# **Area of research in connection subject question at the ACM SIGMIS Computers and People Research (CPR) conference:**

# **How do individual** **humans interact with robotic co-workers?**

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*Abstract: This paper plan to use electronic trading in a capital market where designed computer algorithm identified as* **robotic co-workers show be** *able to act as a human trader by incorporating managerial leadership, participative leadership, situational leadership, transactional leadership to accomplish a usual trading task. That will sum up all aspect of the neuro-network interactive methodology that minimized Human intervention while giving more trust and credit to investment decision made by a robot. My research topic will constitute a framework that demonstrates how an asset manager can use an assistant robot to operate large trading transaction with little interaction. Designing an effective trading set of instruction that would be utilized computer programming-based decision model will provide the conclusive demonstration. We will the generalized by demonstrating why an organization fails in the long run if they do not adopt highly creative and interactive robotic ideas to will be contributing to the business case with their human counterpart to minimize their costs. The leadership role a robot will play to increase productivity and consumer experience is yet to be evaluated. Well elaborated thoughts and concepts that contribute to the good of the company and the society in general where robotic concept prevail seems to be the direction for all.*

*Keywords: Algorithmic, Engine, Processing, Computer, Robot, Interaction, Society, Production, Model, Machine, Training, Cybernetic, Trade, Market,* ***Co-Workers, Cost, Revenue, Electronic, Assistant, Code.***

My research topic touches up a little bit that subject to human’s interaction with robotic co-workers. We know robots are already physically supporting the humans within many processes, but as a step further, can the robots develop the ability to identify and adapt to any individual? (Richert, Shehadeh, Müller, Schröder, & Jeschke, 2016). Considering an interaction a human trader will require from robot’s assistant with algorithmic engines to autonomously execute a buy or a sell’s trade on wall street just as a human trader would do, it remains unclear whether this human trader will implicitly attribute intentions to them and, if so, whether such interactions resemble an interactions between human and human at workplace. (Krach, Hegel, & Wrede, 2008). We will see as we move forward in this analysis that coworker robots are still relying on a lot of human input by the mean of programming language and human expectation is to have the robot to outperform in those instructed tasks. As of now, the robotic system that allows users to instruct and program a robot with a high-level of abstractions, controls, and programs from the robot and that requires some technical expertise. (Neto, Pires, & Moreira, 2010).

I am at my early stage of Ph.D. B.A. Information Systems / Information Technology Management. As a Ph.D. student, we will be writing papers related to a various aspect of automation in the capital market and trading for the financial instrument. This will use processing engine to estimate in real-time the probability of fill for a couple of thousands of orders at multiple price levels in a liquidity fragmented market place and finally carry out an optimization procedure to find the most optimal order placement. (Kumaresan & Krejic, 2015). This process can be executed even faster by using computer aids application of arterial intelligence and probabilistic model on historical data to make an optimal trade decision.

This is achieved, by designing a trading strategy as a robot coworker that would utilize a set decision model and control when to execute, at how much price and how many volumes should be transacted at a given point of time, by preempting the market behavior otherwise. (Kumaresan & Krejic, 2015). This is a cross path between technology and social dimensions not as separate entities, but where a robot is referred to as a colleague. Other literature calls it personal robot assistant, which are just software robot as artificial intelligence (AI) workers with robotic process automation (RPA) to streamline traditional business process, speed up productivity with better quality and production time. **Robotic co-workers** are software, machine or physical object that humans can use as intelligent machines to help workers fulfilling their regular jobs better. Cognitive systems are designed to solve problems by taping in machine learning (ML) engine and natural language processing (NLP) just as human’s way of solving problems; by thinking, reasoning and remembering while reducing compliance in business risk with accuracy.

