Generating intuitive behaviour in artificial intelligence

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***Abstract*— Intuition is a sub-conscious but highly effective decision-making process that makes us questions and increase our intelligence. It is generated on the emotional/creative side of our brain and is something that have been proven to be nonexistent for machines. A stimulation is also presented in this study that will help develop an algorithm that mimic the human intuition process. The main question focused in this study is that can a machine become able to figure out the unknown. This study concludes with the potential areas of where this algorithm can be implemented or what would be the ideal application that can use the intuitive artificial intelligence to answer the unknown.**

Keywords—fuzzy logic, intuition, clustering and classification, neural networks, unsupervised learning

I. INTRODUCTION

Artificial Intelligence is getting smarter and smarter with time. But if you look at a general human brain map, scientist divide it into two parts i.e. Left Brain and Right Brain and both have a different role in our thought process. Left brain is responsible for answering all the logical and mathematical problems whereas; right brain is responsible for all the creativity related tasks. There is an approach called as Lateralization, which is responsible of choosing which side of the brain will be used to solve a particular problem or which side will be given the preference to perform a function or an activity. Here is a good image (Figure 1) that defines which type of activity happen on which side of the brain:

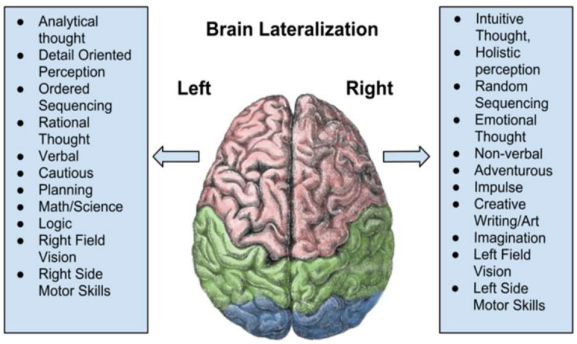


Fig. 1. Brain Lateralization

We have solved many of the problems on the left side of the brain specially when neural networks came out and using the algorithms, we have developed to solve left side of the brain we have used to solve so many of the things on the right side of the brain for example Nvidia GuaGAN transforms sketches into realistic images [1]. Which basically tells us that anything that you can define by a mathematical equation can be done by the computer. So, in this research r goal is to take the concept of Intuition from the right side of the brain and develop an algorithm around it. When it comes to intuitive thinking or decision making many comes together like Recognizing Patterns, Fuzziness of the application and some humanly factors like experience, emotional intelligence, Tolerance, Curiosity, Limitations etc. [2]. Some of these we can make a computer do, but in before going directly into algorithm development one has to understand how intuition actually work for a human decision making and from there, we can gather all the factors ad try to stimulate it into a computer.

A) HOW INTUITION WORKS?

All life forms are atoms which are basically electrons orbiting a nucleus. Two atoms communicate with each other via their electrons. Electrons use photons to communicate with other atoms. Huma body constantly release bio photonic energy and these photons are constantly sending information to every single particle around us. This is the basic biological definition of how intuition works and it happens to every one of us for example we're thinking of someone and we receive a call or a message from them, it's because you're their intuition reaches you before your cell phone network does. Just like you can't see the cell phone tower waves but they arethere just like that intuition is there you can feel it and psychologists have defined it with various terminologies. Intuitions are thoughts that are commonly defined as fast, implicit, parallel, and automatic but V. Hompson [3] argue the very fact and provides a sufficiently different approach that intuitions are based in terms of the mechanisms that give rise to an intuitive thought. Intuitions are the ideas that a person can drive a solution from without any knowledge of how it gets to it but it's the right decision.

B) CAN WE TRANSFORM HUMAN INTUITION INTO MATHEMATICAL EQUATION?

Authors V. Dörfler and F. Ackermann [4] created a model which look similar to a confusion matrix that is widely used for model evaluation for machine learning models. He placed the model on intuitive and non-intuitive insights and judgements as shown in figure 2. This represents that for every intuition to occur there has to be a problem first. Problem is something that is non-intuitive but in order to solve that problem you get the ideas in your head and that's intuition. Some additional models have also been defined in the intuitive models to further advance the knowledge base and based on these reviews we have designed a stimulation which will help

us develop the algorithm that will invoke a machine into taking right decisions intuitively. Intuition is an ambiguous concept where you can find different definitions ad models but to choose the one that can actually define what intuition means for a machine is a place to start with because it'll be a bit different for machines that it is to humans.

