PUBLIC SUBMISSION

Received: May 21, 2025
Tracking No. may-c13t-d3lc
Comments Due: May 28, 2025 **Submission Type:** Web

Docket: NSF-2025-OGC-0001
NITRD_FRDOC_0001

Comment On: NSF-2025-OGC-0001-0001
Request for Information: Development of a 2025 National Artificial Intelligence Research and Development Strategic Plan

Document: NSF-2025-OGC-0001-DRAFT-0091
Comment on FR Doc # 2025-07332

Submitter Information

Name: Uma Chandrasekhar

General Comment

See attached file(s)

Attachments

Recommendations to FedGov

An update to the recommendations to the Federal Government of the United States of America.

Introduction

Artificial Intelligence has become a vital aspect of human life, taking its suitable role in every form possible. AI agents have been helping us, in multitudes, since big data was unveiled in 2004. Whether it is recommender systems or search and social media algorithms, Artificial intelligence has made its unshakeable impact in our lives. In fact as a part of smart home devices, they have become a family member too, knowing all our preferences, starting from culinary delights to entertainment favorites. Nonetheless it is highly important to understand that this marvelous technology is currently, at cross roads and the next turn it takes, is going to be critical, as they are entering our lives, in a futuristic sense, as robotic AIs equipped with genetic algorithms and nano ICs. With that significant thought in our heads, we need to train and test these models to be safe, secure, private, fair and accountable automated systems.

The aim of this update is to provide insights into the futuristic AI systems, through facilitation of their definitions, architectural models, and applications, too.

I am enabling this utopian update in three major classifications.

They are

1) Smart devices with Genetic algorithms
2) Nanotechnology materials and chips
3) Secure , private , accountable, fair AI systems

Let me address the above three topics, in detail, in the same order.

Topic 1

Smart Devices with Genetic algorithms

Smart devices are gadgets connected to the internet equipped with intelligence in the form of sensing, networking and information processing, as their core functionalities. Technically named as 'Internet of things' [IoT], by Bill Gates, the founder and the former CEO of Microsoft Inc, in his book 'The road ahead', published in 1995, the smart devices are electronics distributed across the internet and they are mutually co-operative with minimal human intervention.

Definition

The IoT devices are ubiquitous digital devices, connected to the internet. They are meant to carry out five basic capabilities and they are

- Learn
- Adapt
- Monitor
- Control
- Optimize

Architecture as a part of Feature selection

The smart devices of today are trained using CNN , RNN or ANN, which imitate the human brain , by considering every neuron as weights in hidden layer. The idea of using genetic algorithms in IoT devices is mainly to improve their accuracy based on the natural behavior of the human mind and improving their smartness through exploration and exploitation technique, which is the basis of genetic algorithms. Genetic algorithms can be used for resource scheduling and routing purposes, by exploring and exploiting the network for available channels.

Feature selection helps the genetic algorithms to perform their best mode. The most vital five features of any IoT device, in terms of connectivity, which makes them ubiquitous are

- MAC address of the source and destination
- Port number of the source and destination device,

- IP address for communication [1]*
- ID of the network connected
- Total duration of the communication along with the bytes transferred per second.

Particle Swarm Optimization

The genetic algorithm , I am planning to discuss is chosen for its versatility and its quicker convergence and it is Particle Swarm Optimization [PSO], which is well known for its exploration and exploitation techniques. Though PSO poses challenges to achieve convergence , when it comes to non- co-ordinate systems , such as the resources scheduling systems, I am discussing, it is possible to transform the space using dimensionality reduction techniques or through creating a representation, which maps the problem space to a co-ordinate space, then apply PSO.

In our case, every cell tower and router can be represented as a mapping system in every iteration and the new updated position of the data packets can be calculated and then the local and the global best can be chosen from them. [2]*

It's already been used in route/path planning for autonomous robots, including warehouse robots. It takes into account, collision risk, shortest path length and smoothness of the path, as it takes care of the position and velocity of the agents at every instant, and based on the same, the new position and new velocity is updated in the set of solutions, till the local best and the global best solutions are reached. [3]*

Types of PSO

I am planning to discuss three types briefly using the concept of topologies [4]* which is widely used in PSO algorithms .

1. Guaranteed convergence PSO(GCPSO) can be used in many neighborhood topologies such as 'All' (Global Best) ,
2. 'Ring' (Local Best) and
3. 'Von Neumann' [lattice best also known as k- means algorithm.