 Interactions between humans and collaborative robots are not recorded only in the sector of the financial market, a lot of literature have speculated about the humanoid or the robot form of a human primarily on the negative side. Stephen Hawking, former professor of mathematics at the University of Cambridge and author have in long ago warned of the dangers of intelligent robots becoming too powerful for humans to control. (Ashrafian, 2015). Questions were raised to discuss if the robot can become more intelligent and more powerful than a human in their collaborative workspace. And that they could more likely harm a person by accident, by exerting inappropriate decision, force, and intellect, thus, destroying trust with is not the same kind of trust one builds in any co-worker. Human imperfection creates the need for a robust humanoid, a robot that offers rich perceptuo-motor capabilities with many degrees of freedom, or a cognitive capacity for learning and development. (Mettaa, et al., 2010)

The lack of emotional behavior entails the fact that the robot as an inefficient worker, is not able to react to urgent situations of workflow when we are accounting the relation between technology and society, or other environmental factors in Human-Robot Interaction**.** Research on human-robot interaction (HRI) poses many challenges regarding the nature of interactivity and ‘social behavior’ in robot and humans. (Dautenhahn, 2007). How often humans need to interact or intervene with the autonomous system is yet to reach a consensus, but this is a new dimension related to human-computer interaction (HCI) and furthermore the perceptions of the humanoid as operators ... Sociable humanoid robots pose a dramatic and intriguing shift in the way one thinks about the control of autonomous robots because they are designed to operate as independently and remotely as possible from humans. (Breazeal, 2003).

The vision of collaboration between humans and robots that have created the first robot astronaut, called Kirobo, developed by the University of Tokyo has become reality with sensitive robot-colleagues, or "Cobots". (Lynch, 2015). Robotics, AI, and machine learning become more common in the office, this is really changing the interaction people have on a day-to-day basis with a specific person, team or group.   How robots, artificial intelligence, and machine learning will affect employment is still to be established in today’s society. Human-robot collaboration is a key factor for the development of factories of the future and a space in which humans and robots can work and carry out tasks together. (Maurtua, Ibarguren, & Kildal, 2017). Some predict robots could replace nearly a third of the U.S. workforce by 2030 since more employers would find it expensive to employ humans. Human has discontinued or interrupted schedule, whereas Robots can run 24/7, making them cost-competitive with human workers.

However, robotic technology is still in its infancy. Understanding how robots influence people's emotions during human-robot interactions is important for ensuring their acceptance in society. (Desideri, Ottaviani, & Malavasi, 2019). Automated algorithms, that responds based on pre-defined multi-faceted input or user behavior is certainly AI. Today we are already using machine-learning technology to get smarter, predict better and comprehend our own natural-language. We use robots’ approach to answer questions, requests, search the web for information, shop, schedule appointments, set alarms, and a million other things. We use AI to help for mobility or power our own smart homes. We use behavioral algorithms to predictively learn and assist like Siri, Bixby, Alexa, Tesla, Cortana, Cogito, Boxever, Amazon.com, Netflix, Nest, and google assistant. Samsung has also introduced its own virtual assistant, named Bixby, to compete with Apple's Siri, Microsoft’s Cortana and Amazon's Alexa. Nobody wants to fall behind according to Ng’s views. Andrew Ng, computer scientist, and co-founder of ‎Coursera‎ said: “AI is the new electricity,” he says. “Just as 100 years ago electricity transformed industry after industry, AI will now do the same.” (Parloff, 2016).

Robotic surgery, or robot-assisted surgery, allows doctors to perform many types of complex procedures with more precision due to robotic use. This type of surgery is done with precision, miniaturization, and smaller incisions. The number of robot-assisted surgeries performed with the da Vinci surgical system has increased significantly over the past decade. (Johnson, Schmidt, & Duvvuri, 2014). The da Vinci Surgical System allows surgeons to perform minimally invasive surgery with the help of robotic arms with decreased blood loss, less pain, quicker healing time, flexibility and more control than is possible with conventional techniques. Robotic surgery is usually associated with minimally invasive surgery or procedures performed through tiny incisions, and remote surgery. Some study compare diameter for surgery as a continuous variable like for nephrometry score (RNS) surgery, or in predicting surgical outcomes like a robotic partial nephrectomy (RPN) surgery. (Aaron, et al., 2016).

