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1. Research Question/Aim

Explore Stigmergic Based Optimizations for service composition and adaptations in Decentralised Environments

2. Research Objectives

- Implement Stigmergic algorithm and its different phases e.g: Initialisation phase, forward traversal phase, solution evaluation phase and backward traversal phase.
- Develop and Simulate Agent Community on Cloud (Mobile Agents and Service Agents)
- Evaluate QoS graph obtained by above algorithm against a centralised approach with known QoS values either by assigning dynamic values to the above created simulation or using values generated from prior works

3. Approach/Method to achieve objectives

- Existing literature review to understand existing Swarm Intelligence Approaches in computer science applications, Ant Colony Optimization and role of different parameters in Stigmergic Algorithm for performance tuning for our scenario.
- Implement Stigmergic Algorithm (in Java most preferably)
- Implement Agent Community with services deployed on Cloud and scaled using Kubernetes.
- Execute Algorithm on QoS metric values generated from prior works and compare with centralised approach with a-priori knowledge.
- Tweak above algorithm and it's parameters to improve performance.
- Assign a hypothetical QoS metric to each service and run the Stigmergic Algorithm to generate best set of services / path on the new dynamic scenario.

4. Evaluation

- Implemented Stigmergic algorithm will be tested against existing data and performance evaluation against centralized or a-priori service registry approach will be done.
- Hypothetical values assigned to agent community deployed on cloud will be scaled and stigmeric approach will be tested for different number of services available in a grid.

5. Contribution of your research project

- Currently service discovery based on optimal QoS metrics (usually response time/ resource utilization) require techniques which are either computationally heavy or require a centralized registry mechanism. Stigmergic approach can be useful in dynamic decentralized environments to find optimal solutions for service discovery as it is less computationally heavy and works in dynamic environments.

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Motivation Statement

IoT devices are becoming more resilient and advanced in their adaptations, and we're using multiple techniques to integrate them along with legacy and existing technologies. There are still multiple challenges around choosing the best resources in a dynamic open environment where quality of service may rise or drop at any time.

In a city where multiple such IoT devices are deployed to facilitate a response to a disaster, choosing a device with the best guaranteed Quality of Service becomes critical. Any successful service composition and adaptation approach should take into consideration the above forms of run-time environment changes and work towards overcoming those limitations.

Stigmergic approach and ant colony optimization algorithms, have recently inspired optimizations in a large number of computer applications. Here, the applications interact by leaving and sensing artificial pheromones or markers (encoded information used to achieve a task) in a virtual environment.

To explore the effectiveness of Stigmergic approach, a composition request will return the QoS values of the proposed workflow which will have no prior knowledge of the environment including available service agents and their QoS values, and this can be contrasted against QoS values generated by a centralized approach with a central service registry, in which all the functional and QoS qualities of Web services are recorded.

The centralized approach represents the optimal case with full knowledge of the available web services and a deterministic composition plan. The purpose of this research is to show that the proposed approach can reach near optimal solutions although working under uncertainty and dynamicity that are deeply rooted in decentralized environments.

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Gantt Chart

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Ethics Statement

No Ethical Violations or considerations required as:

- No personally identifiable data linking to any person is being used
- Only numerical data will be used for analysis purposes
- Open source softwares will be used
- Legitimate scenario and proper use of software shall be expected

Skills Developed

Technical Skills

1. Java 8
2. Kubernetes
3. Azure Cloud
4. Algorithmic Thinking and Performance Tuning
5. Swarm Intelligence Applications

Research Skills

1. Investigating state of the art
2. Planning and scheduling
3. Critical thinking and analysis
4. Evaluation (Proof of addressing problem)
5. Citations
6. Accurate documentation