Aalen University

BUSINESS KNOWLEDGE GRAPH

- Optimize business decisions with a system -

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Executive Summary

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The basic idea of the Knowledge Graph is not new. Its beginnings go back to the 1960s - in the 1990s and 2000s there was lively discussion about the Semantic Web, ontologies and taxonomies. The big breakthrough was always a long time coming. Why the hype now? What is new? Why are Knowledge Graphs so important for business practice:

- CRM and ERP systems store a great deal of data about customers and transactions. Important interrelationships such as products and components, companies and suppliers, or social networks are not captured despite their enormous importance. Especially the knowledge and external connections between companies, markets and industries. Knowledge Graphs can close this knowledge gap.

- The extensive use of Knowledge Graphs by digital giants such as Apple, Facebook, Google, eBay, and AirBnB are also contributing to the increased awareness and proliferation of Knowledge Graphs.

- Knowledge spaces are becoming increasingly global and complex. Relevant contexts are increasingly no longer linear but networked. Global supply chains, networked company and stakeholder structures and risk patterns are examples of this. Knowledge graphs are an ideal approach for mapping and managing this complexity.

- Deep Learning is certainly one of the big drivers of Artificial Intelligence. As powerful as this technology is, it often lacks relevant domain knowledge that cannot be easily learned from historical data. AI results are often not transparent, traceable and explainable. Knowledge Graphs are the perfect complement here on the way to "Explainable AI" with resilient and reproducible insights.

- Now we have the technology to create Knowledge Graphs in an automated way, to extend them and to use them intelligently and efficiently within IT infrastructures. Knowledge Graphs are increasingly becoming an integral part of a modern data and analytics infrastructure.

- One of the central challenges is the creation and maintenance of knowledge graphs. For this purpose, there are numerous tools with which companies can model knowledge graphs. Since internal contexts are always company-specific, companies have to make largely from scratch. For external contexts, there are ready-made Knowledge Graphs that companies can use immediately and extend or adapt if necessary. These include open source solutions such as DBPedia, Geonames or WorldFacts as well as professional enterprise solutions such as Palturai's Knowledge Graph.

Introduction

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a. Motivation and development

The idea of the Knowledge Graph is not new, but has become critically important due to increased data volumes, data complexities, and innovation in technological and analytical capabilities.
Organizations today have more data than ever before, in a variety of structures, typically collected in a data warehouse or data lake. Although knowledge is an extremely valuable asset in today's knowledge economy, its use in organizations is continuously.

reaching its limits. It is nearly impossible for a human brain to analyze and make sense of this vast amount of data. Knowledge Graphs, help organizations make sense of their various internal and external data sources.
In addition, individual experts in the organization often have certain knowledge because it has to be obtained from external sources or because it is not considered in the right context. This is exactly where Knowledge Graphs comes in, by making human knowledge "machine-readable" and digitally representable. Unlike isolated and static results of a database query, Knowledge Graphs deliver contextualized knowledge that enables dynamic business insights.
One of the key drivers is the potential improvement in the quality and explainability of AI results. There is consensus in the scientific AI community that combining machine learning with domain knowledge based on Knowledge Graphs is the future of modern AI applications.

Knowledge graphs stand for comprehensible and explainable AI and are thus one of the most important foundations for the digital transformation of information and decision processes.

Thus, knowledge graphs represent an important analytical component for good corporate decisions, and an important component particularly for artificial intelligence. According to Gartner, as illustrated in the the Hype Cycle illustration, they are still at the very beginning of their triumphal march, but have begun to show enormous potential.

Initially, the focus was on knowledge graphs for internal applications such as supply chain management and predictive maintenance in the automotive industry, the optimization of search engines and the improvement of speech-based bot systems. However, a rather new field of application of Knowledge Graphs in the area of external company and market data is particularly exciting. If this data is linked to the company's internal data, completely new analysis and application possibilities arise in domains such as, marketing, sales, risk and fraud management and compliance.

