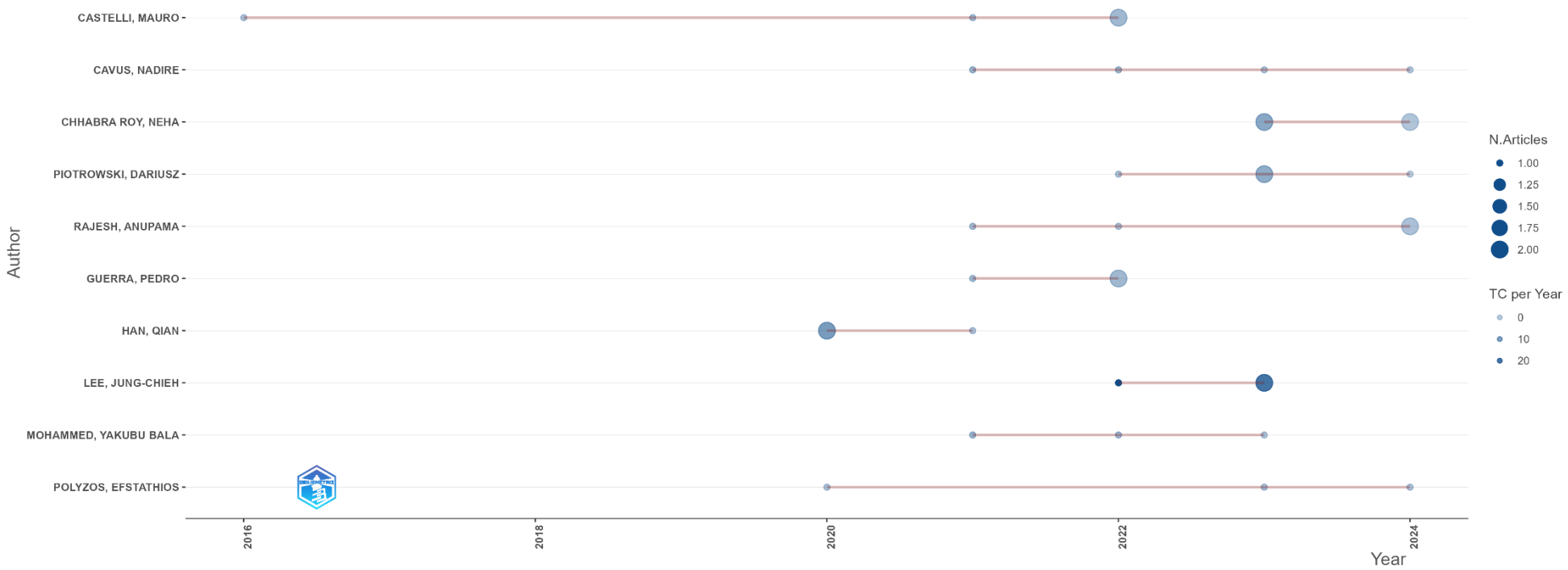
Most Relevant Authors

•Leading contributors include Castelli Mauro, Cavus Nadire, and Rajesh Anupama.
•Work spans fraud detection, risk management, and customer personalization.
•Demonstrates strong interdisciplinary collaboration.



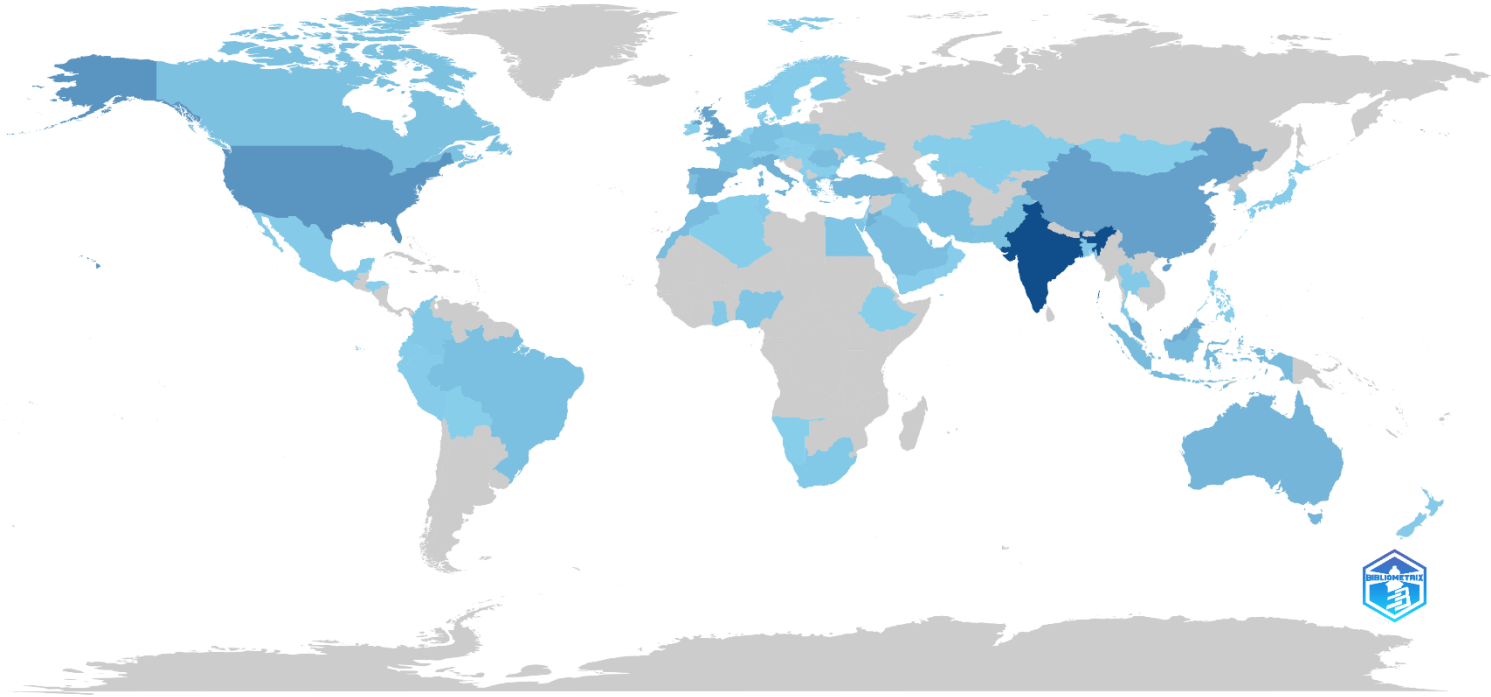
Authors' Production Over Time

- Identifies sustained contributions by key researchers over the years.
- Increased author activity post-2017, aligning with technological advancements.
- Highlights ongoing engagement in AI/ML-driven banking research.



