Online ISSN : 0975-4172
Print ISSN : 0975-4350

Global Journals

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Discovering Thoughts, Inventing Future

VOLUME 13 ISSUE 1 VERSION 1.0

Global Journal of Computer Science and Technology: D
Neural & Artificial Intelligence

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Volume 13 Issue 1 (Ver. 1.0)

Open Association of Research Society

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Employer Identification Number (EIN):
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Contents of the Volume

Global Journal of Computer Science and Technology
Neural & Artificial Intelligence
Volume 13 Issue 1 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Epistemological Differences in Tactical and Strategic Spatial Planning

By Aynaz Lotfata
Technical University of Ankara, Turkey

Abstract - Purpose: In spatial processes, the terms strategy and tactic have frequently appeared without any clear distinguishing, whereas strategies and tactics have epistemologically characterized differently. Strategic knowledge have tries to defining visions of urban space through answering "What" and "Why" questions and its knowledge is the abstract knowledge, while tactical knowledge is the experiential knowledge via answering "How" question. Strategy and tactics are both terms from a military context where strategy has referred to long-term war planning in contrast to tactic as short-term flexible battle planning. Strategy has worked from the position of power that is in a place to force its opponents to accept its conditions. The strategic conventional ideologies empty of tactical policies have destroyed built spaces memories to organize urban society according to elite's tendencies. The Equivalent of strategy in urban planning is Master plan.

Tactics have not operated such dictated forces. Tactics are bottom-up spatial practices. Developing bottom-up dynamics have caused to flexibilities of the prevailed ideologies of the upper policies. Hayden calls short-small actions (Tactics) "power of places" to challenge homogenous urban planning. Homogenous urban planning has planned urban spaces in a frozen platform of time. Another important purpose of this study has been organized to expand "public policy time".

Keywords : strategy, tactic, synergy, imitating, empowered.

GJCST-D Classification : I.2.6

EPISTEMOLOGICAL DIFFERENCES IN TACTICAL AND STRATEGIC SPATIAL PLANNING

Strictly as per the compliance and regulations of:

Epistemological Differences in Tactical and Strategic Spatial Planning

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Findings: Thereby, strategic spatial planning without tactics has justly characterized as an abstract phenomenon. Time and space co-existence policies have gotten its legitimacy via witnessing spatial tactics. The tactics developed by ordinary people are at root attempts to negotiate power relationships, discourses and representations of identity. To develop the empowered spatial planning, the synergic relations amid localities tactics and strategies have to implement for tackling with the stochastic world. And the arguments have orderly developed on permanent and temporary identities of spatial strategic and tactics

Results: The paper has aimed to solve the problem of misunderstandings in tactics and strategies definitions and applications in urban planning. Additionally through explanations of strategies and tactics differences in spatial planning, the project has tries to argue that strategy of locality cannot be duplicated like spatial tactics imitating all over the world. Localities got used to dismantling other localities strategies and tactics to enhance their situation in the competition platform. However, a strategy is hard to duplicating such tactics.

To sum up, strategies and practices (Tactics) have shaped the everyday life of inhabitants and urban planning should make balance in utilizing both. Additionally locality should not imitate spatial tactics and strategies of other localities. Otherwise, it has reified spatial tactics and strategies. Every locality has own priorities to consider in urban planning.

Originality: In planning literature, implementing spatial strategies have not been the recent phenomena. The differences have reverted to the deficiency of synergic relations amid tactics and strategy. The conventional regulated spatial planning has generally formulated without spatial tactics to reach spatial goals while to tackle the real world future, the reciprocal connections of tactics and strategy have gotten priorities. In other words, planning has to move on toward an experimental science of planning.

With considering the novel re-configuring urban planning, the paper has tries to shed light based on simulating urban planning via "Artificial Intelligence" achievements. This will support arguments on systematic planning definitions to control the uncertain world. In moving form toy-world domains that characterized early conventional planning, we are looking at a wide range of issues, including reasoning in uncertain worlds, interacting with processes and events beyond the agent's direct control and controlling systems in real non-linear time. The disciplinary background of the paper is philosophical-epistemological. The enquiry is conceptual.

Keywords : strategy, tactic, synergy, imitating, empowered.

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I. Introduction-Dynamic and Uncertain Domains; Planning with Stochastic Actions

One of the main concerns of socio-spatial policy makers all over the world is to improve their ability to anticipate and control the future. Designing human futurity, whether long or short-term is not a simple matter. The sophistication involved in dealing with ongoing fundamental changes in modern societies challenges the ability to control human futurity and to sustain continuity. Here our concerns in the following exploration are time perception and time management in public policy. Time related public policy literature is generally farmed in terms of long term and short term policy. This study suggests juxtaposing "tactical policy time" and "strategic policy time". Tactical policy time is defined as "taking a specific time-related plan or action aimed at achieving a defined policy result". Tactical policy time has applied in the case of short time tables. Strategic policy time has defined as "taking a specific time-related plan or action with the aim of coping better with uncertainty in the future". These arguments have invited attentions on time-related planning or action aiming to achieve a defined policy result or cope better with uncertainty in the future". The mapping of time management in public policy generally indicates two main trends: 1- a pragmatic trend-short-term policy has based on the response-oriented policy (Tactic) and 2- a normative trend-long-term policy inspired by "the voice of the future" to avoid uncertainty" (Strategy).

In other words, "Why do we plan?" Planning is to respond necessities of real world. To control real world, there are two focus points: coping with uncertainties and real time planning. The planning knowledge is incomplete whereas that is the process. The process definition of planning has gotten back ton on-predicted events in the world by which control and pre-determination of domains have not been done completely. There is the world of uncertainties. The planning has to discovery new approaches of intervention in the world such reactive planning, tactical planning and conditional planning.

The arguments have supported that the planning process has not only defined due to theoretical discussions but also that has included the practical exercises. Relying justly on reactive, tactical and conditional planning with the practical essence has not improved the controlling uncertainties. The planning process requires mutual connections of theory and practice. In reality, tactical, reactive and conditional planning has justly supported the incremental practical planning. However, to control the world with stochastic actions where linear and universal plans have not functioned any more, incremental and conventional spatial practices combinations have insistently emphasized.

Therefore, planning in realistic domains has forced us to confront two main issues: uncertainty and urgency. Uncertainty arises since the planner is neither omnipotent, omniscient one nor alone in the world to control stochastic actions. The paper aims to consider spatial planning as the automatic planning by which planning has prepared to any stochastic actions of the world in which has witnessed the social, economic, environmental and politic upheavals. Thereby the conventional traditional planning should re-modify to achieve goals of planning with high probability. That does not mean, refuting result rationality of conventional planning in which its rationality measures how efficiently the plan achieves its specified objectives. Planner should re-construct planning with making balance between result rationality of conventional planning and process rationality of tactical planning.

Therefore, the lost and disregarded part of planning in dynamic and uncertain world has characterized via tactical planning. Planning has been a process changing its long term focus point toward short term planning. To control uncertain and dynamic world, planners should be familiar with reactive planning. Nilsson has proposed the concepts of actions networks for reactive planning/tactical planning. Actions networks differ from universal plans in that they allow the formation of action hierarchies (Hanks, 1990). This supports argument that we view planning as the process and planning has been converted from long term prospects into short term tasks. That does not mean that process has thrown out the strategic planning and justly focused on tactical planning. This process must consider both the strategic and tactical aspects of planning. Tactical or incremental planning has emphasized on tasks/ actions which achieve short term goals. Purely strategic planning cannot immediately react to a changing world while tactical planning can answer changes quickly. The traditional planning logic is Boolean logic where the values of variable are the truth values, truth and false, usually denoted 1 and 0.

However planning is the process and it has formulated in between 1 and 0. The deductive knowledge of Boolean planning has distrusted on urban society with stochastic actions. The figure 1 has simulated spatial planning with intervention of Artificial Intelligence (AI) in the sphere of urban planning to emphasize on importance of tactics in controlling the stochastic world. There is a Robotic motion planning that explicitly considers actions (Tactics) to control probable uncertainties, avoid collisions and successfully reaching a goal. To reduce system failures, Markov decision process formulates dynamic planning to optimize Robotic motion in the selected path to achieve its goals.

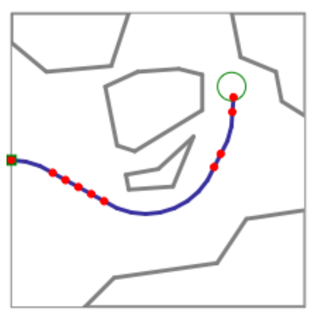

Figure 1 : From an initial configuration (solid square) to a goal (open circle) - Source: (Alterovitz, 2007)

The remainder of paper is organized as follows; section 2 explanation on non-linear world and the world of cause and effect to declare necessity of dynamic planning, section 3 discussion on planning re-cognition names "empowered planning", "synergic phenomena" and "strategic and tactic imitation", section 4 discusses result and future work.

II. Planning as Temporal Reasoning; Necessity of Dynamic Planning

We have invited attentions on modeling dynamic planning rather static traditional planning due to realities of the non-linear real world. Traditional conventional planning has been a model of planning with certain goals whereas in a-changing world, witnessing planning with certain goals has not been the possible phenomenon. The linear world and the perception of cause and effect is simply a trick of the mind to create the illusion of predictability and control. Thereby, tactical spatial planning which has characterized as a short range planning emphasizing on the current operations of various parts of the spatial complex and non-linear system has not been ignorable anymore. Short range has defined as a period of time extending about one year or less in the future. Figure 2 has discussed on the time non-linearity amid events in spatial system. Inhabitants often claim that it is easy to see how the events unfolded with hindsight in linear time. However, it is often possible to understand events reasons with foresight. Additionally events can happen simultaneously instead of the linear pre-determined perspectives and the spatial layouts have been witnessed hidden and complex non-linear causes and effects.

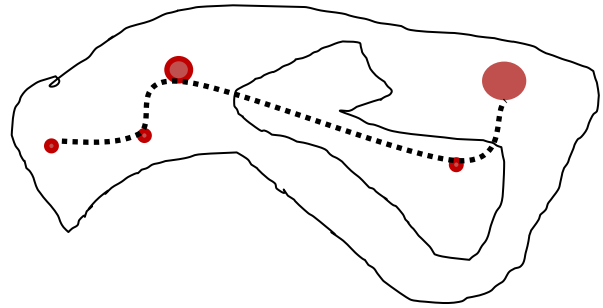

Figure 2 : Dashed line: linear time, filled points: events in spatial layout- Source: by Author

In the real-world framework, there is not any linear reality. The complex spatial system has embedded with pluralities of actions by which the urban system has directed to complexities of causes and effects. The spatial temporal actions have taken place on self-emergencies and planned bottom-up activities. Figure 3 has explained realities of real world where actions have made influences upon each-others and created complex non-linear systems.