The topologies define the local and global population and indicates the information exchange between the particles. [5]*

Quantum Particle Swarm Optimization[QPSO] is also type of PSO, based on the Euler - macaroni constant and Schrodinger's wave equation. The most important part to be considered is the search strategy of the local and global search space, as excessive global search results in slow convergence and excessive local search results in prema-

ture convergence and neither result is good for the algorithmic performance. The compromise is the best exploration- exploitation behavior of the quantum particles. The convergence is controlled by controlling two parameters α, γ [6]*. QPSO can be effectively applied for non- co-ordinate systems, such our case of resource scheduling.

Applications

PSO has an enormous amount of fields of application - to name a few

- Telecommunication [selection and scheduling]
- Control systems[Path planning and shortest path]
- Signal/ Image processing[Image segmentation and feature extraction]
- Data mining and data handling [Cyber security for data in storage and data in transit]
- Smart grids and power systems.[Energy Transmission and distribution

Topic 2

Nanotechnology - Chips

Nanotechnology refers to those methods and techniques carried out at nanoscale, which is one - thousandth of a micrometer. Nanotechnology come in many forms such as chips, materials, scopes, robots etc.,

Definition

A classic but simple definition of nanotechnology is
“the design, characterization, manufacture, manipulation, placement, modeling , measurement and production of materials at nanoscale in order to make matters, systems and devices with novel properties and functions.”

Architecture - Nano chips

‘Nano chips', similar to traditional microchips are silicon chips and contain a number of electronic components such as transistors, resistors, capacitors, etc fabricated at nano scale [one billionth of a meter]. ‘Nano chips' have the potential to revolutionize a

number of industrial applications such as electronics, healthcare and energy. The development of 'nanochips' is done using Extreme Ultra Violet Lithography and there are many challenges in the process of manufacturing ‘nano chips' and this impacts the manufacturing cost , as the process can be improved to develop new technologies and methodologies for designing and testing nano chips.

There are different types of advanced semiconductor architectures built using nano chips, as a part of future evolution in silicon chips. To list the most important

AI driven design for neural networks

Inspired by Von Neumann Architecture, the AI driven architecture design is to optimize the physical layout of chips , minimizing wire length and reducing the overladen look , due to denser packing, using AI algorithms, which explores the various potential design options within the set of constraints and they are allowed to arrive at the objectives to find the optimal chip design. Artificial intelligence algorithms can also be applied to verify the chip designs and generate test patterns . The two famous algorithms which can be put to use are reinforcement learning which closely follows swarm intelligence algorithms, with a few exceptions and GAN [Generative adversarial networks] which are basically two neural networks constructed out of synthetic data , where one network generates new data and trains the model, while the other network determines whether the data used belonged to the original data set or not, thus identifying the fake data. The epochs continues, every time, creating newer data till the first network generates data , which the second network cannot identify as fake. This is highly used fraudulent detection techniques. In other words, the generator has become so good that the predictor cannot find the fake from the real, thus giving birth incredible packed IC design.

Applications

The areas of applications of nano chip and nano-materials are varied and diverse ranging from electronics to health care , from aviation to quantum computing , from space tech to designer babies and so on and so forth.

Topic 3

Secure, private , fair accountable AI systems

AI based systems are ubiquitous as most of the digital gadgets we use are equipped with the artificial intelligence technology, which sort, group the data available to identify and classify the data. The decisions that are made by the automated systems are completely data driven and as rational as the data, fed to them.
Nonetheless, when artificial intelligence is discussed as a technology, four aspects that prop up to be vital features of the same and they are

1) Security of the data collected and handled.
2) Privacy of the data stored and trained on.
3) Fairness of the decisions made by the machine learning algorithms, using the data.
4) Accountability of the algorithms for the decisions made by them.

When the above four aspects are dealt with, we end with error free AI decision making systems, which can be relied on.

Definition

Security & Privacy

Data security is about securing data collection and data handling methods , while data privacy is about the protection of the meta data. While data must be secure, meta data must be kept private and the data regulations must reflect the same.

Fairness

Fair scheduling and allocation involve the fair sharing of the available computing sources such as disk, CPU, memory, etc., equally among the users. Fair resource allocation can be made based on using priority queues.

Accountability

Accountability' is derived from the adjective 'accountable'.
As per Oxford Online Dictionary, 'accountable' is defined as

"responsible for your decisions or actions and expected to explain them when you are asked".

