

Technical White Paper

Atoti Under the Hood

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Introduction



Atoti is a relational, transactional, columnar, in-memory database coupled with a modern, multidimensional OLAP aggregation engine, allowing for real-time, self-service analysis on fast-moving data and direct queries on cloud databases. *Atoti is the fastest data analytics software made for financial services organizations.*

Atoti is the data analytics platform developed by ActiveViam especially for financial services organizations. This unique technology meets the specific needs of the industry in ways general-purpose databases and mass-market business intelligence tools do not.

With its transactional database and modern, multidimensional OLAP aggregation engine, Atoti is the fastest data analytics software in financial services. That's why half of the world's largest banks – along with top hedge funds, asset managers, custodians, exchanges and regulators – work with Atoti.

Atoti offers:



Real-time, self-service analysis of complex non-linear metrics, from top of the organization to trade level.



Continuous recalculation of metrics on datasets that change in real time.



Operational workflows with concurrent data updates, such as signoff and What-if analysis.



The flexibility to handle both in-memory and in-database queries with DirectQuery, Atoti's tool to query external databases directly without loading the data in-memory beforehand.

Atoti delivers speed and precision. Unlike mainstream data analytics technologies that pre-aggregate datasets, pre-calculate metrics and pre-load dashboards, Atoti works on the fly to give users fast access to the data they need along with complete analytical freedom. This requires sub-second aggregation of complex metrics on large volumes of data, which Atoti delivers with database innovations such as in-memory column stores, bitmap indexes, work-stealing multithreading and distributed computing combined with user-defined functions that run at native speed.

Atoti is flexible, purpose-built, scalable and handles massive datasets in sub seconds.

This paper examines the unique technical characteristics that make Atoti a true real-time analytics solution and the customer benefits Atoti delivers.




Never leave you waiting or guessing

In a traditional stack, reference data, positions and numbers generated by risk engines are collected into a database. A batch process then aggregates metrics on this data and a BI tool visualizes the result. In this two-step architecture, the BI tool cannot model complex metrics or aggregate them quickly or efficiently enough for financial purposes.

Furthermore, users are unable to analyze data beyond what is predefined. Should they want to see a new metric or simply modify a report, they must request new development from IT (which can take weeks) or do it themselves in Excel.

This is the slow IT vs. shadow IT dilemma.

Atoti solves this issue by modeling all metrics and computing them on the fly from raw data. Users can slice and dice data any way they want. Therefore:

-  Users don't just watch numbers – they understand and can explain them.
-  Users aren't limited to detecting a risk anomaly – they can track it down to the single transaction that caused it.
-  Users can freely explore the metrics and add new ones intraday.

Beyond pure performance, Atoti offers an unparalleled self-service experience – users never have to go back to IT to generate a new report.

OLAP: From dominance to obscurity to renewed appeal

OLAP – online analytic processing – has been the core technology of data analytics since it was first introduced in 1975. There have been many iterations and offshoots, such as OLTP, ROLAP, MOLAP, HOLAP, all made to serve the same business need: enabling users to analyze and understand their data to make better business decisions.

Over the years, OLAP has taken on a reputation of irrelevancy as other technologies have overtaken it in speed and flexibility. But OLAP is back. And the shift from legacy OLAP to modern, real-time, multidimensional OLAP is the most important technological evolution in the recent history of data analytics. New OLAP gives businesses more dynamic and flexible analytics capabilities – crucial for maintaining competitive advantage. Whether it's the ability to process real-time data or the ease of scalability and integration, modern OLAP cubes are the new gold standard of business intelligence.

Only Atoti offers financial services organizations the combined strengths of the industry's most powerful database and modern multidimensional OLAP, which together make Atoti the fastest data analytics software in the industry. Other key features described in this whitepaper, such as DirectQuery, What-ifs and limits monitoring, reinforce Atoti's position as the best possible product and experience available to financial services organizations.

A universal semantic layer for finance

Atoti is a semantic layer between data and user. It converts files and tables into business hierarchies and metrics that can be utilized and manipulated autonomously.