Executives and decision makers are increasingly discovering the value of Knowledge Graphs in the context of digital transformation for business and government.

b. Definition and components

The literal translation "knowledge graph" implies that it is a visual representation of a subject area with context. In the Knowledge Graph, not only individual data points are mapped, but also their contexts and relations. Instead of a linear-hierarchical order, the Knowledge Graph has a multidimensional structure.
A Knowledge Graph essentially consists of nodes and edges. The edges represent the relationships between the nodes or entities. This creates a representative data model of reality that captures all things that play a role in the company's business processes.

From this, references can be made between disparate information and relationships that would otherwise not have been created or visible. This often involves data that would otherwise not be easily identified as context-related. The Knowledge Graph thus sees beyond the end of its nose, so to speak.

Knowledge Graph

as a business and value driver

03

Hype Cycle for Artifical Intelligence, 2020

a. Added value for companies: Use & Business Cases

Risk Management

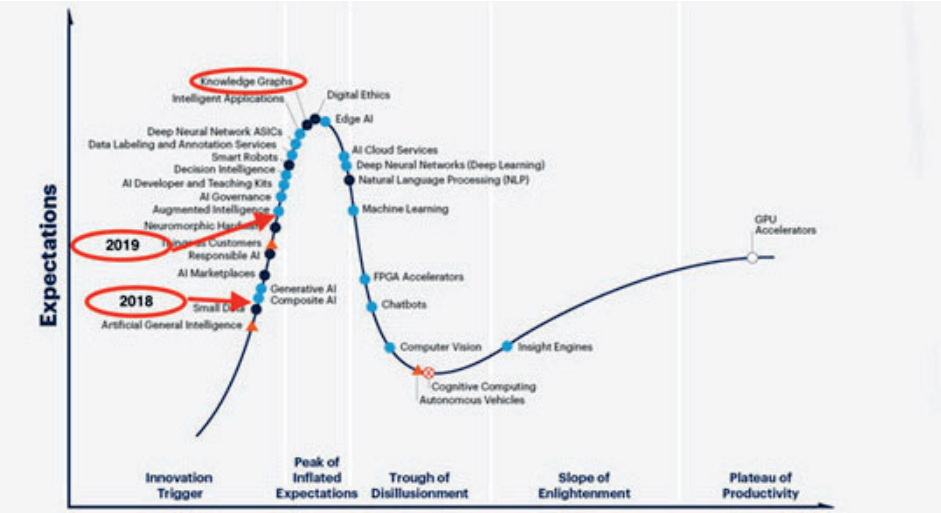
If external data sources are linked with internal data sources via Business Knowledge Graphs, risk analyses and impact assessments can be carried out for any operational decisions. In this way, impact analyses can be performed, such as what influence the change of a component has for the supplier, for the supply chain, as well as for the entire production process and thus in turn for the company's own long-term planning?

Impact assessment with a Knowledge Graph thus has a far-reaching horizon and is significantly more comprehensive than the usual risk analysis in companies. Complex impacts along the entire value chain can be revealed that would not have been considered with traditional approaches.

Compliance

The Business Knowledge Graph can show complex business structures including the pathway to the beneficial owner. As a result, the Business Knowledge Graph solution provides not only their traditional isolated view of customers and business partners but also their relationships with each other in a large global network. This can reveal legal and business relationships that are relevant to compliance. To mitigate today's compliance risks for financial institutions, a sound understanding of a customer's interconnected business network is critical to success. The Business Knowledge Graph thus addresses the problem banks face in that their data is not consistently networked with each other or with other entities. Connections of business partners to external companies and decision makers as well as relationships within the portfolio remain undiscovered.

In order to conceal criminal acts, complex interconnections, such as a web of shell companies, are often deliberately built to obscure the true nature of ownership or business purpose. It is precisely these relations that can be discovered and analyzed by the Business Knowledge Graph. In this understanding, the Business Knowledge Graph helps to detect money laundering, fraud and other forms of white-collar crime. Therefore, not only financial institutions or insurance companies, but also many types of public and private authorities conducting investigations can benefit from the Business Knowledge Graph.



Know Your Customer

Validly identifying and profiling beneficial owners is an important task in many enterprise applications.
This applies not only to banks, where the verification of business partners has long been subject to strict regulations. In industry, too, business partner verification is becoming increasingly important, not least for reasons of risk.