Architecture

Parametric model for fairness and accountability

Setting up a parametric model for implementation using high level languages involves four steps, and they are [7]* [8]*

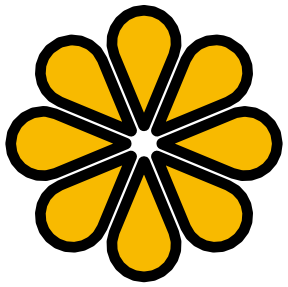
- Setting up the parties involved in the algorithm as parameters, as these variables play a significant role in controlling the artificial neural networks.
- The policy set is taken care of using public function, as policies are specifications which are set for the algorithms to perform a task and reach a result.
- The protocols involved help in executing the set policies using cryptographic commitments.
- The ultimate step defines the roles and responsibilities of each of the parties defined in step 1. The roles and responsibilities are based on a democratic mode of execution also known as checks and balances. This is to make sure that the parties involved, and the corresponding parameters do not exploit one another and to ensure Pareto optimality, in order to arrive at the best result.

Accountability through automated decision systems

It is possible to differentiate users through measuring and reporting the outputs of automated decision systems, thus increasing accountability. The process can be equated to, 'observing different profile data with different privacy settings'. Thus it is possible to identify whether the system follows the stated purposes and practices, fairly, for every user. A score card for every user can be maintained, where an indication can be made when the system understands and act as per the 'User privacy settings' . The measurement of those results is used as a formal approach to assign blame when the decision making systems violate a desirable feature and hence make the 'AI based decision making algorithms' accountable, without revealing any algorithmic code or internal data used to make the decisions, thus gaining transparency and control on the algorithmic systems.

Conclusion

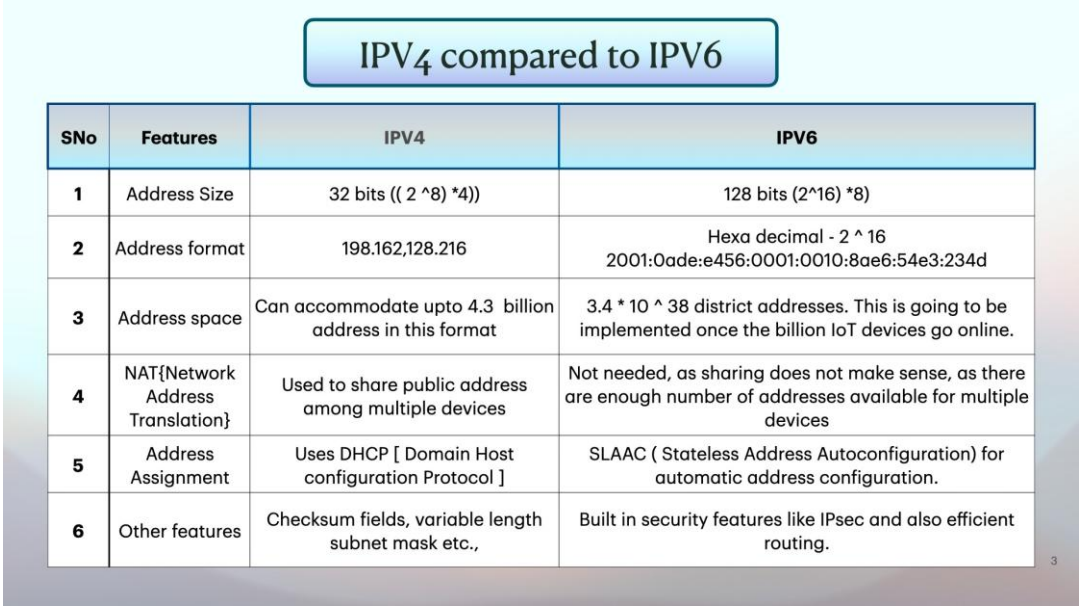
The future technological landscape is vivid and diverse. Yet I focussed on three most important fields of significance, as the three evolutionary fields has absolute impact on every wake of human existence. The super computers which are highly efficient quantum computers are modeled using nano materials, are ubiquitous and evolving to be unbiased accountable systems, with high privacy and security features, as I write this update. The quantum chips recently released by three tech giants, Microsoft, Amazon and IBM are promising and a fodder to any futuristic technological enthusiasts. Along with ample number of benefits, the above mentioned three technological marvels come with pitfalls and drawbacks too and hence must be watched carefully, as they shape the future where we have to co -exist with Artificial General Intelligence [AGIs]