II. INTUITIVE MODELS

Different researchers over the years have presented with some models in which they try to define intuitive decision making. We've chosen two as our work is based on these as foundations or stepping stones which adds to our work as a proof that intuition is something that can be defined by a model and model can be defined in mathematical equation.

A) INTUTIVE INSIGHTS & JUDGEMENT

Machines solve problems so based on the model in figure 2 it'll be more relevant when we're thinking about converting intuition into a mathematical equation. Problem can be identified based on the knowledge that we have and decision will be based on something that we have no knowledge about. Some models of unsupervised learning do the same thing and basically works in an intuitive nature but they are trained to do that and can't make a decision if we put them through a different set of problems that they are not meant to solve.

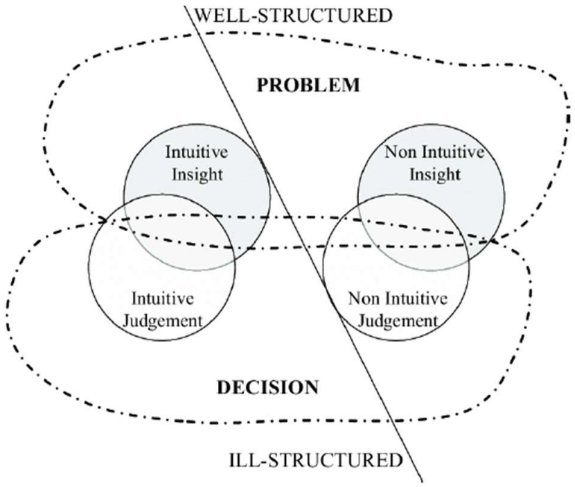


Fig. 2. Intuitive and analytical parts of judgement and insight

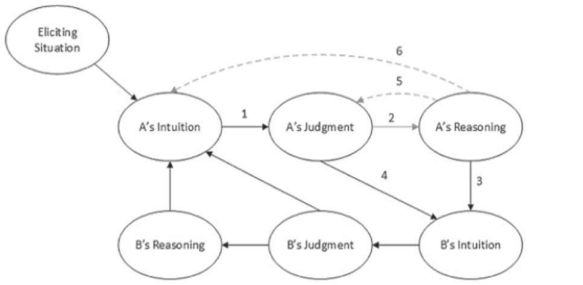
In their work they have discussed cases for two forms of intuitions:

- Intuitive judgement
- Intuitive insights

From Figure 2 you can see that a well-defined difference between the two is shown and it tells us that intuitive judgement is a decision reached on the basis of subjective feelings that cannot easily be articulated and may not be fully conscious whereas insights are something that are understood for example suddenly getting the insight of how to solve a math problem that you have been solving for some time, it works like recombining single element of a problem [5]. So, intuitions are basically thoughts that most of the time proves to be right. The focus of this research is to come-up with a new algorithm or make amendments in a current on which allows computers to identify a problem like classification or clustering etc. and that algorithm can intuitively should do the right thing. But in order to come up with something we need to put the AI in an environment that can stimulate it to take decision based on intuition and will replicate exactly how a human would take decision actions in that environment meaning a stimulation with some rules in which if you put a human or a computer they'll be taking decision based on same scenarios.

B) SOCIAL INTUITIONISM

Social Intuitism is a concept that presents a model that inuitions comes first and reasoning is usually produced after a judgement is made [6]. But as discussion profresses the reasons given by other people sometimes chaange our inuions and judgements. They are focusing on emotional brain as our emotional braian is smarter and emotions is something that is currently not present in our computers but we tried to put gold in the stimulation which represets and an emotion but not the emotional brain that the social intuitionism talks about. The reason for mentioning this concept after all the discussion on intuitions and the stimulation is because this is a very important concept in decision making but out current stimulation does not handle that as we're assuming this algorithm to be used I thigs like Mars Rover which if lost contact with the mission control can be able to figure things out of it's own and there will be no one there to influence it's decision, though it's already very smart. Figure 5 shows how the social intutionism model loooks like.



Defined by Haidt (2001): 1=the intuitive judgment link; 2=the post-hoc reasoning link; 3=the reasoned persuasion link; 4=the social persuasion link; occurring less frequently are 5 and 6, the reasoned judgment link, and the private reflection link, respectively.