Marketing & Sales

Knowledge graphs can help identify, profile, and prioritize potential leads across corporate networks and relationship patterns. Who are the relevant decision makers for sales purposes; how are the beneficial owners connected on the basis of direct or indirect involvement. For defined target customers, relevant marketing and sales questions can be answered:
How can the responsible owner be addressed? What is the shortest path between the company and decision-makers. The identified closeness to the relationship can then be used most successfully for appropriate "warm introductions" in customer acquisition.

Fraud

Our global economy is increasingly becoming a vast, dynamic network. In fast market frequencies, new nodes and relationships are constantly emerging - or being dissolved again. Knowledge Graph metrics and analytics can be used to identify anomalies early on in the complex web of relationships within and between companies and their decision-makers. This is particularly important for fraud detection and prevention in the insurance industry.

Supply Chain Management

The issue of supply chains or supply chain bottlenecks is becoming increasingly relevant, especially for global companies. Better models are needed for predicting how supply chains will develop, including their likely response to shocks. As a result, there are repeated calls for an accurate understanding of supply chains and forecasting of supply chain bottlenecks. This is particularly challenging due to the distributed, multi-layered as well as also often missing data. The Business Knowledge Graph can help to uncover the relevant together and to analyze and predict supply chains with knowledge graph mining methods.

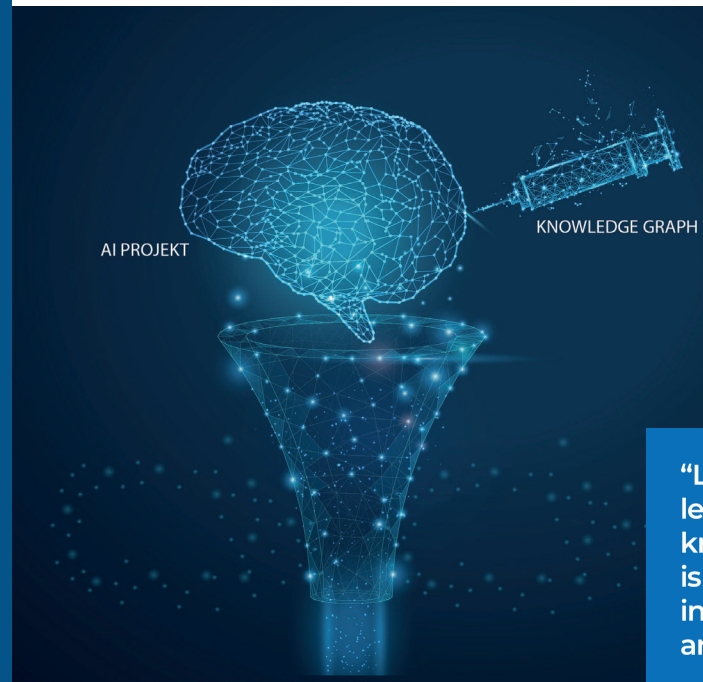
Data Management

Real world evidence continuously reminds us of how poor company master data quality can be. Often, the lack of company data updates are the primary driver on this issue. A well-functioning Business Knowledge Graph takes this into account by continuously monitoring and updating changes. This includes, for example, changes in the business purpose or legal form, managers joining or leaving the company, shareholders entering or leaving the company, changes in shareholdings or relocations
In addition, the integrated data view of Knowledge Graphs helps combat the problem of duplicate data. The Business Knowledge Graph sees data integrated across data silos and disparate sources. It can also show relationships between customers, suppliers and partners, even though these are often used and maintained on a department-specific basis.

Duplicate, out-of-date or incorrect data not only leads to significant additional cost, but above all prevents internal and external compliance requirements from being met.

b. Booster and mega trend for artificial intelligence (AI)

Thanks to Knowledge Graphs, Artificial Intelligence will become even more intelligent - and less "artificial". The well-known machine learning methods of AI, such as deep learning, automatically learn patterns and correlations from large amounts of data. These methods can therefore also be used to build knowledge graphs. However, only the knowledge that is explicitly or implicitly contained in the data can be mapped. If there is further domain knowledge, such as legal frameworks and regulations, knowledge about products and their components or the connections of decision makers and companies, which are not contained in the data, this knowledge is also not learned or taken into account. This can lead to poor or insufficiently informed business decisions.