Atoti is designed to fit into any data analytics architecture — operating between data sources and visualization tools — delivering fast, precise and interactive analytics in any configuration, even for complex metrics that require long chains of calculations and non-linear aggregation.

One of Atoti's unique features is its data modeling capabilities. Once defined in the model, metrics become available as if they were simple sums in a pivot table. Users can include them in any query or report at the required level of granularity, using any of the hierarchies in the model for grouping or filtering without any further programming.

Atoti can be applied to any data analytics challenge a financial institution faces. Atoti has been successfully deployed at banks, exchanges, hedge funds, regulators and asset managers around the globe. Uses range from real-time risk analysis for the front office to market risk management, FRTB and other regulatory reporting, xVA calculations, liquidity management, collateral optimization, credit risk, counterparty credit risk and limits management.

For any use case where other tools struggle to deliver interactive analytics at scale, Atoti is the go-to solution.



Technical Capabilities



Benefits Delivered

In-memory processing
 Linear scalability
 Multi-version concurrency control
 Column store
 Compression
 Bitmap indexing
 Complex data modeling
 End-to-end real-time push
 DirectQuery
 Python & Java APIs
 Parallel loading
 Atoti UI

Interactive analysis



High dimensionality



Mixed workload



Universal semantic layer



What-if analysis



Alerts and limits monitoring



Future-proof



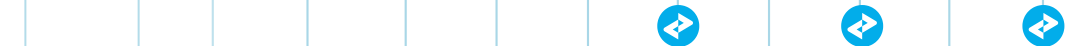
Fast start-up



Cloud agnostic



Visualization



Atoti's Technical Characteristics

In-memory processing

The ability of in-memory computing to process data without interfacing with the data storage is one of the top prerequisites for rapid query performance. Atoti was natively designed to take advantage of in-memory computing to meet the extreme performance requirements of both transactional and analytical environments.

Atoti can process data directly from the computer's main memory. This feature typically provides data access that is several orders of magnitude faster than with other solutions because transactions and queries never need to access a hard disk drive, network storage or any slower device.

Another benefit of using memory as main storage is its random-access support, which eliminates fluctuations in speed and performance when reading and writing data to any part of memory. Memory as main storage gives Atoti a tremendous advantage over traditional disk storage, which has significantly slower random access and requires highly optimized sequential access efficiency.

In addition to these capabilities, Atoti uses conventional methods, such as pre-aggregated caches defined manually or by machine-learning algorithms, to further aggregate the most common and complex queries.

The Atoti platform outpaces traditional RDBMS and traditional OLAP systems by several orders of magnitude in terms of aggregation velocity and modeling flexibility.

Linear scalability

Atoti is designed to handle massive volumes of data at interactive speed — scaling up to billions of rows on a single server — and can cluster servers together without any meaningful loss of performance. While Atoti can run on an old laptop or a tiny cloud VM, it is dynamic enough to leverage “many-core” servers to the fullest, having been tested on machines of 1,000+ cores and 64 terabytes.

Atoti's Technical Characteristics

This power is made possible through a combination of technologies, starting with state-of-the-art parallel computing code using work-stealing and fork-join techniques. Atoti implements a highly scalable memory allocator inspired by the Linux Kernel "SLAB" and benefits from the latest Java garbage collection improvements, developed in partnership by the Oracle Java team and Atoti R&D. On large servers with several processors, Atoti utilizes NUMA (non-uniform memory access) architectures to optimize parallel processing, employing 100% of the memory bandwidth of each individual processor to achieve massive performance gains.

When it comes to horizontal distribution, Atoti is built on three operating principles of a "shared nothing" architecture:

The data nodes in the cluster are themselves cubes and can be started independently. Data nodes do not need to communicate with one another, and exchange data only with a lightweight "query node." If one server fails, cubes on the other servers remain unaffected and their data remains available for queries.

Aggregate queries are distributed. The query node broadcasts the query to data nodes and the partial results are merged automatically, eliminating the possibility of performance degradation, as each server uses its full power to process the query. Supporting polymorphic distribution, Atoti can be used for complex projects with heterogeneous analytics, such as PnL, Sensitivities and VaR. Each application runs on its own independent cube and Atoti federates them on the fly, joining on what they have in common and resolving any mismatches.

