# Inspettur

### A programming framework for a *credit reference system* with analysis and

### intelligence services



## Declaration of authenticity

The research presented in this document presents the findings sourced and referenced through my own references and research, and, these have been documented within the *References and bibliography* section of this document, which is to be submitted to the [University of Malta](http://www.um.edu.mt/) for academic review.

It is assumed that readers have a knowledge of terminology in computer science and are able to follow logical diagrams and statistical concepts that have been referenced throughout this document.

I would like to thank all the persons who have collaborated with me on this research project leading to the completion of the document and the relevant artifacts that may be complementary to the research.



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## Document control

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## Abstract

Credit bureaus collect information from different external sources of information for business and allow for the reporting of information for consumer credit information. Similarly, diligence is carried out prior to the establishment of a business-to-business relationship in order to identify the business risks pertaining to the business continuity of a business-to-business relationship.

The UK *Consumer Credit Act 1974* defines a *consumer credit agreement* as an agreement between an individual (“the debtor) and any other person (“the creditor”) by which the creditor provides the debtor with credit of any amount. Credit is also made available amongst corporate entities, and, this is regulated by company law.

Background checks can include a number of business process applications including recruitment and selection, establishment of business-to-government relationships and social media that provide a limited web-based view of information that can be reviewed to establish basic information – most of which is personal – about the individual or the entity being researched. Such transfer of information is effected by complying with laws such as the Data Protection Directive (1995) that is established within the European Union to protect individuals in the processing of personal information as an important aspect safeguarding privacy and human rights.

Although mathematical and economic forecasts have been subject to critique in their contextual representation for their lack of ability to cope with the economic problems that they might forecast with a degree of accuracy, the establishment of quantifiable criteria are still relevant to provide us with indicators on what may happen under different scenarios, and this supports the management and planning process within the context of operating a business within the larger context of the globalized economy.

The global marketplace is underpinned by web-based technology that seems to have been successful in making available information to the worldwide audience. Verifiable and non-verifiable information are relevant categorizations that provide us with a framework to verify the quality of information being sourced and processed. Information sourced from journalists might be considered as non-verifiable if the report consists of the subjective opinion of the content writer, rather than a factual statement of events as they are occurring. It is also true that some media do not seek to report unbiased information, but tend to sensationalize in order to increase the popularity of a particular article. Politics appear to dominate a good portion of our consciousness as risks as a result of events happening around the globe concern us and thus we seek real-world solutions to reduce these risks. Other concerns such as the concern for the scarcity of resources lead us to attempt to save money for the rainy day and to do a personal budget on a regular basis that allows us to monitor our income and expenditure. This leads us to attempt to create academic frameworks that formalize the process of standardizing the processing of information, and this enables us to be able to compare results and reports processed with standardized quantitative and qualitative criteria. If we consider the weighted average of percentages to represent a valid basis for credit scoring, and, the criteria consists of the analysis of financial performance, reputation, positioning in the market, service provisioning and factors that influence the business relationship, then we have established a basic report that allows us to provide a credit scoring on a number of corporate or individual businesses based on their financial reports and information about their corporate policies.

We then analyze this information and form an educated opinion of the background information that was analyzed and this provides us with a view on the risks involved in initiating the business-to-business relationship. For example, if we establish that Iraq is a country that is invaded with terrorism or political conflict, we would consider it risky to invest a considerable part of our business relationship with professional providers who require us to meet them regularly in the country that is currently torn by war, and, thus we question whether a relationship that does not involve any of our employees traveling to Iraq to be feasible, as there is the need to verify goods either at the country where goods are dispatched if we are importing sand from Iraq or else, they would be verified at the country where the sand is dispatched, with all the risks involved in shipping and merchandise that could affect the quality of the goods or their commercial value, as we seek to use the sand as part of property development.

Newspapers recently highlighted links between criminal organizations and operators within the gaming industry and this brings about financial risks as the costs of processing illegal economic activity involves heavy security and judicial procedures as part of the government that regulates transfer of resources and information amongst others. It also influences public perception as people who might want to disassociate themselves from criminal activity may no longer want to carry out business or engage in relationships with companies that are involved with criminal activity, and, although discriminatory such behavior is a matter of choice, as corporate culture may prefer to take prudential decisions to protect its own business interests. Business executives interviewed with ties and investments in Europe have confirmed to prefer to take prudential decisions that are compliant with European business laws, within the global framework of international governance agreed upon at an international political level, such as that discussed at the [European Parliament](http://www.europarl.europa.eu/), at conventions of the [United Nations](http://www.un.org/en/index.html), or as part of the [Transatlantic Trade and Investment Partnership](https://en.wikipedia.org/wiki/Transatlantic_Trade_and_Investment_Partnership).

What Weber (b. 1864) had referred to as *bureaucracy* when we do not accept the need for information to be provided for the purposes of diligence, sometimes represents some process which attempts to verify the origin and nature of business prior to the business being registered formally within a particular legal jurisdiction and this is also subject to audit. At times bureaucracy serves to protect the very business interests giving rise to claims of alleged abuse of power or corruption, and media still report occurrences where transactions are initiated prior to due diligence being carried out to establish a favorably looked upon business-to-business relationship, whether the risk was one of inadvertent involvement or consciously forming part of criminal activities that would be penalized differently under law, as criminal activities such as fraud or money laundering are subject to investigation by the authorities. Such involvement in criminal activities are likely to result in bad publicity through information published on the global media and this results in the deduction that the prudential verifications made through regulation might be adequate to a certain extend to prevent the social consequences of a transaction which has negative repercussions, as journalists seem to advocate increased transparency within the legal frameworks that make corporate social responsibility and clean governance the policy of today's business organizations.

National debt and private debt are another example of a common cause for concern amongst financial controllers who would be expected to monitor the liquidity and financial feasibility of a business in the context of the economic environment. US National Debt stands at $18 Trillion (April 2015) and the debt is made up of economic criteria that are highly influenced by the day to day business operations and the individual interactions between different members of society that require the support of the federal government to provide an incentive or support business and other systems.

Notwithstanding perceptions of corruption, one might consider formal sources of information within company registries and statistical bureaus to be reliable due to their high level of formal processes for gathering and verifying information. On the other hand, many researchers have argued that sometimes information is not up-to-date and that the statistical processes are lengthy and lead to disappointing executive decisions at the political level.

Nonetheless, there is the risk of information being reported by the state to be subject to bias, excluding certain information or highlighting only particular aspects of information as this can influence the objectivity of the information reported. Reliable information is concerned whether a research is repeatable, and, produces results that can be compared, usually over periods of time. It is also important to indicate the methods by which information is processed in a transparent manner and to validate whether the data or the information represents what it is reported to represent. Moreover, conclusions and deductions from the processing of information have to be justified, and, the results have to be relevant to the context within which they are being reported. Therefore it might be seen to be a waste of time to meet an executive of a company without being prepared with information relevant to the purpose or the agenda of the meeting, specifically highlighting the extent to which the sources of information being processed are reliable, and, giving due weight to these subjective matters in our attempt to use [*neural networks*](https://en.wikipedia.org/wiki/Artificial_neural_network) to mimic the behavior of the human brain and provide an interpretation that is performing functionally and produces results that are at least supporting better decision making in executive management or in day to day management. The old business adage reads “time is money”.