"Linking machine learning with the knowledge graph is the next big step in the evolution of artificial intelligence."

Prof. Dr. Hans Uszkoreit is Scientific Director at the German Research Center for Artificial Intelligence (DFKI), 2021.

If these AI methods are extended to include a semantic dimension, they can understand content and capture meanings based on knowledge graphs. Data is thus considered in contexts and relations, and external sources are also taken into account - this enables companies to use knowledge much more efficiently. The result of the AI model is not simply presented as a black box, but also explained and justified. By using human-coded knowledge, Knowledge Graphs can provide sound and reproducible reasoning, something most AI methods lack.

A purely "Quantitative AI" becomes a "Semantic AI." The semantic model makes the AI results explainable and thus reproducible. Knowledge Graphs thus help with explainability of an AI decision and thus enable the development of an "Explainable AI".

This explainability is particularly important in many use cases and industries, such as detecting fraud, granting credit, or detecting anomalies, as well as any decision that can significantly influence an individual.

Since the Knowledge Graph represents all entities and their relationships to each other, it makes them explainable. When Knowledge Graphs are used by AI systems to document their decision-making processes, they can be used to make the AI decision-making process more transparent. In principle, two approaches can be presented in which knowledge graphs represent added value for companies:

1. AI interacts with the Knowledge Graph

For example, AI is good at recognizing intents in customer queries, but often not the correct answer. The result of a neural network can be extended/ explained with the help of a knowledge graph:

- Service case: The AI recognizes the customer need in a service case. Since the case has not yet been learned, the AI cannot provide an answer. Here, the AI interacts with the Knowledge Graph and provides the correct answer:

- Credit case: The AI model of Kreditreform predicts a default risk of a receivable. Since this is a black-box approach, the Knowledge Graph explains the result via the business context and thus provides a comprehensible prediction.

2. Knowledge Graph as input for AI

Embeddings, attributes and contexts from the Knowledge Graph are used for machine learning. The additional input from the Knowledge Graph increases the explanatory and predictive power of AI models:

- Netflix case: E.g. the search for "Number 5 lives" gives no results. However, the AI model has learned from the embeddings what the movie is about and suggests movies with similar semantic concept. Normally, a full-text search would only look for "number 5" and not return any useful results

- Fraud Case: In a fraud AI model, the relationships between companies and between stakeholders are relevant. An AI model uses historical data for learning. If relevant connections are missing, the result quality of the AI model and thus the decision is poor. However, if the embeddings of the knowledge graph are also learned as input, the explanation and prediction quality of the AI model increases and thus the decision quality.

Business benefit 04

On an aggregate level, the following groove potentials of business knowledge graphs can be described:

Better business decisions

The overriding benefit is the optimization and foundation of corporate decisions. In order to make the right decisions, decision-makers need relevant and reliable information that is up-to-date and in line with their needs. Be it for decisions for marketing and sales, risk and fraud management, compliance or logistics. The Business Knowledge Graph becomes the central backbone for corporate decisions.

Sales Increase

The Business Knowledge Graph shows the relationship proximity between decision-makers. For systematic customer acquisition, these relationships can be used for personal "warm introductions". This allows decision-makers, influencers or investors to be approached more quickly and efficiently. In addition, the Business Knowledge Graph reveals untapped up-selling and cross-selling potential that can be capitalized on through systematic sales activities.

Risk Reduction

The Business Knowledge Graph helps to quickly discover and analyze complex ownership and control structures. Since dubious or economically insecure business partners are also identified at an early stage, the risk of payment defaults, penalties or reputational damage is reduced.

Corporate and market transparency

The Business Knowledge Graph represents a model of how business entities and stakeholders are related. Each entity is represented only once in the context of all other entities and their relationships. In this way, it is possible to quickly and unambiguously recognize on a superordinate level what corporate and business partner networks look like.

