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# ANALYZING THE PROBLEMS OF GRID RESOURCE DEPENDENT SCHEDULING IN GRID RESOURCE INDUSTRY MODEL

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**Abstract**

*Problems surrounding resource sharing form the grounds for grid computing, an evolution of wide area parallel and distributed computing at a multi institutional scale. This paper focuses on our proposed multi objective dependent task scheduling algorithm on economic Grid where user has to pay-per-use. Where prices provided by energy providers aren't correlated with the services of theirs. Thus, user wants much more info such as range of time and price before making choices. For instance, people might choose answers which have somewhat longer time but offer huge savings in execution cost. The proposed Double Hybrid NSGA II (DHNSGA II) algorithm minimizes 3 conflicting goals without making them single scalar objective, using NSGA II. DHNSGA II does hybridization at 2 levels.*

***Keywords: Grid, computing, dependent, scheduling, hybridization, etc.***

## 1. INTRODUCTION

Grid Computing is an appropriated computing model. Grid computing technology coordinates servers, storage frameworks, and networks disseminated inside the network to shape an incorporated framework and give users powerful computing and storage limit. For the grid end users or applications, the grid resembles a virtual machine with powerful capacities. The embodiment of grid computing is to oversee heterogeneous and inexactly coupled resources in a productive manner in this circulated framework, and to facilitate these resources through a task scheduler so they can finish explicit cooperative computing tasks.

Grid Computing can be characterized as a network of computers working together to play out a task that would prefer to be hard for a solitary machine. All machines on that network work under a similar protocol to act like a virtual supercomputer. The task that they work on may incorporate breaking down huge datasets or recreating circumstances which require high computing power. Computers on the network contribute resources like preparing power and storage ability to the network. Existing seeded NSGA II algorithm works on Utility Grid where service price and time are actually reciprocal and user has defining deadline and cost. Memetic NSGA II algorithm applies Simple Neighborhood Search (SNS) as well as reduces the makespan and reliability. An author applied the reference point NSGA II that requires user input. (Chitra et al. 2011) has also released decision maker that suggest best weights for the various goals using fuzzy logic. While we introduced an approach to rank the treatments based on user defined trade off factor Rank of treatments is actually computed using Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) method (Yang and Sen 1998) because TOPSIS method requires very few numbers of input (weights of conditions) to select the ideal option than some other Multiple Criteria Decision Making (MCDM) (Aruldoss et al. 2013) methods. Time complexity of TOPSIS is also lesser compared to other MCDM techniques since it doesn't perform pairwise comparison of each criterion with many other criteria. Following sections illustrate non dominated sorting and crowded comparison operator.

## 1. LITERATURE REVIEW

**Jatin M. Soni (2020)** this paper proposes a controlled power flow between interconnected four photovoltaic (PV) houses and also in grid-connected mode. The voltage and current plans are utilized in PV houses. We have applied Perturb and Observe method to obtain most extreme power. We have connected battery energy storage system (BESS) at each house by three-stage inverters. At the point when all PV houses are connected, created power from each PV is provided to a load of each house.

**Niraj Ramesh Dayama (2020)** Grid layouts are utilized by designers to spatially organize user interfaces while drawing and wireframing. However, their design is generally time consuming manual work. This is trying because of combinatorial explosion and complex objectives, for example, alignment, equalization, and expectations with respect to positions. This paper proposes a novel optimization approach for the generation of differing grid-based layouts. Our mixed integer linear programming (MILP) model offers a rigorous yet effective method for grid generation that guarantees pressing, alignment, grouping, and preferential positioning of components.

**Thomas McSweeney (2020)** Heterogeneous architectures that utilization Graphics

Processing Units (GPUs) for general computations, in addition to multicore CPUs, are progressively common in elite computing. However a considerable lot of the current methods for scheduling priority constrained tasks on such platforms were expected for more differently heterogeneous clusters, for example, the exemplary Heterogeneous Earliest Finish Time (HEFT) heuristic.