Each data node cube loads data independently. If one cube can load data at a rate of 1,000,000 facts per second, then a grid of four cubes will load 4,000,000 facts per second. This makes Atoti capable of reliably handling time-sensitive aggregations for the largest financial institutions. As one example, ActiveViam's large, real-time implementation with Chicago Mercantile Exchange (CME), consolidates 21 servers' worth of data, 16 million trades per day, and 5,000 updates per second for the purpose of publishing margin calls in real time to all market members.

Atoti's Technical Characteristics

Multi-version currency control (MVCC)

The most common way to ensure concurrency control in a database is to prevent users from reading and writing the same piece of data at the same time. However, this method based on locking can prove expensive in mixed workload environments that involve many updates, queries and calculations simultaneously.

Multi-version concurrency control (MVCC) in Atoti works by storing multiple versions of the data in the database so that it can be modified by a user while others continue to work with their own consistent versions. This ability for every user to write-back to the database is the foundation of several key features of Atoti, such as What-if analysis, adjustments, sign-off and validation processes.

Also, unlike the back-ups of traditional database designs, Atoti only stores variations between versions. In-memory architecture makes this type of recall highly efficient, resulting in easy and fast access to previous versions of the database for "as-of" and root-cause analysis.

In short, MVCC is a key enabler of operational applications over large amounts of data that change in real time.

Column store

Conventional database management systems use a row-based store for their tables. Each fact is stored in a compact row, and any access/update to a field requires reading/writing the entire row. While row-based storage is suitable for transactional processing, it is not optimized for multidimensional analysis or complex analytical workloads.

One of Atoti's key differentiators is its column store. With Atoti, the data is stored by column rather than by row. Each column consecutively stores the values of one given field, for all the facts in the table. When a new fact is inserted, all the declared fields are extracted from that fact and stored in the relevant columns.

Atoti's Technical Characteristics

The ability of column-based storage to access only the fields that are required for a particular query – instead of having to read/write the entire row – vastly accelerates query performance.

Additionally, the Atoti column store supports fact updates without requiring the use of an additional row-based store to serve data-refreshing purposes. Unlike most columnar databases whose compression algorithms prevent them from easily updating facts, Atoti's column store is fully updatable.

Consequently, Atoti does not require the combination of row-based tables with columnar tables to support mixed workload requirements. Atoti can process multidimensional queries at unparalleled speeds on data that is updated on the fly, offering a true mixed workload DBMS.

Compression

Atoti's highly efficient memory storage takes advantage of advanced compression algorithms, enabling a low memory footprint and incremental updates.

The first type of compression is dictionary compression. In a database system, most fields only have a small number of possible values. Such fields are said to have low cardinality. For instance, a risk management system may store millions of facts with only a few possible values for each currency or date field.

A basic example of the application of Dictionary compression is for currency values. Instead of storing the full name of each currency in the dataset, Atoti can assign a unique number from 1 to N to each. Another example is with dates and times. Atoti only collates the integers of each timestamp, instead of the larger strings of years, months, days, hours, minutes and seconds.

A second layer of compression uses Java primitive types. When storing floating-point numbers in a column, Atoti creates arrays of Java double primitives instead of highly inefficient double objects. Moreover, when storing integer values, if the range of values is known Atoti will only use the necessary number of bits instead of the full 4 bytes (32 bits) required by a Java int.

Atoti's Technical Characteristics

For example, if it is known that a column will only store values between 0 and 15, then only 4 bits will be used to store these numbers. This interacts nicely with dictionary compression; a dictionary typically has a low cardinality of N members, and the associated integer column can therefore be compressed using only the number of bits required to encode an integer up to N while still supporting an unlimited number of members.

Bitmap Indexing

The goal of an OLAP engine is to execute multidimensional analytical queries. Queries typically need to first select facts based on the value of their fields on some dimension of the analysis, and then aggregate the facts along these dimensions to return business indicators.

