Next Generation Business Intelligence

A Knowledge-based Approach

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Dedication

To Jiddu and U G Krishnamurti—
Whose teachings conditioned me to realize who I am

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I would like to begin by thanking the Dean (R&D), IIT Bombay, for extending the seed fund to continue my applied research on hybrid intelligent systems that lead to the knowledge-based framework, discussed in this book. The lab technology is of no use unless it has practical utility through real-world applications. Without practical applications, they would remain in the lab. Business incubators set up at universities make it possible for researchers to experiment their ideas for commercialization. IIT Bombay has established their technology business incubator under SINE (Society for Innovation and Entrepreneurship) to facilitate researchers to fulfil their entrepreneurial dreams. It was an opportunity for me to add to, shape and fine-tune my work on hybrid intelligent systems using the latest software tools, standards and technologies through SINE.

I am indebted to Siddharth Goel, CEO, Manish Godse and other software professionals of iKen Solutions for allowing and giving me access to software framework, Mooga^{SM} and sharing details of implementations and results of live case studies of various clients in the telecom space. Siddharth made me think of applying hybrid intelligent system approach from a more practical viewpoint starting with the challenging job of personalizing the contents on mobile. The late Prof. C K Prahalad and Prof. M S Krishnan, the authors of the book, *New Age of Innovation: Driving Co-created Value Through Global Networks*, provided Siddharth and me with an impetus to identify and explore where and how BI can be applied to analyse one customer at a time (N=1).

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Rajendra M Sonar

Preface

Business intelligence is something that every CIO is looking for or has it on his/her priority list. It is important to know that the scope of business intelligence(BI) and its applications are wider than its current understanding. Most BI applications are more customer-centric and focussed on domains like customer relationship management(CRM). Typical CRM activities are divided into two parts: operational and analytical. While organizations are extensively using BI tools and techniques for analytical CRM to understand and serve their customers well, they do not use same tools and techniques in other functional areas as rigorously. For example, to understand employees and take care of them well, along with operational human resource management, there can be analytical HRM. It makes sense to add analytics along with operational information systems. Most of the time, analytics is considered more of a decision-making activity, such as determining which customers are likely to churn out and which retention policy would work for them. It involves broad problem categories such as classification, clustering, forecasting, deviation detections, prediction, finding associations and pattern recognition. The outcomes of analysis such as decision rules or trees are embedded into operational system or, sometimes dealt separately with other tools specifically designed for a particular functionality like campaign management.

Operational information systems automate core transactional business processes, interfaces and work-flows. Intelligence can also be added to interfaces and work-flows rather than just to business processes to make them analytical. It may be likened to the fact that most human organs are operational but the brain helps or makes them capable of performing intelligent actions. Of course, this intelligence is achieved by the brain through its abilities to feel, sense, learn and comprehend through the organs themselves. Such intelligence works in real-time, and centrally coordinated by the brain, the signals are passed on—they are sent as well as received through the nervous system. It would be interesting to have such centrally-coordinated and controlled intelligence-making operational activities that are smarter and intelligent within the organization. The data, information and knowledge generated by operational activities themselves can be used to build that intelligence.

Traditionally, analytical and operational activities are done separately. Even the teams are separate. Analytics should be a part and parcel of every business process, user interface and work-flow coordinated centrally. Analytics should work on an on-going basis, should be able to cash on every opportunity and act upon it. Hence, it needs to be operational.

Conventional analytics focus has been on off-line analysis, analysing 'what has happened, where and when' and applying those inferences and learning to new opportunities. Most of the BI frameworks and tools have very limited focus on incorporating human intelligence. Machine and human intelligence complement each other, and it goes without saying that there is no substitute for human intelligence. Machines would not be able to compete with the natural intelligence of humans, nor would human beings be able to compete with computing capabilities of machines. Integrating human knowledge and data-driven intelligence is very effective; it is like a combination of knowledge + experience. Therefore, it makes sense to incorporate human knowledge in BI rather than treating it separately through knowledge management systems. Web 2.0 provides platforms to people to create, share, collaborate and disseminate information and knowledge. Semantic web

provides the underlying core framework of syntax and semantics for machines to automate creation, sharing and dissemination in standard and structured way. Once the information is made available in a structured form with semantics, deriving intelligence out of that becomes relatively easy. Both web 2.0 and semantic web play very important roles in collaborative and collective intelligence.