Appendix

Images mentioned in the report

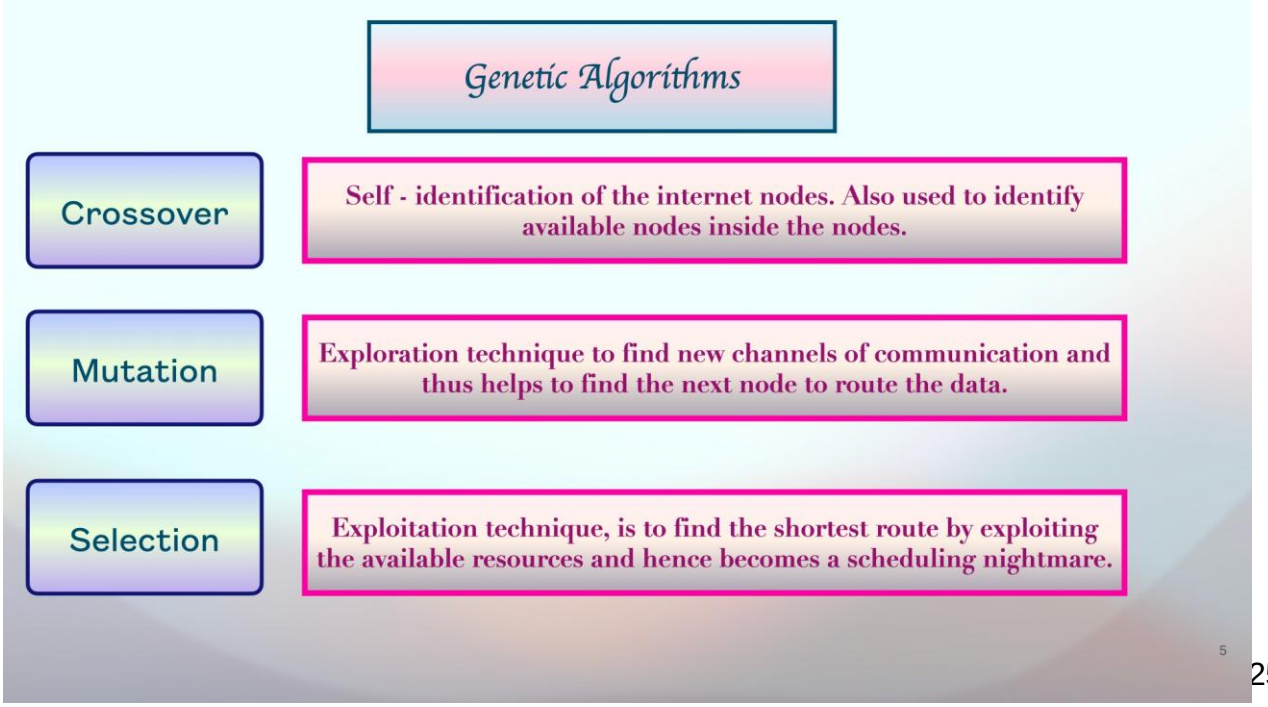
[1]*- Image 1 explains the IPV4 the existing IP address system and IPV6, the futuristic, when IoT explosion takes place.