Data integration and sovereignty

The Business Knowledge Graph combines isolated data sources so that companies can gain an integrated overview of business partners, customers, and suppliers and their relationships with each other, not only at the departmental level but also across departments in global organizations. Knowledge Graph technology also makes it possible to intelligently link different types of data - both internal and external, as well as structured and unstructured data - providing the ideal basis for business analytics and AI applications.

Market overview 05

The knowledge graph market is dominated by providers of databases and tools for creating and maintaining knowledge graphs. These include, for example:

neo4j, ontotext, Amazon Neptune, Nuclino, visirule

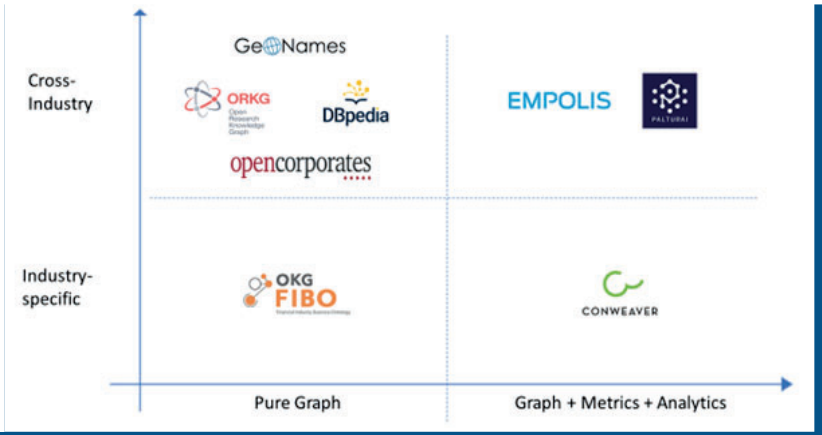
Furthermore, there are providers that offer predefined and directly usable knowledge graphs as a solution. Here, too, there is the distinction between open-source solutions and professional enterprise solutions. For example, an open-source solution for the financial industry is Financial Industry Business Ontology (FIBO), which is defined using a formal language called Web Ontology Language (OWL). FIBO defines both the entities that are relevant in financial business applications and how these entities relate to each other. The FIBO Knowledge Graph were developed by a community of users from various financial institutions.

OKG FIBO, DBpedia, ORKG, GeoNames, opencorporates

Professional enterprise solutions also offer functions to extend the Knowledge Graph as well as to link it with the company's own data. They enable the linking of all available data sources without the need to replace existing legacy systems for them. They provide the ability to explore data from different perspectives and present it in simple relationships, either through manual input or automated processes. Moreover, predefined metrics and scores such as additionally calculated scores: social connect, wealth score, company2sell score or distance2trouble score. Own analysis can also be performed via analysis front-end. These solutions also have interfaces to systems such as SAP or Salesforce.

CONWEAVER, PALTURAI, EMPOLIS

Knowledge Graph Solution Matrix: Industry scope and range of functions



The Knowledge Solution Matrix differentiates between the various solutions based on the criteria of industry scope and functional range. However, a combination of professional Knowledge Graph tools with the open-source solutions is also conceivable.