There are many tools and techniques around. The widely-used ones are: OLAP (Online Analytical Processing) and data mining. These are developed around data warehouses. OLAP tools work on data which is stored in a summarized and multi-dimensional form. Once data is aggregated, it loses granularity, capability of performing analysis at the level of one customer or one product at a time. Most of the data mining algorithms are targeted to find out patterns, classes and clusters not exactly suited for analysing one entity at a time, at the granular level. They focus mostly on grouping, clustering or classifying customers into certain and few groups depending upon behaviour. Group behaviour is applied to the customer to make decisions such as what to cross-sell or up-sell to him. However, there is an issue here: how can millions of customers be clustered into few groups when each individual is different? In the worst case, a million customers can exhibit a million patterns that differentiate one individual's behaviour from others, even though slightly. Even a small retail shop sales person knows the individuals, understands their needs and recommends products or services based on what the customer liked in the past. On the web, especially in the E-commerce domain, filtering techniques have widely been used to offer personalized experiences. However, that needs to be extended to other domains. Technologies like rule-based expert systems facilitate automation of human intelligence or domain knowledge. Tacit knowledge is converted into explicit knowledge, using rules, while technologies like case-based reasoning help to deal with one entity at a time and create a cluster around that entity on-the-fly. For example, (using the steps): 1. considering one customer at a time, 2. creating a cluster consisting of closely matching customers around the customer, and 3. analysing behaviour of the cluster to understand the customer or likely behaviour. Case-based reasoning involves lazy learning, it defers the learning as late as possible taking latest individual experiences into consideration. The clusters are not predefined like in traditional analytics but created on dynamic basis up to the last transaction. Combining expert system and case-based reasoning can offer a blend of both, knowledge and experiences to solve the problems.

Why This book?

There have been many books already on business intelligence tools, mostly focussed on broad technologies: OLAP, data mining and data warehousing. There are various books on knowledge management. In most of the BI literature, the KM component is missing. CIOs are looking for BI which is operational, integrated, delivered through services and that is acted upon within a time-frame. News about BI 2.0 has been around but there is no formal definition of the same. The primary goal of this book is to inform that it is possible to build and implement next generation BI. This kind of intelligence can be called next generation, as it is completely different from what is traditionally followed. All possible inputs required for such kind of business intelligence are covered in the book.

Audience

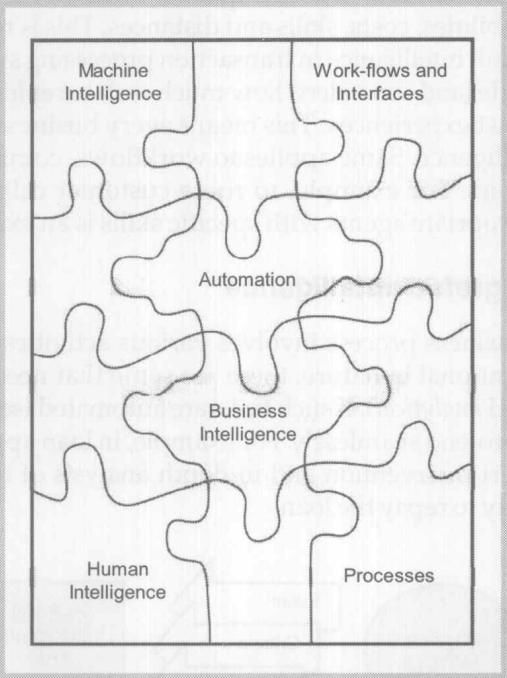
The audience for this book would be professionals working in the domain of business intelligence and analytics, IT managers and people working in knowledge-based intelligent systems.

Author

Contents

1

Introduction: A Next Generation BI



Intelligence

The term intelligence is used to express the ability to think, reason and understand things automatically or by instinct. It reflects an ability to acquire and apply knowledge and skills. Extending this definition to businesses means recognizing the ability of the organization to acquire and apply knowledge about customers, products, services, employees and other stakeholders like suppliers, investors, business partners, and so on. In a competitive scenario, it is imperative to use that knowledge to understand each one better and apply it whenever possible; to make business processes smarter and capable of making their own decisions. Smart organizations continuously look for opportunities and insights on an on-going basis, take decisions and immediately act upon them to offer better customer service, improve products and services, manage supplier relationships, optimize and configure resources on a dynamic basis, and finally improve overall efficiency and productivity. Business intelligence is meant to assist organizations in achieving all of the above.