The automotive industry is not new to the world of robotics. Industrial robots have made their biggest mark in the automotive industry. Industrial robots (IRS) are the important driving force to enable more automotive production and highly efficient activities in modern manufacturing systems. (Zhao, Liu, & Xu, 2017). Acieta provides a variety of robots that create high-impact efficiencies for vehicle assembly. Since the 1960s, car manufacturers have pioneered the use of industrial and universal robots worldwide to automate basic tasks in their assembly plants. One can argue that human to human interaction is less stressful and the working environment is friendly. When people work with robots in the automotive industry, for instance, there are some significant differences in human-human interactions compared to human-robot interaction. (Jiang, Sun, & Gao, 2016).

Between Robot Vision, Computer Vision, Image Processing, Machine Vision and Pattern Recognition are other Robotics applications. Vision Algorithms can be found in many activity fields and processes from start to capture images, object tracking and recognition. Visual recognition system for fine-grained visual categorization where systems are composed of a human and a machine have the duty of working together and combines synergy (Branson, Van Horn, & Wah, 2014). Just like a lot of company are going digital by using today automated document input for their Customized Workflow Processes‎, the US postal market has incorporated its latest achievements in artificial intelligence Optical Character Recognition (OCR) to perform automated mail classification in their triage center. A high throughput robotic machine vision system can quantify seedling development highly spatial and temporal precision, high enough to match the needs of functional genomics research. (Subramanian, Spalding, & Ferrier, 2013). We can better interpret and act on genomic data through genome sequencing and with advances in artificial intelligence and machine learning applications, as we are able to edit DNA and genes.

The U.S. Navy also follows the steps, in addition to its unmanned low frequency in-air ultrasonic sensor combat air vehicle for military need. Its walking robots is able to navigate rough terrain without human input, or its drone flying robot is used in combat critical mission for predominantly intelligence, surveillance, and reconnaissance (ISR). Unmanned marine vehicles (umvs) is a collective term used to describe autonomous underwater vehicles, remotely operated vehicles, semi-submersibles, and unmanned surface craft. (Roberts & Sutton, 2009). The airplanes automated co-pilot by a robot that can be quickly and cheaply installed to control the trajectory of an aircraft without constant hands-on as an air pilot keeps plane.

The list is not exhaustive, we can also mention Educational Robotic (ER), which are robots deployed for educational purposes or Agricultural Robotic (AR), which are robots deployed for agricultural purposes but let shed our attention to Trading Robotic (TR), which are robots deployed for financial investment purposes and let analyses how this process is optimally performed interactively with an actual human trader. My research proposal is just another robotic solution because it is looking to provide compactional strategy or Artificial intelligence model to liquidate or acquire a large volume of a financial asset without driving the market price in the opposite direction for a specific electronic market in wall street. This phenomenon is known as market impact in finance and business administration when the market price moves to the unexpected direction. That notion is supported by the microeconomics concept of supply and demand or market equilibrium.  Competition among buyers will drive the price upward toward the equilibrium price, and vice versa (Mankiw, 1991).

 For each execution, Sn, let us denote sn = visible liquidity just before execution n, and rn = hidden liquidity just before execution n. We know sn, but rn we can only estimate from the relationship rn ≥ wn ≡ max (Sn − sn, 0) (Almgren & Harts, 2007). The is to implement an automate that creates a profitable concept of smart order routing on wall-street (FOUCAULT & MENKVELD, 2008). Because we want to trade fast, we are concerned about driving the price away because larger trade will impact the market, we do not want to avoid fleeing of trade informational advantage that a human worker passes on as a set of instruction to the processing robot.

Artificial intelligence, neural network, and machine learning are computer-based methods to apply and integrate the computer processing power in solving today's business issues just like the one I would try to solve in my paper. Similarities between human-computer interaction (HCI) is basically to minimize emotions and correctly enhance the harmonics of the noise difference between what the user perceives and the optimal action to execute. (Park & Kim, 2015). My dissertation will also display some statistical and probability theory pertaining the human cognitive behavior as opposed to the implemented trading robot introduced in one of those computer servers to execute electronic market orders in wall street. The output for each result set will be improved gradually using machine learning efficiency, and prediction precision will be generated as input for the training task-specific models discretely.