Fig. 3. Social Intuitionism Model

The model highlights two people A and B and as defined A gets and intuition and based on that A makes a judgement and provides reasoning for that. Here after getting the reason A can also get back to its judgement if the reason is not strong enough for A or can get another intuition which will change the judgement and reasoning before passing it to B. A can pass judgement with or without reasoning to B and this creates B's own intuition, then judgement and the reasoning which can influence A's judgement [7]. Because there is another subject involved here and your decisions are influenced by one another that is why it's called as social intuitionism. The highly advanced AI that we usually see in movies learn after communicating with humans basically use aa same concept in which intuitively a question came to their mind and they ask questions and change their intuition and try to make sense of something. The intuitive decision making that'll be applied to this stimulation will be based on the fact that how well we can measure intuition or can we measure intuition? [11] One of the techniques from which we can generate intuitions is to see the limitations of the current intuition based learning (IBL) which

has been used in many problemsolving areas like risk analysis, medical diagnosis and even in law related services like criminal investigations. So, we need to develop a learning model for human-computer cooperative alliance. One such model wat introduced in 2009 by H. ping and colleagues called Trusted Intuition Network (TIN) [12] in which they developed a model of measuring intuition reliably and more accurately and the outcome of such convolutional network is based on the learning and artificial intuition of the intuition-based learning methods. The we have an experiment that was conducted by E. Trivizakis and their colleague that uses deep learning to process mammographic breast density and visualized results from convolutional and neural layer to perform an intuitive analysis. [14]. But will human intuition always remain better tool than AI for exploring the unknown? Will machine ever be able to make something meaningful out of the unknown? [13]. Intuition and logic are two strategies for prediction and problem solving in the unknown knowledge base. Humans are not always taught logical thinking but most humans are still intelligent. Where does this intelligence comes from? Extensive work has been done on developing algorithms for artificial intuition for example Limiting Generalizations Paradigm (LPG) which tells us that basic entities of LGP, With the help of formal models and constructive algorithms, it is shown that the basis for rapid cognition and intuition is the adaptive unconscious - the thought process that works automatically when we have relatively little information to make a decision. [15]

III. THE STIMULATION

To design a stimulation that can enforce intuitive behavior for machines, we went through the early ages of artificial intelligence. We looked at Wumpus World, which was a simple world example to illustrate the worth of a knowledge based agent to represent knowledge representation in the early ages of artificial intelligence. It was developed by Gregory Yob in 1973 and to this date there have been many algorithms that researchers have used like search algorithms, satisfiability algorithms, declarative planning domain descriptions and even Bayesian network interference algorithms have been applied to this this stimulated world [8]. But the concept of Wumpus world is not suitable for an intuitive based environment so in order to develop an algorithm we have changed some rules and added some of our own rules to satisfy some scenarios that'll allow AI to take intuitive based decisions to do the right thing which in this case would be the goal i.e. finding Wumpus. The goal is to develop aa stimulation that when placed in any situation that the machines has not seen before and it try to make sense of it and to a general set of problems and not some specific set of problems. Let's have a look at how this scaled down simulation of generating intuitive behaviors will look like. We have created a stimulation that if played by a human or a computer will go through a similar mindset and we'll also test this in an environment where there is social factor involved to generate a social intuitionism, butt currently it is based more towards V. Dörfler and F. Ackermann model of intuition and insights.

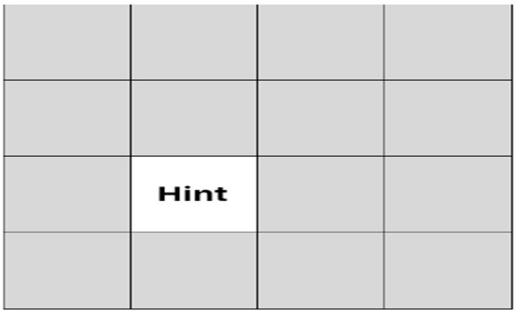


Fig. 4. Wumpus World Stimulation developed for this study

The simulation consist of a 4x4 grid (16 boxes) as shown in figure 3 and out of these, four boxes have a pit and if you select a box that have a pit hidden you'll fall into it hence you'll lose. One box contains gold and one box have Wumpus monster hidden it in. You goal is to find Wumpus. Gold is just there to collect as an optional thing. If you collect gold you get extra points. This basic summary of the stimulation is encouraging three types of behaviors:

- Encouraged Optional Behavior
- Goal
- Risk

The encouraged optional behavior is finding gold. You can directly find Wumpus and win the game but if you find gold that'll give you extra rewards. Now if you put humans through this, you'll basically have two types of people one who will go for getting extra points and one who'll go toward finishing the game in a win state. For AI we can handle this as generating a random 1 or 0, 1 means go for gold 0 means don't go for gold and this random decision will be random and will stimulate an intuitive behavior which will be to strive for something by taking a decision on a simple coin toss and then going for it. The goal is wo find Wumpus because only then you can win and then there is risk which is falling in the pit.

