Stable Machine Learning Knowledge Map Domain Analysis

Mohamed Fayad(✉) and Gaurav Kuppa

San Jose State University, San Jose, CA 95112, USA
m.fayad@sjsu.edu

Abstract. Stable patterns that are widely used in today's software engineering in modelling and it plays an important role in reducing the cost and condensing the time of software product lifecycles. Nowadays, many existing traditional patterns fail to model the subtle changes in context of the implementation of the model. As a result, the reusability of the pattern will significantly decrease. The goal of this paper is to present a pattern language for building a core knowledge of stable patterns called knowledge map. This paper will also represent the first attempt towards a machine learning knowledge map representation via stable patterns as a mean to discover, organize, and utilize machine learning core knowledge. Each stable pattern focuses on a distinctive activity and provides a way by which this activity can be conducted efficiently. The presented stable analysis and design patterns will provide a core knowledge of stable machine learning domain that is easily extensible, stable through time, and focus on stable machine learning of Unified (1) Functional and non-Functional Requirements (2) Unified Design.

Keywords: Stable Machine Learning · Domain analysis · Stable model · Enduring Business Themes (EBT) · Business Objects (BO) · Industrial Objects (IO)

1 Introduction

"Machine Learning: The Evolution From An Artificial Intelligence Subset To Its Own Domain" Machine learning is a process through which a machine learns from experience. Machine learning uses computer science and statistics to make conclusions from data. Machine learning is prominent in predictive schemes, like movie recommendations, email completion, autonomous navigation and personal assistants. The complexity of these applications is accompanied with increased developmental and operational difficulties. Analysis patterns are conceptual models that model the core knowledge of the problem, and the pattern models a specific problem should easily adapt a new problem. As a result, the analysis pattern would be able to model many different scenarios of different contexts with a stable pattern language.

As discussed above, stability has to be considered in mind when building analysis patterns, it would help in producing reusable and stable patterns. Concepts of Enduring Business Themes (EBTs), Business Objects (BOs), and Industrial Objects (IOs) are applied in software stability models. Details about the stable analysis patterns are in

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related work [1–4]. In short, EBT is the overarching goal of the system. BOs extend the system's goal into several general capabilities that each instance of the system must extend. IOs are application-specific objects that extend the BOs. It is important to apply stability model concepts to the notions of software analysis patterns, and the idea behind Stable Analysis Patterns is to analyze the problem by its enduring business themes and business models in order to increase reusability stability. This paper will discuss further to discover, organize, and utilize machine learning endured knowledge.

This paper is organized by eight major sections: Sect. 2 presents an overview of machine learning knowledge map; Sect. 3 provides two scenarios with EBT and BOs in mind to present two goals; Similarly, Sects. 4 and 5 will also represent two BOs and one non-functional requirements respectively by different scenarios; Sect. 6 will describe several architectures of few patterns of the knowledge map represented, and the conclusion is presented in Sect. 7.

2 Stable Machine Learning (SML) Knowledge Map Overview

A knowledge map, also known as stable pattern language, consists of a set of core knowledge sets and stable patterns that represents the functionality of any particular domain i.e. machine learning in this paper. By identifying Enduring Business Themes (EBT) and Business Objects (BO) and Industrial Objects (IOs), this knowledge map will create a comprehensive understanding of the context and the domain of machine learning. Pleaseefer to Knowledge Map Overview in Fig. 1.