A complex part of the query is the selection of facts based on multidimensional criteria. An Atoti instance can contain billions of facts, so the ability to efficiently retrieve and filter is crucial. As an in-memory engine, Atoti has a huge advantage over its disk-based competitors. Even in cases where a query needs to retrieve all the facts and aggregate them, reading the data directly from memory provides a significant speed advantage.

However, when a query needs to filter facts based on conditions by specifying the values of fields, an OLAP engine must use one or more indexes to efficiently retrieve them. Common database indexes (such as B-tree) are only capable of indexing a single attribute. For example, a currency index quickly locates records in a particular currency, or a year index locates records for a given year. Traditional databases therefore perform multidimensional queries by using several simple indexes. This process becomes extremely slow, even when applying only a few variables on a sizable dataset.

Conventional databases have tried to resolve this issue using composite indexes. For example, an index dedicated to “year + quarter + territory.” However, to answer all queries quickly, one would also need to build multiple composite indexes, such as “year + quarter” and a “year + territory,” etc. Assuming the cube has more than a few dimensions, the resources required for such indexes are unmanageable (N -factorial number of dimensions).

Atoti's Technical Characteristics

Atoti resolves this issue with a proprietary multidimensional index called "Bitmap Index." The Bitmap Index (a name that reflects its underlying binary arithmetic and compression schemes) selects records for any random combination of predicates on any number of dimensions. It is a lightweight data structure that filters over billions of records at high speeds and easily supports more than 100 dimensions.

Complex data modeling

In financial institutions, complex metrics are common and often require long chains of calculations and non-additive aggregations. They cannot be modeled in BI tools and demand bespoke development that results in batch processing and canned reports.

With Atoti, user-defined metrics can be modeled precisely using Java or Python APIs. Once defined in the model, even sophisticated metrics become usable by end users, as if they were simple sums in a pivot table. They can be included in any query or report at the level of granularity required, using any of the hierarchies in the model for grouping or filtering. Typical examples include VaR, expected shortfall, potential exposure, CVA and xVA, weighted averages, bucketing, real-time PnL estimation and liquidity ratios.

DirectQuery

DirectQuery is Atoti's tool to directly query external databases, such as Snowflake, BigQuery, Redshift, Databricks, ClickHouse and others, without loading the data in memory beforehand.

Atoti can target cloud-scale datasets that would not fit in memory, giving users the ability to analyze large historical datasets. With DirectQuery, Atoti deploys plug-and-play atop a data warehouse, with cubes starting in seconds since they do not need to load the data. This simplifies projects and allows for on-demand analytics and elastic provisioning. To further accelerate the process, customers can set up aggregate caches on the third-party database, so that the most common aggregates are made available for analysis almost instantly.

Atoti's Technical Characteristics

DirectQuery also works in a hybrid mode. Atoti can combine in-memory and database queries in the same model, dramatically expanding its flexibility and modeling capabilities. To get a complete picture within the same environment, users can cache "hot" data in memory and combine real-time datasets with cloud-scale datasets that do not fit in memory, such as historical data.

This capability delivers four main benefits:

Users have access to granular, detailed data with unlimited historical perspective. All analyses are performed in a single environment, ensuring consistency, auditability and ease of access.

IT managers can precisely optimize which parts of the dataset to load in memory and which parts to leave on a persistent, on-cloud or on-premise database. "Hot" data queried often and by many users can be loaded in memory for instant, fast access, while "cold" data, accessed less often, can remain where it is for cost-effective storage.

The data analysis process involves less data duplication, as a significant part of the data analyzed remains on its persistent storage with no duplication, leading to lower costs and fewer errors.

Projects launch faster because it is all plug-and-play. Cubes start in minutes – or even seconds – because data does not need to be moved, opening new possibilities for deploying analytics on demand and dynamic provisioning.

Atoti's Technical Characteristics

Because the data models in Atoti are separate from the queries, IT developers only need to define a data model once to apply it to any part of a dataset, regardless of where it is stored.