When a new stimulation loads it randomly shuffle the 4x4 grid so every time you'll be getting a new environment with same rules. The new stimulation will open a box at a random spot which will give you a starting hint. Not you can either take that hint and start planning where to move from there or you can open a totally random box out of the 15 remaining. Every hint tells you about what might be in the adjacent boxes. If we talk about the probability of risk of opening a box other than the adjacent boxes let's say it's 0.5, it'll be the same for every box that is not adjacent box to the opened hint box as shown in figure 4. There are adjacent boxes faded just to differentiate that the probability will be different. The probability can be higher or lower based on how the world is generated i.e. on which random sequence. Some hints are good some are bad and every box you open only change probability of its adjacent boxes and some of the non- adjacent boxes but the overall probability of risk remains the same.

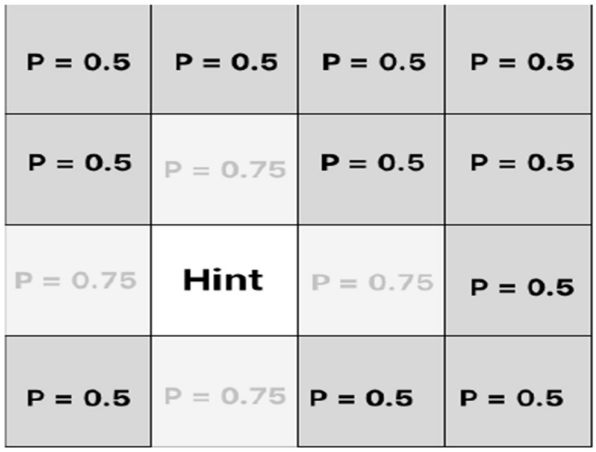


Fig. 5. Wumpus World probability of boxes not adjacent to the hint

As you can see all the non-adjacent boxes have equal risk. If AI or humans pick any of the box there is an equal chance that it might be a pit and they can lose the game. There is also risk in opening adjacent boxes but it's a less risk as because of the hint you have a general idea that what might be in the adjacent boxes. But after running couple of stimulations we found that sometime the hint is indicating that there is a pit in the adjacent boxes, so it's aa risk to take a decision of opening adjacent boxes so in this case will AI take the risk of moving away from the adjacent boxes or will take a bigger risk by trying to open one of the adjacent boxes. So, as you can see there is a lot of ambiguity in this small world but all of this can be defined in a mathematical form. With changing probabilities at every step and based on hints and with actions and behaviors your previous knowledge about the environment is also not helpful as it changes randomly every time you start. It's a great scale down model of how our world works and how we have to take the decisions. We have some knowledge, general laws of the world and similarly here we have the general knowledge of what each hint is and what our goal is, and we have to take risks in order to achieve our goal and those risks are totally random based and totally based on intuition.

We have created this stimulation and generating data on every game play. It stores every small detail about it like the sequence of grid, how user have moved on the grid and what was the outcome. The data is generated by human players and not by a computer so an AI program will be written based on this stimulated world when the experiment will begin and the algorithm will use a existing model or a new model that will help generate intuitive decision making for the machine and comparing the results we can find if the algorithm is making the machine take intuitively right decisions. The accuracy value of this model will be less as intuition in humans have equal amount of risk into facility but as we have seen in computer brain that in can work faster in so many scenarios as compared to humans so there is aa high chance that the intuition of machines will be much higher.

TABLE I. LITERATURE REVIEW MATRIX

Author/ Date	Theoretical/ Conceptual Framework	Research Question(s)/ Hypotheses	Methodology	Analysis and Results	Conclusion	Implication s for Future research	Implications For practice
Dorfler/2012	Intuition in the management literature is generally conceptualiz ed as judgement intuitive insight.	Recent rejuvenation of intuition research within the management literature, significant work has been done on conceptualizi ng intuition	Distinguishing between intuitive judgment and intuitive insight.	There are two distinct kinds of intuition – intuitive judgement and intuitive insight.	To understand problems, we need non-intuitive insights and judgements and for decisions we use intuition.	We'll use this concept in the algorithm to help it understand the problem better. Because if the problem identificatio n is good, we can expect for better intuitive decision making for AI.	Intuition is an ambiguous topic and it can't be simplified into a simple two generic terms. So, we can't entirely base our algorithm on this model.
Matzler/2007	Using intuitions in daily life problems is something that has aa risk factor. So, to answer these questions	They took a scenario of a manager who made executive decisions at their workplace.	The authors draw on examples from the worlds of chess, neuroscience and business - especially Austria's KTM Sport	Intuitive decision making should not be prematurely buried.	Intuition can be used at the work place specially when the scenario occurs in which you're asking questions like "Now what do we do?"	More examples can be included to further the research in the field of management science.	Study of intuition has not been extensively explored as a part of management science