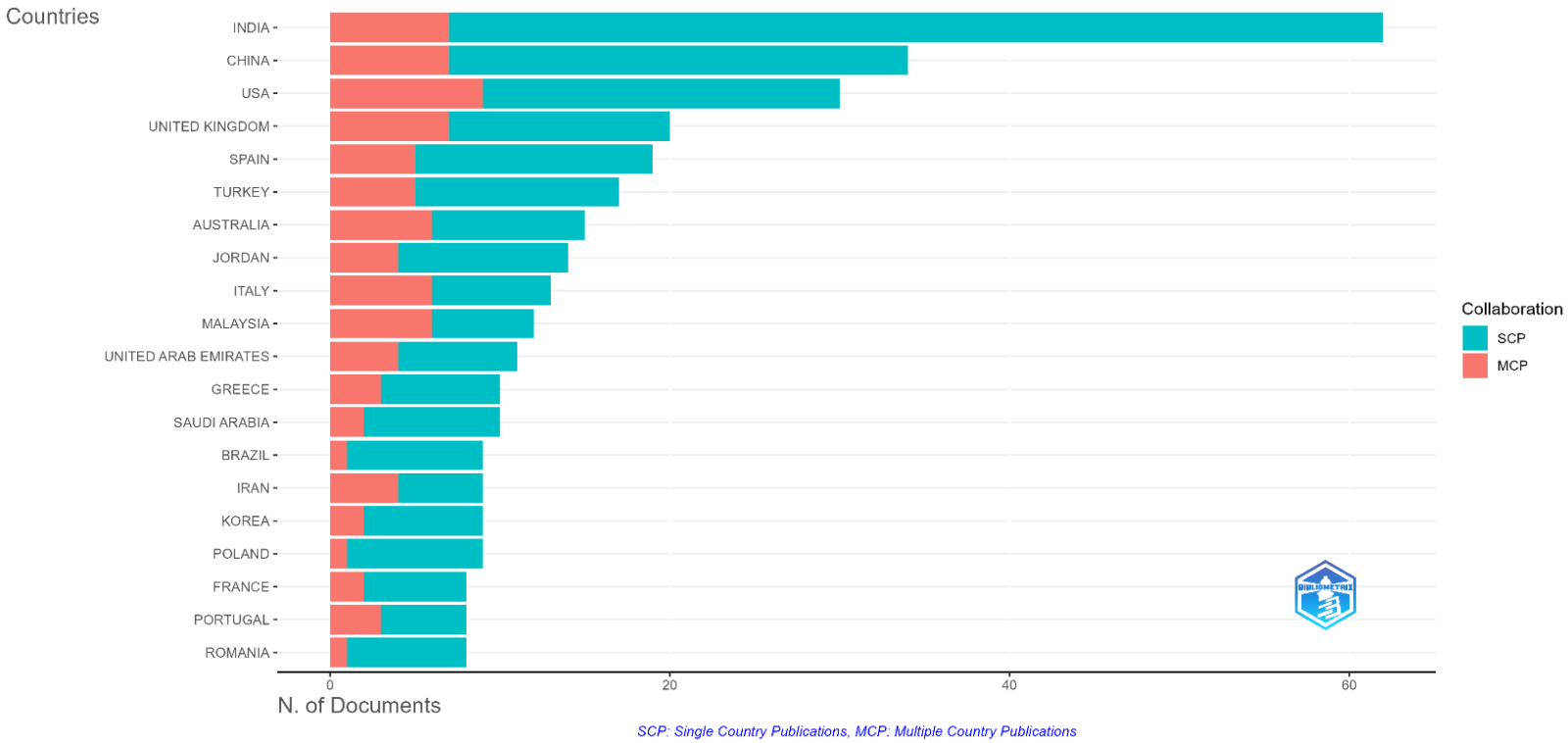
Country Scientific Production

•Visual representation of country-wise research output.
•Highlights the global interest in AI/ML applications in banking.
•Emphasizes contributions from both developed and emerging economies.