Business intelligence should be all-encompassing, routine and part and parcel of all business processes, user interfaces, workflows and decision tasks of the organization. It should be at the enterprise level across all functional areas rather than restricting it to only customer and product centric applications. For example, intelligence can be incorporated into inventory management system to automatically acquire knowledge about what to reorder, when to reorder, which supplier(s) to order from without waiting for explicit manual instructions from human decision makers. Knowledge about the suppliers makes it easy to send order to the right supplier, at the right time in supply-chain, based on various parameters

Note for the readers: *To avoid repetition, the author has referred to both genders (male and female) as he/his/him.*

and factors like urgency, quality, location for delivery, profitability, suppliers, capacities, capabilities, costs, skills and distances. This is real-time configuration of resources. Similarly, in-built intelligence in transaction processing system that automates an ATM transaction can decide (and send alert) how much cash to replenish at what time by acquiring knowledge out of past experiences. This means every business process can become smarter if it has its own intelligence. Same applies to workflows, communications and interactions among various players. For example, to route customer calls based on customer profiles and needs, to appropriate agents with specific skills is an example of use of business intelligence.

Integrated Intelligence

A business process involves various activities or tasks. Although most of the activities are operational in nature, there are some that need decision-making capabilities (these may be called *analytical*). If such tasks are automated (see Fig. 1.1), the entire process can be performed end-to-end seamlessly. For example, in loan application processing, underwriting task needs expert intervention and in-depth analysis of the borrower to assess credit worthiness and ability to repay the loan.

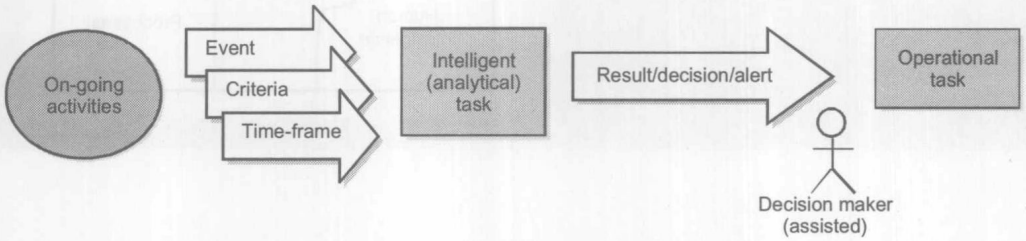


Fig. 1.1: Intelligence (Automated and Assisted)

Opportunities can be found by tracking ongoing activities and interactions within or outside the organization. Such opportunities can be mapped to events. The intelligence should be constantly evolving and business should have the ability to continuously acquire and apply it to look into every opportunity, and decide to take action on it based on criteria within time-frame. The time-frame depends upon the type of opportunity at hand. It can vary from milliseconds to days or even months. Action also can be initiated only when certain criteria is fulfilled to use resources optimally. For example, in a superstore which has RFID enabled products, if the manager knows that most customers indulge in impulse-purchases; it makes sense to generate exclusive personalized offers or find the right ones that fit customers' buying behaviour. Such offer(s) should be sent to the customer instantly before he changes his mind or exits the superstore. In this case, the event 'added to cart' can be raised when the customer picks up the product from the shelf and puts it into the shopping cart. However, action to generate and send personalized offer(s) to him can be subject to certain criteria and may be based on total amount of product(s) selected. Also, the availability of products should be checked before recommending them to the customer. Such intelligence needs to work in real-time or at least within stipulated or acceptable time. There is no point in applying the intelligence once the opportunity is gone. Delays in recognizing, interpreting and acting on the opportunities can be critical impediments to competitiveness. However, all decision-making applications need not take decisions in real time. The time-frame available to react varies from type of opportunity and time available to act and respond. For example, in churn management system, if the system predicts that a particular subscriber would be leaving the telecom operator

soon, say within a couple of days or a week; the decision has to be taken either to talk to the subscriber about why he wants to leave or decide upon what best can be offered to the subscriber to retain him. This decision need not be taken in real-time, but should be well before the subscriber is churned out.

As intelligence can be part of every business process, it must be built for each type of entity like product, service or resource, for example, transaction processing system should have intelligence built for each ATM rather than being based on common knowledge of all ATMs. This is simply because each ATM location is different and its usage can be based on various factors in that locality. However, when an ATM is new or to decide what is the right ATM location, there is the need to analyse transactions of all ATMs or at least those which have similar kinds of locations and likely usage. Similarly, the ability to acquire knowledge about each and every consumer or employee helps to understand better, serve them well and offer unique experiences. Value is based on unique, personalized experiences of consumers. So the bottom line is, have intelligence in every business process, with knowledge about each and every thing that is part of that process, and focus on one entity at a time. When it comes to consumer, organizations have to learn to focus on one consumer and his experience at a time, even if they serve a million consumers. The focus is on the centrality of the individual. Each individual and his behaviour is different. In the worst case scenario, every individual can have his own behavioural pattern.