DirectQuery offers a consistent deployment experience across all cloud providers as well as on-premise databases. The same models, dashboards and data access rules can be deployed on Snowflake in AWS, on BigQuery in GCP or on ClickHouse on-premise. Applications may be lifted and shifted between environments.

Atoti UI

Atoti UI is a full-fledged, web-based, customizable UI platform that enables users to explore data freely, spot inconsistencies, and explain any figure quickly and easily. Atoti UI is for live, collaborative data exploration. It comes with a wide range of out-of-the-box widgets and an extensive API for creating custom widgets and actions. Atoti UI widgets also integrate seamlessly into existing web-based applications.

In contrast to general BI and visualization solutions, Atoti UI has been designed by deeply experienced engineers who understand the unique needs of financial services users, including traders, risk analysts, heads of trading desks and senior managers.

Built in TypeScript with the React framework, Atoti UI complements its powerful backend, Atoti Server. It renders visualizations as quickly as they are calculated, handles on-demand calculations, seamlessly performs What-if analysis, and facilitates edits and write-backs. The result is a responsive, interactive UI where each component can be updated by multiple sources.

Native compatibility with other front ends

In addition to Atoti UI, Atoti can use third-party BI tools to serve as front end. Atoti uses MDX, the standard language for OLAP systems, to describe queries, which makes it natively compatible with front ends such as Tableau and Excel.

Atoti's Technical Characteristics

Using MDX, a user can:



Start with high-level aggregates, then navigate into the details



Slice and dice



Filter and group



Crossjoin

End-to-end real time push

Atoti's unprecedented end-to-end real-time push empowers users to register continuous queries and receive updates to the query results when the database is updated. When new data, such as a new record in the cube itself or a contextual update like a stock price tick, is streamed into Atoti, the engine precisely computes the impact on the registered continuous queries and optimizes performance by recomputing only what has potentially changed. The cells that have changed (and only those cells) are pushed to real-time clients or downstream applications.

Unlike naïve implementations that fully recompute queries and often fail after a few dozen concurrent subscriptions, Atoti optimizes processing power to minimize the bandwidth for transporting updates. A single Atoti node can scale up to hundreds of concurrent, real-time continuous queries with Atoti processing tens of thousands of updates per second.

Atoti's end-to-end, real-time push consists of:

- **Real-time data sources** – Atoti naturally accepts multiple heterogeneous real-time data sources such as Apache Kafka or AWS Kinesis.
- **Continuous update to the cube** – Atoti updates a cube continually in real-time. While some users may work with ad-hoc queries, others need to see live reports that are refreshed whenever the cube data changes.
- **Streaming API** – Atoti notifies registered clients through a proprietary streaming API as soon as the data is updated.

Atoti's Technical Characteristics

Parallel loading

In a modern data stack, the time it takes for an OLAP cube to start is an important criterion.

A cube that starts quickly allows for the design of elastic solutions where cubes are started on demand to match user activity. Conversely, a cube with a very long loading time will require a more static deployment on a dedicated machine, which will need to be duplicated for high availability.

Atoti's data loading phase is optimized with the same effort as its renowned query engine. The code is designed to take advantage of modern multi-core processors through in-memory processing, modern multithreading techniques, and "lock-free" data structures.

Atoti can also leverage its distributed architecture to fully parallelize the startup phase. Each node in an Atoti cluster can load data from persistent storage and into in-memory column stores independently and in parallel with the other nodes. A benchmark of a 100-node Atoti cluster, deployed on commodity hardware instances in a public cloud, was able to load a 40TB market risk dataset in less than 20 minutes.

Python and Java APIs

Atoti is built in Java, and in every instance the runtime of Atoti is Java. However, to make Atoti more accessible to more users, customers have a choice between several APIs to build their applications, create their data models, define measures, add hierarchies and analyze their data:

Atoti's Technical Characteristics



The Java API allows for precise, complex and expert programming of Atoti, with low-level access to the Atoti engine APIs, such as user-defined metrics, prefetchers and data loading pipelines. Users can implement sophisticated, untried chains of aggregation.