Corresponding Author's Countries

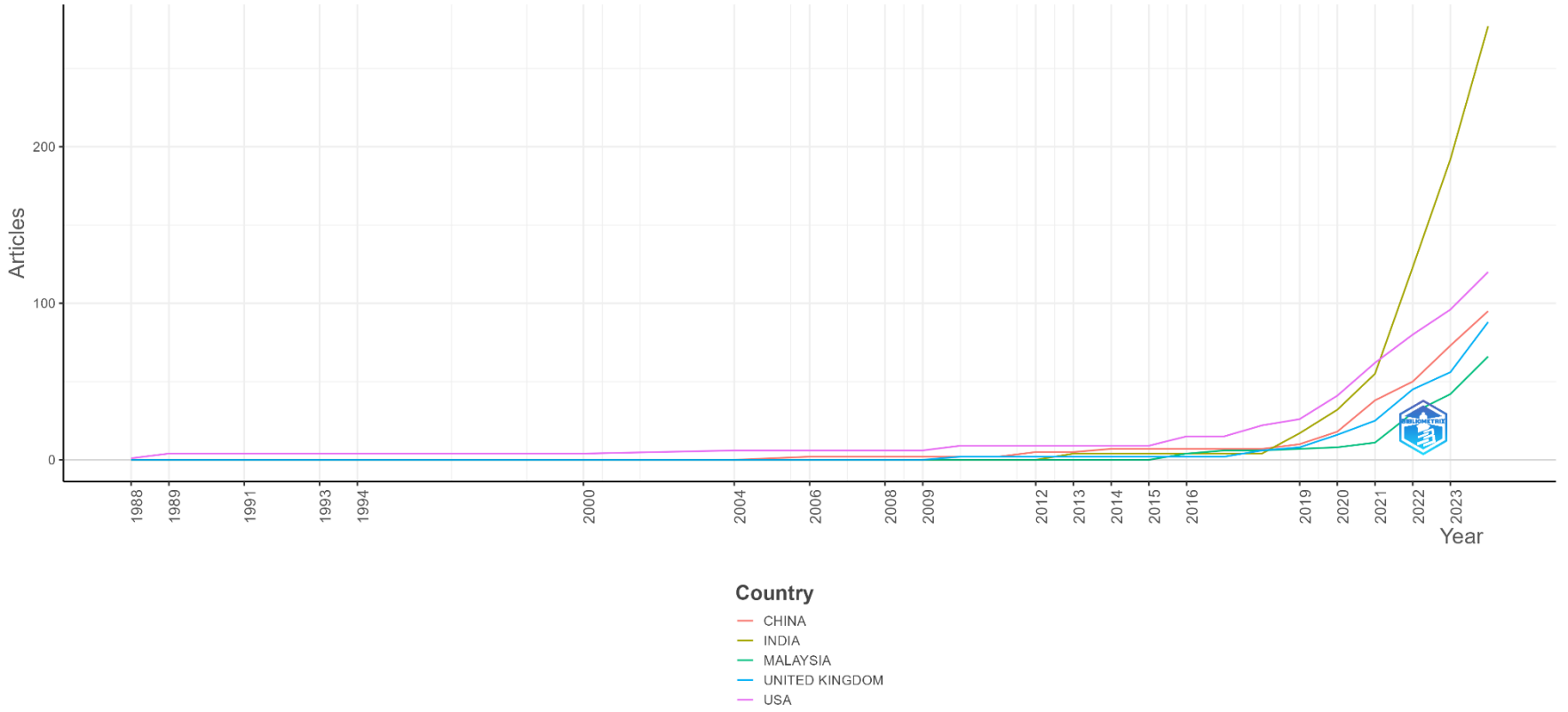
- **Top contributing countries**:
  - India, China, USA, and UK dominate AI/ML research in banking.
- India and China show strong domestic research efforts.
- USA and UK exhibit balanced collaboration with multiple-country publications.



SCP: Single Country Publications, MCP: Multiple Country Publications

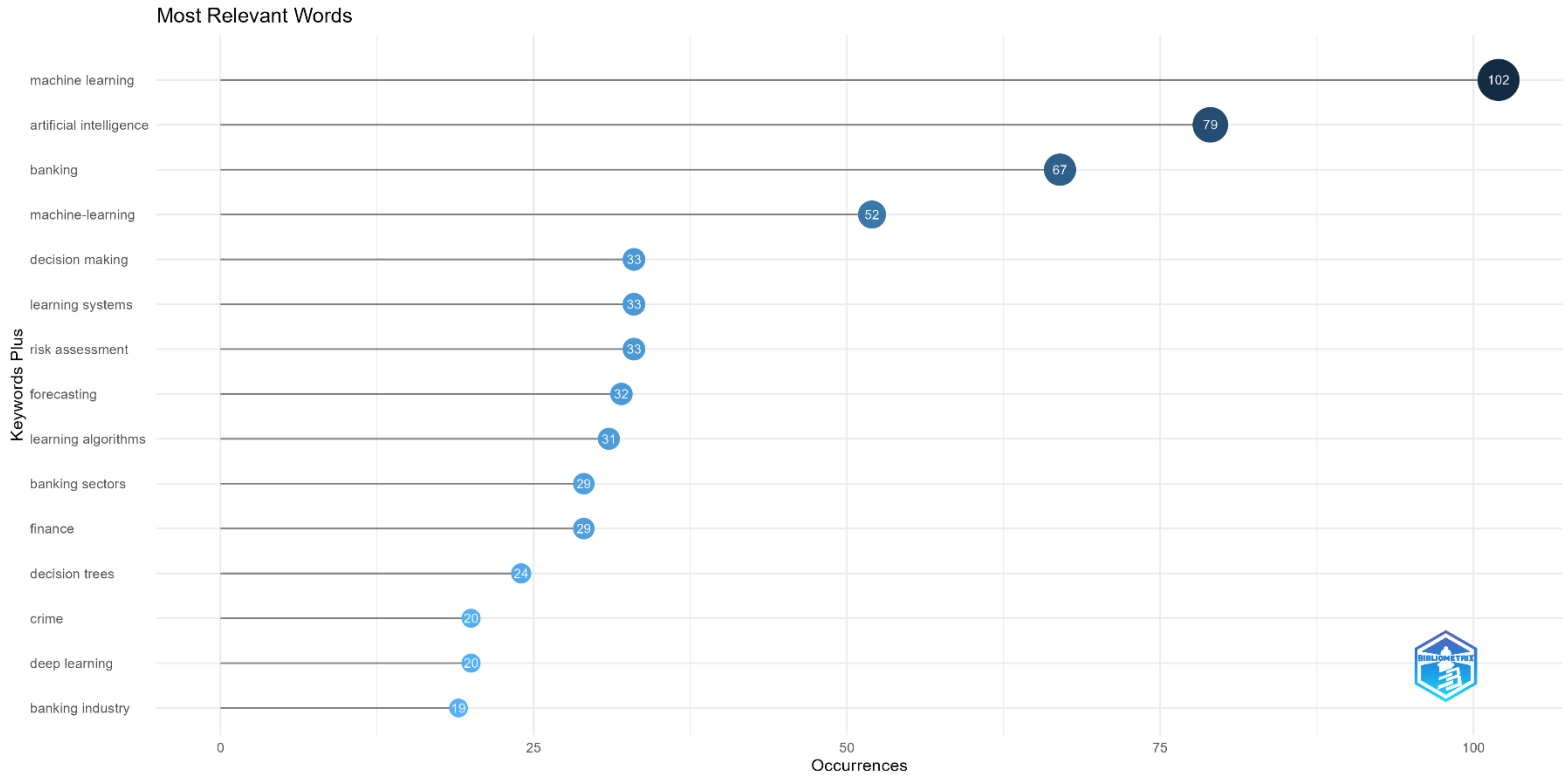
Country Production Over Time

•Notable research growth from China, India, Malaysia, UK, and the USA post-2016.
•Correlates with the increasing integration of AI/ML in banking operations.
•Demonstrates research expansion in response to technological advancements.