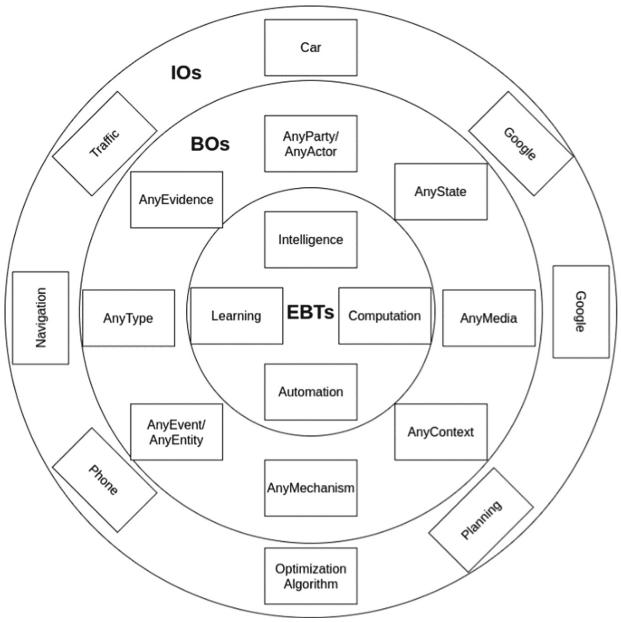

Fig. 1. Knowledge map overview

3 Stable Machine Learning Goals

Table 1. Partial EBTs of "Stable Machine Learning"

#	EBTs/Goals	Description
1	Intelligence	Intelligence is the system's ability to perform tasks and make decisions without human interventions. Machine Learning applies intelligence by organizing features into its respective classes through algorithms and data
2	Automation	For effective machine learning deployment, automation is an absolute necessity. The system must be able to learn and conduct inferential tasks on its own
3	Computation	A machine learning model must be able to do effective and efficient computations through algorithms and model design. These include dimensionality reduction, clustering, and more
4	Understanding	The algorithm needs to use data and information to acquire domain knowledge that the model can analyze and use as experience
5	Learning	The model needs to be able to acquire knowledge and do classification, regression, or other tasks as required by the system designer
6	Analytics	It is vital for a machine learning system to interpret and analyze data to find meaningful patterns. Additionally, the system must use these patterns and generally make predictions for the future

The stable goals of machine learning are detailed in Table 1. In this paper, we will discuss **Intelligence** pattern in detail through two scenarios, other five scenarios in Table 3 and two applications in.

3.1 Name: Intelligence (EBTs)

Intelligence plays one of the most important part in the Machine Learning. The ultimate goals of intelligence is provide the device with its own mind and able to complete any tasks without being explicitly programmed. The scenarios are explored below. Stable analysis patterns have been constructed for each scenario in Fig. 3 and 4, respectively.

Scenario #1: Google Map

The traveler (Jenny) (Any Actor) travels from San Jose to San Francisco to visit her friends (Any Party). She uses Google Maps as her navigation service (Any Type) to guide her through the trip. Google Maps is used through computers and mobile phones (Any Media) and it has its own a route optimization algorithm (Any Mechanism) to determine the best route, based on time of trip, traffic conditions, etc. (Any Evidence) and show the estimated time of arrival. The estimate time will keep changing (Any Rate) depends on the current traffic (Any State) of the route.

Scenario #2: Tesla Auto-Pilot System

Kevin is a proud owner (Any Actor) of a Tesla Model 3 (Any Entity) vehicle. This vehicle has an Auto-Pilot system (Any Mechanism) that can take over control of

driving the vehicle on the highway (Any State). The Auto-Pilot system is designed to autonomously drive (Any Ability) a car (Any Type) with a higher accuracy (Any Rate) than any particular human can based on rigorous testing (Any Evidence) and approval from the US government. All new features are sent to hardware through over the air (Any Media) updates.

Functional Requirements

Refer to Fig. 2.

Non-functional Requirements

We clearly detail the non-functional requirements of intelligence in Table 2.

Table 2. Intelligence EBT non-functional requirements

#	Non-Functional Requirements	Description
1	Brightness	In order to be intelligent, the system must be able to extract patterns from small amounts of data and quickly generalize to predict the future in AnyDomain
2	Understanding	Intelligent beings are apt to acquire a great understanding of the subject at hand. In fact, one of the ways to judge intelligence is by checking AnyParty's understanding of a particular topic or concept
3	Creativity	Intelligence must have AnyParty use creativity to develop AnyMechanism that to be declared intelligent. A creative approach in AnyMechanism is also extended and executed through AnyAbility
4	Learning	Intelligence requires AnyMechanism to constantly learn the task it is performing and improve performance over time. There is a correlation between how fast a system learns and how intelligent the system is
5	Knowledge	Intelligence is manifested through assembling a set of domain-specific knowledge. This domain specific knowledge is importantly used as the bedrock for the system to make more informed and intelligent decisions
6	Recognition	Recognizing an AnyEntity in AnyContext is a matter of intelligence. In other words, intelligent beings must be able to acknowledge the existence of AnyEntity that the being has encountered previously
7	Identification	Furthermore, an intelligent being must be able identify AnyEntity entities into its respective AnyType. This classification task is core to having an intelligence task that can be applied to a broader range of intelligence
8	Thinking	Intelligence is characterized by utilizing AnyAbility to use AnyEvidence in order to create ideas through synthesis. This creation of new ideas, or thinking, is vital to learning and informing intelligence and decisions

