Artificially Intelligent *Mudarib* for Islamic banking

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ABSTRACT

This paper illustrates an Islamic banking product called Mudarabah and shows how this product can benefit from new technologies. Artificial intelligence agents and equation discoveries are two methodologies in computer science that can be used to give the Mudarabah product a new concept that can flow with modern world banking. This paper demonstrates that Islamic banking can adapt and implement advanced and modern technologies.

Key words: Agent, Equation discovery, Islamic Banking, Mudarabah

1. Introduction

Islamic banking involves all banking processes that are controlled by Islamic law in what is called *Shari'ah* in Arabic. Over the last 40 years, Islamic banking has expanded from the first modern Islamic bank in Egypt, which was created by Ahmad Ei Najjar in the late 60s. In fact, experts currently estimate that the Islamic banking industry is worth more than £200 billion per year and is growing by 15% per annum. More than 75 countries have one or more Islamic banks or branches of those banks [1]. Many Islamic products are offered through Islamic banking, including *Mudarabah*, *Murabahah*, *Takaful*, and *Tawarruq* [2], the first of which is the focus of this paper. The most important tenets of Islamic banking are to avoid *Riba*, and to base operations on risk sharing and involvement in trading, buying, and selling with the transfer of full ownership [3]. This paper illustrates the Islamic banking product known as *Mudarabah* and describes artificial intelligence methodologies that can be applied in this product to improve its overall quality.

2. Background

2.1 Mudarabah

Mudarabah is a "special kind of partnership where one partner gives money to another for investing it in commercial enterprise" [4]. From this definition, it is clear that the money comes from the first partner, who is called *Rab-ul-maal*, which means "the money owner". *Rab-ul-maal* has the right to observe the activities of the *Al-Mudarib* and can participate in the investment if Al-Mudarib agrees. The second partner, who is called *Mudarib*, devotes his time to managing and running the investment.

This partnership is established by a contract between the two parties, which declares their profit sharing ratio. In the case of a loss, the *Rab-ul-maal* loses his money and the *Mudarib* loses his time and effort. This contract is made to encourage collaboration between people who have money to invest but no time or skills, and others who have time or skills but no money to invest [5].

Based on Rab-ul-maal's restrictions, there are two categories of *Mudarabah* [4]:

1. Restricted *Mudarabah* (*Al-Mudarabah Al-Muqayyadah*): in this type, *Rab-ul-maal* chooses a particular investment for the second partner.
2. Unrestricted *Mudarabah* (*Al-Mudarabah Al-Mutlaqlah*): in this type, *al-Mudarib* has complete freedom to choose any kind of product in which to invest *Rab-ul-maal's* money.

2.1.1 *Mudarabah* in Stock Exchange

The stock exchange market attracts investors because all they need are money, time and expertise. Assets are not necessary to establish an investment in a stock exchange market. These types of investors are not expert in stock exchange and they are busy with their privet investment. In this case, *Al- Mudarib* takes place and enters into a *Mudarabah* contract with the investor. In the modern world, banks becomes the *Mudarib* for most investors, while other investors use some other privet *Mudarib* because of their well known expertise in stock exchange.

2.2 Artificial Intelligence Agents

An agent is "an active, persistent (software) component that perceives, reasons, act and communicates" [6]. An agent perceives the current state of the environment through sensors or data collection. Agents are modelled to perform particular tasks.
Agents must have at least the following properties:

- **Autonomy**:

Agents should act independently of the user's lead and should control their own behaviour and internal state. Agents should choose the right action at the right time for the right situation in a fully automated way [7].

- **Proactive**:

Agents should react to change in their environment if the current state does not lead to goal-directed behaviour; in other words, agents should generate and attempt to recognize chances to achieve goals [7].

- **Reactivity**:

Agents' environments will not remain static. As the environment changes, agents should continue interacting with and responding to the environments in a timely manner so that the responses are useful [7].

- **Social Ability**:

The real world is a multi-agent environment, thus some goals cannot be reached by a single agent. Cooperation with others may be needed to achieve a goal, so agents need the capability to interact with other agents and humans, rather than simply communicating with them [7] [8].