Most Relevant Keywords

- Top keywords in AI/ML banking research:
  - “machine learning” (102 occurrences), “artificial intelligence” (79 occurrences), banking (67 occurrences)

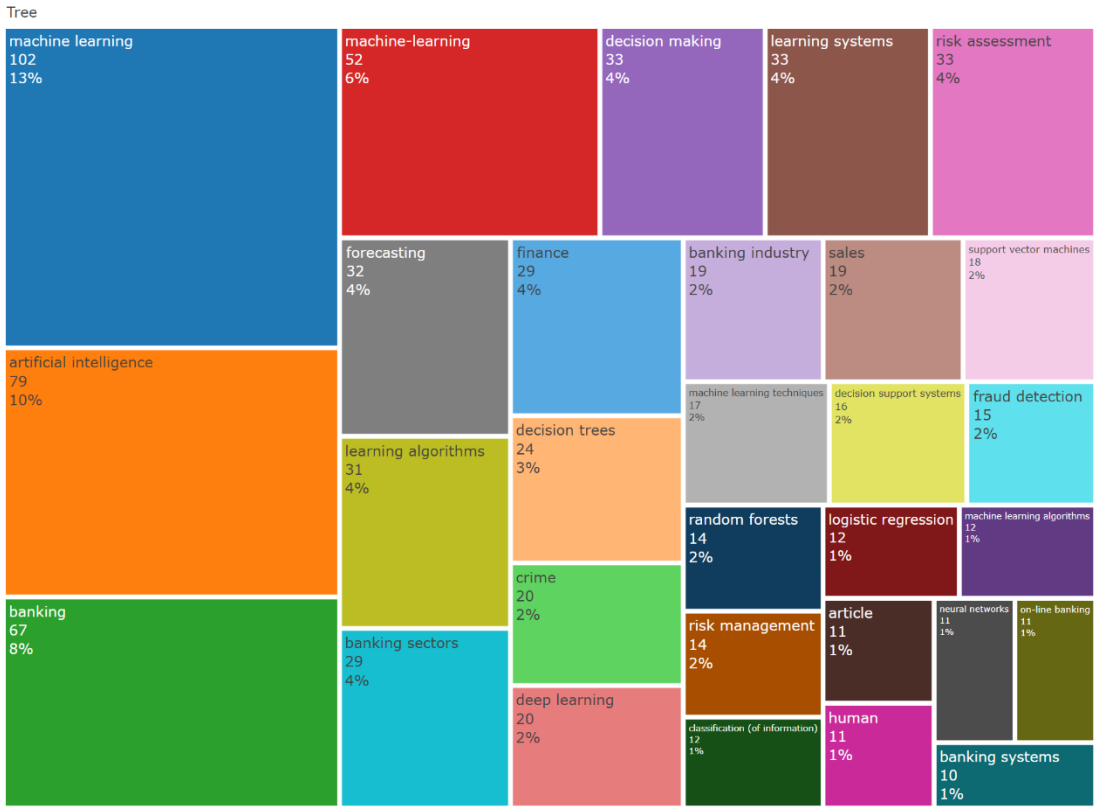


Word Cloud

- Visual representation of frequently used research terms.
- Larger font sizes represent dominant research topics.
- Reinforces the importance of AI/ML in risk management and financial decision-making.

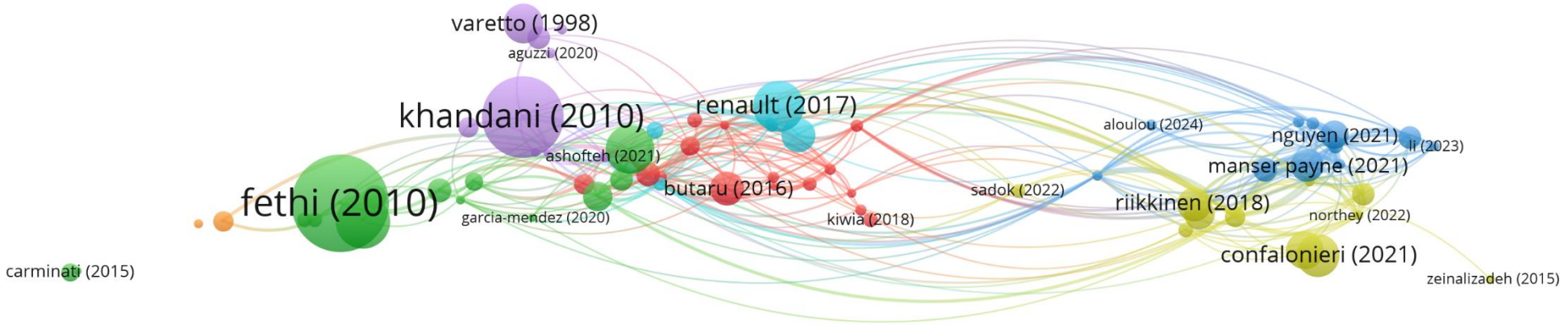
Word Treemap

- Comparative visualization of key research themes.
- Highlights major topics like fraud detection, machine learning models, and risk assessment.
- Identifies secondary research areas such as cybersecurity and support vector machines.