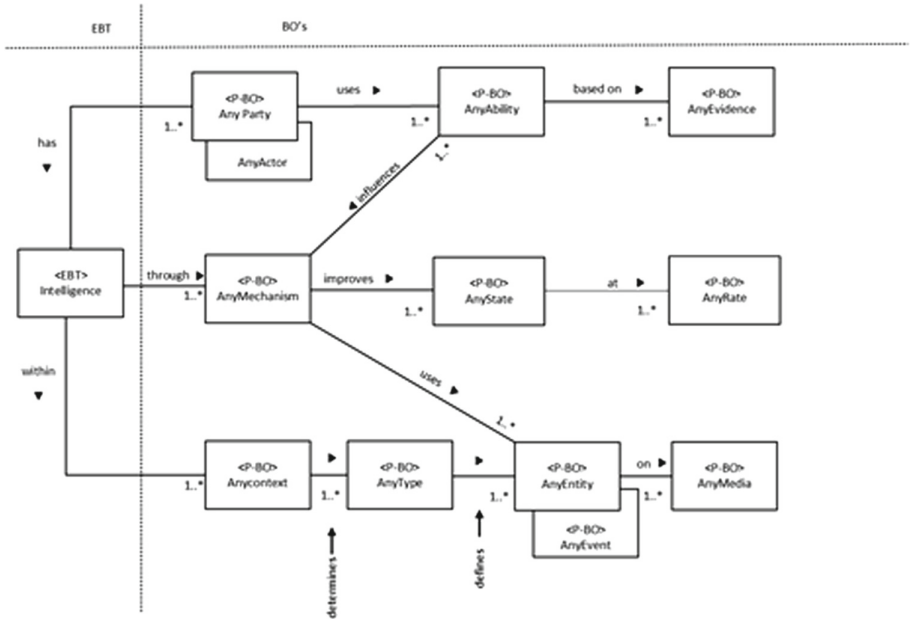

Fig. 2. Intelligence stable analysis pattern (Intelligence functional requirements)

Table 3. Five applications of intelligence EBT

EBT	BOs	App-1– Improving Previous Tests	App-2– Practicing Language	App-3– Google Maps	App-4– Amazon Alexa	App-5– Tesla AutoPilot
Intelligence	AnyParty/ Any Actor	Teacher Student	Speaker Teacher	Phone Owner Car	Personal Assistant Customer	Driver Car
	Any Ability	Problem-Solving	Speaking	Routing	Task Execution	Autonomous Driving
	Any Evidence	Grade	Knowledge	State of Traffic	Task Performance	Driving Experiments
	AnyMechanism	Teaching	Duolingo	Route Optimization	Natural Language Processing Techniques	AutoPilot system
	AnyState	Preparation	Practicing	Distance from Destination	Speaking	Highway

(*continued*)

Table 3. (*continued*)

EBT	BOs	App-1– Improving Previous Tests	App-2– Practicing Language	App-3– Google Maps	App-4– Amazon Alexa	App-5– Tesla AutoPilot
	AnyRate	Semester	Making Mistakes	Time of Arrival	Response Accuracy	Model Accuracy
	AnyContext	Math	Social	Route Planning	Task Execution	Transportation Safety
	AnyType	Practical	Language	Navigation Service	Voice Assistant	Car
	AnyEntity/AnyEvent	Classroom	Spain	Phone	Speaking	Driving
	AnyMedia	Textbook	Application	Google	Speech	Wireless Updates