The smart order routing in wall street also infers to the Theories of Management that is totally relevant to the discipline, of Information Systems and Information Technology Management. The Behavioral Theories and the Contingency Theories linked together is the direction my paper will take. This paper will justify why a very well-established corporate management would have no choice but only contingently Trader Robots to preempting other market participant behavior by constantly adjust business strategy and investment decision toward a particular market segment. In that regards, our robot trader will be performing a continuous mean/variance portfolio optimization to enhance every trade. (Karagiannidisa & Vozlyublennaia, 2016). This type of model is making a considerable impact on the development of financial theory, organizational decision decision-making, and trading policy to ensure organizational growth and leadership activities. HCI and HRI are always evolving in the right direction to adapt the modernized exchange market while fulfilling the efficient market hypothesis theory.

The optimal trade allocation volume will be decided by our robot, for a set of specific trade venue. And it will be selecting the best available opportunity to get rid of their larger volume at once or subsequently choosing the most relevant set of market, to trade that assigned volume with. The trading robot can route their order through, by allocating some subset of their existing inventory based on some probability distribution. So, instruction and assignment will be done differently for each robot or group of robots. Each member in the automation chain will be capable of deciding its own execution path such that, it is most commensurate with its current state in the overall system. (Lee & Kim, 2017). For each execution, the smart order routing algorithm or our smart robot designed to trade asset should act fast as new market condition flow in as input. Its model is concern about impacting the market and drive the price away because want to avoid fleeing informational advantage, this is known as “alpha” on wall street.

The Research Question:

* How would smart order routing algorithm in Wall-Street go about using genetic programming approach to find market m(1), market m(2), market m(3), and market m(k) where k is the total market venue we agree to trade with amongst capital, K representing the total number of market is used as a set of instruction to enhance the trade efficiency?
* How would smart order routing algorithm in Wall-Street go about using machine learning algorithms to find a v (1) volume to allocate to the market m(1), a volume v(2) to allocate to the market m(2) , the volume v(k ) to allocate to the market m(k) of the initial parent volume V. K is the number of the market and v (1) + v(2) + ..... + v(k) = V, as a set of interaction with the trader robot to mitigate transaction risk linked to other traders’ behavior in the market?
* How would smart order routing algorithm go about providing output to human trader leveraging artificial intelligence by allocating volumes for every market or calculate probability distribution P that measure the likelihood of volume v(k) and instrument I(k) to be filled in that specific dark pool market m(k) under the utility theory argument?

So, the research Question can be summarized at: How can Human-robot software can interact and leverage a deep learning or neural network to find the optimal volume of order to be allocated in different set dark pool market for execution for a better trading outcome?

My paper will also display some regression model, with statistical and probability theory implemented using some pseudo-code that can be introduced in one of those computer servers that execute electronic market order in wall street as a human coworker. We will study related regression models that involve data sampled at different frequencies for each trade. (Andreou, Ghysels, & Kourtellos, 2010). The output result will be improved using machine learning efficiency and prediction precision for the training task-specific models discretely. The problem of smart order routing is the task of executing a single order as rapidly as possible (Almgren & Harts).

Independent variables are:

– actions: position(s) of orders within the book  
– rewards: prices received for executions  
– stochastic:  state evolving differently over time

– state: time and shares remaining

 – state: Bid volume, ask volume

– state: signed transaction volume, price volatility

– state: bid-ask volume misbalance, spread volatility, bid-ask spread,

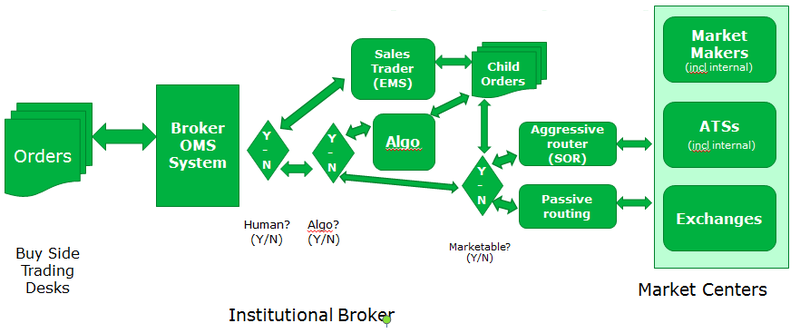
– state: price level, immediate market order cost