Due diligence in the broad sense refers to the level of judgment, prudence, care and activity that a person is expected to do under particular circumstances. Effectively, in tort law, a duty of care is an obligation which is imposed on an individual requiring adherence to a standard of reasonable care, while performing any acts that could be seen as risking to harm others:

Within the context of corporate governance, the UK Companies Act 2006 clearly outlines the duties of company directors, as falling within the following general rules:

1. Duty to act within one's powers as a director

2. Duty to promote the success of a company

3. Duty to exercise independent judgment

4. Duty to exercise reasonable care, skill and diligence

5. Duty to avoid [conflicts of interest](https://en.wikipedia.org/wiki/Conflict_of_interest)

6. Duty not to accept benefits from third parties

7. Duty to declare interest in a proposed transaction or arrangement within the company

Other forms of legally registered entities are possible within the majority of company registries as specific forms of incorporation might apply according to the specific regulations supervising the particular industry, therefore the regulations and corporate governance practices that apply to the manufacturing industry would differ from those that apply to the business of insurance, as would supervisory functions and obligations to the regulatory bodies, usually as stipulated by specific regulations and guidelines. One of these structures is called a [*special purpose entity*,](https://en.wikipedia.org/wiki/Special_purpose_entity) which is setup to fulfill specific or narrow objectives.

Before undertaking to form a business or non-profit entity, it is would be thus prudent to undertake procedures commonly referred to as those relevant to [*know your customer*](https://en.wikipedia.org/wiki/Know_your_customer) (KYC) prior to formalizing a business-to-business (B2B) relationship, as information arising out of the diligence process might provide you with insight that is useful to risk management, in the context of corporate governance.

[Supercomputers](https://en.wikipedia.org/wiki/Supercomputer) are usually required to process large sets of information and their cost is quite considerable, given the fact that they are usually large scale research projects, with an estimated cost estimated to start from around half a million US dollars.

In order to prevent and avoid problems relevant to breach of [data integrity](https://en.wikipedia.org/wiki/Data_integrity) a careful process of extracting, [transforming](https://en.wikipedia.org/wiki/Extract%2C_transform%2C_load), loading and verifying data as it is being interpreted through automated coding units is important in providing a reasonable quality assurance for the final product that is to be utilized by the user commonly for business analysis.

Along with making good use of design and usability, automated processes that adhere to good principles of software engineering add to the quality of software, making best use of hardware and hardware interface that can be provided as a soft layer to allow the business user to analyze and dissect information relevant to the scope of analysis. Within the context of mining of large data sets, statistical techniques and functions can be used to review trends in data reported and presented in a visual manner that allows the user to analyze the information – typically through a *reporting engine*, whilst text mining makes use of fuzzy logic, text matching and similar programming functions providing filtering capabilities that can support search and locate functions that appear to simulate reasoning. It is clear that only logical functions differentiate a program that simulates a chess player from one that transforms large data sets into meaningful information that can be reported, possibly making use of an object-oriented programming framework to allow further programming using the objects within the scope of analysis, thus allowing an application programming interface to be evolutionary, as research provides us with meaningful insights on ways by which cognitive psychology and other patterns we learn through experience provide us with new patterns and abstractions through which virtual objects can be designed to represent simulations of real-world objects. This in itself provides a virtual environment that can be used for research, training and analysis.

Science fiction writer Isaac Asimov appears to confirm a common sense form of fear on the potential risk of allowing robotics and artificial intelligence to learn unsupervised, and, this brings about considerations worth controlling in view of the risks of not having a controlling function as part of the technology architecture:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings, except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws.

In later books, another rule was introduced:

A robot may not harm humanity, or, by inaction, allow humanity to come to harm.

[Elon Musk](https://fr.wikipedia.org/wiki/Elon_Musk) (b. 1971) an entrepreneur based in North America, was reported to have cautioned to be “super-careful on artificial intelligence” on his Twitter feed on August 3rd, 2014. This gives rise to the logical need for a controlling software logic that overrides unsupervised computer operations as a security measure, without foregoing mitigation of other information security risks, however bearing in mind that professional software engineering can capably control programmatic behavior through careful and diligent design of algorithm that allows for different levels of supervised and unsupervised processing.

Throughout this research we are focusing on quantitative research and qualitative research within the realistic constraints and dependencies encountered throughout the course of carrying out the study, using an evolutionary approach that does not attempt to create solutions that are already existing with the use of existing technologies, given the wide extent of technical knowledge and applications that are already available on the market, but that nevertheless does not exclude designing a prototype as a *proof of concept*, which can evolve into a programming framework that can compete in the global marketplace, using professional project management principles and methodologies.

The brain controls bodily and psychological functions in most living beings and in this research we shall focus on the human brain illustrating a basic model for computational logic by outlining the different parts of the human brain.

Illustration 1: The human brain (above) and illustration of the structure of a [neuron](https://en.wikipedia.org/wiki/Axon) (right hand side).

The brain maintains the following functions and thus is analogous to a system:

1. It controls body temperature, blood pressure, heart rate and breathing, although global warming and excessive or abrupt changes of temperature may give rise to dehydration or to malfunction of some of our organs.

2. It accepts information from the external world through hearing, seeing, smelling, tasting and touching, unless there is an impairment which can be assisted through accentuating information received from other senses.

3. It monitors motor functions of the body including physical movement when walking, talking, standing or sitting.

4. It allows you to dream (sleep),reason, experience emotions, and, reach your conclusions based on your reasoning.

The human brain controls functions maintained by the rest of the body, and, its health is thus important to our moments whether we are conscious or unconscious.

The software architecture we are proposing is holistic and encompasses a system which accepts information from different jurisdictions, processes the verified data using carefully selected software algorithms, and, attempts to devise reasoning or objects that allow such reasoning to occur within a programmatic framework of reference that is made of objects. It is quite possible to design software that supports interaction when the end-user has a physical impairment through the use of [assistive technology](https://en.wikipedia.org/wiki/Assistive_technology). Applications and robotic extensions of applications that are programmable are both possible theoretically and in practice as empirical evidence has shown the researchers. Such applications would be beyond the narrow scope of this research, however, there is a wide range of applications where artificial intelligence can be applied and codified using algorithms.

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## Overview

Chapter 1 titled Literature review outlines theories and technologies relevant to business intelligence, artificial intelligence, corporate governance and management and cognitive psychology as a model for designing a software framework capable of engaging in supervised or unsupervised machine learning.

Chapter 2 titled Research design and methodology outlines the research design and methodology along with the advantages and limitations of the research project.

Chapter 3 titled Hypothesis statements provides the hypothesis and constraints of the conceptual framework by which the software project is to be designed and engineered, and, these are then elaborated further within subsequent chapters.

Chapter 4 titled Conceptual framework provides an outline of the software architecture and the components making up the theoretic machine learning software being proposed in this research.

Chapter 5 titled Research findings presents the main findings as a result of testing the hypothesis statements and carrying out quantitative analysis to prove or disprove the hypothesis statements although there is a possibility of a low response from the respondents of the detailed questionnaire that follows the initial questionnaire.

Chapter 6 titled Analysis presents the qualitative findings and analysis, and, as such this may be integrated with the previous chapter.

Chapter 7 titled Conclusion concludes on an overall review of the research project presenting the benefits of the knowledge learned throughout the research and arguments for critique and improvement and advancement of our ontology and epistemology as it is applied in artificial intelligence and business intelligence.

## Literature review

Learning is the act or cognitive process of acquiring new, modifying or re-enforcing existing knowledge, behavior, skills, values or preferences and may involve synthesizing different types of information. Machine learning evolved from the study pattern recognition and computational theory in artificial intelligence.

Models that can be then transformed into an evolutionary prototype for the benefit of software engineering can be built in order to simulate the process of a machine that processes knowledge based on the analogy that it appears to be controlled by a single brain and attempting to overcome the heuristic deficiencies that are typical of a controller that has not been programming in advance to use sets of inference rules and mathematical operators that can be abstracted for the generic use of different applications, whilst using the framework of reference generated as an application programming interface in order to allow the programming of or program sets of rules that support decision making.

The system does make use of a series of inputs which form a number of hypotheses and formulae that can be developed into algorithms which simulate reasoning.