Application: Scenario #1: Google Map

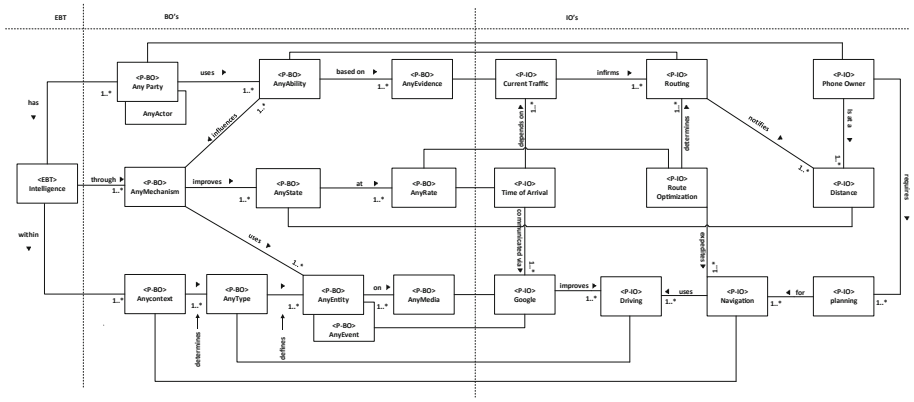

Fig. 3. Intelligence stable analysis pattern–Google Map

Application: Scenario #2: Tesla Auto-Pilot System

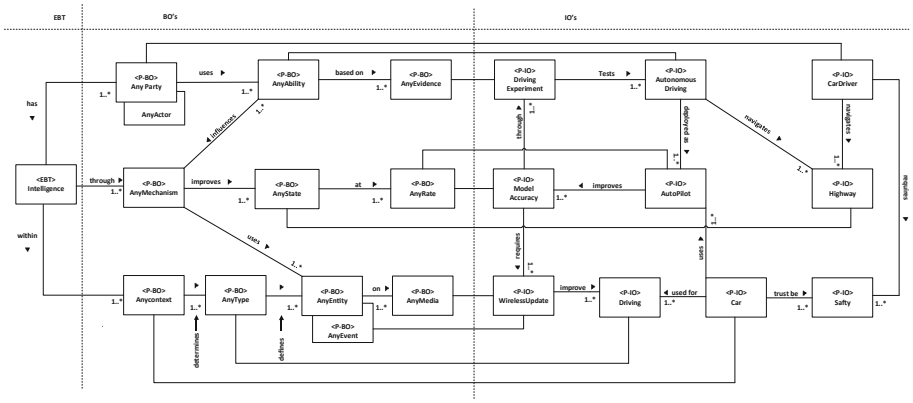

Fig. 4. Intelligence stable analysis pattern–Tesla auto-pilot system

4 Machine Learning: Decision (BOs)

BOs are important objects that extend the stable goals of Machine Learning. From the seven BOs of Machine Learning, shown in Table 4, Data and Decision are two BOs which play an important roles in Machine Learning.

Table 4. Partial BOs of "Stable Machine Learning"

#	BOs	Description
1	Model	A model is a mathematical representation of the domain-specific process or real-world activity [5]. This model is used to gain knowledge on the domain in question
2	Optimizer	An optimizer is used to learn the correct weights of features. In learning these features, the optimizer is used to maximize the metric that represents the model's understanding of the domain
3	Mechanism	A mechanism is an established process by which something takes place. For example, linear regression performs prediction based on these mechanisms
4	Pattern	Patterns exist in every form of the information in the world. The model tries to extract this pattern and generalize it among future pieces of data [6, 7]
5	System	A system is a collection of components that are organized for a machine learning model. This describes how each component of the system interacts with one another
6	Decision	Each machine learning model must make a decision based on data it has not seen before. This decision is the output that is used by real-world applications of machine learning
7	Metric	A metric is a way to quantify a certain abstract idea. Metrics are used in machine learning to quantify retention of knowledge, accuracy of predictions, and more

4.1 Any Decision (BOs)

The amazing part of Machine Learning is that the machine will make it own decision based on the data it collected.

Functional Requirements
Refer to Fig. 5.

Non-functional Requirements
The non-functional requirements of the Decision BO are listed in Table 5.