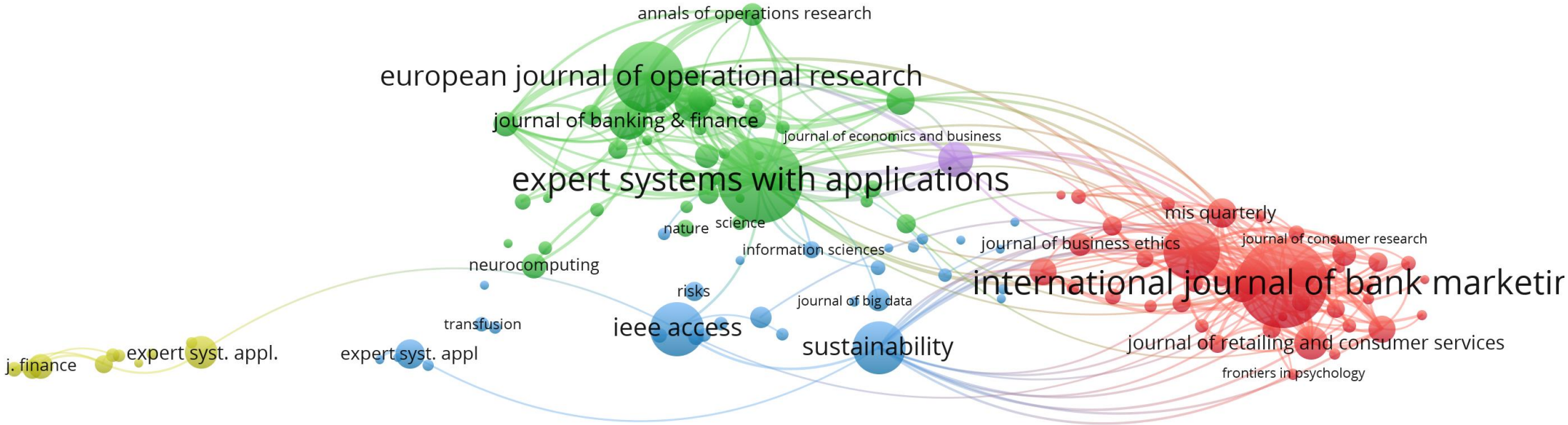
Bibliographic Coupling Analysis

- Illustrates connections between highly cited publications.
- Foundational works such as Khandani (2010) and Fethi (2010) form key clusters.
- Highlights major themes like credit risk modeling and operational efficiency.



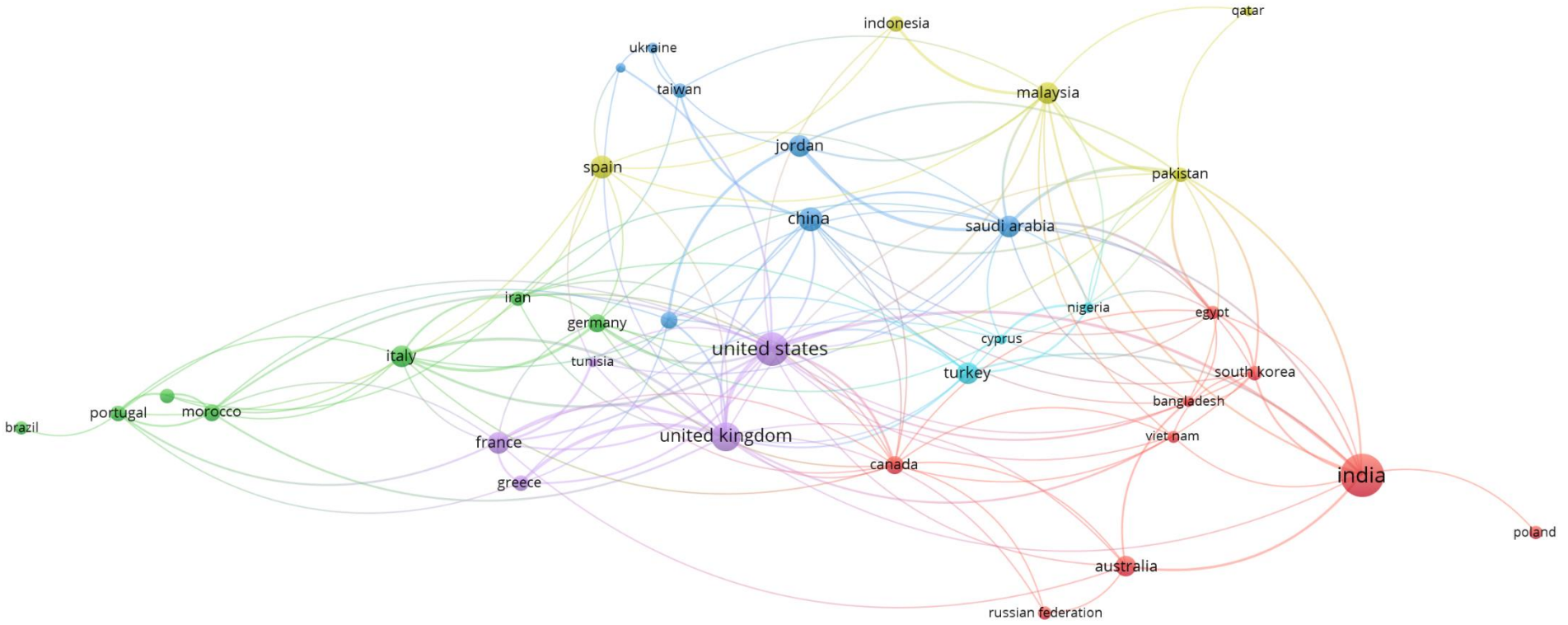
Co-Citation Analysis of Journals

- **Most influential journals in AI/ML banking research**:
  - International Journal of Bank Marketing, Expert Systems with Applications, European Journal of Operational Research.
- Strong connections to IEEE Access indicate growing interest in AI ethics and sustainability.