Knowledge: Tacit, Implicit and Explicit

To build intelligence capabilities, knowledge about the customers, products and services need to be acquired through various sources. The two basic sources are—**explicit** and **tacit**. Tacit knowledge is available internally in the organization, one that resides in people's minds. There is no substitute to human intelligence and employees are considered to be knowledge assets. The challenge remains how to capture, represent, store and share such knowledge to build intelligence capabilities. If organizations develop such knowledge management processes and make it a culture and practice to capture, store and share that knowledge, it would help them to incorporate and apply it right into business processes. Knowledge management tools and techniques facilitate sharing and collaboration amongst employees as well as customers.

Explicit knowledge exists in various forms and it can be derived from various sources. Most businesses are IT enabled or have many of business processes automated. It is easy to capture every transaction in many transaction processing systems. Use of sensors and digital devices such as swipe-cards, digitization of products, automation of various products and services using software makes a huge amount of data and information available. More and more information is shared and available on the Internet about the products, content, reviews and ratings through semantic web in structured formats using well accepted standards like RDF (Resource Description Framework) through RSS (Really Simple Syndication) feeds and so on. Many tools exist that facilitate creation and sharing of knowledge on the Internet. These tools can be used inside the organization to enable knowledge creation, sharing, adding meta-data (data about the product or content), meta-knowledge (like categorization, tagging) and reusing in a standard and structured way through Intranet and external partners using extranet. This facilitates collaborative and collective intelligence. It is possible to build knowledge based on interactions and transactions without talking to customers or even doing any kind of primary survey. The transactions of the customers reflect on the type of

Note: The author has used the term 'consumer' and 'customer' alternatively to indicate a person or organization that uses/consumes a commodity or service.

customer, spending patterns, etc. The acquisition of right knowledge depends upon exploiting the right source of knowledge with correctness and accuracy.

Intelligence based on proper blend of tacit and explicit knowledge combines power of human intelligence and data driven intelligence. In technical literature, **knowledge is divided into three types: tacit, implicit and explicit knowledge**. All subsequent references are based on these three types. Explicit knowledge is actionable knowledge like business rules, manuals, operating procedures, etc. Implicit knowledge is knowledge which is not in explicit form but in implied form, and explicit knowledge can be derived from it. Again, the level of implied knowledge can vary based on source type. For example, knowledge about the customer can be derived from transactions and interactions of the customer. If a customer regularly buys luxury cosmetic products, one can infer that the customer must be having a good income and high standard of living. It is possible to reuse the knowledge which is created during the process of solving the problem, if presented in well-structured and proper formats. For example, maintenance and support records of technical equipments by technical help-desk constitute knowledge that can be reused by technical support staff. Implicit knowledge requires meta-knowledge especially using human expertise, to build context to add value to it and derive correct explicit knowledge. The level of meta-knowledge depends upon type of implicit knowledge. Some of the meta-knowledge is added by the community. Adding tags and keywords to the contents is an example. Tasks such as categorization of the contents using taxonomy, building ontologies (to describe the contents and relationships), finding out important attributes or features also forms meta-knowledge. There are various methodologies, techniques and tools available to convert tacit and implicit knowledge into explicit knowledge; and subsequently use and apply it. Few of them are part of artificial intelligence called intelligent techniques.

Machine Intelligence

Humans acquire knowledge and skills in a variety of ways, e.g., by practising, reading, experimenting, observing, solving problems, and so on. Machines can be made intelligent either by feeding explicit knowledge in a format they can easily interpret or by letting them learn on their own. Intelligent systems mimic intelligence of human thinking and behaviour using intelligent techniques. Popular techniques used in business applications include expert systems, neural networks, case-based reasoning, genetic algorithms, model-based reasoning and fuzzy logic. Some of these systems, especially expert systems and case-based reasoning, are also referred to as knowledge-based systems. Most of these intelligent techniques are modelled on biological systems. For example, neural networks simulate the working of nervous system using mathematical models, especially learning capabilities, while case-based reasoning mimics how humans solve new problems based on past experiences. These techniques differ on the basis of underlying foundations on which they are built. So, in a way, they build and use knowledge from knowledge sources. For example, rule-based expert system has more explicit knowledge expressed in the form of rules, especially expressed by domain experts while neural networks use implicit knowledge sources like transactional data to get insights and build knowledge.