The Python API offers all the flexibility and accessibility of the Python language to manipulate data and create your data models, as well as integrate into the larger Python ecosystem, particularly the Pandas library and the JupyterLab notebook.



The Python API is a major differentiator for Atoti: Python empowers business teams to leverage their own programming skills and make them less dependent on the IT for analytics tasks. The IT team puts framework, data and infrastructures at their disposal and empowers the business to lead their data analysis as they want, while keeping a tight control over security, compliance and cost.

Whether in Python or Java, Atoti offers short and expressive APIs for teams with various needs and skill sets, from enterprise development teams to single quant analysts. The choice of API is only one of convenience, it has no impact on performance or reliability at runtime.

Benefits Atoti Delivers

Interactive analysis of large datasets

The speed and multidimensional modeling capabilities of Atoti, enable users to freely explore complex metrics over large datasets, from top-of-the-house level to single records. They can group metrics using any combination of hierarchies, filter out elements, create their own dashboards on the fly – all independently.



Users don't just watch numbers – they understand and can explain them.



Users don't just detect a risk figure issue – they can track the issue down to the single record that caused it.



Users can freely explore the metrics and add new metrics intraday.

High dimensionality

One of the key challenges of traditional OLAP systems is quickly aggregating data across different dimensions. Unlike most OLAP engines that only support a small number of analysis dimensions, Atoti supports “many-dimensional” queries via:

- **A multidimensional bitmap index** that filters billions of records and supports hundreds of dimensions.
- **A column store indexer** that enables the processing of multidimensional queries at unparalleled speeds for data that is updated on the fly.
- **An efficient data compression mechanism** using a dictionary and Java primitive types, which, when combined, enable efficient data storage and access in memory.

Benefits Atoti Delivers

- **Multi-core architecture** designed from the ground up, with parallel algorithms running on multiple threads that leverage the computing power of multi-CPU machines.
- **Polymorphic distribution** that enables developing simple independent applications for heterogeneous data, which are federated on the fly.

Mixed workload

Typically, users are forced to select either an OLAP or OLTP (Online Transactional Processing) system, depending on the workload. Atoti offers a mixed workload solution that supports both a modern, multidimensional OLAP aggregation engine and an OLTP capable of easily handling write-backs, updates and adjustments. The same database engine performs data updates and complex analytical queries so that analytical work is always done on up-to-date data reflecting the current state of the business. Atoti's mixed workload is enabled via:

- **Multi-version concurrency control** that supports multiple queries to the database (both big and small) as well as write-backs simultaneously.
- **An in-memory database engine** offering ultra-fast data access and the ability to insert/update large amounts of data while concurrently performing queries and analytics.
- **Multi-threaded algorithms** that maximize the usage of all computer cores and process transactions and queries simultaneously to deliver the best possible throughput and response time.
- **An updateable column store** that preserves the underlying facts, so they are easily updateable and quickly accessible for multidimensional queries.
- **A continuous real-time push engine** that ensures the data used for analytical queries is always the most recent and propagated in real time to end users.

Benefits Atoti Delivers

Universal semantic layer

Atoti integrates with most data sources and risk engines, commercial or in-house. Many financial institutions have migrated to open architectures that decouple analytics, allow federated data from several systems and blend in external data. Atoti supports this open architecture as the semantic layer turning data into actionable business metrics.

Atoti provides users with a global picture that consolidates data from position-keeping systems, market data providers, and metrics generated by risk engines such as prices, sensitivities and simulations. Data can be read from open format files such as CSV, CRIF, and Parquet, fetched from relational databases (including Snowflake, BigQuery, and RedShift), data lakes or streamed from messaging queues such as Kafka.

Atoti integrates with any in-house or commercial risk engine that exports its results, with a track record of successful implementations alongside MUREX, Calypso, RiskMetrics, Numerix and others.

Measures calculated in Atoti may be visualized in any MDX-compatible front-end, including Excel, Tableau, Python notebooks, and of course Atoti UI.

Atoti has been deployed successfully in production for use cases as diverse as real-time front-office risk and PnL, FRTB-compliant risk management, xVA calculations, liquidity management, collateral optimization, credit risk, counterparty credit risk and limits management.