	this research was taken place.		motorcycle AG				
Nigam	How intuition works for stock market investors specifically because it's a very unpredictabl e market.	Stock market is a business where intuition is used the most. So, how can we check factors affecting intuitive ability of investors.	Taking personality types, consciousness, mindfulness, and religiosity put them through intuitive ability and get efficacy of stock market investors	Higher the intuitive ability of stock market investors, higher the efficacy of stock market investors.	Depending on the year of experience an investor have in the stock market is directly proportional to cognitive ability of that investor.	They have used one sector and included many factors like gender, years of experience etc. we can advance it by adding more factors to the equation.	If we try to implement current study to build and AI that can-do stock investment it might not be a good study to follow.
Park/2019	Adobe & Nvidia joint forces to study and develop an AI that can learn from the lyda sensor (Latent Vector) type image to create a realistic imagery.	Can AI transform a sketch into a realistic image?	Style encoder network captures the style into a latent code, which our image generator network combines with the semantic layout via spatially-adaptive normalization to generate a photo-realistic image that respects both the style of the	GAN models work and they enable people without drawing skills to effectively express their imagination.	GAN model was successful to create stunning realistic images from sketches making it very hard to differentiate between the real or fake landscapes.	This study will be used to see how aa creative process takes place in the mathematica l world. Using the multilayer convolutiona l networks, they were able to generate a process that usually takes	We need to identify the type of thing we're painting in the sketch which increase chances of the model to depend highly on data and we're trying to achieve something in a totally unbiased environment.
			guide image and content of the semantic layout.			place in an artist mind.	
Thompson/201 4	Clearing the norm and confusions that revolves around intuition by explicitly explaining what intuition is and what not.	Do intuitions define in terms of their supposed characteristic s, for example, fast, implicit, parallel, and automatic? Look for points of intersection between these views and to suggest avenues for future research	Examine the role of coherence in terms of both the information that gives rise to intuitive judgments and the processes that monitor those judgments.	Intuitive thought is best understood in terms of the mechanisms that give rise to it	This works colluded with a discussion of the relative value of intuitive and deliberate thinking.	Intuitions may arise from a number of different memory processes, such as associative learning, skilled memory, recognition memory, and gist memory. Many metacognitiv e processes, specifically, the processes by which our cognitive processes are monitored, are also a form of intuition.	A totally different but extended way of defining what intuitions are. I see no implications to use this practice in the proposed algorithm.
Bryce/2011	Wumpus World was ana early age AI stimulator which was used to test expert systems and other AI based early researches.	To see how different algorithms, perform in the Wumpus world and how each algorithm has different impact on Wumpus world environment.	Wumpus world stimulation was tested on search algorithms, satisfiability algorithms, declarative planning domain descriptions, and Bayesian network inference	Neural networks proved to be the best one to have the highest efficiency among all in solving Wumpus world problems.	Neural network is without a doubt some of the best algorithms of today with highest accuracies.	Using neural network and improving some of the bias values based on the intuitive insights could do wonders towards increasing accuracy of the decision- making	Study doesn't highlight if there are other environments will the algorithm still works as they should? Because for a classification problem if we

