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A Finite State Model for a Self-help System Based on Minhaj 'Al Abidin

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Abstract: Finite state models even though very traditional can also be applied to the analysis and design of both abstract and physical systems. A general finite state model has been developed and applied to a self help system to assess the initial state of the user and discern the ways that the user can transit from that state to higher states ultimately progressing to reach a certain goal. The general model has also been diversified to show, how it can be used to add different features to the system. A proto type system entitled self-help maqam-based search system based on the seven maqams or hurdles mentioned in the book Minhaj 'al Abidin has been used as a use case. In this book, Minhaj 'al 'Abidin by Imam Ghazzali (RA), it has been illustrated how a man by crossing seven distinct hurdles one at a time by achieving certain knowledge and performing specific deeds, one can gain bounties of Allah (SWT) at the end.

Key words: Finite state model, self-help system, maqam, deeds, hurdles

INTRODUCTION

Finite state machines entail a set of states, set of input and output events and some transition triggers. Using the present state and the input events, these transition functions return a new state and output events. Finite state machines are considered as abstract machines.

Finite-state machines are perfect for simple computational models that can have finite number of states and transitions between these states.

FSMs are usually represented through state transition diagrams which consist of vertices that indicate states and edges that signify transitions. Basically, it is a directed graph as shown in Fig. 1.

There are several reasons why finite state model is popular for modeling. The first is practical. As mentioned earlier, there are some practical applications which are best modeled as a finite state machine. A compiler can be even write or obtained that will take a finite state machine's specification and produce code that behaves correctly.

Secondly finite state machines are important because they allow us to explore the theory of computation which help us discover what resources are needed to compute different types of problem (James, 2014).

Applicability of FSM is diverse. FSMs allow the improvement of the processes and allow the organization of the logic of systems, so that it can also be applied to the analysis and design of abstract and physical systems and can be used to model any type of systems.

Now a system offering a self-help assessment of a person's current state with the opportunity to learn the ways of improvement has not been developed yet in the concept of spiritual enhancement. A system that will help provide resources and appropriate guidance to improve one's spiritual state of mind is required. The book "Minhaj 'al Abidin" by Imam Al-Ghazali (RA) instructs seekers of inner peace to resist hindrances and impairments in order to find salvation and lead into the path towards tasawuf. A self-help maqam-based search system (Othman *et al*., 2014) has been developed that will guide an individual through the 7 hurdles or maqams based on the book, Minhaj-al Abidin,.

The user can go through a series of questions that is associated with each individual maqam or hurdle where his/her state can be identified. And then the user can start to cross the indvidual maqams by the help of the system. Each maqam is associated with set of questions in the form of statements which the user is required to answer. Based on the answers the system can assess whether the user has the required knowledge and whether the user performs the specific duties and tasks pertaining to that

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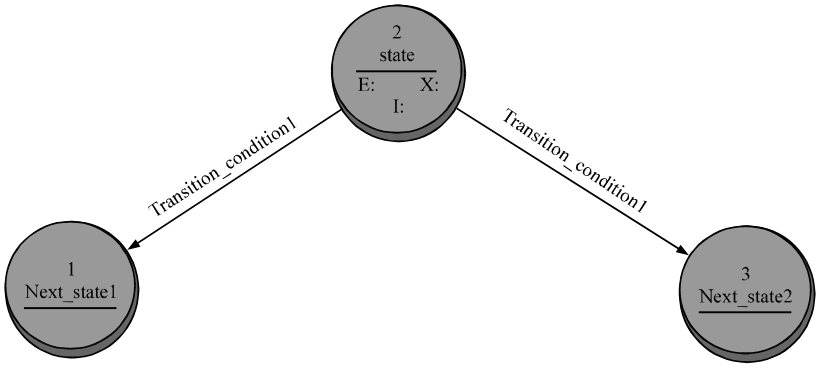

Fig. 1: The state machine definition. From finite state modeling approach a practical approach by Wagner *et al*. (2006), New York, NY; Auerbach publications

maqam or state. The system identifies what the user lacks to cross a certain level and will provide the resources to the user based on the book "Minhaj 'al Abidin" by Imam Ghazali (RA). Thus, this allows a user to self assess one's state and provide the opportunity to learn ways of improving to a higher state which will lead to the highest spiritual level attainable by a muslim.

The self-help maqam-based search system will assess input events to evaluate certain rules to allow the person to transit from one maqam to the other thus allowing a person to improve upon his or her spiritual state while climbing the maqams (Othman *et al*., 2014). The system has a familiarity with states and transitions. So, this system will act as a use case for the proposed finite state model.