2.3 Machine learning, Equation discovery and LAGRAMGE

Machine Learning (ML) is "the study of computer programs that improve through experience their performance at certain classes of tasks, as measured by a given performance measure" [9]. In general, ML is a set of concepts—language, knowledge-based, hypotheses or learning bias—that are applied to a learning algorithm to solve exciting problems [10]. Learning algorithms cannot be predicted with out employing a bias [9] to limit the range of possible models and hypotheses from the hypothesis language [11].

Equation discovery is a subset of ML, which is specialized in searching and discovering quantitative laws, expressed as equations. LAGRAMGE is an example of an equation discovery system that is able to find algebraic equations for more than two variables exclusively from observed data [12, 13, 14]

3. Artificially Intelligent *Mudarib* (AIM)

In this paper, I propose an artificial intelligence agent that can be considered as a *mudarib*. This agent will use equation discovery methods to predict market movements. The investor will choose to enter into a restricted or unrestricted Mudarabah contract with the bank. Investor restrictions can focus on which will combine the *mudarib* trade, the maximum loss acceptable, and whether to share their money with other investors. The figure below shows the proposed design.

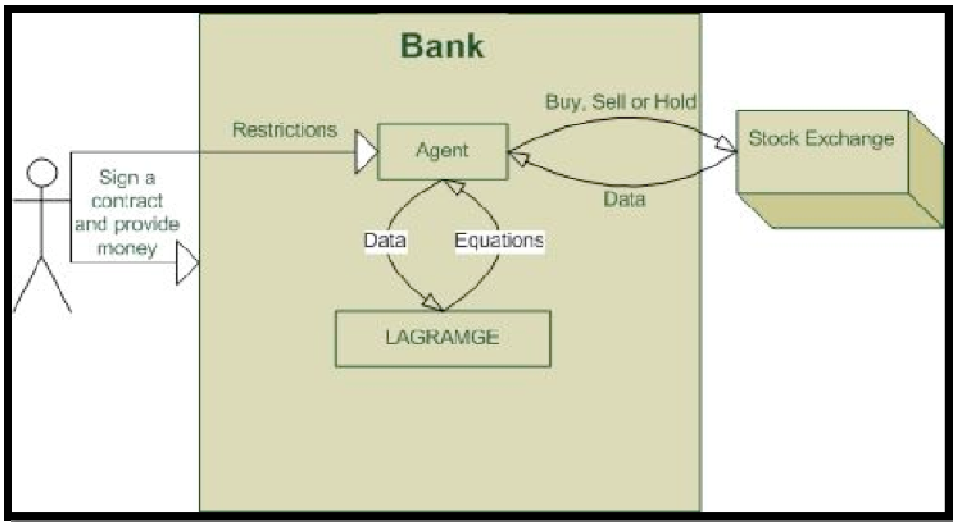

Figure 1 Artificially Intelligent *Mudarib*

Proposed Scenario:

- Customer signs a *Mudarabah* contract with the Bank and provides money.
- Bank creates a new AIM for the investor.
- Investor gives the AIM the restrictions (companies to trade in, maximum loss, sharing with other AIM)
- Agent collects data about the companies from the stock exchange.
- Agent reformats the data for each company to include current price, previous day's price, and two-day preceding price, and resends it to the LAGRAMGE equation discovery.

```
time curr_price ydays_price two_ds_ago;

1 2286.42 2139.26 2133.68;
2 2253.57 2286.42 2139.26;
3 2079.70 2253.57 2286.42;
4 2141.27 2079.70 2253.57;
5 2112.50 2141.27 2079.70;
6 2151.03 2112.50 2141.27;
7 2253.27 2151.03 2112.50;
8 2198.37 2253.27 2151.03;
9 2240.17 2198.37 2253.27;
10 2274.50 2240.17 2198.37;
11 2351.57 2274.50 2240.17;
12 2336.97 2351.57 2274.50;
```