Pavlov stipulated that [classical conditioning](https://en.wikipedia.org/wiki/Classical_conditioning) is a learning process in which an innate response to a potent stimulus comes to be elicited in response to a previously neutral stimulus. It can be argued that this controlling function is the basis of a sociological argument that stipulates that our actions are conditioned by the pairing of two stimuli where an initially neutral stimulus is conditioned by one that elicits a response. Therefore, decision making and individual responsibility are the basis of many arguments in philosophy, management, leadership and justice. Therefore, what if the machine is able to understand the basic influences and theoretically attempted to form a hypothesis that encompasses the basis of our epistemology and ontology.

“Parents can only give good advice or put them on the right paths, but the final forming of a person's character lies in their own hands.”

― Anne Frank, sourced from www.goodreads.com

On the other hand, it is valid to argue that psychological traits are passed on from generation to generation through DNA-based structures as we pro-create and regenerate the human race, amidst theories and applications of genetic engineering that many consider to be still experimental to this day.

Law itself is founded on forming a set of rules, where everyday persons are expected to obey, even though we only have a common sense consciousness of them in our everyday lives, thus it can be argued that law is an example of an inference that we can use in order to guide our behavior, whilst at the same time the very law is conditioning our behavior and influencing the probability of simulating experimental 'what if' scenarios out of a research laboratory, as some might be conscious of the negative consequences of breaching laws.

Physical theorists who followed the theories of Einstein have given us a deep insight on how point-like particles of particle physics are replaced by one-dimensional objects called strings, and, string theory in physics describes how these strings propagate through space and interact with each other. This theory appears to have formed the basis of the theories of parallel universes, where it was argued by researchers that it is possible that what-if scenarios are possible to simulate if we assumed that time is relative and that it is possible to travel back in time and simulate different behavior by changing variables or occurrences that are pertinent to lead to a particular course of action. Actions guide our decisions as these are influenced within the environment and therefore by changing variables in a virtual world we are able to understand and forecast the consequences of actions and decisions ahead of time.

Artificial intelligence as relevant to the scope of diligence and business analysis taking into consideration wider objectives of business would include:

1. Image tagging, where web-based social media whose architecture appears to have been planned based on [network theory](https://en.wikipedia.org/wiki/Network_theory) and [graph theory](https://en.wikipedia.org/wiki/Graph_theory), is used to pinpoint objects (or human beings) within an image where this information is then relevant to gather our attention in the use of social media.

[Quantum complex theory](https://en.wikipedia.org/wiki/Quantum_complex_network) provides further insight on the impact of complex network architectures, which give rise to questions not only in quantum mechanics, but add to the potential of creating networks which are capable of transporting larges volumes of information at higher speeds, amidst social issues around ethics and privacy that seem to dominate headlines on media reports. Image tagging can form the basis of using facial recognition for security purposes or when carrying out an investigation, and this would be based on accurate 3-D shapes forming features of the human body that are nowadays used in the field of [biometric](https://en.wikipedia.org/wiki/Biometrics) recognition.

2. [Optical character recognition](https://en.wikipedia.org/wiki/Optical_character_recognition) where manuscripts or text are scanned and interpreted, using an algorithm which transforms the image of a written character to the corresponding letter, which are based on different variants of [glyphs](https://en.wikipedia.org/wiki/Glyph).

3. Self-driving cars, where experimental versions are being tested based on algorithms that learn how to travel within the road network using sensors that indicate where the end of the road indicates a series of maneuvers to make in order to travel without bothering to drive.

Regulatory safety issues imply that quality assurance and usability of this technology has to undergo long periods of testing within existing road infrastructure and reports on the road infrastructure within the [Republic of Malta](https://en.wikipedia.org/wiki/Malta) do not seem to convey a positive sentiment on the viability of these technologies that would otherwise have a potential in facilitating driving for people who are not familiar with driving, as would engineering solutions and cleaner energy, technologies that are notoriously demanding of information systems to control their inputs and outputs and to monitor their performance as contextually representative.

Technologies are based on [context dependent memory](https://en.wikipedia.org/wiki/Context-dependent_memory) underpin the design of many technologies such as geographical information systems which can be use to support spatial views of landscapes and places and require a high level of [usability](https://en.wikipedia.org/wiki/ISO_9241) ([ISO-9241](https://en.wikipedia.org/wiki/ISO_9241)) that has made search engine multinationals gain more prominence in the last two decades, over and above five decades since the first inception of a network that runs over the [TCP/IP](https://en.wikipedia.org/wiki/Internet_protocol_suite) suite, [ARPANET](https://en.wikipedia.org/wiki/ARPANET).

4. Spam filters are also in use to reduce the number of mass electronic unsolicited marketing and may use bags of keywords to identify unwanted electronic communication, amidst many issues around netiquette and regulations that discourage misleading or inappropriate advertising that provide a legal framework for regulators to support. Such spam filters might make use of [Naive Bayes](https://en.wikipedia.org/wiki/Naive_Bayes_classifier) spam filtering, as a common approach to text classification.

5. Sentiment analysis is useful to [neuromarketing](https://en.wikipedia.org/wiki/Neuromarketing) and psychological support for people who might be disabled from expressing themselves orally or through written means due to an incidence of illiteracy and disabilities arising from physical or mental impairments. This may give rise to questions on [ethics](https://en.wikipedia.org/wiki/Etiquette_in_technology%22%20%5Cl%20%22Netiquette) in the way that experiments are carried out as people might argue that covert research might appear to be intrusive, whilst one might argue that spontaneity might be a better measure for spontaneous thought rather than one which appeases the response expected by the researcher, amidst other biases that may arise out of research methodologies and approaches.

6. Information extraction is useful to analysis that we commonly read about in statistical analysis through the use of application software that allows us to analyze quantitative information through desktop solutions, which can also happen on a large-scale where large data-sets of data that consists of images, numbers, and, text can be processed using automated or semi-automated algorithms that lead us to create supervised and theoretically unsupervised algorithms leading to machine learning. Fraud detection is a common application used in business.

*Data mining* refers to the process of discovering patterns or attempting to make predictions from the data, and, this can take form of statistical analysis, and, common applications are found in anomaly detection such as fraud checks, deducing inferences and associations such as in the case of online marketing and web-marketing analytic software solutions, grouping of data sets in order to be able to quantify, analyze and criticize the analysis, which is supported by the use of existing software, and, predictions, which may be based on existing analysis, such as the [Monte Carlo](https://en.wikipedia.org/wiki/Monte_Carlo_method) methods which are computational algorithms that rely on repeated random sampling to obtain results, or chaos theory, where the [butterfly effect](https://en.wikipedia.org/wiki/Butterfly_effect) is the sensitive dependance on initial conditions.

In order to generate a learning algorithm, Yaser et. al (2012) initially propose the creation of a hypothesis that leads to the formulation of a hypothesis, and, this hypothesis would then be supervised feeding it a large data set as sample inputs and then reviewing the results in order to match whether the hypothesis is equivalent to that which would have been computed separately, either through an independent automated test, or else using a semi-automated test, commonly with the support of software testing tools designed for this purpose.



In order to create an index an average would have to be derived to arrive at the score upon which the threshold is based, which could be weighted or rationalized based on *risk factors*:

 total score =$\sum\_{}^{}\left(w\geq threshold\right)$

*threshold = total score / number of valid individuals* that are chosen to form part of the representative sample for setting the threshold, which is a sample that should be greater than 2500 according to theorists in statistical research.

Thus, for a credit scoring exercise on an individual, we would use the following formula to assign credit to customers applying for credit, where *w* represents the score for this customer, whilst the threshold would be a flexible standard based on quantified risk that would allow the algorithm to compare the credit score of this particular instance of a credit score to the standard acceptable scoring, as this would be relevant to the credit scoring of an individual based on the quantified information, gathered from the questionnaire.