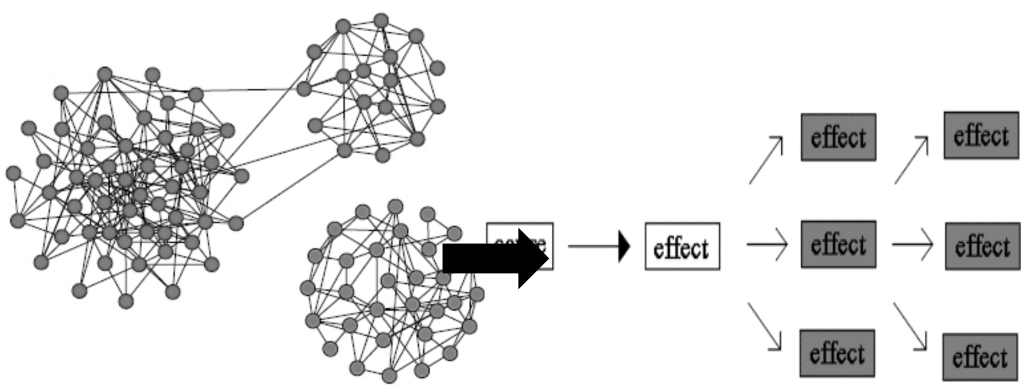

Figure 3 : Cause and effects dynamics of bottom-up spatial activities- Source: by Author

The bottom-up planned actions are spatial tactics/reactions by which time and space co-existence have implemented. And tempo-spatial co-existence policies can immediately re-act urban society's upheavals. In figure 4, the incremental tempo-spatial changes have been manifested. The emphasizing on relationship between space and time has been formulated in the most diverse planning theories and has fascinated mankind from the beginning until the conventional planning strategy by which real-time tends to zero.

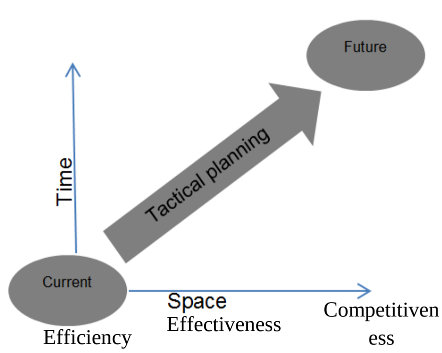

Figure 4 : Co-existence of time and space in tactical planning; 1- The efficiency: is the operational level of planning via asking" how can we best deploy and control resources?" 2- The effectiveness: is the tactical level of planning via asking" how can we best organize ourselves to reach success?" 3- The competitiveness: is he strategic level of planning via asking" what are our aims and what are marketable to do global competitiveness?" - Source: by Author

Global Journal of Computer Science and Technology (D) Volume XIII Issue I Version I Year 2013

The next section of the paper has discussed on re-formulating planning named "empowered planning" through integrate tactical spatial practices in conventional classical planning to configure planning system.

III. Plan Recognition; Empowered Planning

Strategic planning has emphasized on the analyzing future and tactical planning has functioned on controlling everyday life. Despite their differences, tactical and strategic planning is internally related. System without strategy only based on tactics leads to shooting in dark. Sun Tzu innovation on "The Art of War" has taught the strategy such the timeless lesson as humans' nature. Strategy and tactics have depended on each other. Goldratt has defined "Strategy" as, simply, the answer to the question: "What for?" (The answer is the objective of a proposed change). "Tactic" is defined as, simply, the answer to the question "How to?" (The answer is the details of the proposed change). From these definitions, it is clear that every Strategy (What for?) should have an associated Tactic (How to?) and therefore Strategy and Tactic must always exist in "pairs" and must exist at every level of the organization (Figure 5).

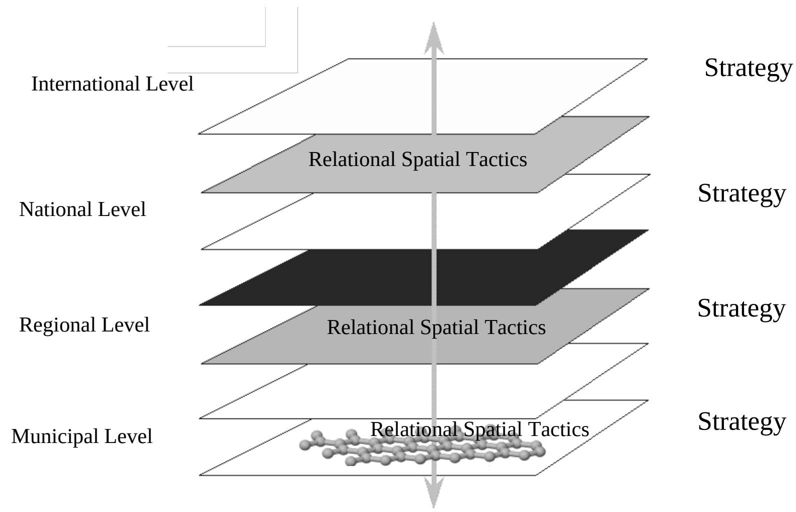

Figure 5 : Every level of organization such Municipal level has composed of strategic vision and relational spatial tactics which has connections with the upper plans such regional levels orderly – Source: by Author

Tactical planning should focus on what to do in short term to contribute the spatial organization achieving the long term objectives determined by strategic planning. The short term tactical policies are more common in the political competitive sphere where citizens involvement in public sphere management. In the area of planning, there has been considerable debate about whether top-down or bottom-up planning is best spatial practice. However the empowered planning model has combined and made balance between long term and short term planning. Foucault's (1991) notion of 'govern mentality' has also composed of active tactics and strategies by governments and agents. Strategy without tactics is the slowest route to victory. Tactics without strategy is the noise before defeat.

The conventional instrumental planning has modeled relied on the rational calculation is also the strategic challenge apart from tactical policies. However, great upheavals in uncertain world have led to the lack of trust on rational calculation empty of spatial tactics to control the stochastic actions. To support the argument, Friedman (1987) said that municipal level of the spatial development cannot justly answer local spatial dynamics via upper policies strategies, but it has to consider the local bottom-up knowledge and plan spatial tactics to reach strategic goals of the locality. In planning literature, it is time to integrate tactical spatial practices in conventional strategic planning. In this sense, the planning organization has simulated the novel "process policy" on spatial planning which Habermas (1995) has put forward that on "communicative action theory". Generally, "strategy" is really at the highest level of spatial systems by which the directions of all activities are dictated and "tactics" are lower down in spatial systems and define the activities that are needed to implement the Strategy, then where does "Strategy" end in which do "Tactics" begin.

The figure 6 has represented differences on strategic and tactic perspectives in detail by which the paper next argument has clarified via declaring difficulties on imitating spatial strategies rather socio-spatial tactics.

Strategy	Tactic
Future (Longer Term)	Now (in the moment)
Preparing and Planning	Doing activities
A journey	A trip
Broad perspective	Narrow perspective
A purpose	A task
Anticipation	Reaction
Risk	Caution
Important	urgent
Difficult to copy	Easy to copy
Large scale	Small scale

Figure 6 : Strategic and tactics differences-source: by Author

a) Strategic and tactical imitations

Imitation strategy is the strategy that mimics the strategy of other territories. Territories have performed this kind of the imitation strategy to attract global capitals. This strategy is an illegal and unethical activity on condition that territories inner dynamics have refuted (Figure 7).

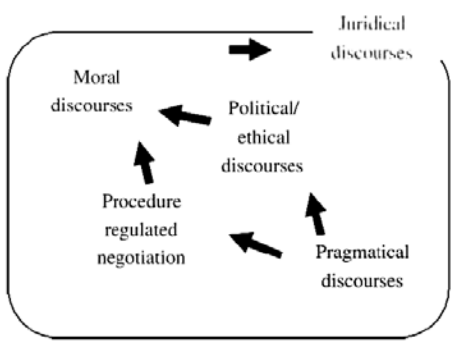

Figure 7 : The bottom-up ethical process- Source: (Nielsen, 1994)

The more interesting argument is duplicating spatial tactics without paying attention on territories authenticities and dynamic bottom-up knowledge. In reality, tactics vary with circumstances and, especially, technology. Alan Emrich says, "If I were to teach you how to be a soldier during the American Revolution, you would learn how to form and maneuver in lines, perform the 27 steps in loading and firing a musket, and how to ride and tend to a horse. Naturally, yesterday's tactics won't win today's wars – but yesterday's strategies still win today's wars… and will win them tomorrow and into the future. Therefore, strategy and tactics require a different focus." After debating on necessity of strategic and tactical planning authenticity to dismantle empowered spatial planning, it will be more interesting to concentrate on in what manner spatial tactics have integrated in urban planning through "synergic planning".

b) Synergic Planning

Synergy comes from the Greek word synergia, meaning joint work and cooperative action. Synergy is when the result is greater than the sum of the parts. Synergy has been created when things work in concert together to create an outcome that is in some way of more value than the total of what the individual inputs is. The synergic phenomena have supported "What to change, but more importantly, what not to change and especially How to implement the changes and Why." Empower planning has ethically planned socio-physical-spatial changes owing to making synergy amid different spatial localities of urban systems such synergy in between two localities strategies and tactics towards planning overlapping to reach mega goals of a territory (Figure 8).

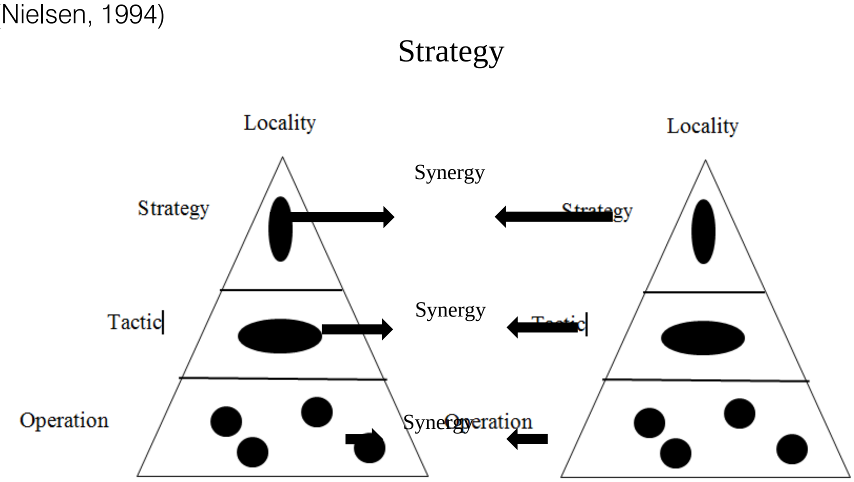

Figure 8 : Synergy in between two localities strategies, tactics and operations – Source: by Author

IV. Conclusion

The discussed arguments have attracted attentions on empowered planning not to avoid uncertainties, but to control uncertainties. This supports arguments that inclusion epistemologies of two trends of planning; tactical and strategic policies have led to easily deal with stochastic world. And planner and geographers have attracted on "real time planning" where the long term planning and short term planning have combined and utilized in balance. This research has tries to introduce a new mode of intervention in planning since the empowered planning is the sub-ordinate system theories framework. System theories focus on complexity and system inter-dependencies. The followers of the system theory in the field of sociology also give light to what is happening in the socio-spatial context in cities. Among them, Nikolas Luhmann argues the significance of the continuity of social processes and inter-activities among parts in such processes.