			algorithms applied to Wumpus World			process.	use clustering algorithms it'll not work properly, so the research failed to answer that.
Prokopchuk/20 17	Intuition and logic are two important strategies for prediction and problem solving. If we look at the major focus of the focus of research, then we'll	How does intuition work? Author believes that artificial intelligence requires artificial intuition.	Modeling the work of intuition is proposed on the basis of the Limiting-Generalizations Paradigm (LGP).	The key components of the intuition model are: basic entities of the LGP; a task-inductor space, event space, an "artificial connectom",	We can achieve AI Intuition by combining concepts from both formal models and constructive algorithms.	We can use the methodologi es used in the research to further enhance our own algorithm.	The proposed model is the methodologic al basis for creating promising IT, as well as intuitive agents, robots which can be very useful for our algorithm so
	see it's mostly on logical brain of both humans and computers.			coherence mechanisms; Thin Slices. [15]			I found no implications.
Zander/2016	This study finds out if intuition precedes insight. Insights and intuitions are very closely bound totally different things.	The two processes appear similar; according to a lay perspective, it is assumed that intuition precedes insight	By examining the conceptualizatio ns of the assumed underlying cognitive processes of both phenomena, and by also referring to the research traditions and paradigms of the respective field	Intuition denotes ideas that have been reached by sensing the solution without any explicit representatio n of it. insight has been understood as the sudden and unexpected apprehensio n of the solution	Predominant scientific conceptualizatio ns of intuition and insight consider the two processes to differ with regard to their (dis-)continuous unfolding	If we are able to generate intuitions in AI, we'll be needing insights or a similar concept to verify them.	Need experimental studies and to initiate scientific cooperation between the research fields of intuition and insight that are currently still separated from each other.
Hodgson/2016	A broad agreement that brings attention to the codes of ethics, ethical reasoning and social intuitionism in the field of social work education.	What Can Moral and Social Intuitionism Offer Ethics Education in Social Work?	An inquiry designed to explore our practice as social work educators in the context of the debates about ethics in social work education.	Bridge the divide between rational and a socially situated and reflective approach to ethics, often considered appropriate to practice.	Our experience is best illustrated by a social intuitionist approach to moral development that has emerged in recent years	A brief study that does not include AI but other aspects of social intuitionism which can be useful to define machine version of the factors that can influence its power of influential decision making.	Briefly made for the domain it is focused on, no clear information if the model proposed can be used for a broader perspective.
Havasi/2009	Many of the limitations of artificial intelligence today relate to the problem of acquiring and understandin g common sense.	How can we generate commonsens e in a machine?	The Open Mind Common Sense project began to collect common sense from volunteers on the Internet starting in 2000. The collected information is converted to a semantic network called ConceptNet.	Reducing the dimensionali ty of ConceptNet' s graph structure gives a matrix representatio n called Analogy Space, which reveals large-scale patterns in the data, soothes over noise, and	Using these techniques, they created a method that uses singular value decomposition to aid in the integration of systems or representations.	The dataset can be harnessed to find and exploit correlations between different resources, enabling commonsens e reasoning over a broader domain.	I see no implications to use this practice in the proposed algorithm however the dataset can include more data points.
				predicts new knowledge.			

IV. CONCLUSIONS AND FUTURE RESEARCH

Intuitive is affected with a lot of factors and some of them were discussed in this work but there are many others. So, a possible futuristic view of this work would be to add more factors like different emotions that might affect intuition [9]. Define emotions for machines, how would look like in a machine or what type of emotions would be in a machine. Using the stimulation developed in this work,

add/modify rules to generate different behaviors that lead to improving accuracy of making the right decision intuitively. Also it can prove to be a very good start if we look at the common sense as it's a thing where we can see patterns in the data and if computer is able to gain knowledge without any support for example 2+2 is 4 and the computer understand that 3+6 will be equal to 9 would be something that ca be a starting building block in the field of intuitive artificial intelligence [10]. One potential application of this algorithm would be used I the rovers that are being sent to other planets where they know the basic stuff like moving, consuming energy, taking pictures, sending them back etc. ow what if the rover lost contact with the mission control which has happened in the past. If a human would be on that planet it would think of two things at that moment. One is to how to survive when the supplies runs out and two how to contact back to the base. To achieve that human would try different things and will follow its intuition as in that case it can use the limited knowledge, they have but rest will be based on intuitive decisions, insights, judgments, and reasoning. Another future aspect would be as intuition is a field that can be extended to the largest possible level if we can improve the current proposed stimulation I which we can train a machine intuitively and that stimulation can produce higher accuracy. Machine intuition can only be created by combining different fields but as we're progressing in the field of AI we need more unsupervised and unbiased algorithms with high accuracy because only then we can strive towards an era where machines and humans are going had I hand, because we are aiming towards making intelligent machines rather than labor machines.

Many of the reference are old but it is only because intuition is an ambiguous topic and there is not much work done on it from technology point of view. Psychologists define it in so many terms and because it is the knowledge that we all have but no one can actually understand how so it was essential to see old and new material and use it in this research as moving forward we'll be combining knowledge from different domains to develop the algorithm that'll generate intuitive behavior in machines.

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