Literature review: In a recent system (Fernandez-Caballero *et al*., 2012) deals with the idea of jointly modeling simple and complex behaviors in natural scenes using FSM to point out local and global human activities. They have incorporate knowledge about the problem domain into an expected structure of the activity FSM model. The proposed system will be able to detect simple actions and queries and adapt to a number of states. Also, it will be able to detect a number of behavior patterns which in turn is associated with alarms. To represent this type of patterns, finite state machines are used. Also another experimental system which employs virtual humans for education and training in X3D/VRML worlds (Ieronutti and Chittaro, 2005) where the behavioral engine of the system to specify how the virtual human will behave is based on the finite state model. They present a novel game observation system that extracts high-level semantic information about the action-taking place in a game and displays it visually using finite state modeling. They have used the FSM to represent the structure of an interactive lesson which has the inherent purpose of showing an individual how to accomplish a physical activity.

In the learning and pattern recognition area, this FSM proposes using the part of speech tags of tokens as target observation of name boundary definer tool (Munkhdalai *et al*., 2011). They proposed an approach for modeling finite state machine as the boundary definer. Aided by machine learning methods including frequent pattern mining method and Bayesian network, the finite state machine learns on part-of-speech tag of tokens in bio-text data. The finite state machine based on Bayesian network is named BFSM. In addition, we report the influence of part-of-speech tagger tool for learning of BFSM. Experimental results show that the named entity recognition system using the BFSM gives us high accuracy. In another system that the usage of finite state machine approach is to find patterns of communication protocols to improve their own efficiency a self improving systems for communication protocols (Basicevic *et al*., 2010). They present a Finite State Machine (FSM) based execution of SIP protocol stack. The FSM based framework was used in the design development process. Then a comparison analysis quantitatively of the implementation with a well-known open source SIP was done, and reciprocated. Results show viability of FSM-based approach, most importantly its support for modularization (Basicevic *et al*., 2010).

Cashiers in retail stores while handling items have to perform some recurring actions. Perceiving such activities plays an important part in most retail fraud detection. The system (Trinh *et al*., 2011) proposes a highly competent and strong vision technique to detect checkout-related actions based on a hierarchical Finite State Machine (FSM). Their deterministic approach uses visual features and previous spatial restraints on the hand motion to determine specific motion patterns performed during the original actions. They also apply their approach to the problem of retail fraud detection. Data captured in the form of video data from retail stores have proven that this

approach can accomplish better results in finding check out linked activities and check out linked deceitful actions.

Another study (Tsarev and Egorov, 2011) in the bio medical domain discusses the use of finite-state model for genetic algorithms which works with fitness functions. The objective of this system is to detect and define the boundaries amongst typical words and bio medical words. So, this system works in the domain of automated information extraction for biomedical literature. The process is bio named entity recognition process. Another objective is to classify the words according to domain knowledge. It also uses the finite state approach to verify and validate.

Objective: The self-help maqam based search system is unique in its application. The system will also provide relevant search criteria for the user to not only assess his or her state but also provide access to resources and information that will help the user to journey through the states accordingly.

The theories in the papers mentioned in the literature review lacks the structure of well-defined states that have a strict sequential dependency that FSM is based upon. But our system will be based upon the states or maqams defined in the Minhaj 'al 'Abidin which are well structure. Hence using the FSM model will be more effective in order to create a more efficient system. And also rather than taking some input and just classifying a state; our system aims to guide the user from state i to i+1 which makes the use of FSM a more suitable solution to identify the triggers and make suggestions to the user at each state.

Since, the book, Minhaj 'al 'Abidin" by Imam Ghazali (RA), instructs seekers of inner peace to resist hindrances such as fear and impairments such as conceit in order to find salvation and lead into the path towards tasawuf, it has well-defined states that have a strict sequential dependency to reach the ultimate goal. The problem domain can divide in to the parts:

- Identify the initial state the user is i.e., state n
- Identify and suggest possible practices to the user that will take him to the state n+1 according to Minhajul Abidin
- As the user interact with the system create a stochastic model of the user that would used to measure and track her progress through the different maqams of Minhajul Abidin

GENERAL FINITE STATE MODEL FOR THE PROPOSED SYSTEM

The state diagram shown in Fig. 2 represents the basic finite state model protraying the self-help-based system based on Minhaj 'al 'Abidin's seven Maqam. A new user will start at the initial state where the conditions and rules are not known. For the user to transit from the initial state to the next state of Maqam n where n = 1 which represents The hurdle of knowledge ['ilm] and insight (marifa), the first hurdle or maqam in the journey towards tasawwuf, he or she needs to fulfill the conditions of state or maqam 1 triggers . Here the maqams