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Global Journal of Computer Science and Technology
Neural & Artificial Intelligence
Volume 13 Issue 1 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

A Proposed SAT Algorithm

By Bagais A., Junaidu S. B. & Abdullahi M.
Ahmadu Bello University, Zaria-Nigeria

Abstract - This paper reviews existing SAT algorithms and proposes a new algorithm that solves the SAT problem. The proposed algorithm differs from existing algorithms in several aspects. First, the proposed algorithm does not do any backtracking during the searching process that usually consumes significant time as it is the case with other algorithms. Secondly, the searching process in the proposed algorithm is simple, easy to implement, and each step is determined instantly unlike other algorithms where decisions are made based on some heuristics or random decisions. For clauses with three literals, the upper bound for the proposed algorithm is $O(1.8171^n)$. While some researchers reported better upper bounds than this, those upper bounds depend on the nature of the clauses while our upper bound is independent of the nature of the propositional formula.

Keywords : propositional satisfiability, NP-complete, complexity, complete algorithms.

GJCST-D Classification : F.2.1

A PROPOSED SAT ALGORITHM

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I. Introduction

Propositional satisfiability (SAT) is one of the classical problems in Computer Science. The importance of SAT comes from the fact that a large class of real-world problems can be expressed in terms of a SAT instance and that it was the first problem proven to be NP-Complete (Cook, 1971). The SAT problem has a wide range of practical real world applications (Barbour, 1992; Crawford & Baker, 1994; Devadas, 1989; Kauts & Selman, 1992; Larrabee, 1992). Many algorithms, categorized into complete and incomplete algorithms, were proposed to solve this problem efficiently over the last decades.

Complete algorithms can state whether a SAT instance is satisfiable giving the satisfying assignments or unsatisfiable giving a 'no' answer. Incomplete algorithms can only give an answer of 'yes' for satisfiable SAT instances only but cannot give an answer for unsatisfiable instances.

This paper proposes a new complete algorithm that differs from the ones in the literature in the following aspects:

- No backtracking during the searching process that usually consumes significant amount of time.
- Has a simple, deterministic and easy to implement search process, unlike other algorithms where decisions are either made randomly or based on some heuristics.

The remainder of the paper is structured as follows. Section 2 describes the proposed algorithm with the aid of an example. Section 3 captures the algorithm in pseudo code while Section 4 presents the complexity analysis of the algorithm. We present related work in Section 5. Sections 6 and 7 summarize and provide references, respectively.

II. Illustrating the Proposed Algorithm

Unlike other algorithms that make a decision on a single value (true/false) for a variable x, the proposed algorithms takes into consideration all satisfying assignments for a clause C and use them for the next clauses so that backtracking is avoided.

Consider the following formula: $F = (x_1 \vee x_3 \vee \overline{x_4}) \wedge (\overline{x_1} \vee x_2 \vee \overline{x_5}) \wedge (x_2 \vee \overline{x_3} \vee x_4)$

The first clause can be satisfied by any of the following assignments $x_1 = true, x_3 = true, x_4 = false.$ The algorithm tries to find assignments for all variables in clause while preserving at least one of the given assignments for x_1, x_3, or x_4 in the first clause.

In general, the process starts from the first clause c_1 and produces the set of assignments that satisfy c_1 which obviously are the literals in that clause.

If the clause has k literals, then k assignments can satisfy it (as in the previous formula, the first clause has three assignments). In the next step, the set of assignments that satisfy the set of previous clause(s) are checked with all the literals of the next clause. The process continues until all the clauses in the formula are covered, after which the resulting set of assignments each satisfies the formula.

When a set of assignments from previous clause(s) is checked with the literals of the current clause, each literal may *agree*, *disagree* or be *neutral* to the assignment. A literal agrees with an assignment when the assignment includes the literal. A literal disagrees with an assignment when the assignment includes a negation of the literal. A literal is neutral to an

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assignment when the assignment neither agrees nor disagrees with the literal.

$$F = (x_1 \vee x_3 \vee \overline{x_4}) \wedge (\overline{x_1} \vee x_2 \vee \overline{x_5}) \wedge (x_2 \vee \overline{x_3} \vee x_4)$$

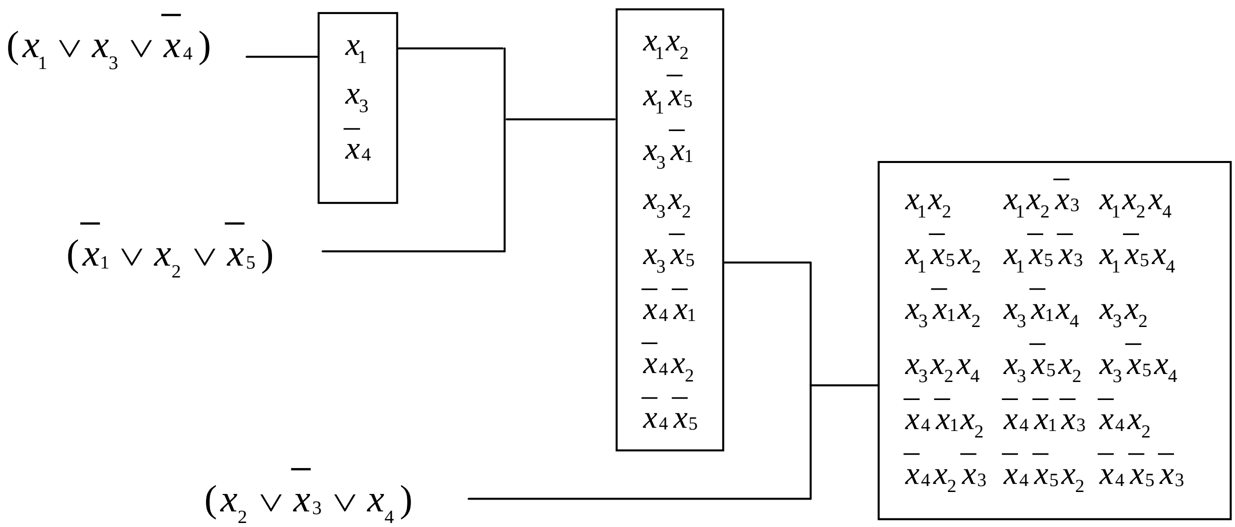

Figure 1 : Assignment Production

In the first step, the satisfying assignments for the first clause are its literals. The assignments produced for the first clause are shown in the top-left rectangle in *Figure 1*. Each of these assignments is checked with the literals of the second clause, $(\overline{x_1} \vee x_2 \vee \overline{x_5})$. The assignment of x_1 disagrees with the first literal of the second clause, $\overline{x_1}$ resulting in no assignment produced. The same assignment, x_1 is checked with the second literal, x_2. Since this literal is neutral to x_1, a new assignment is produced by combining x_1 and x_2, as shown in the middle rectangle in *Figure 1*. Next, x_1 is checked with $\overline{x_5}$, giving $x_1\overline{x_5}$, since $\overline{x_5}$ is neutral to x_1. Similarly, the assignments x_3 and $\overline{x_4}$ are checked with the literals of the second clause leading to six additional assignments as shown in the middle rectangle of *Figure 1*. To complete this example, the literals of the third clause are checked with these eight assignments producing the 18 new assignments in the right-most rectangle of *Figure 1*. Note that each of these 18 assignments satisfies the given formula.

Note that when an assignment agrees with the clause in consideration, the process might produce shorthand for $x_1 \vee x_2$ etc. We will illustrate this with the pair of clauses:

$$(x_1 \vee x_2 \vee x_3)$$
$$(x_1 \vee x_4 \vee x_5)$$

The satisfying assignments for this pair of clauses are:

$$\begin{array}{lll} x_1x_1(or\ x_1) & x_2x_1 & x_3x_1 \\ x_1x_4 & x_2x_4 & x_3x_4 \\ x_1x_5 & x_2x_5 & x_3x_5 \end{array}$$

From this group, it can be seen that the assignments $\{x_1x_4, x_1x_5, x_2x_1, x_3\,x_1\}$ are subsumed in the first assignment x_1. This is because each of these assignments produces the same result as x_1.

Thus, these assignments can be dropped to avoid redundancy. Therefore, *Figure 1* can now be redrawn without the subsumed assignments as shown in *Figure 2*.

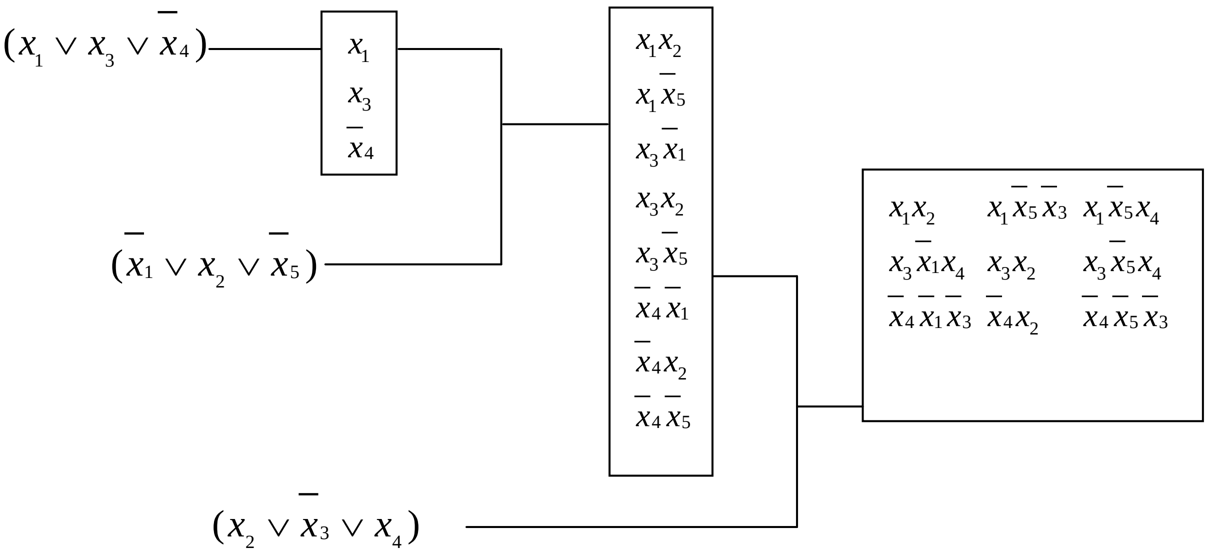

Figure 2 : Satisfying assignments without redundancies

Since the subsumed assignments are produced from clauses that have a literal in common, the proposed algorithm starts by extracting all clauses that do not share a literal. For a satisfiability formula with n literals each clause containing exactly k literals, the minimum number of clauses in which no two clauses have a common literal is $\frac{2n}{k}$.

$$F = (x_1 \vee x_2 \vee \bar{x}_4) \wedge (\bar{x}_1 \vee x_3 \vee x_4) \wedge (x_1 \vee \bar{x}_3 \vee x_6) \wedge (x_5 \vee \bar{x}_2 \vee \bar{x}_6) \wedge (x_4 \vee \bar{x}_5 \vee x_2) \wedge (x_3 \vee \bar{x}_6 \vee \bar{x}_5)$$

For example, we need at least 4 clauses to have the 12 literals in the following formula. But because of the distribution of literals, we need 5 for that purpose. Therefore, the algorithm will extract the clauses that do not have common literals. There are two advantages in doing so:

1. The algorithm will save the time to check the existence of subsumed assignments which is a process that consumes an amount of time equal to the number of assignments.
2. The time complexity of the algorithm becomes easier to prove (see Section 4).