Table 5. Decision BO non-functional requirements

#	Non-Functional Requirements	Description
1	Reliability	It will be able to accomplish competency in performance. It will be able to accomplish competency in performance. It will consistently performs according to its specifications
2	Scalability	This is the non-functional requirement of decision. A dynamic representation is required to characterize constant changes and progress. It will be able handle a growing amount of work in a capable manner. It has an ability to enlarge to accommodate that growth
3	Performance	The action or process of carrying out or accomplishing an action, task, or function. It will accomplish very well, the given task measured against known standards of accuracy, completeness, cost, and speed

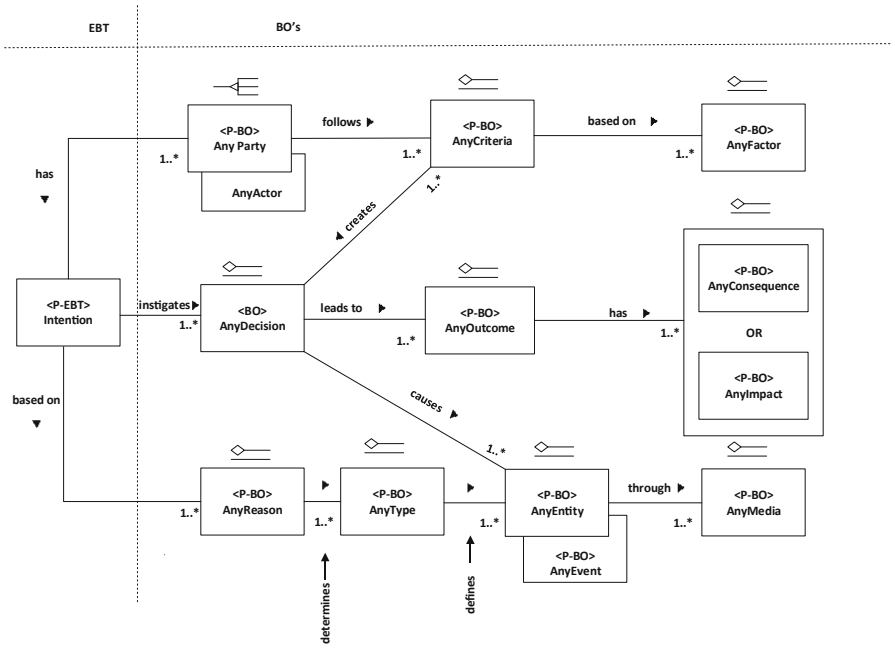

Fig. 5. AnyDecision stable design pattern (AnyDecision functional requirements)

5 Non-functional Requirements of Machine Learning

The following section will introduce three non-functional requirement of Machine Learning.

5.1 Assessment

It is the extent to which the system continues to perform as expected. System effectiveness is a function of capability, availability and dependability. The functional requirements are presented in Fig. 6.