Atoti brings consistency to workflows that are often spread across several analytical environments. With Atoti, a metric (e.g., VaR and expected shortfall) is defined concretely. Every user has the same understanding, avoiding common errors that arise from different definitions across systems. Atoti resolves operational risk and misalignment between teams working on the same data, but with different tools. By providing a single global solution, Atoti offers the best possible return on investment.

Benefits Atoti Delivers

Fast start-up

Thanks to parallel loading, virtual hierarchies and DirectQuery, even the largest Atoti applications are ready for actual analysis within minutes. This is an essential capability to take full advantage of the “pay-what-you-use” model of the Cloud, but also to face any unforeseen circumstances: in a crisis, Atoti can bring to the fore the relevant data to make the right decision quickly and decisively, even if such data resides outside of the perimeter of day-to-day operations.

Cloud agnostic

Atoti runs seamlessly on Amazon Web Services (AWS), Microsoft Azure and Google Cloud Platform (GCP). It supports all major cloud-based data warehouses (Snowflake, BigQuery, Databricks and RedShift), as well as their deployment and orchestration systems with high-performance connectors to facilitate integration.

The deployment experience is consistent across all public clouds as well as on-premise. Customers do not need to reinvent data models, dashboards or retrain their teams. They can lift and shift from one environment to another, and even create hybrid solutions that are part in the cloud and part on-premise.

While public cloud stacks are comprehensive, well-managed and state-of-the-art, they also come with the risk of vendor lock-in. Atoti makes it easy to switch from one to another or to support a mix of public and private clouds for different functions. Users do not need to set up data access rights for each environment they support or reinvent processes for data modeling and publishing dashboards. They can lift and shift their models and visualizations from one platform to another.

Benefits Atoti Delivers

What-if analysis

With Atoti, users can perform instant simulations and What-If analysis on huge datasets to evaluate alternative scenarios, make projections and reach informed business decisions.

What-if analysis leverages Atoti's ability to perform real-time transactions and to execute queries immediately on the updated data. Thanks to MVCC, users create their own environments on the fly, where they can perform personalized What-If simulations and queries with no impact on other users.

Atoti's What-if capability is enabled via:

- **User-defined aggregate functions**, which allow complex and non-trivial aggregations that can rely on internal and external data.
- **An updateable column store** that stores the underlying facts that are easily updatable and quickly accessible for multidimensional queries.
- **An in-memory database engine** that supports real-time transactions (such as inserting or updating data) with queries performed immediately on new data.
- **Multi-version concurrency control** enables users to create private environments on the fly, adjust any parameters, analyze and share the results and ultimately validate or discard the changes.

Alerts and limits monitoring

The key requirement for monitoring business indicators and alerting users is to be informed of a change in underlying data. Atoti's alert and monitoring capabilities immediately notify users when any change to specified data is made.

Benefits Atoti Delivers

Using advanced measures, users may also be alerted to any business logic defined. For instance, an alert may be issued if a KPI increases/decreases by more than the average of competitors during a specific timeframe. Contrary to conventional databases that use triggers or polling to monitor data, Atoti's alerts and monitoring capabilities are enabled via:

- **An updatable column store** that stores the underlying facts, so they are easily updatable and quickly accessible for multidimensional queries.
- **An in-memory database engine** offering fast data access and the ability to insert/update large amounts of data while concurrently performing queries and analytics.
- **A best-in-class aggregation engine** that recalculates aggregated data and limits on the fly.
- **A continuous, real-time push engine** that alerts users when data of interest has changed.
- **Powerful What-if capabilities** that enable users at all levels to test potential decisions and assess their impact on limit breaches.
- **Tools for reporting** that ensure auditability, enable root-cause analysis and assist with incident tracking.
- **An optional extension module, Atoti Limits**, that allows customers to centralize all limits into a dedicated cube to facilitate management, monitoring and the investigation of potential breaches.

Future-proof

Designed to scale-up and scale-out, Atoti supports expansion of business data and the need to continuously increase the scope and depth of data analysis over time.