Theorem 1

Consider a satisfiability formula with m clauses each of k literals. An agreement between an assignment and a literal in the i^{th} clause produces at least $\begin{cases} 2(k-1)k^{m-i};\ i=2 \\ (k-1)k^{m-i};\ 3 \le i \le m \end{cases}$ redundant assignments.

Proof: (By induction).

Base Case

The base case is when $i=m$ and the total number of redundant assignments will be $(k-1)k^{m-m} = (k-1)k^0 = (k-1)$. Clearly, the theorem holds for $i=m$.

Inductive Hypothesis

Suppose the theorem holds for $i = 2,3,4,\ldots,p$ for some clause $2 \le p < m$. The total redundant assignments will be $\begin{cases} 2(k-1)k^{m-p};\ p=2 \\ (k-1)k^{m-p};\ 3 \le p < m \end{cases}$. If a literal with which an assignment agrees is in $p+1$ clause, then the total redundant assignments will be

$$\begin{cases} \dfrac{2(k-1)k^{m-p}}{k} = 2(k-1)k^{m-p-1} = 2(k-1)k^{m-(p+1)};\ i=2 \\ \dfrac{(k-1)k^{m-p}}{k} = (k-1)k^{m-p-1} = (k-1)k^{m-(p+1)};\ 3 \le i \le m \end{cases}.$$

That is, the theorem holds for $p+1$. By induction on p, the theorem is true for all values of i.

Theorem 2

Consider a satisfiability formula with m clauses each of k literals. A disagreement between an assignment and a literal in the i^{th} clause reduces the number of assignments by at least by $k^{m-i};\ 2 \le i \le m$.

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Proof: (By induction)

Base Case

The base case is when $i = m$ and the total number of assignments will be reduced by $k^{m-m} = k^0 = 1$. Clearly, the theorem holds for $i = m$.

Inductive Hypothesis

Suppose the theorem holds for $i = 2, 3, 4, \ldots, p$ for some clause $2 \le p < m$. The total assignments will be reduced by k^{m-p}. If a literal with which an assignment agrees with is in $p+1$ clause, then the total assignments will be reduced by $\dfrac{k^{m-p}}{k} = k^{m-p-1} = k^{m-(p+1)}$. That is, the theorem holds for $p+1$. There by induction on p, the theorem is true for all values of i.

III. The Proposed Algorithm Pseudocode

The most important step in any complete or incomplete SAT algorithm is the decision over the value of a given variable in the formula. If the decision on that variable is wrong, the algorithm will waste its time searching for a solution before it discovers that the value assigned to the variable does not lead to a satisfying assignment and consequently a backtrack is done to change that value. The problem with making a decision for a variable x using the heuristics is that they do not consider how this decision or assignment will affect other related variables that appear in the same clauses as the variable x. If the search process keeps all possible assignments that satisfy a clause before moving forward, then no backtrack is needed. Instead, these assignments can be used to determine the values of variables that satisfy the next clauses. In the case that none of the variables in the current clause agrees with all the assignments, then the formula is unsatisfiable. This leads to the main idea of the proposed algorithm for assigning values to the variables.

The Algorithm

```
Input: F[m]; //formula with m clauses
Output : A[k^m]; //Possible assignment satisfying m clauses.

1.   getDistinctClauses(F[m]);

2.   For i = 1 to disticntclauses.length – 1;//number of distinct clauses
For j = 1 to k //k is the number of literals in a clause
LIT[i][j] := disticntclauses[i];
            End for
     End for

3.   For i = 1 to k
A[i] := LIT[1][i]; //literals of the first clause(initial set of satisfying substitutions)
End for

4.   For i = 2 to disticntclauses.length;//number of distinct clauses
For j = 1 to k
generateAssignment(LIT[i][j], A[], temp[]);
//A[] contains the set of satisfying substitutions from previous clauses
//temp[] contains assignments formed by combining assignments in A[]  with a literal LIT[i][j]
End for
A[] := A[] + temp[];
  End for

5.   For i = distinctclauses.length + 1 to m;//number of distinct clauses
For j = 1 to k //k is the number of literals in a clause
LIT[i][j] := nondistinctclauses[i];
            End for
     End for

For i = distinctclauses.length to m
For j=1 to k
```

```
generateAssignment(LIT[i][j], A[], temp);
End for
removeSubsumedAssignments(tempassignments[], arraysubsumed[]);
A[] := A[] + temp;
    End for

6.    If A[] is empty
            Output "the formula is unsatisfiable";
Else
Output the assignments in A[] as the satisfying assignments for the formula F.
```

Procedure *getDistinctClauses(F[m])*
Input: *Formula with m clauses*
Output: *arrayofdistinctclauses and arrayofnondistinccaluses*

```
distinctclauses[1] = clause[1];
n1:=0;
n2:=1;
distinct = true;
for i = 2 to m
        for j = 1 to distinctclauses.length – 1
                if (distinctclause[j] intersection clause[i] != empty)
                        nondistinctclauses[n1++] = clause[i];
                        distinct = false;
                        break;
                Endif
        Endfor
        If (distinct == true)
                disticntclauses[n2++] = clause[i];
        Endif
Endfor
```

Procedure: *removeSubsumedAssignments(tempassignments[], arraysubsumed[])*
Input: *list of assignments containing subsumed assignments and list of assignments subsuming the subsume assignments.*
Output: *list of assignments without subsumed assignments.*

```
n:=0;
For i = 0 to tempassignments.length – 1
        For j = 0 to arraysubsumeb.length – 1
                If (arraysubsumed[j] is not contained in tempassignents[i])
                        arrayassignments[n++] = tempassignment[i] ;
        Endfor
Endfor
Return  arrayassignments[];
```

Procedure: *generateAssignment(lit, A[], temp[]);*
Input: *a literal in a clause and a list of assignments in A[].*
Output: *a list of assignments stored in temp[] produced by combining lit with A[].*

```
For i = 1 to A.length
        If lit did not conflict with the assignment then
                Combine the lit and the assignment;
                Add the combination in temp[];
        elseif lit agrees with the assignment then
                Add the assignment in temp[];
                Add the assignment in arraysubsumed[];
        Endif
Endfor
Return temp[];
```

Figure 3 : The Proposed Algorithm

IV. Time Complexity of the Algorithm

The first three steps of the algorithm take polynomial time of number of clauses. Steps four and five are clearly the main contributors to the time complexity of the whole algorithm. These two steps rely on the number of assignments generated in each iteration of the for-loop. For step four, that number is determined by the clauses in CLS and for step five, that number is determined by the end of step four. Therefore, let us start with step four.

a) Finding number of assignments

Whenever a clause is considered in the for-loop, the number of assignments is multiplied by k (in the worst case). The first clause initializes A with k assignments (the literal in that clause). Then, the second clause will produce at most k^2 assignments, and the third clause may generate as k^3 assignments and so on. That means the number of the assignments is $\le k^m$ where m is some number of clauses. In step four, clauses in CLS could either be:

1. $\frac{2n}{k}$ clauses (worst case).

2. or more than $\frac{2n}{k}$ clauses (as explained in Section 2).

Case 1 is the worst because if more than $\frac{2n}{k}$ clauses are needed, then we must have repeated literals. This can be shown easily as follows: If we have $\frac{2n}{k}+1$ clauses, then the number of literals is $(\frac{2n}{k}+1)k$ which gives us $2n+k$ literals. That means we have k repeated literals in these clauses.

Because of the existence of repeated literals in Case 2, Case 1 will produce the maximum number of assignments (see Theorem 3).

We now determine the number of possible assignments, $A(n)$, in the worst case. If the clauses in CLS have conflicting literals, $A(n) \le k^m$.

In this case, a literal in one clause will not be combined with a literal $\overline{x}_1$ in another clause. The number of substitutions to be eliminated is shown by Theorem 2.

To count the exact number of assignments, the principle of inclusion-exclusion is used. The principle states that the number of elements that have property 1, property 2, property 3, …, or property n is found by the summation.

$$N(P_1,P_2,P_3,\dots,P_n)=\sum_{1\le i\le n}|A_i|-\sum_{1\le i<j\le n}|A_i\cap A_j|+\sum_{1\le i<j<k\le n}|A_i\cap A_j\cap A_k|-\dots+(-1)^{n+1}|A_1\cap A_2\cap A_3\cap\dots\cap A_n|$$

The proof of the principle can be found in (Rosen, 1999).

If P_i is the assignment where x_i and $\overline{x}_i$ appear for $i=1,2,3,\dots,\alpha$ where $\alpha\le n$, then the exact number of assignments for case 1 is $k^{\frac{2n}{k}}-N(P_1,P_2,P_3,\dots,P_\alpha)$.

For any satisfiability instance, the previous quantity cannot be found. That is because unlike the example given earlier, the arrangement of variables or literals differs from one instance to another. However, there is an arrangement that will produce the highest number of variables.

b) The upper bound

At this point, we need to prove two theorems. One that states case 1 is the worst case and the other states the arrangement that will produce the highest number of assignments.

Theorem 3

In step 5 of the algorithm, generating assignments with the least number of clauses $(\frac{2n}{k})$ that include 2n literals is the worst case.

Proof

If more than $\frac{2n}{k}$ clauses are needed to include the $2n$ literals then we must have literals that are repeated. If we have one additional clause, then there must be k literals repeated and this will make the set of assignments to be excluded more than n. Having a repeated literal means that we have three clauses of this form: $x_1\vee x_2\vee x_3$ $\quad x_1\vee x_4\vee x_5$ $\quad \overline{x}_1\vee x_6\vee x_7$.