The variables in lower case refer to the grouped mathematical scores on the last page of the appendix, namely, financial factors (f), strategic risks and positioning (s), reputation (r), customer engagement (e), organizational factors (o), service provisioning (s), and, learning and organizational growth (g), which are then weighted according to the importance of the factor to the diligence exercise being carried out for each of the factors used to score the particular entity at that point in time.



In order to compute the average, a weighted average of the sum of scores of corporates held within the database is computed and this serves to review the threshold as a measure of performance, allowing for factors to establish rational scores based on the constituent criteria used for credit scoring the company:

$\sum\_{}^{}\left(average\left(f.W1+s.W2+r.W3+e.W4+o.W5+s.W6+g.W7\right)\geq threshold\right)$

Pseudo-code of the above formula follows:

*function calcScore* (f, s, r, e, o, s, g, W[7])

*{*

 *score = avg(f \* W1 + s \* W2 + r \* W3 + e \* W4 + o.W5 + s.W6 + g.W7)*

 *if score >= threshold then return true;*

}

Similarly the threshold is reviewed based upon a rationalized aggregate of scores, which are valid to be considered as part of the sample for computing the standard threshold and weighted according to *risk factors*, being broken down into variables that we are mentioning in this documentation as an example. A factor is then derived to set the standard for the threshold against which the score of different companies is evaluated when reviewing information provided for the purposes of due diligence. The representative sample should consist of at least 2,500 companies according to researchers in statistical research.

One may refer to the file named *KYC-FAQ-TEMPLATE-V0.1-JC-2015-08*, within the sub-folder named *forms* that can be used to collect information. It is assumed that the programming language will follow operators of precedence where the mathematical operators will be prioritized as computing [BODMAS](https://en.wikipedia.org/wiki/Order_of_operations).

**Appendix B** includes source code written using Java Programming Language to demonstrate that this formula can be coded in the majority of fourth generation programming languages, however the complete software architecture requires considerable resources that are not accessible to the researcher and therefore this document remains an academic transcript for the time being.

## Research methodology and design

Research comprises the work undertaken on a systematic basis in order to increase knowledge, including knowledge of humans, culture and society and use this knowledge to devise new applications.

Initially a brief survey was sent out to a selected number of business executives where we asked them questions on the importance of background checks in the frame of business management. We devised a set of standard questions based on the hypotheses being proposed as the ground rules for rationality within the frame of mind of an educated information systems specialist, and, sent out the questionnaire to 1,000 business executives, asking them to provide additional information in a manner that gives rise to user participation and in order to contribute constructively to the research and the design of the information system(s) being documented herewith.

The response rate did not meet the expectations required for a representative sample, unfortunately.

An initial survey was carried out to understand the scoping of

- initial survey with low response rate

- ethnographic and understanding of big picture

- based on empirical research and business statistics including financial risks, laundering, fraud and legal risks of money transfer and corporate organization. Know your customer and economic indices based on business and economic risks e.g. inflation.

Additional survey can be made.

- qualitative review of business opportunity for information system and programming framework, and, review of information system or prototype of system.

- quantitative analysis of programming framework for performance-related issues, functional points.

## Hypothesis statements

1. A credit reference system provides information based on existing financial and other aspects of the organization that seek to satisfy the needs for a background checks.

1.1 A historic view of financial information is relevant to understanding the financial stewardship capability of the entity or the individual with a view to assess the financial sustainability of the business operations.

1.2 Economic and financial forecasts are relevant to understanding the future economic viability of the entity or the individual within the micro-economic environment and the macro-economic environment.

1.3 Economic forecasts are subject to monitoring as empirical evidence provides us with insights on the social consequences of peaks and troughs within the macro-economic environment.

1.4 Economic forecast are as reliable as the sources of information upon which they are based and the validity of the calculations used to create the forecasts, that create the necessity for comparing results over a dimension commonly periods of time.

1.5 Economic forecasts are susceptible to doubt when corruption or political stability of the country where the statistics were originally issued is in question.

1.6 A credit scoring system is a reliable measure of assessing individual creditworthiness, particularly in connection with credit terms.

1.7 Late payment charges are indicative of a negative track record in debt management and these should be separately tracked within an information system.

1.8 Alternative information such as utility bills indicate levels of regular consumption and are relevant to the process of evaluating creditworthiness of an individual or an entity.

1.9 The past financial performance is only an indicator of future performance.

1.10 Forecasts have to be validated and verified not only on the basis of their mathematical validity but also on the basis of their ecological validity.

2. An information system has to be globally integrated and has to avail from information that meets data integrity requirements and therefore the quality of information has to reflect up-to- date information on the business environment and the external environment within which the business operates or is expected to operate.

2.1 Historic records of credit scoring with financial institutions provide an indication of the ability to repay of the individual or the entity being assessed for creditworthiness.

2.2 Forecasts are reliable when they originate from different sources of information, which are reliable themselves.

2.3 Forecasts are reliable when they are based on economic criteria which are used as part of formal research methodologies.

2.4 When engaging an external credit reference agency requires ensuring that the credit reference agency provides information sources that are verifiable and in the public domain.

2.4 Culture is an important aspect in evaluating diverse business proposals and scenarios particularly when an information system gathers the information on different enterprises or operates within different industries.

2.5 Political stability is relevant in establishing a tax jurisdiction for the financial operations and technical operations of a company and it influences the business relationships with its clients and stakeholders.

3. An information system has to be technically functional and performing to acceptable levels of response, whilst timing, qualitative factors including functionality and usability, cost and a structured manner of organizing the development, roll-out and commercialization of the information system has to reflect the demand within the corporate environment where the information system is expected to be utilized also in view of competitive information systems that may provide similar features.

3.1 Validation and verification processes are an essential part of the quality assurance of an information system.

3.2 Adequate change management processes have to be in place in order to control the flow of information and manage the transit to the commercial roll-out (or go live) of an information system, that supports its users and stakeholders with adequate training and information supporting its use, providing a professional level of service level management.

3.3 Usability is a relevant aspect of design particular in the design of user interface and user interaction since simplicity brings about an easier path to adopting the use of an information system.

3.4 Adequate commercial standards and quality standards have to be adopted in assessing the quality of an information system.

3.5 Business analysis supports the process of data analysis as it increases the relevance of the use of information to the context within which it is applied and thus allows the architecture of information to be designed and adapted to the needs of the environment within which it operates.

4. The information system has to meet up-to-date, intrinsic, contextual, representational and accessibility requirements, as theoretically expected through a framework that advocates data integrity, appropriate and efficient algorithms for processing of information, and, a high level of information quality.

4.1 Accurate information has to be available as part of a background check.

4.2 Omission of information from a credit report is a negative indicator in background checking.

4.3 Including irrelevant or conspicuous information without qualifying it as an opinion is a negative indicator on the professionalism by which the background check is being carried out, and, including an opinion statement has to be justified within the context of the background check and the relationship being established otherwise it is safe to omit subjective information, with the exception of highlighting business and other risks.

4.4 The public service telephone network might be considered as unreliable if the telecommunications provider is not in a position to provide copies of recorded verbal conversations and transcripts of these conversations with the relevant legal remit from the judiciary authorities, or even without such an order if the information is being requested with the power of attorney or legal authorization of the data subject as this would reduce bureaucracy unless the technology does not currently include such data processing as part of the services offered to organizations interested in carrying out diligent background checks on other entities with all the relevant legal authorizations in order.

4.5 Algorithms for processing information have to demonstrate an efficient manner of processing large volumes of structured information, which are based on good principles of data integrity and which make efficient use of algorithms that are mathematically verified or verifiable in the manner by which they sort, match and filter information as part of the processing of the information.

5. The information system allows the business user to carry out a background check relying on historic information that is sourced externally from reliable sources of information, and, encourages the user to take decisions based on the qualitative or quantitative information provided.