– state: signed incoming volume

Transformational leaders’ theory will help to show the integrity, and the expertise necessary to develop a robotics trading system thus inspiring vision of the future enhancement. This motivate people to achieve this cybernetic vision, to manage its delivery, and build ever stronger and more successful teams (mindtools, n.d.). Human interaction with Artificial intelligence, neural network and machine learning are computer-based methods to apply and integrate the computer processing power in solving today's business issues just like the one the subject matter in this paper. These intelligent agents, or electronic robots (e-bots), are a software-based unit with intelligent capabilities and functionality capable of perceiving, reacting and learning from its interactive experience with human, rather than just waiting for input data and information and reacting to it. (Rodriguez, Zalewski, & Kirche, 2007)

The computer science program and rule-based engine are now a day the tool of choice for electronic trading. An interacive information system that represents every automated entity, software and hardware to manipulate wisely financial information, is getting interfaced by information technology for the good of business process optimization in today’s society. The performance of such instruction-based algorithms will depend on the neural-network-based classifiers weighted one-against-all, or weighted parallel structured, with traditional classifiers namely k-nearest neighbor classifier and naive Bayes classifier. (Ekonga, Liua, aHugo, HoLing, & Chan, 2014) . Just as the problem of smart order routing, or the task of executing electronic order as rapidly as possible, the modern wall-street trader will be facing prioritization issue training their robot to buy or to sell a large stock of an S&P order for instance to a specifics markets. When the similar stocks are traded on numerous market venues at the same time, this causes a phenomenon known in wall street as market fragmentation. Traders must well instruct their robot to electronically trade with market venues that will be getting some of those subsets of volume. Another set of rules should include a set of suitable marketable financial assets representing a big portion of the original trade to execute. Executing remaining liquidity across all those markets and completely fill their order need the use of a human coworker as a computer information system that requires the input of data, a processing capability, and the ability to produce an output that can be stored for future use. (simplyeducate.me, n.d.).

My dissertation representing the interaction between human and robot will also display some statistical theory and probability distribution implemented using some pseudo-code that can be introduced in one of those computer servers to execute electronic market order in wall street. We have assumed that expected payoffs are always non-negative, the fixed upper bounds Rmax and Varmax on the means and variances of the payoff distributions, necessary for finite-time convergence results are fixed. (Kearns & Singh, 2002). The output result will be improved using machine learning efficiency and prediction precision for the training of task-specific models discretely for business administration. Between a set dark pools market, the robot will choose which of those trade venues to perform trade execution with specialy when tradeable information is not available to the trader to input as an instruction. By constantly adding a set of other market venues, the trader will have to conceive a robotic trading strategy or an interaction model that would provide the optimal trade allocation volume for these trade venues. My research question is seeking for the answers that would resolve the optimization of instructions of a smart order router (SOR) in a trading desk, in an investment brokerage system as per this image below representing the trading flow. The below institutional order flowchart shows that all orders ultimately end up being executed by a series of aggressive and passive orders sent to market centers (Weisberger, n.d.).



This robot act as a portfolio manager that looks at ratings of companies, capital structure and macro data such as social and geopolitical risks in order to help cut costs, save time and avoid errors, on the financial traded instrument. (World, 2018). I justify why a very well-established corporate leadership would have no choice but to use robots to contingently preempt other market participant behavior, by constantly adjusting related business strategy and fine-tune robots’ training toward that market segment. Organizational decision making, organizational growth and leadership activities are always evolving to the right direction, to adapt the modernized market exchange where robot as assistant are included. This fulfill the efficient market theory hypothesis also covered in my research area. Investors now build “all-weather” portfolios that are more resilient and have a higher probability of achieving their long-term objectives than traditional stock and bond portfolios (investing, 2017).

The core of this research proposal is to constitute a framework that demonstrates how an asset manager can leverage robotic co-workers to operate large trade, and that robot would be executing micro-transaction, each with a predefined set of strategy with any given counterparty in the market without impacting the behavior of the overall market or the behavior of other market participants for the same traded asset class. Human-robot interaction (HRI) has increased productivity and flexibility of the production lines, as it combines human and robot capabilities. (Tsarouchi, Makris, & Chryssolouris, 2016).

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