The two clauses that have the repeated literal x_1 will produce the unnecessary assignments. These assignments are generated when the repeated literal is combined with the $(k-1)$ literals of the other clause. This means that the assignments that include $\{x_1x_4, x_1x_5, x_1x_2, x_1x_3\}$ are unnecessary. The only useful assignment is x_1 produced from (x_1x_1). This indicates that $2(k-1)$ sets of assignments should be discarded. In addition to these assignments, the two repeated literals when combined with $\overline{x}_1$ will produce two sets of assignments of the form $(x_1\overline{x}_1)$ that are also discarded from the total number of assignments when we count them using the inclusion exclusion principle. Therefore, a repeated literal will result to discard $2(k-1)+1$ additional sets excluded.

Writing the inclusion exclusion series with n sets plus $k(2(k-1)+1)$ sets is hard because there will be many possibilities for the intersection of sets. The approach to show that 2n/k is the worst case is to exclude the additional sets first from the total number of assignments and compare that with the worst case. The number of assignments of the additional sets can be counted by:

$$A=(2(k-1)+1)*C(k,1)*k^{\frac{2n}{k}-1}-(2(k-1)+1)^2*C(k,2)*k^{\frac{2n}{k}-3}$$
$$+(2(k-1)+1)^3*C(k,3)*k^{\frac{2n}{k}-5}-\ldots+(-1)^{k+1}(2(k-1)+1)^k*C(k,k)*k^{\frac{2n}{k}-2k+1}$$
$$=\sum_{i=1}^{k}(-1)^{i+1}(2(k-1)+1)^i C(k,i)k^{\frac{2n}{k}-2i+1}$$

Excluding this from the total assignments

$$N=k^{\frac{2n}{k}+1}-\sum_{i=1}^{k}(-1)^{i+1}(2(k-1)+1)^i C(k,i)k^{\frac{2n}{k}-2i+1}$$
$$N=k^{\frac{2n}{k}-2k+1}(k^{2k}-\sum_{i=1}^{k}(-1)^{i+1}(2(k-1)+1)^i C(k,i)k^{2(k-i)})$$

Evaluating $(k^{2k}-\sum_{i=1}^{k}(-1)^{i+1}(2(k-1)+1)^i C(k,i)k^{2(k-i)})$ for values of k gives quantity less than k^{2k-1} and result to a number of assignments less than $k^{\frac{2n}{k}}$ and excluding the n sets of the form (v -v) from N gives a value that is less than the one in the worst case.

$k^{\frac{2n}{k}}$ excld(n sets) $>k^{\frac{2n}{k}-2k+1}(k^{2k}-\sum_{i=1}^{k}(-1)^{i+1}(2(k-1)+1)^i C(k,i)k^{2(k-i)})$ excld(n sets) because $k^{\frac{2n}{k}}>k^{\frac{2n}{k}-2k+1}(k^{2k}-\sum_{i=1}^{k}(-1)^{i+1}(2(k-1)+1)^i C(k,i)k^{2(k-i)})$.

This is for one additional clause. For i additional clauses the limit of the summation is to ik and this also will give the same result.

Theorem 3 tells us that step six will not generate assignments that are more than step five. This should make step 5 the dominant factor for time complexity.

Theorem 4

For the worst case, the upper bound is $(k(k-1))^{\frac{n}{k}}$

Proof

The inclusion-exclusion principle takes care of assignments that are counted more than once by considering the intersections between the n sets to be excluded as seen in the summation. Therefore, the least value of $N(P_1,P_2,P_3,\ldots,P_n)$ indicates the maximum possible number of assignments generated by the algorithm. This occurs when each set $x,\bar{x}$ is intersected with the maximum possible number of other sets. For example consider two clauses that has x_1 and $\bar{x}_1$ literals:

$$\begin{matrix} x_1 & x_2 & x_3 \\ \bar{x}_1 & x_4 & x_5 \end{matrix}$$

The assignments that include x_1 and $\bar{x}_1$ can never occur with assignments that include x_2 and $\bar{x}_2$, x_3 and $\bar{x}_3$, x_4 and $\bar{x}_4$, x_5 and $\bar{x}_5$ literals. Therefore, there is no intersection between $x_1\,\bar{x}_1$ assignment set and 4 sets of assignments. The least intersection $(k-1)$ happens if both clauses of x_5 and $\bar{x}_1$ have literals of the same variables. For the previous example the two clauses should look like this

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$x_1 \vee x_2 \vee \bar{x}_3 \quad \bar{x}_1 \vee \bar{x}_2 \vee x_3$ to make the quantity $N(P_1, P_2, P_3, \ldots, P_n)$ the least. If this happens with all variables, the following arrangement will produce the maximum number of assignments.

$$x_1 \vee x_2 \vee \bar{x}_3, \bar{x}_1 \vee \bar{x}_2 \vee x_3, \bar{x}_4 \vee \bar{x}_5 \vee x_6, x_4 \vee x_5 \vee \bar{x}_6, x_7 \vee \bar{x}_8 \vee x_9, \bar{x}_7 \vee x_8 \vee \bar{x}_9, \cdots$$

The number of assignments between clauses of conflicting literals is $k(k-1)$. Since we need $\frac{2n}{k}$ clauses to consider n variables and each 2 clauses have $k(k-1)$ assignments, then the number of assignments will be $k(k-1)^{\frac{n}{k}}$.

c) *Related Work*

Complete algorithms for SAT satisfiability problems include those algorithms that can state whether or not a SAT instance is satisfiable, giving a 'yes' answer together with a satisfying assignment or a 'no' answer as the case may be. The first complete algorithm is the Davis Putnam procedure (Davis & Putnam, 1960). This procedure is based on resolution rule to eliminate variables one by one till the formula is satisfied. When a variable is eliminated in each iteration, all resolvents are added to the set of the clauses. This algorithm requires polynomial space. It handles CNF formulas and it is one of the efficient SAT algorithms. (Davis, Logemann, & Loveland, 1962) Developed a divide-and-conquer algorithm that enhances on (Davis & Putnam, 1960). This improved algorithm is the main procedure for most state-of-the-art SAT solvers today. The search space of DPLL could grow as large as 2^n which is the worst case for any complete algorithm. Due to the possibility of consuming huge amount of time, researchers have been focusing on mechanisms to reduce that and came up with more reasonable time complexities. These improvements usually come in two aspects: the decision to branch to next literal and the backtracking mechanism if a solution is not found in the chosen branch. The achievements accomplished in improving SAT algorithm in these two aspects show that the complexity could be reduced significantly.

i. *Branching Decisions*

DPLL procedure chooses any literal for branching and goes down that region in the search space. The procedure will spend time searching for a solution and if it discovers that the branch is not successful, it backtracks to the other branch and continues searching. Choosing the next literal for branching more carefully will allow the algorithm to save time exploring a region where a satisfying assignment cannot be found at all and direct the searching to regions where a solution is likely to be found. In order to accomplish this, several heuristics have been proposed and the most effective ones can be found in (Bruni & A., 2003; Freeman, 1995; Hooker & Vinay, 1994; Jeroslow & Wang, 1990; Li & Anbulagan, 1997; Moskewicz, Madigan, Zhao, Zhang, & Malik, 2001; Pretolani, 1993).

ii. *Backtracking Mechanisms*

When the algorithm fails to find an answer or an empty clause (contradiction) appears down the path of the search tree, it backtracks to a certain point and continues searching in another part of the tree. The DP backtracks to the most recently untoggled (complemented) literal and tests its complement branch. As mentioned earlier this will cost a lot of time for DP to discover that this part of the search space does not have a solution and search for a solution elsewhere. For backtracking in the DP procedure, much work has not been done as compared to branching decision. This is due to the fact that backtracking is an essential step in any algorithm to prove its completeness. Nevertheless, there are a number of proposals to improve the backtracking in the DP procedure. (Lynce & Marques-Silva, Building State-of-The-Art SAT Solver, 2002) tested different backtracking strategies and the most effective ones can be found in (Lynce & Marques-Silva, 2002; Stallman & Sussman, 1977).

iii. *Upper Bounds*

The improvements made in backtracking and branching heuristics are of practical interests. However, the experimental analysis of these improvements indicates that satisfiability could be solved in time less than 2^n. A number of people gave lower bounds for this problem but most of them rely on a certain structure or property that exists in the formula. The following are some of the achievements made to find an upper bound that is better than the trivial one.

a. *Autarkness Principle*

The first attempt to achieve a non-trivial upper bound for SAT was done by (Monien & Speckenmeyer, 1985). They introduced the notion of autarks which are partial assignments of variables. If all clauses that include the variables in the assignment are satisfied, then that assignment is an autark. They proved that the time complexity of their algorithm is $O(2^{n \log \alpha_k})$.

b. *2-clause*

When dealing with 3-SAT problem, the clauses with 2 literals help in reducing the search space. Schiermeyer was the first to make use of the number of clauses with 2 literals after the resolution step is made (Schiermeyer, 1993). He said that for the next branch, a 2-clause is chosen such that it produces at least one new 2-clause in every branch that follows. With the help of these reduced clauses, he proved an even lower bound for 3-SAT with time complexity O(1.579^n). (Kullmann, 1999) showed that the algorithm of Schiermeyer can perform better through a new concept called blocked clauses. A clause C is blocked for a literal l if every clause C' containing l has also another literal that is complemented with C. By making use of these blocked clauses, Kullmann proved that the algorithm in (Schiermeyer, 1993) can have a time complexity of O(1.504^n).

c. *Saisfiability Coding Lemma*

This lemma is based on isolated assignments which are satisfying assignments to the formula where a change of one value of any variable will make it dissatisfying. The lemma states that such assignments can be encoded in a message of length $(n-\frac{n}{k})$ and this is where the complexity comes from. (Marques-Silva & Sakallah, 1999) shows that through satisfiability coding lemma their algorithm finds an answer in $O(2^{n-\frac{n}{2k}})$.

d. *P-literal*

(Hirsch, Two New Upper Bounds for SAT, 1998) presented two algorithms that rely on P-literal notion. This notion says that if a literal occurs exactly 2 times in the clause set and at least 3 times in its negation form, then it is P-literal. He used these special literals to simplify the formula and came up with two algorithms with time complexity O($2^{0.3089m}$) and $O(2^{0.10537L})$ respectively where m is the number of clauses and L is the length of the formula. An improvement was made to the second algorithm in (Hirsch, 2000) to become O($2^{0.10299L}$).

e. *Covering Codes*

(Danstin, et al., 2002) proposed a deterministic algorithm that is based on covering codes. This algorithm can be seen as a derandomization of (Schoning, 1999) algorithm that uses random walk model. The search space is divided into group of assignments say balls of some radius r. Each group or ball represents some assignment *a* and all assignments that differ with it in r variables. The algorithm checks in each ball if there is a satisfying assignment and if there is none in any ball then the formula is unsatisfied. The authors of (Danstin, et al., 2002) showed that the time complexity of this $O(2-\frac{2}{k+1})$ for k-SAT. For 3-SAT, they managed to further improve the algorithm by identifying useless branching and reduce the search space to come up with running time O(1.481^n).