5.1 Qualitative information is useful to the reader, however it has to be translated to the natural languages that are most adequate for the reader to be able to make a business decision with a reasonable response time that is adequate for the modern needs of international business within the context of operating in an interconnected global business environment.

5.2 Quantitative information can be processed using statistical methods of grouping and analyzing numeric information in a manner that can be compared and analyzed, commonly over periods of time. Time can also give rise to the analysis of other dimensions for analysis.

5.3 Quantitative information that uses moving averages and various statistical analysis techniques to analyze numeric data are a useful manner by which one can analyze trends over a period, commonly representing time.

5.4 Information can also use other dimensions by which trends are analyzed through the visualization of reporting and the programming of objects that provide the data or information which support the interaction of objects within the context of object-oriented programming. This does not exclude the possibility of structured programming methods to be used.

5.5 The quality of information is relevant to the review of the use of information within the context where the information is useful and relevant, and, this implies that the interpretation of information has to be clear, processed in a manner which can support supervised and unsupervised learning methods and the reporting of information to the decision making user, through an executive information system.

6. The information system does not breach the ethics, privacy or any laws stipulating unfair competition, as it is underpinned by professional business practices that require contractually binding agreements between different entities participating in the exchange of information, whether the contracts are provided as an online resource or on paper.

6.1 Data processing requirements have to be explicitly stated in advance and agreed upon by all parties involved in the process.

6.2 Data processing is fair and relevant to the process of carrying out a credit reference check in a professional manner that is relevant as a preparation for a business-to-business relationship.

6.3 Contracts and agreements are explicit to all parties involved and are compliant with the regulations and laws where these agreements are to be negotiated and agreed upon, whilst admitting that a level of standardization in the agreements limits the flexibility of changing the terms and conditions as this might give rise to claims of discrimination, preferential treatment or unfair bargaining.

6.4 Standardization is perceived to be a dominant manner by which legal agreements are to be agreed upon, and, whilst one size may not fit all requirements, there is a strict requirement for compliance to the mentioned terms and conditions being drafted in preparation for formalizing the relationship between the different parties involved that operate or make use of the information system.

6.5 The exchange of information allows for a visual representation of the process and the information being exchanged, where large sets of information may be underpinning information that includes supervised and unsupervised processing that is being made using the algorithms prescribed in this document at the risk of all parties involved in the case of default.

7. The information system has to be compliant with the jurisdictions within which it is advertised to operate.

7.1 Generic templates for contracts are not a substitute for exchanges and transactions that are regulated in various jurisdictions by specific regulations within the context of a globalized international business environment.

7.2 Customization might be necessary in order to allow for the processing of information according to regulations, standards and practices that apply in different jurisdictions.

7.3 Practical solutions might be applied but only as a temporary manner of patching technical problems arising that necessitate the planning of solutions that are considered holistic and contextually valid and in a manner that makes the retention and processing of information legal.

7.4 Marketing literature published alongside the product or services that the information system may necessitate organizing shall be truthful and shall comprise no false or misleading statements in their form or meaning.

7.5 Information systems that necessitate the automated processing of information do not exclude that user input is relevant to contributing to the quality of the information being processed, and, does not exclude the possibility of manual business processes to support the very information system in its configuration, during the respective phase of its development and installation.

8. The information system provides up-to-date, accurate financial information about the entities in the level of detail that is required to analyze risks and benefits of a proposal being reviewed by a business user.

8.1 Information is up-to-date and accurate to the extent allowed by the theoretic and practical implications of data processing in the various manners that are stipulated, programmed and implemented therefore artificial intelligence is evolutionary and iterative and may be subject to the imperfections of human error, unless this behavior is controlled.

8.2 The business user is responsible for ultimate decision making even where the decision is based upon the processing or the information reported within the information system aforementioned and documented herewith.

8.3 An adequate risk management framework may require quality assurance that is independent of the automated processing of the information system being documented herewith.

8.4 An adequate cost-benefit analysis of the information system and how it delivers benefits through the appropriate categorization and scoring of information with the support of user-driven input shall indicate the adequacy of the information system within the context and environment that the information system operates and is implemented.

8.5 Cost and benefit are commonly quantified through the use of an exchange of value, however, a qualitative analysis of benefits and risks provides further insight to the analysis, and, this is a portion of intelligence based on what we commonly refer to as common sense as we analyze contextual representation of the virtual software model being proposed herewith, with the limitations and constraints encountered in the process.

9. The information system provides a framework of reference or a programming paradigm upon which a technological/software architect is to be prototyped, where qualitative information and quantitative information can be analyzed using efficient algorithms that have been mathematically and statistically quality assured, and, allows the programmer to elaborate further by coding and implementing the complete software architecture being proposed herewith.

9.1 The information system being documented herewith is a theoretic model based on existing academic knowledge and therefore, analysis of the efficiency and adequacy of processing depends on the success and mathematical verification of the algorithms used and integrated for use within the coding of the information system, that may or may not take place as part of the project being prepared.

9.2 Information, artifacts and code are provided “as is” and although reasonable quality assurance is made to verify the functional quality of the software and all the components interacting with the software, dependencies on other technologies and external bodies necessitate clarifying that the scope of this research is limited to providing an academic or theoretic guideline leading to the actual development and coding of the information architecture being illustrated and documented herewith.

9.4 Software development is made using professional standards of software development throughout the useful life-cycle of the software itself, making the most adequate and diligent use of software development and project management methodologies that are fit for the size and complexity of the software project. Changes have to be managed in a highly organized and structured fashion using a software project management methodology that allows for resources and people management.

9.5 It is a truism that resources are scarce and that an automated process is only as perfect as the underpinning cognitive process designing the processes, and therefore this may be an indication of an imperfect software product that has to be supported throughout its useful life-cycle.

10. The technical architecture covers the risks in a manner that they can be reasonably controlled through the user interaction (front-end logic) that validates inputs and provides and interactive response time and triggers the storage of information to back-end logic of the programming framework, and, the analysis would then include technical risks, external business risks, organizational risks, social-economic risks, market risks, legal risks and political issues arising that may influence the business continuity of the operation of the entities being analyzed within the information system, in a manner that is relevant to the relationship between the business user and the entities that they are representing and the entity involved. This is envisaged to be made with a stable software prototype or artifact and the integration of existing theoretical frameworks that are relevant to business analysis, within the limitations of practicality and realism.

10.1 The front-end logic is based on design that is adequate to enable or guide a user through a series of steps in performing a task that would otherwise require training, as it is useful for gathering information, verifying and validating the information and transferring it to the back end logic so that it can be stored within the data store.

10.2 The back-end logic is made up of programming functionality that processes and stores information retrieved from different sources and assumed to have been verified and validated. This would include modules for business logic, logic for interacting with databases or objects that encapsulate data and functions performed on data, and, other logic that can make use of existing technologies or attempt to create technologies that are innovative. Software algorithm design is an essential part of the planning in back-end logic, as the efficiency of sorting, matching and processing is an indicator of performance.

10.3 Risks falling outside of the scope of technical analysis may be handled through business policies/analysis, and, whilst we propose templates within this document, specifications and further refinement of the forms might have to be adapted in view of factors changing within the external environment such as the legal environment, and, the international business environment. Risks which are to be contained as part of the technical analysis are taken into consideration within the design of the software architecture which are being presented alongside this document. Relationship may give rise to risks including business risks and technical risks, and, these are to be taken into consideration as well.

10.4 A prototype consists of a version that is intended to demonstrate the wider framework of reference that the software model is meant to propose, and, this needs to be adapted over time, in view of changing requirements and circumstances within the external environment along with changes due to the internal conflicts arising between different modules and components making up the system, whether these are software components or hardware components.