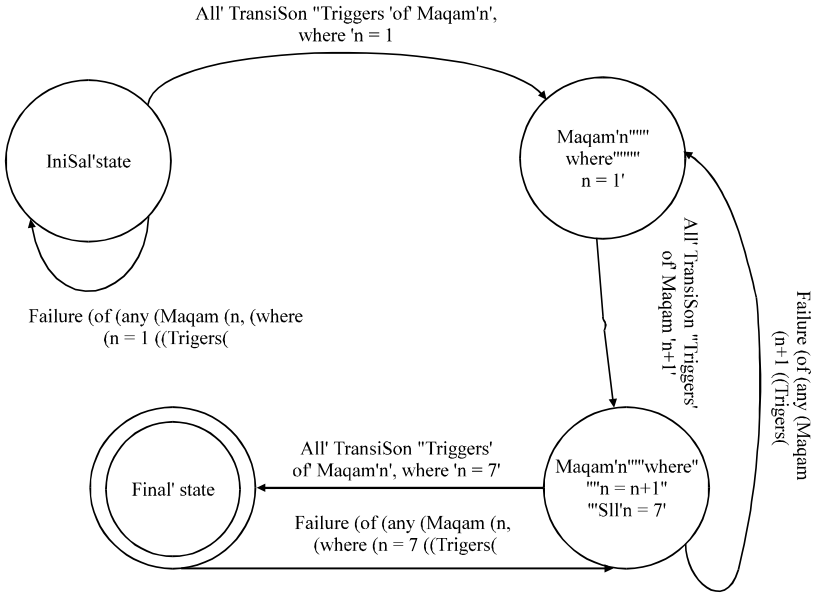

Fig. 2: Basic finite state model for Minhaj al-'Abidin's seven maqam in case of all triggers being mandatory

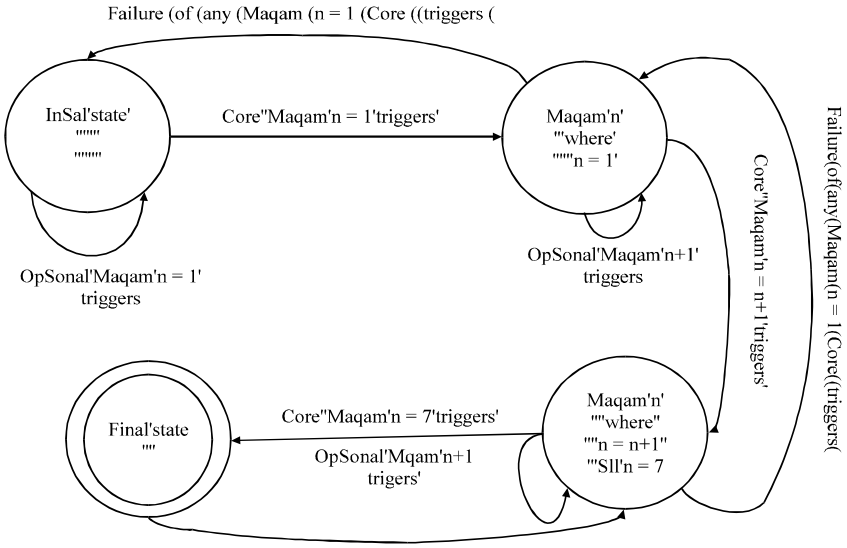

Fig. 3: Basic finite state model for Minhaj al-'Abidin's seven maqam in case of a combination of mandatory or core and optional triggers