V. Conclusion and Future Work

The proposed does not require the clauses or the formula to have any specific structure to achieve a competitive upper bound which is a significant advantage over the existing algorithms in the literature where they derive their time complexity based on a property that must exist in the formula. The algorithm gives a new insight towards solving SAT. Most of the other algorithms are based on the classical rule of splitting the search space into regions and search for a solution in each one. The new perspective of the algorithm has the potential to design further effective SAT algorithms that outperforms the existing ones in theory and practice.

The implementation of the proposed algorithm will be considered in future work. The algorithm proposed here can also be improved. The time complexity of the proposed algorithm is based on pre-processing of clauses in the formula. This arrangement is so unlikely to exist in all clauses considered. That means that there exists a tighter upper bound for the algorithm but to achieve that the order in which clauses are considered should be more intelligent. To show that such an upper bound exists, many cases have to be covered and counted. Parallelisation of the proposed algorithm is also a potential future work.

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Global Journal of Computer Science and Technology
Neural & Artificial Intelligence
Volume 13 Issue 1 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Efficient V-B Block Designs for CDC Method 4

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Summary - Some optimal incomplete block designs for complete diallel cross method 4 are known in literature. These designs require several replications for each cross and thus consume more resources such as experimental units, experimental material, time etc. So, there is a need to evolve designs which require minimum possible replications of parental lines. In this paper a method of construction of these designs is proposed by using mutually orthogonal Latin squares. These designs are connected for cross effects and perform well when compared to connected and not connected optimal designs reported by Dey and Midha (1996), Chai and Mukerjee (1999) and Gupta and Kageyama (1994), respectively.

Keywords : *latin square, complete diallel cross, general combining ability, specific combining ability, mating design.*

GJCST-D Classification : *F.2.m*

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I. Introduction

Orthogonal Latin squares are used for construction of Graeco Latin square, balanced incomplete block designs and square lattice designs. A set of p-1 orthogonal Latin square of side p can always be constructed if p is a positive prime or power of a positive prime.

If $p = 4t+2$ and $t > 1$, then there exits pairs of mutually orthogonal Latin squares of order p (Bose, Shrikhande and Parker (1960)). From a practical view point, mutually orthogonal Latin squares are important and an exhaustive list of these squares is available in Fisher and Yates (1963). In this paper we use mutually orthogonal Latin squares in construction of mating designs for the diallel cross method 4 referred to Griffing (1956).

A diallel cross is a type of mating design used in plant breeding and animal breeding to study the genetic properties and potential of inbred lines or individuals. Let p denote the number of lines and let a cross between lines i and j be denoted by $i \times j$, where $i<j = 0, 1, \ldots, p$-1 and $p(p-1)/2$ possible crosses. Among the four types of diallel discussed by Griffing (1956), method 4 is the most commonly used diallel in plant breeding. This type of diallel crossing includes the genotypes of one set of F_1's means of the type $(i \times j) = (j \times i)$, but neither the parents nor the reciprocals with all possible v = $p(p-1)/2$ crosses. This is sometimes referred to as the modified diallel. We shall refer to it as a complete diallel cross (CDC).

The problem of finding optimal mating designs for complete diallel cross experiments has received attention in recent years; see Gupta and Kageyama (1994), Dey and Midha (1996) and Chai and Mukerjee (1999). Most of the results on optimal block designs for diallel crosses have been derived for the general combining ability (gca) under the assumptions that the model does not include parameters representing the specific combining ability (sca) Gupta and Kageyama (1994) and Dey and Midha (1996) but with few exceptions Chai and Mukerjee (1999) and Choi et al. (2002). The designs of these authors can be used to estimate specific combining ability (sca) but they demand more resources in terms of experimental units and experimental material. In such a situation there is need for designs which require minimum possible number of experimental units in conducting CDC experiments and are equally efficient in comparison to optimal block designs and randomized block designs when the model, in addition to the block effects and general combining ability, includes specific combining ability.

In the present paper we are proposing efficient variance balanced incomplete block designs for CDC experiments through mutually orthogonal Latin squares under the assumption that the model includes the parameter of specific combining ability.

II. Method of Design Construction

It is known that when p is a prime positive integer or a power of prime positive integer, it is possible to construct (p-1) orthogonal Latin squares in such a way that they differ only in a cyclical interchange of the rows from 2^{nd} to p^{th}. Such squares are taken for the construction of incomplete block designs for diallel crosses. For p =6, such squares cannot be constructed.

Assume that there are p inbred lines and it is desired to find an incomplete block design for a mating design involving $p(p-1)/2$ crosses. Out of (p-1) mutually orthogonal Latin square (MOLS), consider any two MOLS of semi-standard form of order p and superimposed one square over the other. We obtain one Graeco Latin square in which each cell contains ordered pairs of integers (i, j) taking values from 0 to p-1 . These ordered pairs of integers occur once in a square. From Graeco Latin square remove the pairs of the type with $i = j$ and considering other ordered pairs of integers as crosses between lines i and j and the columns as blocks. By doing so we get an incomplete block design d for diallel cross experiment method 4 with parameters v = p (p-1)/2, b = p, k = p-1, and r = 2. The total

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number of experimental units to be allotted to $v = p(p-1)/2$ is $n = p(p-1)$. Henceforth d (v, b, k) will denote the class of all block designs with v treatments, b blocks and block size k.

Example1:-

Let us consider the mating design for CDC experiment method 4 for $p = 5$ parents. Consider two mutually orthogonal Latin squares L_1 and L_2 of semi-standard form of order 5. Superimposing one over the other square we get Graeco Latin square.

L_1						L_2				
0	1	2	3	4		0	1	2	3	4
1	2	3	4	0		2	3	4	0	1
2	3	4	0	1		4	0	1	2	3
3	4	0	1	2		1	2	3	4	0
4	0	1	2	3		3	4	0	1	2

After superimposition L_2 over L_1 and removing cross of the type i = j and considering columns as blocks, we obtain design d as given below:

Design d

B_1	B_2	B_3	B_4	B_5
1×2	2×3	3×4	4×0	0×1
2×4	3×0	4×1	0×2	1×3
3×1	4×2	0×3	1×4	2×0
4×3	0×4	1×0	2×1	3×2

III. Analysis

For the analysis of data obtained from design d, we will follow Singh and Hinkelmann- (1998) two stage procedures for estimating gca and sca effects. The first stage is to consider the proposed designs to estimate cross effects, say,

$\boldsymbol{\tau} = (\tau_{01}, \tau_{02}, \ldots, \tau_{(p-2)(p-1)/2})$ for design d by the following model.

$$y = \mu 1 + X\boldsymbol{\tau} + D\boldsymbol{\beta} + e \qquad (3.1)$$

Where **y** is an n × 1 vector of observations, **1** is the n × 1 vector of ones, **X** is the n × v design matrix for treatments and **D** is an n × b design matrix for blocks, that is, the $(h,u)^{th}$ $((h,l)^{th})$ element of **X** (respectively, of **D**) is 1 if the h^{th} observation pertains to the u^{th} cross (to l^{th} block), and is zero otherwise ($h = 1, \ldots, n$; $u = 1, \ldots, v$; and $1, \ldots, b$), μ is a general mean, $\boldsymbol{\tau}$ is a v × 1 vector of treatment parameters, $\boldsymbol{\beta}$ is a b × 1 vector of block parameters and **e** is an n × 1 vector of residuals. It is assumed that vector $\boldsymbol{\beta}$ is fixed and **e** is normally distributed with $E(\mathbf{e}) = \mathbf{0}$, $V(\mathbf{e}) = \sigma^2 \mathbf{I}$ and $Cov(\boldsymbol{\beta}, \mathbf{e}') = (\mathbf{0})$, , where **I** is the identity matrix of conformable order.

Following Tocher (1952), Raghavarao (1971) and Dey (1986), the least square method for the analysis of a proposed designs leads to the following reduced normal equations for the model (3.1).

$$C_d\boldsymbol{\tau} = Q_d \qquad (3.2)$$

Where $C_d = r^{\delta} - N k^{-1} N'$ and $Q_d = (Q_{1d}, \ldots, Q_{vd}) = T - N k^{-\delta} B$

In the above expressions above r^{δ} and k^{δ} are diagonal matrices of order v × v and b × b with elements 2 and p, respectively of design d. $N = X'D$ is the v × b incidence matrix of the design d; $T = X'y$ and $B = D'y$ are vector of cross totals and block totals of order v × 1 and b × 1 for design d, respectively.

Hence a solutions to (3.2) is given by

$$\hat{\boldsymbol{\tau}} = C_d^{-} Q_d \qquad (3.3)$$

Where C_d^{-} is a generalized inverses of C_d with property $C C^{-} C = C$. The sum of squares due to crosses are $Q'_d C_d^{-} Q_d$ with degrees of freedom (d.f.) = rank (C_d) for design d and expectation and variance Q_d is as

$$E(Q_d) = C_d\boldsymbol{\tau} \text{ and } V(Q_d) = \sigma^2 C_d \qquad (3.4)$$

Now we will utilize the above equations to estimate the genetic parameters in the proposed design. The second stage is to utilize the fact that the cross effects can be expressed in terms of gca and sca effects. So we can write

$$\tau_{ij} = g_i + g_j + s_{ij} \qquad (3.5)$$

Where g_i (g_j) is the gca for the i^{th} (j^{th}) parent, s_{ij} ($s_{ij} = s_{ji}$) is the sca for the cross between the i^{th} and the j^{th} parent ($i < j = 0, 1, \ldots, p-1$). In matrix notation equation (3.5) can be written as

$$\boldsymbol{\tau} = Z g + s \qquad (3.6)$$

Where $Z = (z_{ui})$ ($u = 1, 2, \ldots, n : i = 0, 1, \ldots, p-1$) is the cross and gca relation matrix.

$z_{ui} = 2$, if the u^{th} cross has both parents i.

$= 1$, if the u^{th} cross has only one parent i.

$= 0$, otherwise.

Following the approach used in Kempthorne and Curnow (1961), equation (3.2) can then be written as

$$C_d\boldsymbol{\tau} = C_d Z g + C_d s$$
$$\text{or } E(Q_d) = C_d Z g + C_d s \qquad (3.7)$$

Since the matrix **C** is singular, we use the unified theory of least square due to Rao (1973). So we get estimator of **g** as

$$\hat{\mathbf{g}} = (Z' C_d C_d^{-} C_d Z)^{-} Z' Q_d = (Z' C_d Z)^{-} Z' Q_d \qquad (3.8)$$

Here the matrix $(Z' C_d Z) = 2p(p-3)/(p-1)\,[I_p - \frac{1}{p} 1_p 1'_p]$.