## Conceptual framework

Software architecture

Drawing 1: Software architecture (high-level)

User interface

User interface

Views on services and data

Inspettur

Business Analysis Services

Intelligence Services

Web

Services

(API)

Real time process

Batch processes

Controller

The *user interface* provides a layer where the business user is guided to provide or upload valid inputs to the information system, where the information acts as an open-ended system with a restricted *scope of analysis* pertinent to the process of due diligence as it applies within the context of international business management.

*Views* on data provide an additional layer for database developers that pre-fetch views on data which is assumed to be validated and calculated according to the established calculations within the business and technical analysis. In this respect, even programmers making use of *web services* are incorporated within this layer as they would be using web services that are designed according to the calculations that have already been assumed to be coherent to the *scope of analysis*, in a manner that advocates a way of computing and interpreting data to information reducing as far as possible the possibility of using different weights for different measures. Underlying data within the databases is nonetheless normalized for applications or de-normalized for the scope of business analysis and data mining as there is a focus on giving the analyst the data objects relevant to the analysis.

The system design is envisaged to include *batch processes* which compute large sets of data in a manner that is sequential and that validates data using standardized processes, reporting the results and exceptions to respective technical logs, logs indicating breaches of data integrity and information quality and other exceptions that may arise out of inappropriate user-interaction or processing thereof, which gives rise to the necessity of a *controlling* logic that is used to log issues within the existing data sets. There would arise a need to mathematically verify algorithms being used not only for performance but also for mathematical accuracy and to allow the machine(s) to learn and therefore bridge the gap between processing information that is subject to supervisory functions whether these are automated or controlled by the expert user, and, the stage where data sets can be processed unsupervised as they are deemed reliable after long periods of extensive testing. *Real time processes* allow for specific processes that need to be programmed to provide for shorter periods of response that is not technically possible or not acceptable to process as batch process or else to be able to use the units of logic to test functions in a modular fashion in a top-down approach or in another approach within the context of the programming paradigm used in each of the modules. The information system is expected to retrieve information from reliable formal sources of information such as company registries. The concept of splitting processing into *real-time processing* and *batch processing* not foregoing validation and verification, is based on *lambda architecture*.

### Business process

In addition to reviewing the information within the form, the following table allows the executive to carry out a reconciliation between the ranking given by the learning algorithm, using their judgment that is based on experience in contributing to risk management and risk categorization.

### Quality assurance

### Introduction

The following table outlines typical cognitive processes involved in reconciling information obtained from different sources of information which are assumed to be reliable and the cognitive process leading to decision making, that in the sphere of international business takes on short timings, as executives report taking more than 35,000 decisions per day, and, the technology proposed is designed to take decisions that are of better coherence and quality which can be transmitted at superior speeds due to the technologies underpinning neural networks.

We categorize the ratings as follows and then attempt to compare the results generated through different applications independently:

|  |  |  |  |
| --- | --- | --- | --- |
| Corporate ranking  | Interpretation  | Executive rating  | Computer rating  |
| Corporate ranking is a weighted factor based on financial score – particularly ability to repay, strategic alignment, reputation, engagement, internal organization, service provision, and learning and organization growth.  | Interpretation of the information originally collected may influence the scores, along with perceptions relevant to collection of feedback from customers, employees, suppliers and other stakeholders. Global media might also influence one's ethical and social policies and one has to understand [*sensationalism*](https://en.wikipedia.org/wiki/Sensationalism) rationally. | Executive focuses on the interests of the stakeholders within the scope of managing the organization and making plans to mitigate the risks, that are nonetheless to be taken in the context of business continuity, if this applies to the business being managed i.e. unless it is insolvent. | Computer-generated rating through the supervised training data with a view to shift to unsupervised training and evolution of the algorithm includes factoring in information that are seen to improve the predictability and ability to forecast, both on a case by case basis and in aggregate as large data sets of information about corporates is shared as the software model is widespread.A *shadow tree* containing data structure and content may be created to allow independent testing or rejected data and for audit.  |

Illustration 2: Supervising the algorithm by feeding it large sets of data and rating the results

The quality assurance framework seeks to understand the different [permutations](https://en.wikipedia.org/wiki/Permutation) relevant to interpretation and to compare the processes and results generated through the different ratings, as reliable manner of quantifying scores that can be used amongst other purposes for credit management.

The quality assurance framework essentially attempts to review the workings made by examining the original documents containing information, and, the results generated independently by the computer and subsequently by an independent business executive using an [audit process](https://en.wikipedia.org/wiki/Audit), thus adding further business analysis that may in turn improve the micro-management of the entity and the quality of the software through user participation and feedback, that is logical and relevant to the scope of analysis. The *scope of analysis* is as broad as possible in order to allow for the widest possible breadth of factors that influence risk management, including external factors such as the global market and economics and factors relevant to business management or operations management.

### Quality assurance planning

### Overview

Quality assurance is a highly influential process within the production of software and test driven development guides us to provide testing objectives in order to certify the high level functional and non-functional objectives of the software framework in the context of the environment within which it is planned to be operational.

### Functional requirements

In software engineering (and systems engineering), a functional requirement defines a function of a system and its components. A function is described as a set of inputs, the behavior, and outputs (see also software).

Functional requirements may be calculations, technical details, data manipulation and processing and other specific functionality that define what a system is supposed to accomplish. Behavioral requirements describing all the cases where the system uses the functional requirements are captured in use cases.

1. The software architecture is available to the intended users, in the context of the original specification devised.

1.1 Users that have been configured to use the software applications and components are trained in order to be able to understand the concepts and to capably include inputs that result in predictably outputs, taking note of relevant exceptions as possible sources of feedback to improving the software design itself as part of the user-participation process.

1.2 Users understand the context within every use case or test case being tested, and, do not misinterpret one case for another. This may give rise to different use cases and complicated sequences that might not have been planned during the software design and are to be reported as exceptions to the project management and software engineering teams.

2. The software and hardware components supporting the information system are functional and have been verified to work as specified and are fit for purpose. There is a process that allows for timely changes that allows for the quality of the software to be verified and validated through the project management framework.

2.1. Software components have been tested in part and in whole with an approach to software integration where all modules are working within a coherent system.

The simplest form of verification and validation is matching expectations with actual results but nevertheless this is also subject to interpretation and thus peer review might be required for complex interactions or processes to be engineered keeping in mind performance of the information system in its various states and environments where it is operational or in a state of awaiting processing, recovery and other states that should not threaten the stability or integrity of the information system and the underlying data. [Data integrity](https://en.wikipedia.org/wiki/Data_integrity) and [information quality](https://en.wikipedia.org/wiki/Information_quality) are relevant concepts in quality assurance.

[Software testing](https://en.wikipedia.org/wiki/Software_testing) includes unit testing, installation testing, compatibility testing, smoke and sanity testing, web testing, software re-factoring with software engineers, code reviews with software engineers, regression testing, acceptance testing (done in collaboration with the user), alpha/beta testing, destructive testing, software performance testing, A/B testing, concurrent testing, conformance testing, and, legal compliance vetting due to the fact that diligence might be specifically different in its inference rules within different legal jurisdictions. White box, black box and gray box testing techniques are used using bottom-up or top-down fashion of organizing test scenarios for different modules.

Other techniques include stress testing, validation of minimum and maximum input and testing erroneous scenarios to certify how stable the information system is when error conditions are met, and, how descriptive the error messages are in guiding the user to reverting back to a stable state of using the information system. Other types of testing are outlined in 2.1.

2.2 Software testing coverage can be measured and documented quantitatively and analyzed, in order to provide insight to the software engineering team, and, amongst, classification methods the [Orthogonal Defect Classification](https://en.wikipedia.org/wiki/Orthogonal_Defect_Classification), can be used, that places an emphasis on root cause analysis.

2.3 All modules within the software are functional and integrally work together in a synergistic fashion. This may be subject to perceptions of success and failure criteria that might be elaborated by the management team responsible for performance.