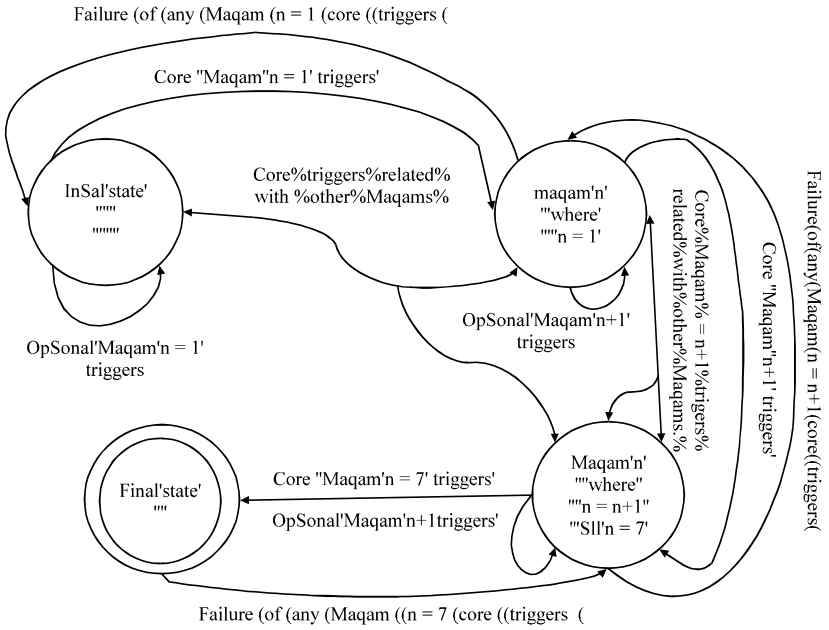

Fig. 4: Basic finite state model for Minhaj al-'Abidin's seven maqam in case of a combination of mandatory or core, optional triggers and inter-related triggers

are repesented by the value n starting from 1 and subsequently increasing by n = n+1 to the last maqam which is 7. Each state or maqam has its own set of triggers or conditions that needs to be fullfilled so that an user can cross that particular maqam or state. For example when a user is able to fulfill all the coditions or trigeers of maqam n = 1 only then the user is allowed to cross maqam n = 1 and will be shown the conditions of maqam n = n+1, i.e., that is the next maqam or state. Unable to fulfill the rules or conditions holds the user at the current state. And also if a user fails to maintain any of the conditions or rules the user will revert back to the previous state from his or her current state. The final state represents where the user has fullfilled all conditions of the last maqam n = 7 and the user has reached the stage of close proximity towards Allah (SWT) and is reaping His blessings and rewards.

The edges shown from one state to the other towards the end state are the conditions or triggers that will allow the transition. The ones that revert back to the states/maqam are triggers that will take the user back one step. All seven states have different triggering events for the transition. The above diagram represents a linear transition from one maqam to the next.

To provide the options of diversification; two other finite state model were developed based on the basic finite sate model shown above. In the case of the second variation shown in Fig. 3, not all triggers are essential for state transitions. So, a maqam will be associated with some core or mandatory triggers and with some optional triggers. User will be allowed transition from one maqam to another based on the core statements only. Answering only the optional ones will not allow the user to transit.

In the case of the third variation shown in Fig. 4, t not only core and optional triggers are present but also some triggers of different maqams can be interrelated. And those inter related triggers can be answered by the user irrespective of which maqam the trigger belongs to. If an inter related trigger of a particular maqam is activated correctly by the user, then the user will be given the option to act on the other related triggers of the different maqams. An user will be allowed to go through the associated triggers of different maqams, even though the user did not activate any other triggers of the particular maqam.