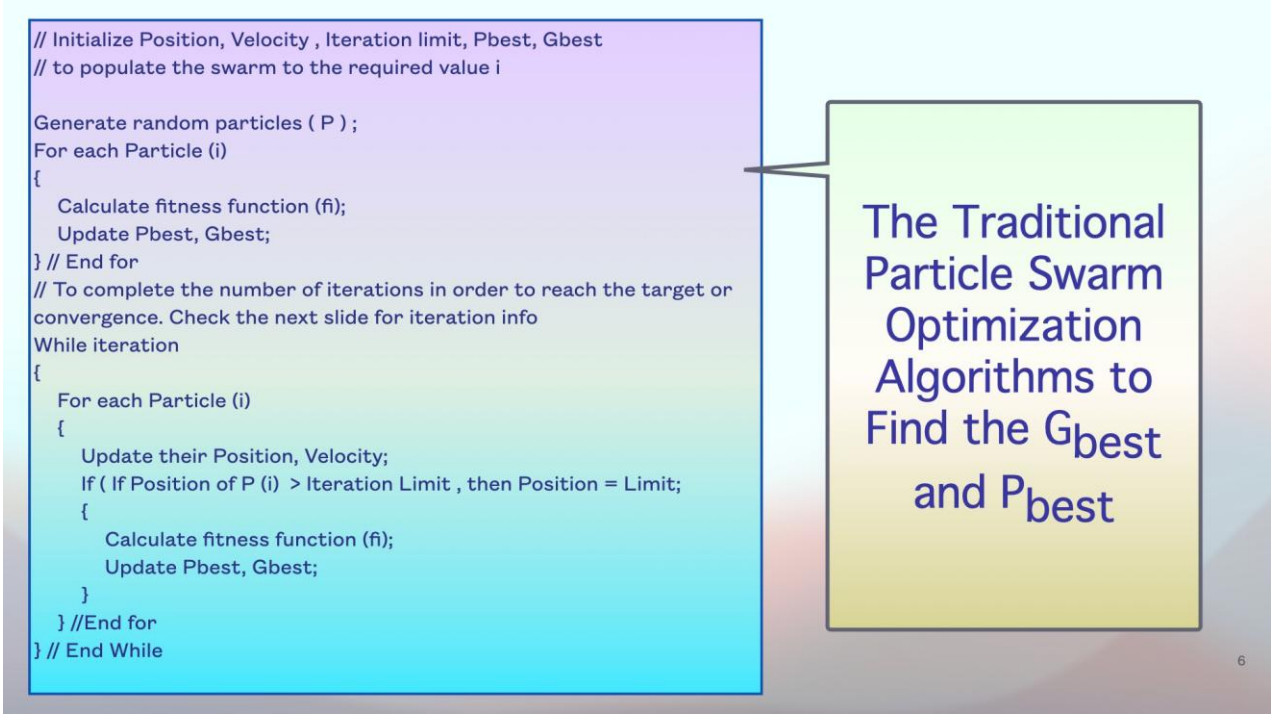
IPV4 compared to IPV6

SNo	Features	IPV4	IPV6
1	Address Size	32 bits ((2 ^8) *4))	128 bits (2^16) *8)
2	Address format	198.162,128.216	Hexa decimal - 2 ^ 16 2001:0ade:e456:0001:0010:8ae6:54e3:234d
3	Address space	Can accommodate upto 4.3 billion address in this format	3.4 * 10 ^ 38 district addresses. This is going to be implemented once the billion IoT devices go online.
4	NAT{Network Address Translation}	Used to share public address among multiple devices	Not needed, as sharing does not make sense, as there are enough number of addresses available for multiple devices
5	Address Assignment	Uses DHCP [Domain Host configuration Protocol]	SLAAC (Stateless Address Autoconfiguration) for automatic address configuration.
6	Other features	Checksum fields, variable length subnet mask etc.,	Built in security features like IPsec and also efficient routing.

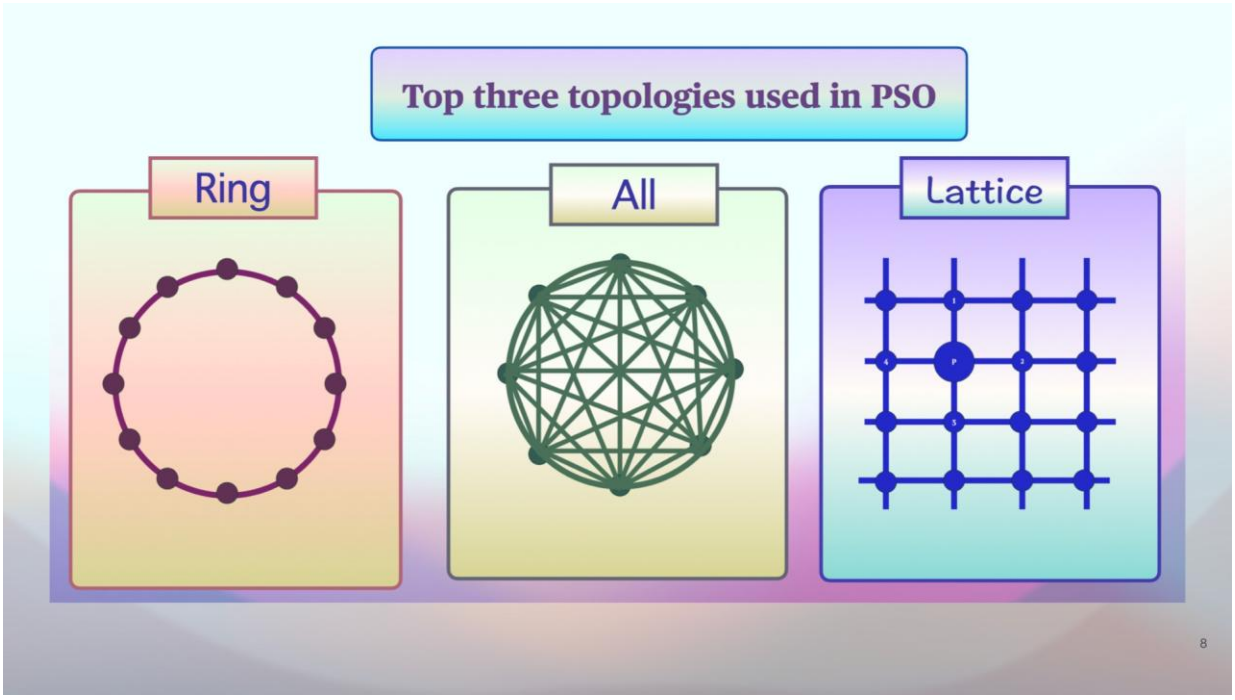
[2]*- Image 2 explains the three important operators used in PSO algorithms to achieve the goal