So $\hat{\mathbf{g}} = (Z'C_dZ)^- Z'C_d \boldsymbol{\tau}$ (3.9)

Hence $\hat{\mathbf{g}} = H_1 \boldsymbol{\tau}$, where $H_1 = (Z'C_dZ)^- Z'C_d$

Now $\text{Cov}(\hat{\mathbf{g}}) = H_1 C_d H'_1 \sigma^2 = \sigma^2 (p-1)/2\, p\, (p-3)\, I_p$ (3.10)

Since the covariance matrix of $\hat{\mathbf{g}}$ is a constant times the identity matrix, therefore the proposed design d is variance-balanced for general combining ability effects. We thus have the following results.

Theorem

For a positive prime $p>3$, if there exits a mutually orthogonal Latin square of order p, then there always exist variance- balanced incomplete block design for CDC experiment method 4.

Now substituting the estimate of **g** in equation (3.6), we obtain the estimator of **s**.

$$\hat{\mathbf{s}} = (C_d^- - (p-1)/2\,p\,(p-3)\,ZZ')\,Q_d = (C_d^- - (p-1)/2\,p\,(p-3)\,ZZ')\,C_d\,\boldsymbol{\tau}$$
$$= H_2\,\boldsymbol{\tau} \quad (3.11)$$

Where
$$H_2 = (C_d^- - (p-1)/2\,p\,(p-3)\,ZZ')\,C_d$$
$$\text{Var}(\hat{\mathbf{s}}) = H_2 C_d H'_2 \sigma^2 \quad (3.12)$$

Since $H_1 1_v = 0$, $H_2 1_v = 0$, $H_1 H_2' = 0$, rank $(H_1) = p-1$ and rank $(H_2) = v-p$.

It follows that **g** and **s** represented by treatment contrasts that carry p-1 and v-p degrees of freedom respectively and that contrasts representing **g** are orthogonal to those representing **s**. It means the proposed design d allows for gca and sca effects to be estimated independently.

The sum of squares due to gca and sca for d are given by

$$SS\,(gca) = Q'_d\, Z\,(Z'C_dZ)^- Z'\, Q_d \quad (3.13)$$
$$SS\,(sca) = Q_d'\,(C_d^- - (p-1)/2\,p\,(p-3)\,ZZ')\,Q_d \quad (3.14)$$

The ANOVA is then given in Table 1.

Table 1 : Analysis of variance for design d

Source of variation	Degrees of Freedom	Sum of squares
Block	p-1	$B'B/p - G^2/p(p-1)$
Crosses (adjusted for blocks)	rank (C_d)	$Q'_d C_d^- Q_d$
gca	rank (H_1)	$Q'_d Z(Z'C_dZ)^- Z' Q_d$
sca	rank (H_2)	$Q_d'(C_d^- -(p-1)/2p(p-3)ZZ')Q_d$
Residual	(n-1) – rank (C_d) – rank (H_1) – rank (H_2)	$y'y - G^2/p(p-1) - B'B/p - Q'_d C_d^- Q_d$
Total	n-1	$y'y - G^2/p(p-1)$

G = grand total of all n observations

IV. Efficiency Factor

If instead of the proposed design d, one adopts a randomized complete block design with 2 blocks and each block contains p $(p$-1)/2 crosses, the C_R- matrix can easily shown to be

$$C_R = 2\,(p-2)\,(I_p - 1/p\,J_p) \quad (4.1)$$

Where I_p is a identity matrix of order p and J_p is a matrix of 1's . So that the variance of best linear unbiased estimate (BLUE) of any elementary contrast among the gca effects is $\sigma_1^2/(p-2)$, where σ_1^2 is the per observation variance in the case of randomized block experiment. It is clear from (3.10) that using design d each BLUE of any elementary contrast among gca effects is estimated with variance $\sigma^2 (p-1)/p(p-3)$. . Hence efficiency factor E of design d as compared to randomized block design under the assumption of equal intra block variances is

$$E = (\sigma_1^2 = \sigma^2) \text{ is } p\,(p-3)/(p-1)\,(p-2) \quad (4.2)$$

In Tables 2, 3, and 4 , we are presenting the efficiency factors of CDC by Gupta and Kageyama (1994) , universally optimal and efficient block designs reported by Dey and Midha (1996) and design d in relation to randomized block design, respectively.

Table 2 : Efficiency of GK designs and designs d in comparison to RBD

S.No.	p	n	r	2k	E_{GK}	E_d
1	4	6	3	4	1.00	0.66
2	5	10	4	4	0.83	0.83
3	7	21	6	6	0.93	0.93
4	8	28	7	8	1.00	0.95
5	8	28	7	4	0.66	0.95
6	9	36	8	8	0.96	0.96
7	9	36	8	6	0.85	0.96
8	10	45	9	10	1.00	0.98
9	10	45	9	6	0.83	0.98

10	11	55	10	10	0.97	0.98
11	12	66	11	12	1.00	0.97
12	12	66	11	6	0.80	0.98
13	12	66	11	4	0.60	0.98
14	13	78	12	12	0.98	0.99
15	13	78	12	6	0.78	0.99
16	13	78	12	4	0.59	0.99
17	14	91	13	14	1.00	0.99
18	15	105	14	14	0.98	0.99
19	15	105	14	6	0.77	0.99

GK denotes Gupta and Kageyama

Table 3 : Efficiency of Optimal DM designs and designs d in comparison to RBD

S.No.	Ref. No.	p	n_1	E_{DM}	n_2	E_d
1	T2	5	30	0.83	20	0.83
2	T3	5	60	0.83	20	0.83
3	T4	5	90	0.83	20	0.83
4	T8	7	210	0.70	42	0.93
5	T22	7	210	0.93	42	0.93
6	T40	8	280	1.00	56	0.95
7	T41	9	252	0.96	72	0.96
8	T54	10	315	1.00	90	0.98

Table 4 : Efficiency of DM efficient designs and designs d in comparison to RBD

S.No.	Ref.	p	n_1	E_{DM}	n_2	E_d	S.No.	Ref	p	n_1	E_{DM}	n_2	E_d
1	T12	5	60	0.84	20	0.83	9	T58	5	60	0.84	20	0.83
2	T13	5	90	0.92	20	0.83	10	T60	5	60	0.97	20	0.83
3	T33	5	40	0.94	20	0.83	11	T94	7	210	0.84	42	0.93
4	T34	5	80	0.80	20	0.83	12	T95	7	210	0.91	42	0.93
5	T37	5	100	0.87	20	0.83	13	T77	8	196	0.98	56	0.95
6	T44	5	30	1.00	20	0.83	14	T85	9	252	1.00	72	0.96
7	T45	5	60	0.84	20	0.83	15	T91	10	405	0.92	90	0.98
8	T57	5	30	0.84	20	0.83							

DM denotes Dey and Midha , Ref means the design number reported by Dey and Midha(1996), n_1 and n_2 are number of experimental units required by Dey and Midha's designs and design d , respectively. E_{GK}, E_{DM} and E_d are the efficiencies of GK, DM and design d in comparison of RCBD, respectively.

V. Discussion

In Table 2, we find that for p = 4, 5, 8, 9, 10, 11, 12, 13, and 15 parental lines , the design d perform well in comparison to optimal diallel cross Gupta and Kageyama (1994). In Table 3, for p = 5, 7 and 9 the performance of design d is more or less same in comparison to optimal design Dey and Midha (1996). In Table 4, for p = 5, 7, 8 and 10 the design perform well in comparison to efficient designs. Since design d requires minimum possible experimental units, therefore, design d can be used in place of GK and DM designs for estimating gca and sca effects.

VI. Illustration

We show the essential steps of analysis of a diallel cross experiment, using an incomplete block design proposed in this paper. For this purpose, we take data from an unpublished experiment conducted by Dr. Terumi Mukai on *Drosophila melanogaster* Cockerham and Weir (1977) on page 203. For the purpose of illustration, we take data of relevant crosses from this experiment. Each cross is replicated twice. The layout and observations in parentheses are given below.

B_1	B_2	B_3	B_4	B_5
1×2 (21.0)	2×3 (16.8)	3×4 (13.8)	4×0 (18.8)	0×1 (16.5)
2×4 (15.2)	3×0 (16.2)	4×1 (12.2)	0×2 (31.8)	1×3 (13.0)
3×1 (11.4)	4×2 (15.4)	0×3 (17.8)	1×4 (13.6)	2×0 (30.4)
4×3 (15.2)	0×4 (14.6)	1×0 (15.4)	2×1 (23.0)	3×2 (16.3)

The following are the vector of treatment total, block total and adjusted treatment total, respectively.

T = (31.9, 62.2, 34.0, 33.4, 44.0, 24.4, 25.8, 33.10, 30.6, 29.0) ′

B = (62.8, 63.0, 59.2, 87.2, 76.2) ′

Q = (-1.95, 21.35, 3.45, -4.15, 6.50, -10.35, -10.80, -1.70, -0.85, -1.50) ′

ANOVA, estimates of gca, and sca along with their standard errors are shown in Tables 5, 6 and 7.

Table 5 : Analysis of variance of the data

Source	D.F	Sum of squares	Mean sum of square	F
Blocks	4	137.81		
Crosses	9	418.92	46.54	53.70
g.c.a	4	341.70	85.42	98.56
s.c.a	5	77.20	15.44	17.81
Intra block error	6	5.2	0.86	
Total	19	561.93		

Table 6 : Estimates of the general combining ability and their estimated standard error

Parent	Estimates of (gca)	± S E
0	-1.24	0.4147
1	-0.65	0.4147
2	-2.16	0.4147
3.	2.58	0.4147
4.	1.47	0.4147

Table 7 : Estimates of sca effects and their estimated standard error

SCA	Estimate of (sca)	± S E	SCA	Estimate of (sca)	± S E
s_{01}	-0.63	0.4818	s_{13}	-5.29	0.4818
s_{02}	8.65	0.4818	s_{14}	-5.61	0.4818
s_{03}	3.13	0.4818	s_{23}	-1.26	0.4818
s_{04}	-3.04	0.4818	s_{24}	0.52	0.4818
s_{12}	2.58	0.4818	s_{34}	0.95	0.4818

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Global Journal of Computer Science and Technology
Neural & Artificial Intelligence
Volume 13 Issue 1 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

A Simple Neural Network Approach to Software Cost Estimation

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GJCST-D Classification : *B.2.m*

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Anupama Kaushik [α], A.K. Soni [σ] & Rachna Soni [ρ]

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I. Introduction

Software cost estimation is one of the most significant activities in software project management. It refers to the predictions of the likely amount of effort, time and staffing levels required to build a software system. The effort prediction aspect of software is made at an early stage during project development, when the costing of the project is proposed for approval. It is concerned with the prediction of the person hour required to accomplish the task. However, estimates at the early stages of the development are the most difficult to obtain because very little is known about the project and the product at the beginning. So, estimating software development effort remains a complex problem and it continues to attract research attention. There are several cost estimation techniques proposed and they are grouped into two major categories: (1) Parametric models or Algorithmic models, which uses a mathematical formula to predict project cost based on the estimates of project size, the number of software engineers, and other process and product factors [1]. These models can be built by analysing the costs and attributes of completed projects and finding the closest fit formula to actual experience. (2) Non Parametric models or Non algorithmic models which are based on fuzzy logic (FL), artificial neural networks (ANN) and evolutionary computation (EC). In this paper, we focus on non parametric cost estimation models based on artificial neural networks, and particularly Back-Propagation networks. Neural networks have learning ability and are good at modelling complex nonlinear relationships. They also provide more flexibility to integrate expert knowledge into the model. There are many software cost estimation models that have been developed using neural networks over the years. The use of radial basis function neural networks for software effort estimation is well described by many researchers [2, 3 and 4]. The clustering algorithms used in those designs are the conventional algorithms.