**Akhil Nigam (2019)** Smart grid has been supplanted with traditional electrical power grid with its various technologies. In today's world smart grid has risen in as solution of expanding demand. They convey energy at low cost and high caliber as could reasonably be expected. The smart grid effectively employments of renewable energy resources and smart evaluating strategy so as to accomplish energy productivity. Information communication technology helps the grid in collection of data from various consumers. Essentially progressed metering infrastructure comprises of collection, storing and utilizing energy use data are thought to be the primary tool of smart grid. S

**Afroz Ahmad (2019)** a lot of electricity is consumed by datacenters to operate and bring massive electricity bills to operators. Another sort of electrical grid, called the smart grid, is rising nowadays. The primary function of smart grids is to empower two-path communications between the power generators and consumers. Smart grid technology carries a few remarkable highlights to encourage the productive and solid transmission of power. Revolutionary change in the smart grids is because of the offices and

moderations by ICT. New and advance smart grids are because of the upgraded communication standards. Many developing technologies offered by telecommunication sector have been introduced. WAN, FAN and HAN networks are introduced in wire communication.

## 2. STEPS OF NSGA-II

NSGA-II has the following steps:

1. Initialize a population using uniform random distribution method.

2. Apply crossover and mutation operators to generate children solutions.

3. Combine the children and parent population to compute non-dominated sorting.

4. Compute the objective value of each solution.

5. Compute the non-domination rank of each solution and assign different fronts. The solutions having lesser rank are better candidates for next generation.

6. Compute the crowding distance of every option within the front side. For a minimization type optimization issue, a solution x wins with another answer □ in case (□) solution □ has better rank than solution □ , or perhaps, (□) if the remedies □ , and □ have the same ranking, but solution x has large crowding distance than solution □.

Crowded comparison operator uses non domination matter of every option in a population. Next, it can make different fronts of treatments based on non domination count. Each option in a specific face computes the density of answers with additional ways in the front. Density of an individual is actually computed using average distance of 2 areas on either side of this stage along each goal of the issue. This value is known as crowding distance. And then, the answer that resides in the less crowded region is actually preferred in a specific group.

## 4. GRID RESOURCE SCHEDULING PROBLEM

This section formulates the Grid resource scheduling problem into Grid resource industry model. It thinks the economic Grid which is a set of heterogeneous clusters and community information. Clusters are actually heterogeneous in processor design and pricing. Network resources have different speed and price. We use Directed Acyclic Graph (DAG) to model an application as shown in Fig. 4.1a. A workflow is actually represented by a □□□′□′ = (□, □, □), □, where □ and □ are actually the set of projects and directed edges respectively. A node in the undertaking graph represents a process which works non preemptively on any cluster. Each edge is actually denoted by $e_{ij}$ corresponding to the information communication between $t_i$ and $t_j$, where ti is actually called immediate parent task of $t_j$. Kid task can't be started until all of its parent responsibilities are actually completed. A process which doesn't have a parent process is actually called entry task $t_{entry}$. A process which doesn't have a kid process known as exit task $t_{exit}$. x is actually computation matrix in which xij is actually computation time of job I on cluster j. c is actually the communication matrix shown where cij is actually the communication time between (□, □).

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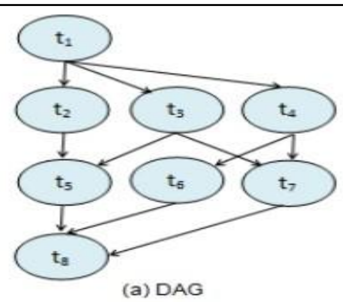
Completion time of task: The completion time comij of a task ti on the cluster cj is given by

$$com_{ij} = st_{ij} + x_{ij} \quad (1)$$

Here, $st_{ij}$ is actually the start time of the job $t_i$ on cluster $c_j$ and computation time $x_{ij}$ is actually added. Start time of the entry process is actually zero. Other tasks start time is actually computed by thinking about the conclusion time of all quick predecessors of the job. The communication time $c_{ij}$, is actually added if the dependent tasks are actually allocated to different clusters.