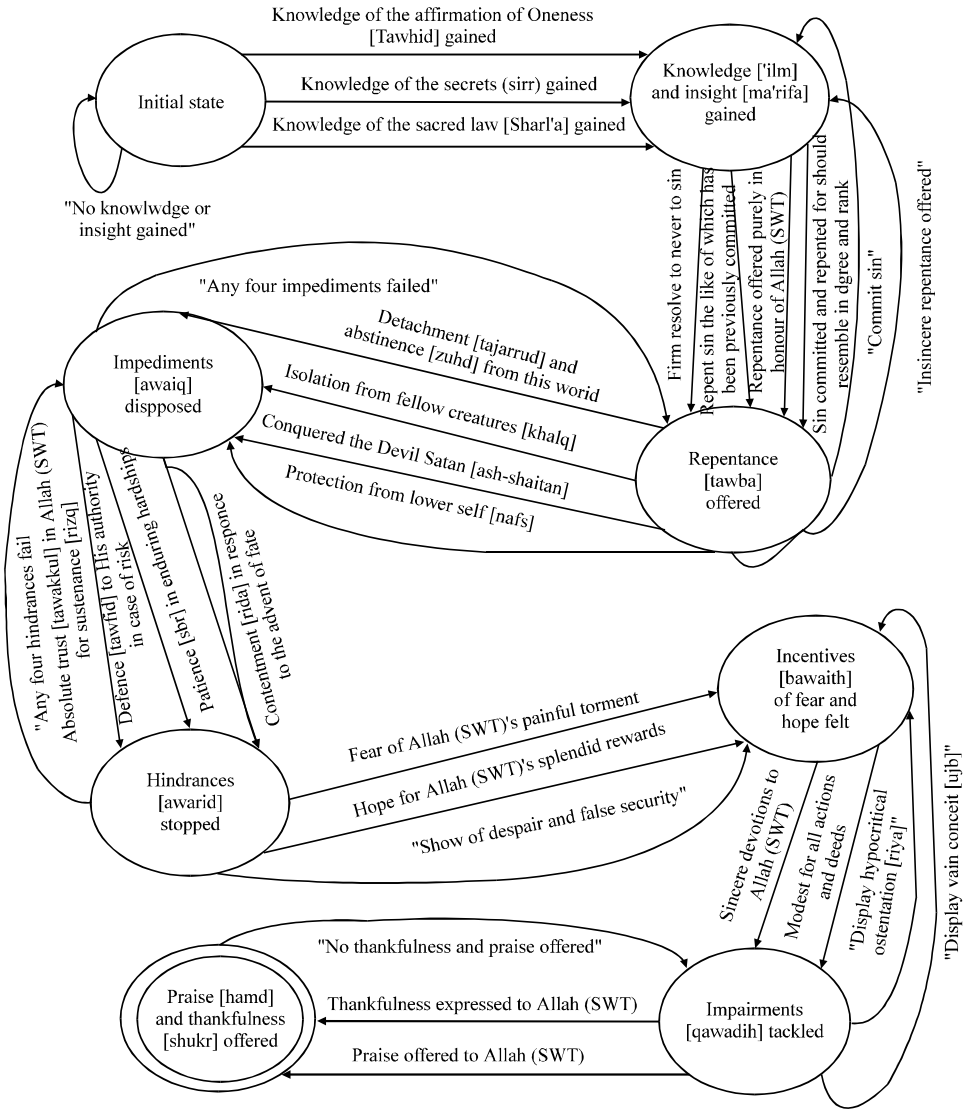

Fig. 5: Detail finite state model of the self-help maqam-based search system based Minhaj al-'Abidin ila Jannati Rabbi 'I-'Alamin by Imam Abu Hamid Al-Ghazali (RA), translated by Muhtar Holland published by Al-Baz Publishing Inc, 2011

For example, trigger 1 of maqam 1 is associated with trigger 5 of maqam 2 and trigger 7 of maqam 3. While being in maqam 1 an user activates trigger 1, then the user is allowed to act upon trigger 5 of maqam 2 and trigger 7 of maqam 3. But the user will be still in maqam 1, until and unless he activates all the core triggers of maqam 1. Please do not set running heads or page numbers.

FINITE STATE MODEL WITH DETAILED TRANSITION TRIGGERS

The state diagram shown in Fig. 5 represents the detailed state diagram of Minhaj al-'Abidin ila Jannati Rabbi 'l-'Alamin's seven maqam based on the English translated version by Muhtar Holland published by Al-Baz Publishing Inc in 2011.

A new user will start at the initial state where the conditions and rules are not known. For the user to transit from the initial state to the next state of "knowledge and insight gained" which represents "the hurdle of knowledge ('ilm) and insight (marifa)", the first hurdle or maqam, he or she needs to fulfill the condition of gaining the three kinds of knowledge. These three kinds of knowledge together will be the stimuli to trigger the transition of the user to the next state of "repentance Offered". Unable to fulfill the rules or conditions holds the user at the current state. And if the user while being in a particular state is not able to maintain the conditions, the user will revert back to the previous state.

The edges shown from one state to the other towards the end state are the conditions or triggers. The ones that revert back to the states towards the initial state are triggers that will take the user back one step. And also as without the complete three knowledge inputs from the initial state, the transition cannot be done, so this model is a non-deterministic model. All seven states are in accordance to the seven maqams or hurdles mentioned in "Minhaj-al 'Abidin" by AL-Ghazali. Each maqam or hurdle has its own set of rules or conditions based on the book. And there the transitions are linear that is all triggers or questions are mandatory to cross a particular maqam.

CONCLUSION

A system architectural model using the finite state machine approach has been established which can be used for any self-improvement or self-testing applications. This framework will not only allow building any similar systems but can be used in iterative process to make it more efficient.

FSM may be too predictable. Predictability induces typical behavior. Large FSM with many states and transitions can be difficult to manage and maintain causing state explosion. Sometimes conditions may also be too rigid for the user. As self-improvement systems cannot be too much structured as it then do not allow for qualitative analysis for the inputs and outputs. Not all cases will follow a rigid structure; it is then difficult to create alternative options in using FSMs.

In future the relationship between the answers to questions by the user and the finite state machine model of the system must be clarified. This clarification will provide the opportunity to back track to explore the use of formal analysis to support the chances of self-improvement. The aim of such analysis can be stated as finding area of self-improvement in a formal analysis of the answers issued by the users. This framework will backtrack the transitions of the finite states to explore the main criteria for self-improvement.

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