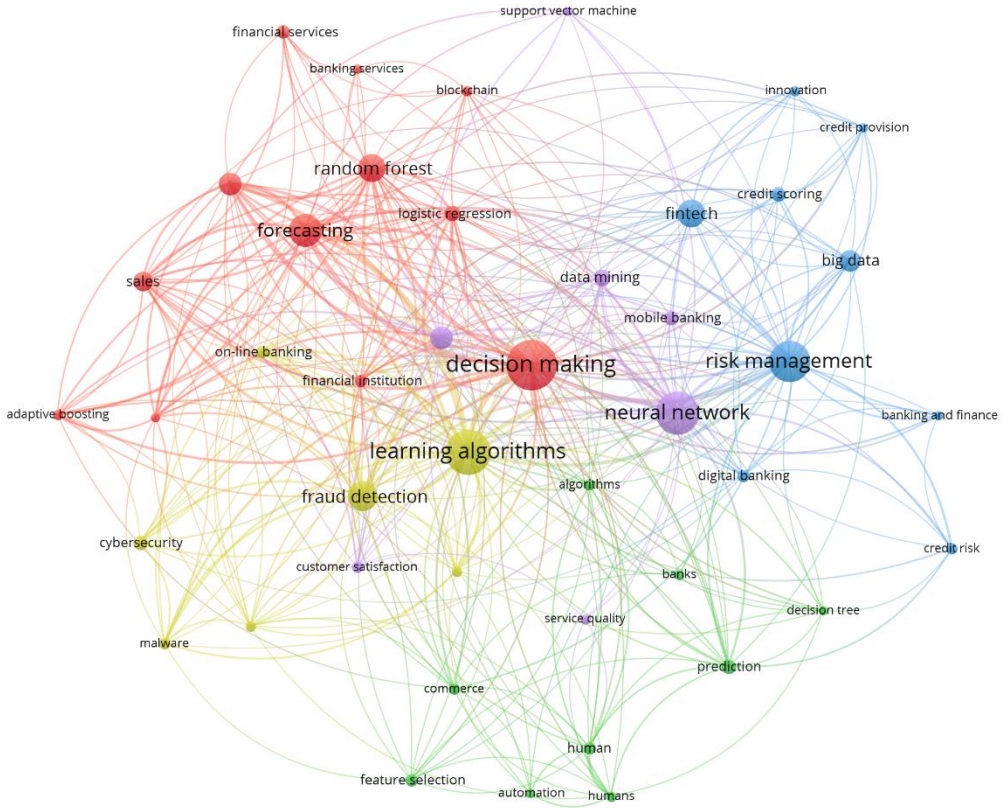
Co-Authorship Network by Country

- India, USA, and UK are central hubs in research collaboration.
- Thick links indicate strong co-authorship relationships, such as India-USA partnerships.
- Reflects the global nature of AI/ML-driven banking research.



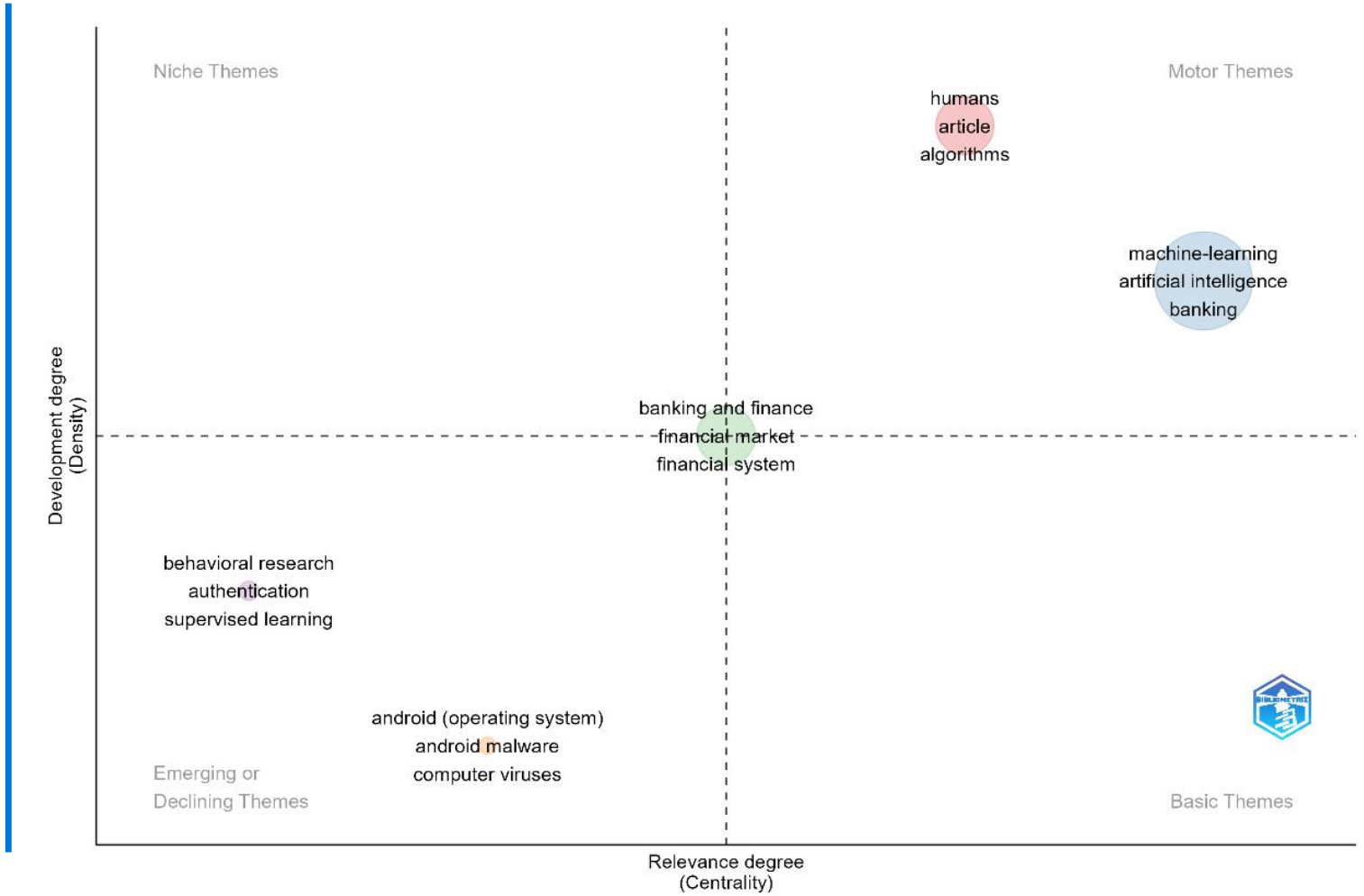
Co-Occurrence Network of Keywords

- Shows keyword relationships in AI/ML banking research.
- Central themes include "decision-making," "risk management," and "fraud detection."
- Emerging topics highlight AI applications in cybersecurity and financial analytics.