| | $t_1$ | $t_2$ | $t_3$ | $t_4$ | $t_5$ | $t_6$ | $t_7$ | $t_8$ |
|---|---|---|---|---|---|---|---|---|
| M1 | 15 | 14 | 16 | 13 | 17 | 12 | 18 | 15 |
| M2 | 14 | 13 | 15 | 12 | 16 | 11 | 17 | 14 |
| M3 | 16 | 15 | 17 | 14 | 18 | 13 | 19 | 16 |

(b) Computation Matrix

| $t_i$ | $t_j$ | Time |
|---|---|---|
| 1 | 2 | 75 |
| 1 | 3 | 74 |
| 1 | 4 | 76 |
| 2 | 5 | 73 |
| 3 | 5 | 77 |
| 3 | 6 | 72 |
| 3 | 7 | 78 |
| 4 | 5 | 71 |
| 4 | 6 | 79 |
| 4 | 7 | 70 |
| 5 | 8 | 80 |
| 6 | 8 | 69 |
| 7 | 8 | 81 |

(C) Communication Matrix

**Figure 1: Workflow of 8 Tasks**

Completion time of cluster: The conclusion time $com_j$ of cluster $c_j$ is actually the maximum of completion time $com_{ij}$ of all assigned jobs is actually given as

$$com_j = \max\left(com_{ij}\right) \; \forall \; i = 1 \ldots k \quad (2)$$

Here k is the set of all assigned tasks to the cluster $c_j$.

Makespan: Makespan of the workflow is the maximum of comj . It is defined as follow

$$makespan\,(sch) = \max\left(com_j\right) \; \forall \; j = 1 \ldots m \quad (3)$$

At this point, $com_j$ is actually the conclusion time of cluster $c_j$, m is actually the amount of clusters, as well as such is actually routine of the workflow.

Computation Cost: It occurs whenever a job is actually carried out on a bunch. The computation price of job $t_i$ on cluster $c_j$ is actually determined

$$compuCost_{ij} = compuCost_j \times x_{ij} \quad (4)$$

Here, $compuCost_j$ is cluster $c_j$ computation cost in G$ (G$ means Grid Dollar), and xij is computation time of task i on cluster j. Computation cost compuCost of schedule sch is calculated as follows
:

$$compuCost(sch) = \sum_{i=1}^{n} compuCost_{ij} \quad (5)$$

Here, n is the number of tasks.

Communication Cost: It occurs if a cluster transfers product of a job to various other clusters. The correspondence price is identified as

$$commuCost_{ij} = commuCost_j \times c_{ij} \quad (6)$$

Here, $commuCost_j$ is cluster $c_j$ communication cost in G$, and $c_{ij}$ is the communication time between task i and j. Communication cost is not reciprocal of communication time. Communication cost *commuCost(sch)* of schedule sch is computed as follow

$$commuCost(sch) = \sum_{i=1}^{n} commuCost_{ij} \quad (7)$$

The task scheduling problem is developed by thinking about the goals of reducing the makespan, computation price as well as correspondence price of the schedules.

## 5. SIMULATION AND EVALUATION

A Java based simulator has been created using jMetal equipment kit. jMetal stands for Meta heuristic Algorithms within Java. jMetal toolkit offers a world to solve multi objective optimization issues. In order to evaluate the usefulness of the DHNSGA II, world DAG that is real of Gauss Elimination algorithm is actually utilized as being a workflow. Gauss elimination graph is actually launched by (Topcuouglu et al. 2002). Gauss Elimination algorithm discovers the top triangle of a square matrix. This particular software calls for matrix of size m as an input, which must be $2^m$. The entire amount of jobs in a Gauss elimination graph is actually the same to $(m^2 + m - 2)/2$. DHNSGA-II calls for 2 types of parameters; to make a workflow & accomplish the DHNSGA II. The parameters to generate a workflow as matrix size, typical computation price, and computation to correspondence ratio, etc. is actually displayed in Table 1. DHNSGA-II parameters are revealed in Table 2. It takes likelihood of crossover as well as mutation operators, etc

.