Figure 2 Reformatted data

- LAGRAMGE runs the data and provides a number of equations to predict the price for each company before it sends it to the Agent.

```
Best equations:
curr_price = 3584.46 + -0.626514 * two_ds_ago + -12.8432 *
time * sin ( -0.334339 * time + 2.97822 ) + -6.8568 * time *
sin ( -0.41148 * ydays_price + 10 )
curr_price = 3189.48 + -0.42332 * two_ds_ago + -0.311495 *
two_ds_ago * sin ( 0.503794 * time + 1.35849 ) + 0.356904 *
ydays_price * sin ( 0.477793 * time + 1.63674 )
curr_price = 3261.21 + -0.454159 * two_ds_ago + 125.692 * sin
(-6.63245 * time + -6.14736 ) + -2.28042 * time * sin ( -
0.371691 * two_ds_ago + -10 )
curr_price = 3343.4 + -0.508411 * two_ds_ago + -0.0242406 *
two_ds_ago * sin ( 0.655398 * time + -1.34924) + -14.7394 *
time * sin ( -0.347327 * time + -3.05494 )
curr_price = 3269.6 + -0.464362 * two_ds_ago + -17.0299 * time
* sin ( -0.426 * time + -1.75364 ) + -0.051132 * two_ds_ago *
sin ( 0.580844 * time + -0.613737 )
curr_price = 3521.24 + -0.586466 * two_ds_ago + 24.6073 * time
* sin ( -0.525154 * time + 5.66213 ) + -35.3059 * time * sin (
-0.433834 * time + 4.38342 )
curr_price = 3244.91 + -0.446628 * two_ds_ago + 140.377 * sin
```

Figure 3 Best Equations

- Agent tests the equations and determines the best equation based on the data reviewed.

	A	B	C	D	E
1	time	two_ds_ago	ydays_price	curr_price	Predict_price
2	1	2,133.68	2,139.26	2,286.42	2,241.26331049294
3	2	2,139.26	2,286.42	2,253.57	2,235.9753276232
4	3	2,286.42	2,253.57	2,079.70	2,115.61684232912
5	4	2,253.57	2,079.70	2,141.27	2,104.36284688713
6	5	2,079.70	2,141.27	2,112.50	2,193.33861543799
7	6	2,141.27	2,112.50	2,151.03	2,138.13726841491
8	7	2,112.50	2,151.03	2,253.27	2,254.70239468567
9	8	2,151.03	2,253.27	2,198.37	2,196.84785603842
10	9	2,253.27	2,198.37	2,240.17	2,219.21605582597
11	10	2,198.37	2,240.17	2,274.50	2,298.33615798448
12	11	2,240.17	2,274.50	2,351.57	2,329.01068364939
13	12	2,274.50	2,351.57	2,336.97	2,335.71157789054
14	13	2,351.57	2,336.97	2,293.04	2,299.87585265792
15	14	2,336.97	2,293.04	2,244.33	2,253.63317027935
16	15	2,293.04	2,244.33	2,360.77	2,386.71206456616
17	16	2,244.33	2,360.77	2,365.41	2,330.48031434235
18	17	2,360.77	2,365.41	2,301.30	2,304.01939164203
19	18	2,365.41	2,301.30	2,183.53	2,209.58480423642
20	19	2,301.30	2,183.53	2,178.27	2,159.08442328151

Current_price = 3584.46 + -0.626514 * B2 + -12.8432 * A2 * SIN (-0.334339 * A2 + 2.97822)

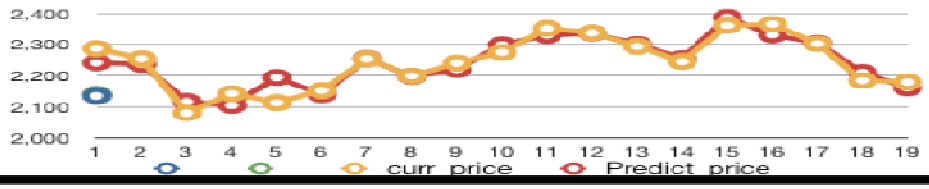

Figure 4 Best Equation

- Agent obtains a clear view of the price predictions for all companies.
- Agent builds a strategy to maximize profit from overall trading.
- Agent chooses to buy, sell or hold from the stock exchange.

4. Conclusion

Every year, the number of Islamic banking customers increases, but very limited research has been conducted to investigate how Islamic banking can obtain benefits from new technologies. This paper describes a method to trade in the stock exchange. This approach involves focusing all participants in the *Mudarabah* product on the same goal, which is to increase profit. Using agent technology will increase the speed of the process, which thus minimizes the risk involved in trading. Agent properties help the operation through its social ability.

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