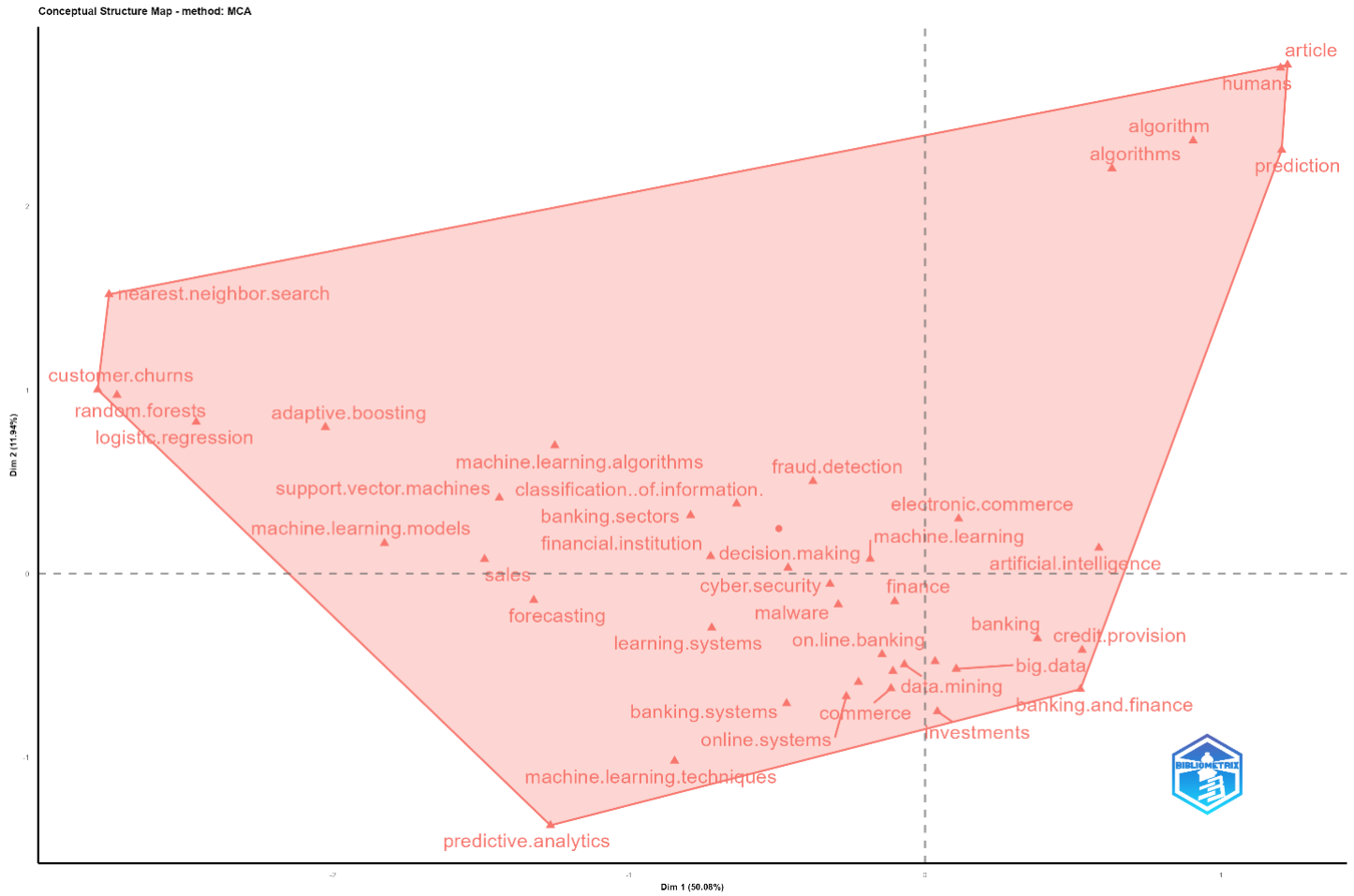
Thematic Map

- Categorizes research themes based on centrality and density.
- **Core themes**: Decision-making, learning systems, and risk assessment.
- **Emerging topics**: Biometrics, natural language processing, and cybersecurity.



Conceptual Structure Map

- Visualizes AI/ML themes in banking using Multiple Correspondence Analysis (MCA).
- Clusters include predictive analytics, decision-making, and financial cybersecurity.
- Identifies key research areas such as big data applications and online banking.



Summary of Trending Topics in AI/ML in Banking

- **Decision Making:** AI/ML is being used to improve decision-making in various banking functions, including credit scoring, fraud detection, and customer service.
- **Learning Systems:** The use of machine learning algorithms, such as neural networks and random forests, is increasing.
- **Risk Assessment:** AI/ML is being used to assess and mitigate various risks, including credit risk, liquidity risk, and operational risk.
- **Fraud Detection:** AI/ML is being used to detect fraud in real-time, particularly in areas like credit card transactions and money laundering.
- **Customer Churn Prediction and Retention:** AI/ML is being used to predict which customers are likely to leave and to develop targeted retention strategies.
- **Technology Adoption:** The adoption of AI/ML technologies in banking is being driven by factors such as trust, perceived usefulness, and ease of use.

Summary of Trending Topics in AI/ML in Banking

- **Bank Failure Prediction:** AI/ML is being used to predict bank failures by analyzing macroeconomic indicators and firm-specific attributes.
- **Customer Service Automation and Personalization:** AI/ML is being used to automate customer service and provide personalized financial advice.
- **Credit Scoring and Risk Assessment:** AI/ML is being used to improve the accuracy of credit scoring and risk assessment.
- **Financial Crime Detection and Cybersecurity:** AI/ML is being used to detect financial crimes and improve cybersecurity.
- **Bank Performance Management:** AI/ML is being used to improve bank performance by optimizing operations and decision-making.
- **Portfolio and Wealth Management:** AI/ML is being used to provide personalized investment advice and manage customer portfolios.

Summary of Trending Topics in AI/ML in Banking

- **Liquidity Risk Management:** AI/ML is being used to assess and manage liquidity risk.
- **Predictive Analytics and Market Forecasting:** AI/ML is being used to predict customer behavior and market trends.
- **Operational Risk Management:** AI/ML is being used to identify and predict operational risks.
- **Systemic Risk Management:** AI/ML is being used to assess and manage systemic risk in the banking sector.
- **Operational Efficiency and Process Automation:** AI/ML is being used to automate tasks and improve operational efficiency.
- **Regulatory Compliance and Risk Management:** AI/ML is being used to ensure regulatory compliance and manage risks.