2.4 Effective *regression testing* is carried out within the virtual environment which would hold data structures, source code and simulations at regular dimensions, commonly points in time, and, one would have to verify whether the virtual environment would then be similar to the environment where the software is implemented, should there be a roll-out of software that is abstracted to include inferences including legal, business and other rules from different jurisdictions, each having different requirements as business culture might influence business operations and the processing of information and its interpretation thereof, that may effectively contribute to the machine learning process and its quality assurance.

2.5 Application layer (software), operating system (software) and network management layers, and, physical hardware layers within the IT conceptual framework of technology along with interfaces developed and used to communicate between the layers require specific environment that may be simulated but this does not necessarily mean that the virtual environment mimics the actual environment or will be successful.

2.6 Tests are followed through to closure by the quality assurance team.

2.4 Inputs from the software are valid and verified automatically or otherwise manually through a documented procedure that has been formally communicated to the user through training.

2.1 The use of different environments where the software components operate may provide suitable version and configuration control that supports regression and online technical troubleshooting engineering for urgent fixes, even in cases where fixes are applied to the live environment rather than phased through the use of a test environment, development environment(s), and a live environment that is considered to host the stable version of the software components.

2.2 Service management should be in place to support the systems administration of the infrastructure hosting the software components, using professional standards of service management and governance, such as [ITIL](https://es.wikipedia.org/wiki/Information_Technology_Infrastructure_Library), whether software components are available as a service on the cloud or else as an isolated installation within a data center that is controlled and has additional security features permeating hardening and highly controlling access to information, that are should comply to standards of service, including [ISO/IEC:27001](http://www.iso.org/iso/home/standards/management-standards/iso27001.htm) and information security practices that might arise through research.

3. The use cases and test cases devised for use with the information system are acceptable by the end-user representative and any defects are known to the software company. Requests for changes to the system that are supported with logical flows and business analysis documents are being communicated as supported by the project management framework. Irrational flows are questioned and investigated as early as possible throughout the software design process.

4. The software architecture and the solution allows for support of the systems administration, web administration and network administration to be carried out, possibly in real time, allowing for a review of batch processes using validation tools and maintenance of application, system and network maintenance, to support its maintenance within the host that operates its architecture and supports the flow of information and the use of the software in its various environments and configurations.

4.1 The information system provides suitable visual and audible alerts that display information on its status and the status of its components and has a color scheme that can be adapted for persons who have a visual impairment including color-blindness. Other impairments are designed for by accentuating the interaction through the use of other senses including hearing, possibly olfactory, and, kinesthetic, using a suitable theoretic framework for planning training such as [Neil Fleming's VAK/VARK Model](https://en.wikipedia.org/wiki/Learning_styles%22%20%5Cl%20%22Neil_Fleming.27s_VAK.2FVARK_model).

4.2 The information system provides or allows interfacing with external systems and application programming interface, including interface where software developers can write code that communicates with the objects or structures designed within the software architecture.

## Non-functional requirements

Functional requirements are supported by non-functional requirements (also known as quality requirements), which impose constraints on the design or implementation (such as performance requirements, security, or reliability).

1. Response time for user-interaction is adequate and acceptable according to the different types of uses and interactions with the software model.

1.1 The time taken to input information within the system is relevant to the manual process that has to be supported through the manual input of information and the relevant processing that needs to be carried out within the information system.

1.2 Training documentation is accurate, up-to-date, complete and meets the holistic needs of the end-user(s), and makes use of examples and specific documentation of the logic and the mathematical functions involved in the back-end and front-end logic of the software.

1.3 Documentation for technical support and programming is factual, up-to-date, complete and meets the holistic needs of the advanced user.

1.4 Forms are in place to support the reporting of software defects, errors, requests for information, and, requests for changes, within a formal or an informal project management that is agreed upon between the customer and the provider of software services within a managed service management environment.

1.5 The design can be qualified as interactive and provides adequate and accurate information as output. Information is up-to-date to the extent of the accuracy and reliability of the underlying sources of information and the processing that occurs, that includes batch processing and real-time processing.

2. The access control module of the software allows access to information based on the minimum right to use and this can be adjusted by a system administrator.

2.1 Software can be configured to allow users and roles to access specific user interface and data within the framework of reference.

2.2 Actions can be enabled or disabled for different users and roles. Actions restrict programmatic access to the information system, to the user interface and to the specific actions that one can take within the context of the software applications that are developed as a result of the solution development of the information system.

2.3 Time limits such as start dates and end dates can be included to control access to the information system or its components from internal access or external access.

2.4 Information system has been hardened against known security breaches using software hacking and software engineering techniques.

2.5 Heuristic analysis and risk management documents are in place to document the risks that are known to occur but have not been completely automated or mitigated technically or require intervention from a network administrator or a systems administrator.

3. The system does not have an unnecessary impact on the network capability within the networks it is deployed to operate, and this may include an internal network or a wider network, such as the Internet.

3.1 Network management as being part of the infrastructure that supports the application layer (see [OSI model](https://en.wikipedia.org/wiki/OSI_model)) is as supportive as the technical specifications of the underlying hardware and the operational network protocols enabled and configured to optimize network traffic across the network or networks that data and other signals transmitted through the physical cables or the wireless transmission using appropriate protocols (such as [BGP](https://en.wikipedia.org/wiki/Border_Gateway_Protocol) for transmission of information between autonomous systems in the case of a the need to architect the information system as a distributed system over the Internet along with [TCP/IP](https://en.wikipedia.org/wiki/Internet_protocol_suite) and [IEEE 802.11](https://en.wikipedia.org/wiki/IEEE_802.11) for devices that enable wireless transmission) with the technical limitations and constraints that a layered form of structured network communication may bring about, and this may include network latency, although software engineers shall work towards the resolution of such latency issues given the response times being prescribed as part of the quality assurance framework.

4. The system is user-friendly and guides beginners to adequately trained user in the use of its intended functions and allows them to provide feedback with little effort using conventional office or communication software such as email or supportive technologies developed that support information elicitation, information gathering and communication that is specifically relevant to the needs of software and technology professionals.

4.1 Applications are independently tested by trained users and testers, having different needs. Persons with disabilities would be suitable for testing accessibility features of the software as it applies to their real perception of the software and thus may provide additional insight that is not possible through the architecture, analysis, design, coding and testing phases of software engineering.

4.2 Software engineering team shall carry out its automated and non-automated testing prior to releasing the software in an attempt to produce a defect free software product although through empirical evidence this cannot be guaranteed.

4.3 Marketing surveys and research on user experience shall highlight further changes to the design of the software and artifacts that would have been produced through the software engineering processes.

4.4 Communication shall take place embracing user participation as constructive and leading to the generation of solutions through brainstorming. Communication shall consider all relevant stakeholders.

4.5 Psychological concepts such as speed of thought and impressions shall not be a holistic and scientific measure to substitute scientific methods for evaluating the quality of software and other artifacts produced, although they might be relevant to usability and user experience in providing insights to improving the design, color scheme and flow of user interaction through the design and programming of front-end technologies that interact with back-end technologies. Aesthetics play a relevant role in software design and user interaction.

5. The information system and its various software and hardware applications have been signed off following a quality assurance exercise that allowed the end-users to participate in the quality assurance process.

5.1 Ongoing professional support through service management does not indicate that the software is not acceptable at the point of time when the requirements have been independently as meeting the requirements of the user(s) for which the applications and other artifacts have been produced and quality assured.

5.2 User participation is a manner of involving key users in the software design, business analysis and testing processes within the software engineering process, with an option to involve them in coding depending on the level of programmable interfaces that it may provide through web services.

6. The information system and its applications whether software or hardware have consideration for usability features and impaired users, whether the impaired users have a physical disability or a mental impairment.

6.1 Design and quality assurance shall include the participation of users who might be impaired as per 5.1, 5.2 and other guidelines mentioned within references and bibliography as guidelines and insights for software engineering.