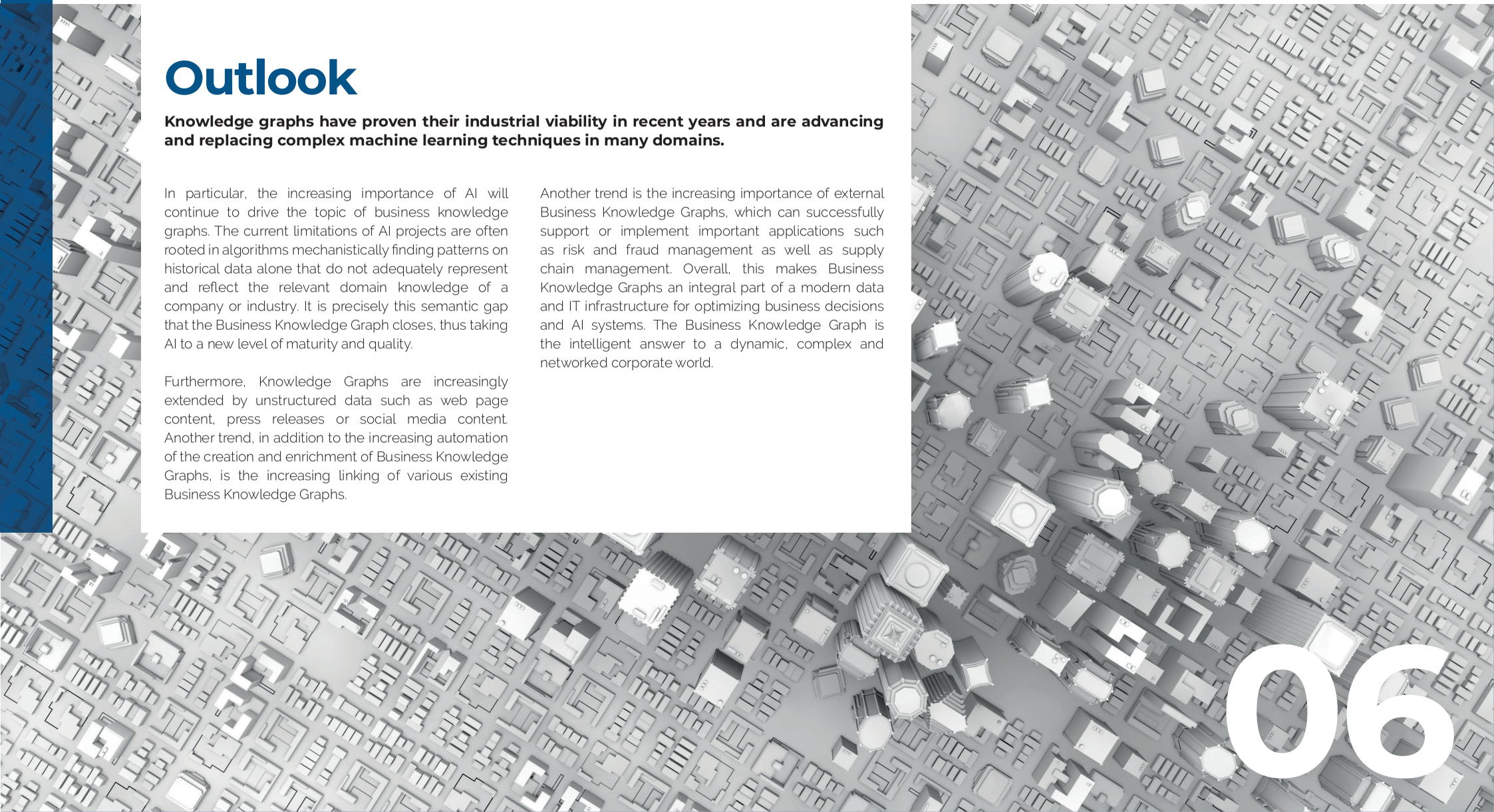
Outlook

Knowledge graphs have proven their industrial viability in recent years and are advancing and replacing complex machine learning techniques in many domains.

In particular, the increasing importance of AI will continue to drive the topic of business knowledge graphs. The current limitations of AI projects are often rooted in algorithms mechanistically finding patterns on historical data alone that do not adequately represent and reflect the relevant domain knowledge of a company or industry. It is precisely this semantic gap that the Business Knowledge Graph closes, thus taking AI to a new level of maturity and quality.

Furthermore, Knowledge Graphs are increasingly extended by unstructured data such as web page content, press releases or social media content. Another trend, in addition to the increasing automation of the creation and enrichment of Business Knowledge Graphs, is the increasing linking of various existing Business Knowledge Graphs.

Another trend is the increasing importance of external Business Knowledge Graphs, which can successfully support or implement important applications such as risk and fraud management as well as supply chain management. Overall, this makes Business Knowledge Graphs an integral part of a modern data and IT infrastructure for optimizing business decisions and AI systems. The Business Knowledge Graph is the intelligent answer to a dynamic, complex and networked corporate world.



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