Intelligent Systems

Intelligent systems use various mechanisms to acquire, represent, store and reuse the knowledge and also to learn and adopt new knowledge. Intelligent techniques are selected based upon the type of task, availability of knowledge and knowledge sources. For example,

if senior employees are ready to share their domain knowledge and the knowledge can be easily modelled in rule-based form, then, using expert system technology is the best option. Many loan underwriting systems use expert system technology to automate the underwriting process.

Intelligent systems can be part of the business processes to make them smarter. Intelligence can be incorporated into business processes in two ways: by adding explicit knowledge like business rules into the business process and applying it whenever required or by letting the intelligent technique to build the knowledge from implied knowledge sources like databases. However, both types can supplement each other by combining explicit knowledge, (e.g., judgemental) by human experts and knowledge derived from implicit sources. The implied knowledge sources can be internal like data generated and accessed by the processes as well as external to the processes.

All intelligent systems do not have all the capabilities, they have some inherent strengths and weaknesses. Some techniques are better suited to the kind of problem on hand. There are many business processes that vary the inputs they take and the outcome that they produce. This makes it difficult to use only a single technique. In such a scenario, it makes sense to use a combination of various intelligent techniques rather than a single technique. This also helps to balance the weaknesses of one technique by the strengths of the other. Sometimes, the techniques are complementary in nature. There exist many ways to integrate the intelligent techniques. Various models, mechanisms and architectures have been suggested and implemented to build hybrid intelligent systems.

Intelligence at Enterprise Level

With the focus on enterprise level automation, many organizations are shifting to centralized integrated IT solutions. This addresses the issues faced because of heterogeneous IT systems. Most enterprise solutions use popular database servers as their back-end. Current databases can store and handle huge amount of information. Common databases store information at the organization level with integrated view of customers, products, people and suppliers. Most of the widely-used database management systems have an in-built mechanism to ensure integrity and consistency of data and information stored along with security and back-up provisions. Once such proper checks are defined and enforced in databases; the data and information about products, customers and transactions remain in a standard and integrated state. There is no need to process and clean the data to build the knowledge. However, it definitely needs to be standardized. With the advent of web technologies and web 2.0 and standards like RSS and RDF, even external information from other sources like websites is available in a standard format. Integration of external information to build knowledge is possible without exerting too much effort. As most business processes access centralized databases, the databases become implicit knowledge sources. Smarter business processes can build knowledge using these sources. Another option is to store the relevant information in separate databases meant to be source of implicit knowledge for all business processes. All such smarter business processes give the enterprise view of intelligence. Using external knowledge sources adds more value to that.

Adding intelligence in every business process (see Fig. 1.2), workflows and even in interfaces, lends to building of intelligence with better agility in modular and distributed fashion. Modularity means each intelligent task can have well-defined functionality such as underwriting or deciding what to cross-sell. However, they can be centrally managed, coordinated and administered. It is how the biological brain coordinates all activities and

operations of various organs of the body. Although the operations are carried out by individual organs, they are under the control of the brain. Being centrally coordinated means knowledge can be shared amongst various intelligent tasks. Each intelligence task needs to be configured to acquire, build and apply the knowledge subject to some event such as an opportunity to cross-sell related stuff to the customer based on the transaction he does. Events can be triggered based on transactions happening which meet certain criteria. All transactions need not be monitored, only relevant ones should be studied. Intelligence task corresponding to the event requires to take the decision and to respond automatically within stipulated time-frame by triggering corresponding actions based on the decision. However, some intelligent tasks, especially complex ones, need human intervention to take a final decision.

Once the processes are capable of learning and taking their own decisions in automated way, their performance needs to be measured in terms of how effectively they take the decisions. They can be reconfigured or remodelled based on performance. There is need to have some sort of counter intelligence to keep track of effectiveness of decisions. For example, in recommender system in eCommerce portal, performance can be measured based on how many times the consumer ends up buying the recommended products. If most consumers are not buying the recommended products but other products using the search option, it means recommender system needs improvement. Based on types of intelligent tasks, corresponding measures are required to evaluate the performance.