6.2 Software design shall be as far as realistically possible and within the stipulated parameters of time, quality and other criteria stipulated through project management meeting the holistic needs of different users of the applications and other artifacts produced.

7. Interaction through the various input devices including keyboard, mouse, and, the interactions with the graphical user interface of the software provides an experience that guides the user in a step-by-step approach and in a manner that allows them to complete business processes in a fashion that is guided and asks specifically for input. Software interaction makes optimal use of the optimal design and sequence of events in order to enable the user to carry out tasks seamlessly and finding the appropriate documentation and guides as documentation or as validation within the software applications that are designed to support the framework.

7.1 Statistics can be maintained of the frequency of impressions, clicks and interactions with the system through various inputs, events generated by different devices – such as mouse clicks and their frequency, eye scanning to identify where different users focus during a process, as part of feedback to the user experience, that has been mentioned in 2.1 and 4.

7.2 User experience is fundamental for productive user of applications and for assessing how well the users interact with the information systems as providing inputs and using outputs for their analysis.

The *references and bibliography section* of this document includes further information that gives rise to insights, critique and training resources along with providing a useful reference of academic verification.

## Research findings

- how well the hypothesis statements are met with the information system after this is tested?

- are the hypothesis relevant to the verification and validation necessary in understanding the realistic issues involved in project management of technology solutions?

- how far does the information system meet the needs of corporate business needs for due diligence andcredit reference?

- how hypothesis is scored:

 *frequency. score*

 $\sum\_{}^{}\left(stdev.frequency.score\right)$

where score represents the answer given to the agreement on the hypothesis statements using a [Likert scale](https://en.wikipedia.org/wiki/Likert_scale) and verify results using t-test or validation of null hypothesis.

## Analysis

- analysis of surveys and testing of information system

 - risks of pstn

 - go through hypothesis statements

- functionality needs met?

- usability? What ISO standards? Who adopts them well?

- Security flaws? Analysis of security threats and their impact on information systems.

- What can we do to mitigate security risks?

- performance?

- feedback analysis and possibility of lack of feedback as a business opportunity for AI

- generating assumptions when data is generic and based on templates and objects and abstractions and identifying their accuracy

- misinterpretation

## Conclusion

- what went well?

- what could improve?

1. lack of feedback is beyond the author's control

2. information system is still in theory

- artifacts available and prototype

## References and bibliography

*The following academic references are relevant to the understanding of the academic framework for the design of artificial intelligence systems.*

1. A. DeMarco, *An engine for perception-based speaker identification*, submitted to the University of Malta, the website of which is available [online] at <http://www.um.edu.mt/>.

2. G. Micallef, *User centric analytical insight and interpretation of web-user behavior*, submitted to the University of Malta.

## Further reading

The following references include relevant articles sources from magazines, journals and online media that include products commercially available and relevant to the scope of analysis, in the wider frame of theoretical analysis or business application and other online resources and resources that were deemed to be a reliable secondary source of information through books were referred to or were influential to writing up this document.

1. FICO, How Europe's Card Fraud is evolving available [online] at <http://www.fico.com/en/latest-thinking/white-papers/how-europes-card-fraud-is-evolving>.

2. Fraud Detection using Data Analytics in the banking industry available [online] at <http://www.acl.com/pdfs/DP_Fraud_detection_BANKING.pdf>.

3. Balanced Scorecard Institute, available [online] at <http://balancedscorecard.org/Resources/About-the-Balanced-Scorecard>.

4. DSDM Consortium, available [online] at <http://www.dsdm.org/>.

5. Principles behind Agile Manifesto, available [online] at <http://www.agilemanifesto.org/principles.html>.

6. Cray XC 40 specifications available [online] at <http://www.cray.com/products/computing/xc-series> and press release at <http://newsroom.intel.com/community/intel_newsroom/blog/2014/07/10/chip-shot-intel-xeon-and-xeon-phi-processors-to-power-next-generation-multi-petaflop-cray-supercomputer-deployment-at-nnsa>.

7. The Elegant Universe, available [online] at <http://www.pbs.org/wgbh/nova/physics/elegant-universe.html>.

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## Appendix A – Software and hardware resources

Throughout the research project, the following software was used on trial in order to identify existing applications that provide the statistical functions required for the mathematical computation of the scores.

* IBM SPSS, available for download at <http://www-01.ibm.com/software/analytics/spss/>.
* Microsoft Office, available for download at <https://products.office.com/it-IT/>.
* LibreOffice, available for download at <https://www.libreoffice.org/>, and information on filing bugs at <https://wiki.documentfoundation.org/QA/BugReport>, as some software and usability issues were highlighted as relevant to the use of application software in fulfilling the needs of this projects. Some usability issues were duly reported as they appeared to influence the quality of the documentation produced herewith.
* Other software including tools for data mining and [Eclipse IDE](https://www.eclipse.org/).

The project was written using a computer running Microsoft Windows, and, office software that is sourced through open-source software community projects.

|  |  |
| --- | --- |
| Operating system | [Microsoft](http://www.microsoft.com/en-mt/) Windows Server Standard Edition SP 2 (2007) 32 bit |
| Processor | Intel Pentium 4 |
| Central Processing Unit clock speed | 3.20 Giga hertz(not overclocked) |
| Random Access Memory | 4 Gigabytes |
| Java Virtual Machineversion | 1.8 |

Access to a data center or a supercomputer was beyond the budget of the author along with access to resources that would imply a specific business analysis to be carried out for customization of software to take place at the right level.

### Appendix B: Source code

The following is sample source code written using Java Programming Language that demonstrates the basic algorithm for calculating a single score of an individual or a corporate entity, as the core calculation meeting the intended requirement of this project.

**public** **class** Score {

 **public** **double** getIndividualScore (Object \_individual, **double** credit\_score)

 {

 **if** (credit\_score < threshold) {System.***out***.println("WARNING: credit score is less then threshold.");}

 **return** credit\_score;

 }

 **public** **double** getCorporateScore (Object \_corporate, **double** financial\_score, **double** financial\_score\_weight,

 **double** strategic\_risk, **double** strategic\_risk\_weight,

 **double** reputation, **double** reputation\_weight,

 **double** customer\_engagement, **double** customer\_engagement\_weight,

 **double** organizational\_factors, **double** organizational\_factors\_weight,

 **double** service\_provisioning, **double** service\_provisioning\_weight,

 **double** learning\_and\_growth, **double** learning\_and\_growth\_weight)

 {

 **if** ((financial\_score\_weight < 1) && (strategic\_risk\_weight < 1) &&

 (reputation\_weight < 1) && (customer\_engagement\_weight < 1) &&

 (customer\_engagement\_weight < 1) && (organizational\_factors\_weight < 1) &&

 (service\_provisioning\_weight < 1) && (learning\_and\_growth\_weight < 1))

 { **double** credit\_score = (financial\_score \* financial\_score\_weight) +

 (strategic\_risk \* strategic\_risk\_weight) +

 (reputation \* reputation\_weight) +

 (customer\_engagement \* customer\_engagement\_weight) +

 (organizational\_factors \* organizational\_factors\_weight) +

 (service\_provisioning \* service\_provisioning\_weight) +

 (learning\_and\_growth \* learning\_and\_growth\_weight);

 **if** (credit\_score < threshold) {System.***out***.println("WARNING: credit score is less then threshold.");}

 **return** credit\_score; }

 **else** **return** -1; //error condition

 }

 **public** **int** threshold = 100;

 **public** **void** setThreshold (**int** threshold)

 {

 **this**.threshold = threshold;

 }

}

A complete solution will follow the research exercise and its academic accreditation, hopefully this will lead to commercialization also in view of the considerable costs involved to implement the architecture that have to be quantified with a feasibility study.