**Table 1: Workflow Parameters**

| Parameter Name | Range |
|---|---|
| Matrix size | 8 to 64 |
| Average computation cost | 10 to 200 |
| Computation to communication ratio | 0.1 to 10 |
| Heterogeneity factor of resources | 0.2 to 0.5 |
| Cost of computation resources in G$ | 0.1 to 0.9 |
| Cost of network resources in G$ | 1 to 10 |

In order to evaluate the search ability of the suggested algorithm, we've produced sixteen Gauss elimination graphs of a specific matrix. And then a specific graph, is 10 times created, every time various computation price as well as computation to correspondence ratio is arbitrarily selected from specific set. As a result, a certain matrix graph is actually evaluated 160 times. We've compared the seeded NSGA II, Memetic NSGA II, and DHNSGA II with reference strategies. Memetic NSGAII applies the local search on the most effective answer. The most effective remedies are actually picked out using Roulette wheel selection technique because (G. and Noraini 2011) has recommended that anytime solution quality is actually the primary concern, then rank based choice (Roulette wheel are available under this category) tactic is actually the most desirable

**Table 2: DHNSGA-II Parameters**

| Parameter Name | Value |
|---|---|
| Population size | 100 |
| Cross over rate | 0.8 |
| Mutation | 0.3 |

| | |
|---|---|
| Generation | 500 |
| Crossover operator | Two point crossover |
| Mutation operator | Move based mutation |
| Selection operator | Binary tournament |
| Local selection operator | Roulette wheel |
| Local operator | Swap |

**Performance Index**

Multi-objective Optimization (MOO) algorithms measure 2 parameters about the obtained option set as well as reference remedy set. It must converge near the reference remedy set, and this ought to keep several fix set. The very first state definitely guarantees that the obtained answers are close to optimum, and the other state guarantees that broad ranges of trade off remedies are obtained. Hyper Volume (HV) signal is actually utilized to calculate both convergence as well as diversity. It computes distinction between non dominated option set received from algorithm as well as reference remedy set. Reference remedy set is received by merging all the non dominated treatments produced by many of the algorithms. The bigger value is actually much better for HV. Statistical significance with alpha worth (0.05) is actually computed (Garg et al. 2010), (Yu 2007).

**Results of DHNSGA-II**

Fig. 3.4 to 3.6 display the comparison between reference remedy set as well as nondominated option set received of matrix size sixty four. In the figures, correspondence price (blue color), and computation price (green color) show the reference remedy set, and correspondence cost (red color) as well as computation cost (yellow color) show the answer set of various algorithms. Reference treatments have least correspondence price, computation price, as well as makespan. By the figures it's clearly apparent which DHNSGA II Fig. 4.6 has least computation price, correspondence price and makespan. DHNSGA-II has much more number of answers across the reference point while some other remedies are scattered. This is since the original public of it's seeded and local research is used. DHNSGA-II has no less than twenty % less makespan, correspondence price, and computation expense compared to some other algorithms. By the figures it could be additionally found that Seeded NSGA II performs much better compared to Memetic NSGAII. Thus, we determine that the pre selection operator plays a much better role as opposed to the neighborhood search. Seeded NSGA II has fifteen % less unbiased worth compared to Memetic NSGA-II.