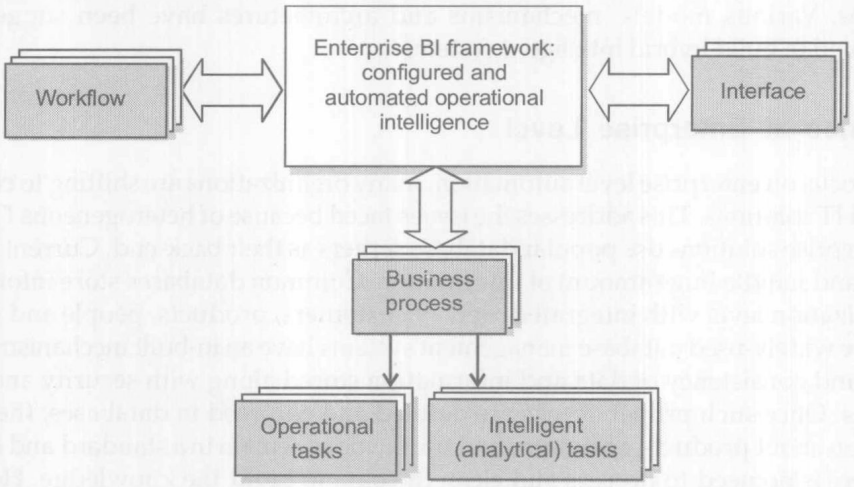


Fig. 1.2: Integrating Intelligence into Business Processes, Workflows and Interfaces

The next question is, what is the right technical architecture to integrate intelligence into existing software systems that automate operational business processes and workflows. The focus of operational systems is to automate business processes while the focus of intelligent systems is to take or assist in decisions by automating intelligence. The software that is used to build intelligent systems or implement intelligent techniques are different from that of operational systems. There are various ways to interconnect different IT systems loosely. Currently, web services have been one of the widely-used technologies. They are part of well accepted, service-oriented architectures. Since each intelligent task does a well-defined job, they can be delivered using web services. They can be accessed by operational systems in loosely coupled fashion. This makes it easier to make updates to intelligent tasks without change in operational tasks.

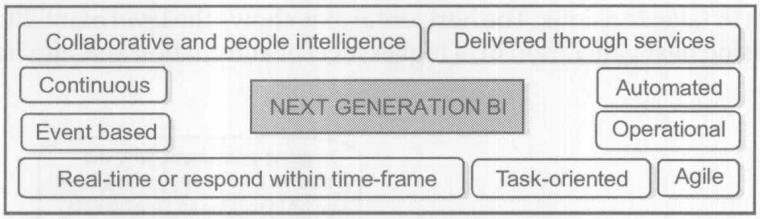


Fig. 1.3: Characteristics of Next Generation BI

Next Generation Business Intelligence

In short, business intelligence should be (Fig. 1.3):

- *Operational*—part and parcel of operational business systems and at the enterprise level
- *Automated*—should have self-learning capabilities and be able to take own decisions with less and less human intervention after tasks are modelled and configured.
- *Continuous and Event Based*—every opportunity matters, probably each and every transaction or activity should be looked into.
- *Collaborative and People Intelligence*—there is no substitute for human intelligence, people are the best source of explicit and collective knowledge, web 2.0 is all about people and participative web. Such knowledge should be integrated into business intelligence systems.
- *Real-time or Respond Within Time-frame*—whenever opportunity exists, the action on that should be immediate or within appropriate time-frame before it is lost.
- *Task-oriented*—instead of doing analysis with broader perspectives like clustering customers based on their behaviour and buying pattern, intelligence can be built around small, focussed and specific tasks. Even inputs can be restricted to specific entities like one customer at a time. For example, an intelligent task *Get Cross Sell Products* can return a list of products that are very relevant to the given customer based on his past transactions.
- *Agile*—knowledge and intelligence needs to be upgraded, reconfigured, remodelled whenever required. For example, changes in business rules need to be done on dynamic basis depending upon changes in compliance rules, availability and demand of products, price margin, etc.
- *Delivered Through Services*—intelligence can be centrally coordinated and administered. It is accessed into operational systems loosely instead of embedding or integrating (like hard-coding) it completely. This gives flexibility to integrate intelligence whenever required and facilitates distributed and modular intelligence.

There are various tools and technologies that are part of business intelligence. Figure 1.4 shows generic names for tools, technologies and methodologies used to achieve business intelligence. Some of them like *static reports* need substantial human expertize to interpret them and take decisions based on them. *Descriptive and predictive modelling* using data mining techniques is a semi-automated task. Predictive analytics enables predicting future events: *what is likely to happen* and needs less and less of human intervention for prediction tasks. In figure 1.3, vertical axis indicates level of automation, it shows how much of decision-making activities can be automated on an on-going basis in operational systems with less human