Summary of Trending Topics in AI/ML in Banking

Topic	Methods Used	Dependent Variable	Research Gaps
Credit Risk	Support Vector Machines, Neural Networks, Decision Trees, Hybrid models	Creditworthiness, Loan default risk	Data imbalance, Model bias, Explainable AI
Customer Churn	Neural Networks, Statistical models, Rule-based algorithms	Customer churn, Customer retention	Data heterogeneity, Model scalability, Explainable AI
Technology Adoption	Quantitative surveys, Hybrid models, Machine learning	Technology acceptance, User adoption	Generational differences, Societal impacts, Ethical AI
Bank Failure	Statistical models, Machine learning, Early warning systems	Bank failure, Financial distress	Data imbalance, Model accuracy, Real-time prediction
Fraud Detection	Imbalanced classification, Machine learning, Deep learning	Fraud detection, Anti-money laundering	Dynamic fraud patterns, Ethical concerns, Real-time analytics
Customer Service	AI, Case-based reasoning, Machine learning	Customer satisfaction, Service efficiency	Ethical AI, Legacy systems, Human-centric service
Credit Scoring	Machine learning, Explainable AI	Credit score, Default prediction	Dataset imbalance, Model interpretability, Fairness
Cybersecurity	Behavioral analysis, Machine learning	Threat detection, Fraud prevention	Insider threats, Ethical practices, Sustainability
Bank Performance	Data analytics, Machine learning	Bank efficiency, Profitability	Data quality, Analytics talent, Regulatory conditions
Liquidity Risk	ANNs, BNs, Ensemble models	Liquidity risk, Early warning systems	Cultural considerations, Dynamic risk, Model interpretability
Market Forecasting	Hybrid models, Machine learning	Transaction forecasting, Cash demand	Model accuracy, Data heterogeneity, Feature extraction
Operational Risk	AI/ML, Bayesian networks	Operational risk, Risk events	Model validation, Bias in training data, Explainable AI
Systemic Risk	Theoretical frameworks, Machine learning	Systemic risk, Contagion effects	Dynamic and unpredictable events, Procyclicality, ESG integration

Summary of Trending Topics in AI/ML in Banking

Topic	No. of Articles	Keywords
Bank Performance Management	18	Bank efficiency, Profitability, Data quality, Analytics talent, Regulatory conditions
Customer Churn Prediction and Retention	10	Customer churn, Customer retention, Data heterogeneity, Model scalability, Explainable AI
Customer Service Automation and Personalization	19	Customer satisfaction, Service efficiency, Ethical AI, Legacy systems, Human-centric service
Technology Adoption	22	Technology acceptance, User adoption, Generational differences, Societal impacts, Ethical AI
Bank Failure Prediction	12	Bank failure, Financial distress, Data imbalance, Model accuracy, Real-time prediction
Fraud Detection and Anti-Money Laundering (AML)	13	Fraud detection, Anti-money laundering, Dynamic fraud patterns, Ethical concerns, Real-time analytics
Credit Scoring and Risk Assessment	9	Credit score, Default prediction, Dataset imbalance, Model interpretability, Fairness
Financial Crime Detection and Cybersecurity	9	Threat detection, Fraud prevention, Insider threats, Ethical practices, Sustainability
Portfolio and Wealth Management	6	Personalized investment advice, Customer portfolios
Liquidity Risk Management	4	Liquidity risk, Early warning systems, Cultural considerations, Dynamic risk, Model interpretability
Predictive Analytics and Market Forecasting	6	Transaction forecasting, Cash demand, Model accuracy, Data heterogeneity, Feature extraction
Operational Risk Management	4	Operational risk, Risk events, Model validation, Bias in training data, Explainable AI
Systemic Risk Management	4	Systemic risk, Contagion effects, Dynamic and unpredictable events, Procyclicality, ESG integration
Operational Efficiency and Process Automation	4	Automated tasks, Operational efficiency
Regulatory Compliance and Risk Management	4	Regulatory compliance, Risk management, Explainable AI
Cross-selling	5	Cross-selling, Customer relationship management (CRM), Marketing
Technology Critique	16	Technology adoption, Risk management, Regulatory compliance, Operational efficiency

Conclusion: Responses to Research Questions

- How have AI/ML been applied in the banking sector to address key challenges?
  - AI/ML significantly improves fraud detection, credit risk management, and customer service.
  - Machine learning models such as anomaly detection outperform traditional fraud prevention techniques, enabling real-time fraud prevention.
  - AI-driven predictive analytics enhance customer churn management by offering retention strategies based on behavior patterns.
  - Chatbots and virtual assistants improve customer engagement, reducing response time and operational costs.

Conclusion: Responses to Research Questions

- What are the emerging trends in AI/ML research in banking?
  - Increasing adoption of cybersecurity-focused AI to protect sensitive financial data.
  - The rise of explainable AI (XAI) to improve transparency and trust in AI-driven financial decisions.
  - AI-based regulatory compliance automation helps banks reduce penalties and meet legal requirements efficiently.
  - Predictive analytics are advancing, allowing financial institutions to anticipate customer behavior and mitigate market risks.

Conclusion: Responses to Research Questions

- What gaps exist in the current literature on AI/ML applications in banking?
  - Limited use of **unsupervised learning** in banking, despite its potential for fraud detection and risk analysis.
  - Ethical concerns, such as biases in AI-driven credit scoring and loan approvals, require further exploration.
  - Existing AI models lack real-time adaptability, highlighting the need for **real-time learning systems**.
  - **Explainability and interpretability** of AI models remain a challenge, necessitating further research into transparent AI decision-making.

Conclusion: Responses to Research Questions

- How can bibliometric and thematic analyses contribute to identifying future research directions in AI/ML for banking?
  - Bibliometric analysis reveals key research trends, influential authors, and collaboration patterns.
  - Thematic analysis highlights critical research areas such as **fraud detection, predictive analytics, and customer relationship management (CRM)**.
  - The study identifies gaps in **cybersecurity, real-time AI applications, and regulatory compliance**, shaping future research priorities.
  - Tools like **Biblioshiny and VOSviewer** provide structured insights into AI/ML applications, helping refine research strategies.