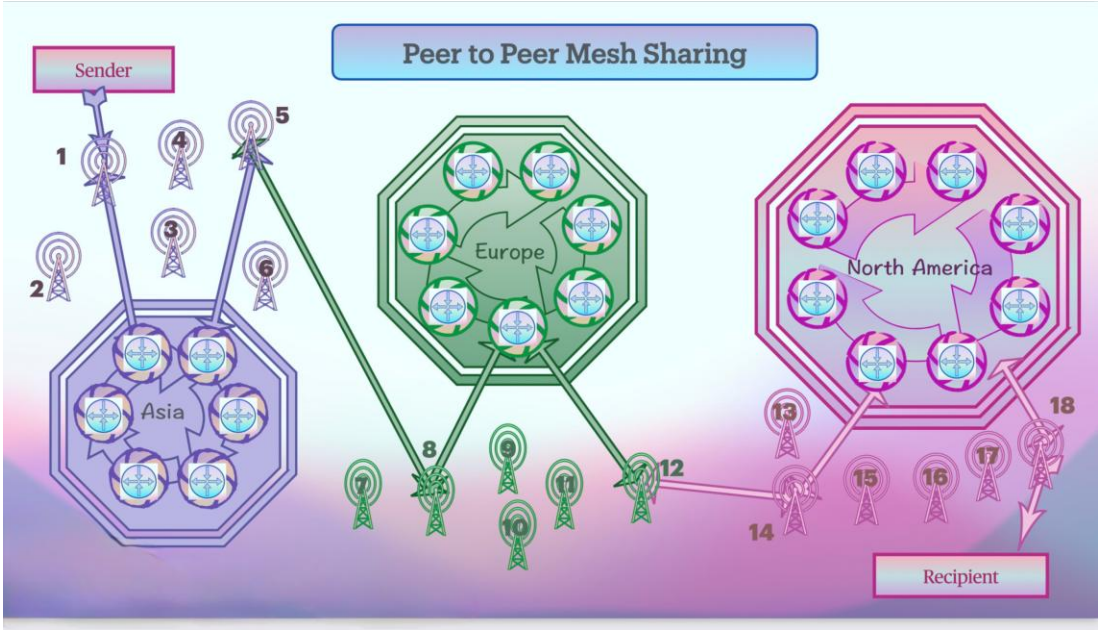
[3] * - Image 3 illustrates the PSO algorithm



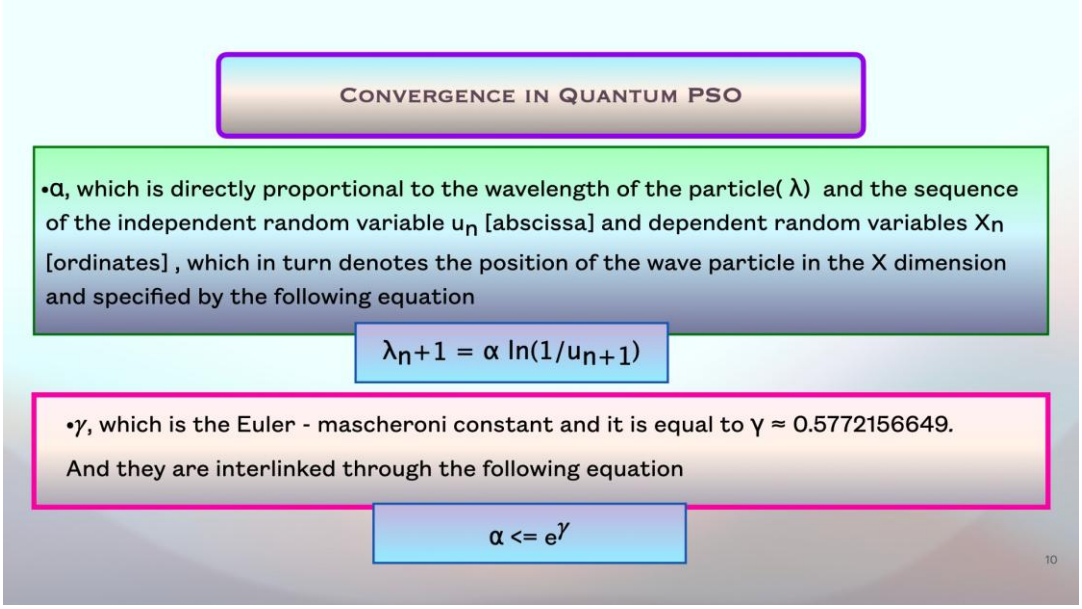
[4] * - The image 4 illustrates the three topologies