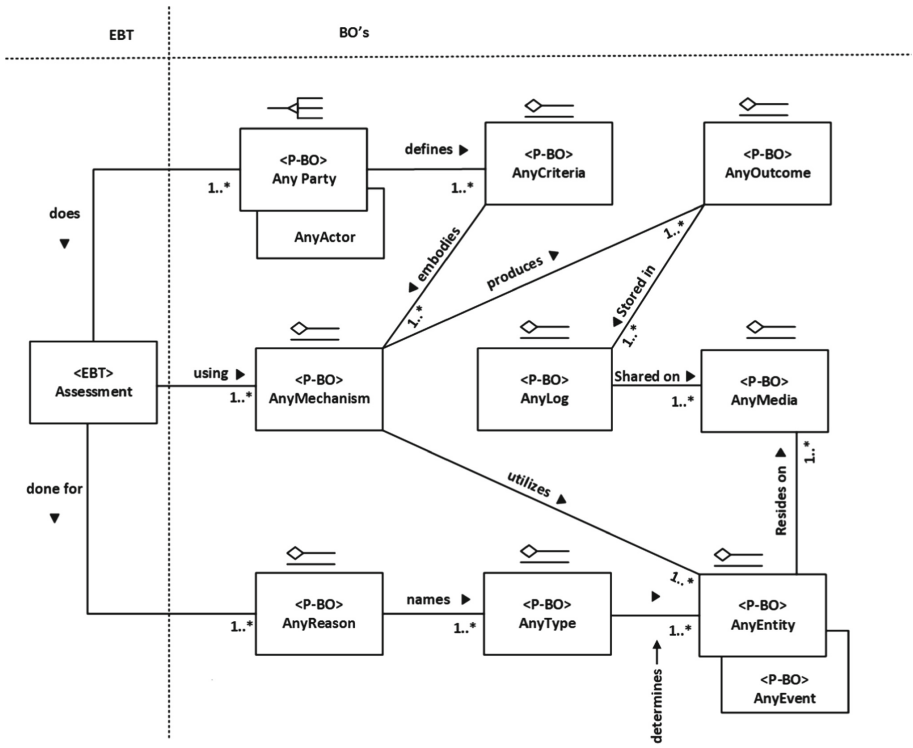

Fig. 6. Assessment stable analysis pattern (Assessment functional requirements)

6 Architectural Patterns for Machine Learning Knowledge Map

6.1 A Data Analysis Stable Architecture Pattern

Functional Requirements
Refer to Fig. 7.

Non-Functional Requirements

The non-functional requirements of data-analysis architectural patterns are listed in Table 6.

Table 6. Data analysis non-functional requirements

Quality Factors	Description
Comprehension	The algorithm used in analysis should be easy to understand
Completeness	The data should be complete data. should not loss any important attribute
Stability	The result from an action should be stable. Such as the same data should get same result after data analysis
Documentable	It refer to the capability of being supported by documentary evidence. This is necessary to prove the usefulness of the data analysis
Testability	The data should support testing in a given data set
Security	The data should be stored into secure section to ensure the safety
Usability	The data can be used by specified consumers to achieve quantified objectives with effectiveness, efficiency, and satisfaction

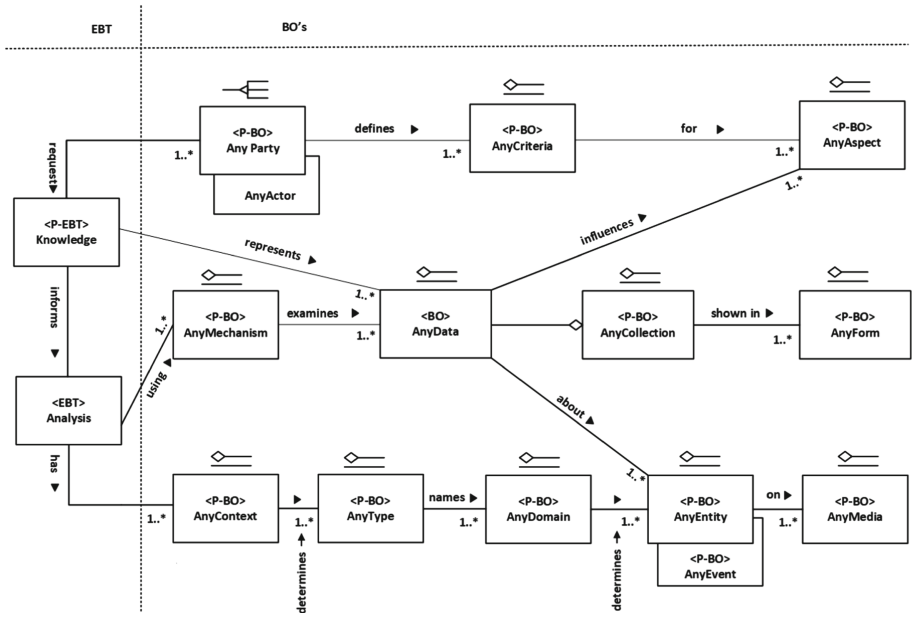

Fig. 7. Data analysis stable architecture pattern

7 Conclusion

Machine learning has become one of the most hot topics around the world. It allows machine to learn and make decision without any human intervention. In this article, we have identified different Enduring Business Themes (EBT) and Business Objects (BOs) for machine learning and presented knowledge map for the same. Knowledge Map has great potential to transform and change the current software development process. We can develop application faster and more stable. However this is relatively a new concept and is in its early stages and much work has to be done. How do we implement knowledge map? How do we verify it? How do we build it correctly meeting requirements, how do we test knowledge map. All these require immediate attention. However we are confident that knowledge map will add some value to software development process.

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