Benefits Atoti Delivers

This is achieved via:

- **Multi-threaded parallel algorithms**, which enable Atoti to maximize its use of computer cores. Adding more cores allows Atoti to scale-up on a single box.
- **Efficient data-compression algorithms**, which allow for the storage of large amounts of data within each Atoti instance. This enables the application to grow while using a minimal amount of memory.
- **Horizontal distribution**, which automatically adds more instances to a distributed Atoti deployment, resulting in increased computing power and available storage.
- **Polymorphic distribution**, which simplifies the data architecture and enables the efficient management of multiple cubes for different business area.

Data visualization

Atoti provides intuitive visualization and data analysis in near real time. Data visualization is enabled via:

- **Multiple UIs like Excel, Python notebooks, Tableau and Atoti UI**, which provide a graphical interface to the Atoti engine in MDX, the standard query language for multidimensional analysis. Users may select the front-end they prefer to perform work.
- **A continuous, real-time push engine** which ensures users view the most recent data to facilitate optimal business decisions.
- **A multidimensional index** that supports hundreds of dimensions.
- **User-defined aggregation functions and post-processors** which allow users to define the exact datasets to be visualized for their business goals.

AI-Enabled Enhancements

Atoti is getting even smarter, faster and more intuitive with the integration of artificial intelligence. These AI-enabled enhancements are pushing Atoti's capabilities further and elevating data users' analytics experience:

Self-optimizing query engine

The Atoti query engine learns from user interactions to optimize itself continuously. By employing machine learning algorithms, such as hierarchical agglomerative clustering, Atoti can classify runtime queries and recommend the best configurations for aggregate caches, partitioning and other tuning parameters. This self-optimizing capability enhances performance and ensures faster, more efficient data retrieval.

AI-powered assistance for developers

Developers will soon benefit from an intelligent assistant when creating Atoti models. This AI-driven assistant will not only explain data modeling APIs but also generate the corresponding Python code based on the developer's requirements. This feature will significantly streamline the development process, allowing for more efficient and accurate model creation.

AI-driven KPI explanations

Understanding the reasons behind changes in KPIs can be challenging. Atoti AI will automatically explain variations in measures, whether they occur between different dates or regions. Using marginal calculations within the underlying cube, Atoti AI will highlight the cube members contributing most significantly to these changes. This feature will provide analysts with immediate insights, streamlining the investigation process.

AI-Enabled Enhancements

Natural language dashboard interaction navigating complex

Atoti dashboards can be daunting, especially for occasional users. With AI, users will be able to build and interact with dashboards using natural language. This capability will simplify the user experience, removing barriers to entry and allowing users to leverage Atoti's full potential without a steep learning curve.

Automated analysis and highlighting

Atoti will use generative AI to provide an initial analysis of dashboard data, highlighting critical points of attention. This experience will save analysts significant time, visually accentuating important aspects and offering brief explanations to clarify their significance.

Enhanced Market Risk scenario generation

To better assess potential extreme market outcomes, Atoti will use Generative Adversarial Networks (GANs) to generate additional stress scenarios. This will enhance VaR calculations and other risk metrics by incorporating a broader range of potential market conditions. This feature will provide a more comprehensive risk assessment framework.

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About ActiveViam

Founded by industry experts, ActiveViam understands the data analytics challenges faced by financial institutions across trading desks, risk, and compliance. ActiveViam pioneered the use of high-performance analytics in finance, helping the largest investment banks, asset managers and hedge funds make better decisions, explain results with confidence, and simulate the impact of their decisions.

ActiveViam's mission is to deliver train-of-thought analysis on terabytes of data in the most cost-effective way so clients can explain their results with confidence and model the scenarios that will optimize their business. ActiveViam specializes in risk data analytics for one of the fastest-moving and most regulated industries with a presence in the world's leading financial marketplaces – London, New York, Singapore, Sydney, Hong Kong, Paris, and Frankfurt.

ActiveViam's purpose-built analytics technology has been recognized as "FRTB Product of the Year" by Risk.net and as the "Best Sell-Side Credit Risk Product" by Waters Technology.

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