[5]*- In the image 5, the shortest path taken by the PSO , by choosing the global best routing nodes , which are 1, 5, 8, 12, 14 and 18, among the local best nodes, by constantly updating the traffic information, resources available and the duration and speed of the communication channel availability, is shown.

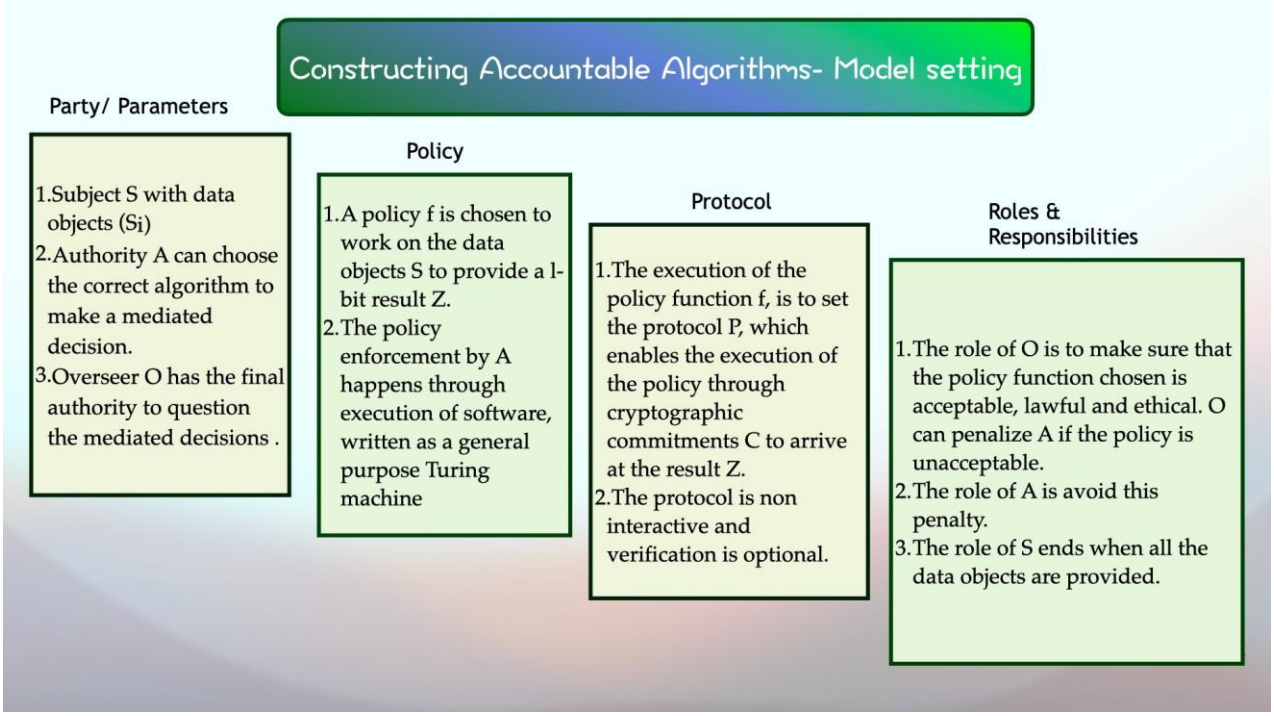


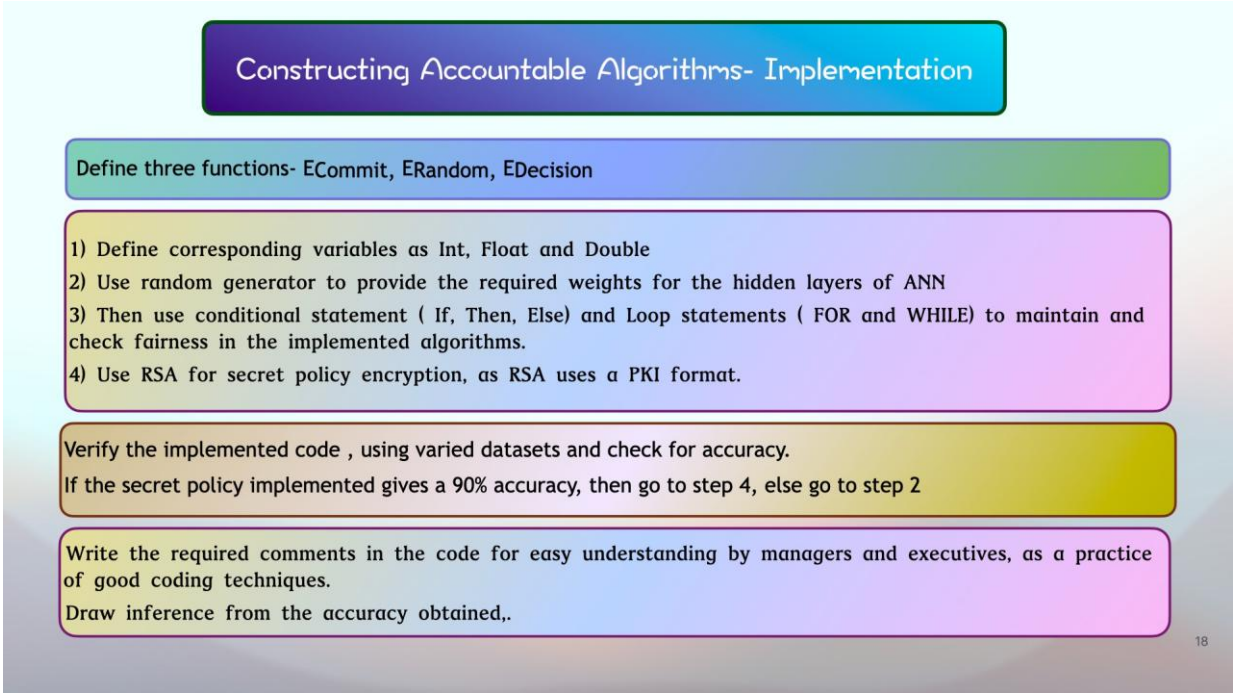
[6]*- Image 6, shows the required equations to control the global and the local best in Quantum PSO



* - Images in Appendix

[7]* [8]* - Image 7 & 8 shows that of constructing accountable algorithms - model setting & implementation





References

- https://link.springer.com/article/10.1007/s12652-018-0715-5
- https://onlinelibrary.wiley.com/doi/10.1155/2022/8806184
- Ant Colony Op,miza,on Vi2orio Maniezzo, Luca Maria Gambardella, Fabio de Luigi, h2ps://people.idsia.ch/~luca/aco2004.pdf
- Strengthening the PSO algorithm with a new technique inspired by the golf game and solving the complex engineering problem by Dereli .S and Koker. [2021] R, h2ps:// doi.org/10.1007/s40747-021-00292-2
- Quantum-Behaved Par,cle Swarm Op,miza,on: Analysis of Individual Par,cle Behavior and Parameter Selec,on by Jun Sun, Wei Fang, Xiaojun Wu, Wenbo Xu, Key Laboratory of Advanced Process Control for Light Industry (Ministry of Educa,on), Jiangnan University, Wuxi, Jiangsu 214122, China, and Vasile Palade, Department of Computer Science, University of Oxford, Oxford, OX1 3QD,
  United Kingdom
- Swarm Intelligence based algorithms: A cri,cal Analysis by Xin-She Yang, Middlesex University, UK
- h2ps://www.mdpi.com/2076-3417/12/14/6938#
- h2ps://www.iinano.org/what-is-nanotechnology/
- “Why Should I Trust You?” Explaining the Predictions of Any Classifier, by Marco Tulio Reibeiro, Sammer Singh, Carlos Guestrin , University of Washington, Seattle, WA
- Digital discretion: A systematic literature review of ICT and street- level discretion by Busch, Peter Andre and Henriksen, Helle, 2018.https://www.researchgate.net/publication/322462443_Digital_discretion_A_systematic_literature_review_of_ICT_and_street-level_discretion