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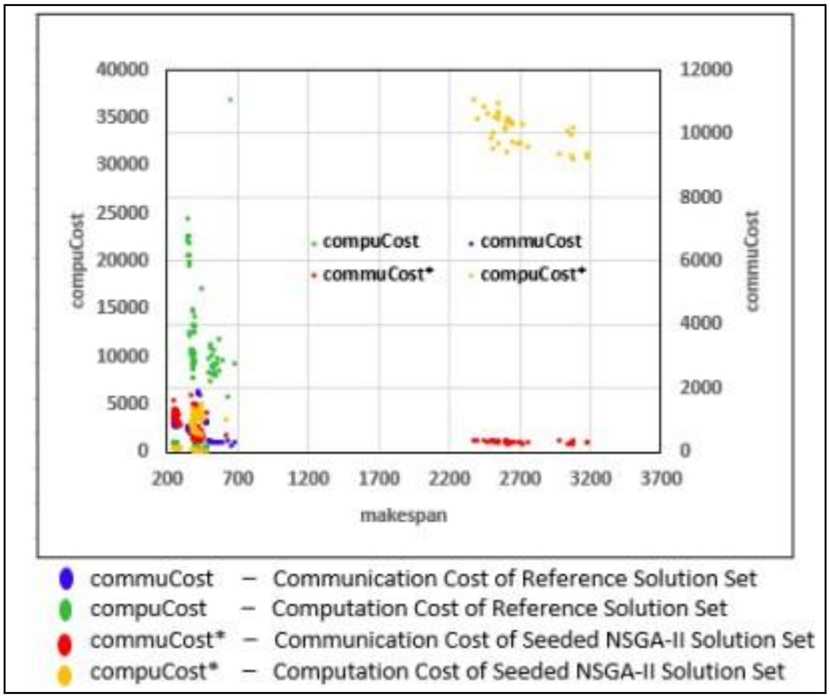


**Figure 2: Comparison of Seeded NSGA-II Solutions with Reference Solutions**

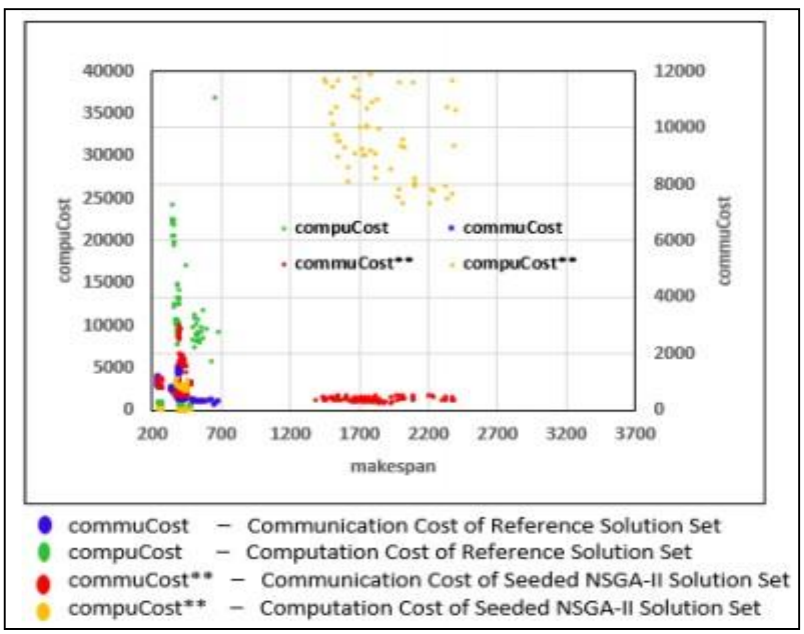


**Figure 3: Comparison of Memetic NSGA-II Solutions with Reference Solutions**

**6.**

**7. CONCLUSION**

With this paper, workflow scheduling issue is examined and answers are carried out for economic Grid. Our proposed algorithm DHNSGA II minimizes the computation price, makespan, and correspondence price. The multi objective issue of workflow scheduling is resolved by using GA, NSGA II, and neighborhood research approaches. We've compared our proposed algorithm DHNSGA II with Seeded NSGA II and Memetic NSGA II. The reference remedy set is received by merging the Pareto front of all of the algorithms.

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