K. Vinay Kumar et al. [5] Uses wavelet neural networks for predicting software development cost. B. Tirimula Rao et al. [6] provided a novel neural network approach for software cost estimation using functional link artificial neural network. G. Witting and G. Finnie [7] uses back propagation learning algorithms on a multilayer perceptron in order to predict development effort. N. Karunanitthi et al. [8] reports the use of neural networks for predicting software reliability including experiments with both feed forward and Jordan networks. N. Tadayon [9] also reports the use of neural network with a back propagation learning algorithm. However it was not clear how the dataset was divided for training and validation purposes. T.M. Khoshgoftaar et al.[10] presented a case study considering real time software to predict the testability of each module from source code static measures. Ch. Satyananda Reddy and KVSVN Raju [11] proposed a cost estimation model using multi layer feed forward neural network. Venkatachalam [12] also investigated the application of artificial neural network (ANN) to software cost estimation.

Artificial neural networks are the promising techniques to build predictive models. So, there is always a scope for developing effort estimation models with better predictive accuracy.

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II. Overview of the Models and Techniques Used

a) COCOMO II Model

The COCOMO model, is the best known algorithmic cost model published by Barry Boehm in 1981 [1]. It was developed from the analysis of sixty three software projects. It is a hierarchy of software cost estimation models, which includes Basic, Intermediate and Detailed sub models. It was the most cited and plausible of all the traditional cost estimation models. COCOMO II is the revised version of the original COCOMO and is tuned to the life cycle practices of the 21st century. It also provides a quantitative analytic framework, and set of tools and techniques for evaluating the effects of software technology improvements on software life cycle costs and schedules. It consists of three sub models and they are:

- Application Composition Model: This model is suitable for quickly developed applications using interoperable components like components based on GUI builders and is based on new object point's estimation.
- Early Design Model: This model is used in the early stages of a software project and can be used in Application Generator, System Integration, or Infrastructure Development Sector. It uses Unadjusted Function Points (UFP) as the measure of size.
- Post Architecture Model: This is the most detailed of the three and is used after the overall architecture for the project has been designed. One could use function points or LOC as size estimates with this model. It involves the actual development and maintenance of a software product.

COCOMO II describes 17 cost drivers and 5 scale factors that are used in the Post Architecture model. The cost drivers for COCOMO II are rated on a scale from very low to extra high. Their product is used to adjust the nominal effort. Table 1 lists COCOMO II cost drivers along with their multipliers. Scale factor is a particular characteristic of the software development that has an exponential effect of increasing or decreasing the amount of development effort and they are Precedentness, Development flexibility, Architecture/Risk resolution, Team cohesion and Process maturity. These factors are rated on a six point scale i.e., very low, low, nominal, high, very high and extra high as given in Table 2.

COCOMO II post architecture model is given as:

$$PM = A \times [\ size]^{1.01+\sum_{i=1}^{5}} \times \prod_{i=1}^{17} E \quad (1)$$

Where PM is the effort expressed in person months, A is a multiplicative constant, size is the projected size of the software project expressed in thousands of lines of code KLOC, EM_i (i=1,2....17) are effort multipliers and SF_i (i=1,2....5) are exponent scale factors.

b) Artificial Neural Networks

An artificial neural network (ANN) is an efficient information processing system which resembles in characteristics with a biological neural network. ANN's possess large number of highly interconnected processing elements called neurons. Each neuron is connected with the other by a connection link. Each connection link is associated with weights which contain information about the input signal. This information is used by the neuron net to solve a particular problem. Each neuron has an internal state of its own. This internal state is called the activation level of neuron, which is the function of the inputs the neuron receives. There are a number of activation functions that can be applied over net input such as Gaussian, Linear, Sigmoid and Tanh. It is the Sigmoid function that is the most frequently used in neural nets. Thus, the models of ANN are specified by the three basic entities namely [13]:

1. The model's synaptic interconnections;
2. The training or learning rules adopted for updating and adjusting the connection weights;
3. Their activation functions.

The neural network process starts by developing the structure of the network and establishing the technique used to train the network using an existing data set. Neural network architectures are divided into two groups:

1. Feed forward networks where no loops in the network path occur.
2. Feedback networks that have recursive loops.

Table 1 : COCOMO II cost drivers with multipliers

S.No	Cost Driver	Very Low	Low	Nominal	High	Very High	Extra High
1	RELY	0.75	0.88	1.00	1.15	1.39	--
2	DATA	--	0.93	1.00	1.09	1.19	--
3	CPLX	0.75	0.88	1.00	1.15	1.30	1.66
4	RUSE		0.91	1.00	1.14	1.29	1.49
5	DOCU	0.89	0.95	1.00	1.06	1.13	
6	TIME	--	--	1.00	1.11	1.31	1.67
7	STOR	--	--	1.00	1.06	1.21	1.57
8	PVOL	--	0.87	1.00	1.15	1.30	--
9	ACAP	1.50	1.22	1.00	0.83	0.67	--
10	PCAP	1.37	1.16	1.00	0.87	0.74	--
11	PCON	1.24	1.10	1.00	0.92	0.84	--
12	AEXP	1.22	1.10	1.00	0.89	0.81	--
13	PEXP	1.25	1.12	1.00	0.88	0.81	--
14	LTEX	1.22	1.10	1.00	0.91	0.84	--
15	TOOL	1.24	1.12	1.00	0.86	0.72	--
16	SITE	1.25	1.10	1.00	0.92	0.84	0.78
17	SCED	1.29	1.10	1.00	1.00	1.00	--

Table 2 : COCOMO II Scaling Factors

Scaling Factors	Very Low	Low	Nominal	High	Very High	Extra High
Precedentness	6.20	4.96	3.72	2.48	1.24	0.00
Development Flexibility	5.07	4.05	3.04	2.03	1.01	0.00
Architecture/Risk Resolution	7.07	5.65	4.24	2.83	1.41	0.00
Team Cohesion	5.48	4.38	3.29	2.19	1.10	0.00
Process Maturity	7.80	6.24	4.68	3.12	1.56	0.00

The most common architecture of neural networks which is used in software cost estimation is the Back-Propagation trained Feed Forward networks [14, 15]. The training algorithm of back propagation involves four stages:

1. Initialization of weights
2. Feed forward
3. Back Propagation of errors
4. Updation of the weights and biases

III. Proposed Work

The performance of a neural network depends on its architecture and their parameter settings. There are many parameters governing the architecture of the neural network including the number of layers, the number of nodes in each layer, the transfer function in each node, learning algorithm parameters and the weights which determine the connectivity between nodes. There is no rule which determines the ideal parameter settings but even a slight parameter changes can cause major variations in the results of almost all networks. This property of the neural network is captured in the present work for predicting the software costs. The neural network model proposed is based on multi layer feed forward neural network and it uses the architecture given by Ch. Satyananda Reddy and KVSVN Raju [11]. The model accommodates the COCOMO II model.

The aim of this work is to evaluate the results of software cost estimation using COCOMO II by varying the activation functions at the input, hidden and the output layers. The model proposed uses the identity function at the input layer which is defined by $f(x) = x$. The hidden and the output layer uses unipolar sigmoid function defined by $f(x) = \frac{1}{1+e^{-x}}$.

This function is especially advantageous to use in neural networks trained by back-propagation algorithms. Because it is easy to distinguish, and this can interestingly minimize the computation capacity for training.

a) Architecture of the Neural Network Model

The proposed structure of the neural network accommodates the COCOMO II post architecture model given by Eq. 1. The use of neural network to estimate PM (person months) in Eq. 1 requires twenty four input nodes in the input layer which corresponds to seventeen EM's, five SF's and two bias values. The COCOMO model which is a non linear model is transformed into a linear model using natural logarithms as shown in Eq. 2.

$$\text{Ln (PM)} = \ln(A) + \ln(EM_1) + \ln(EM_2) + \ldots\ldots + \ln(EM_{17}) + [1.01 + SF_1 + \ldots\ldots + SF_5]*\ln(\text{size}) \quad (2)$$

The above equation becomes :

$$C_{PM} = [b_1 + x_1*z_1 + x_2*z_2 + \ldots\ldots + x_{17}*z_{17}] + [b_2 + z_{18} + \ldots\ldots. + z_{22}]*[y_i + \ln(\text{size})] \quad (3)$$

Where,

$C_{PM}=\ln(PM)$;
$z_1=\ln(EM_1)$; $z_2=\ln(EM_2)$;……;$z_{17}=\ln(EM_{17})$;
$z_{18}=SF_1$;……..;$z_{22}=SF_5$;

b_1 and b_2 are the biases and the coefficients x_i and y_i are the additional terms used in the model which act as the weights from the input layer to the hidden layer.

The COCOMO II model as given by Eq. 3 is shown in Fig.1. This network consists of two hidden layer nodes C_{EM} and C_{SF} that take into account the contribution of effort multipliers and scale factors. C_{PM} is the node of the output layer where we get the value of ln(PM) which is the desired output of the model. In the above network all the original EM_i and SF_i values of COCOMO II are pre processed to $\ln(EM_i)$ and $\ln(SF_i)$ and used as input nodes. The two bias values are denoted by b_1 and b_2, which are ln(A) and 1.01 respectively. The size of the product is not considered as one of the inputs to the network but as a cofactor for the initial weights for scale factors (SF). The weights associated to the input nodes connected to the hidden layer are denoted by x_i for $1 \leq i \leq 17$ for each input ln(EMi) and b_1. On the other hand, the weights associated to the hidden layer for each ln (SFi) input nodes and b_2 are y_i+ln (size) for $18 \leq i \leq 22$. These weights are initialized as $x_i=1$and $y_i=0$. The weights from the hidden layer to the output layer are denoted by p and q and initialized as p=q=1.

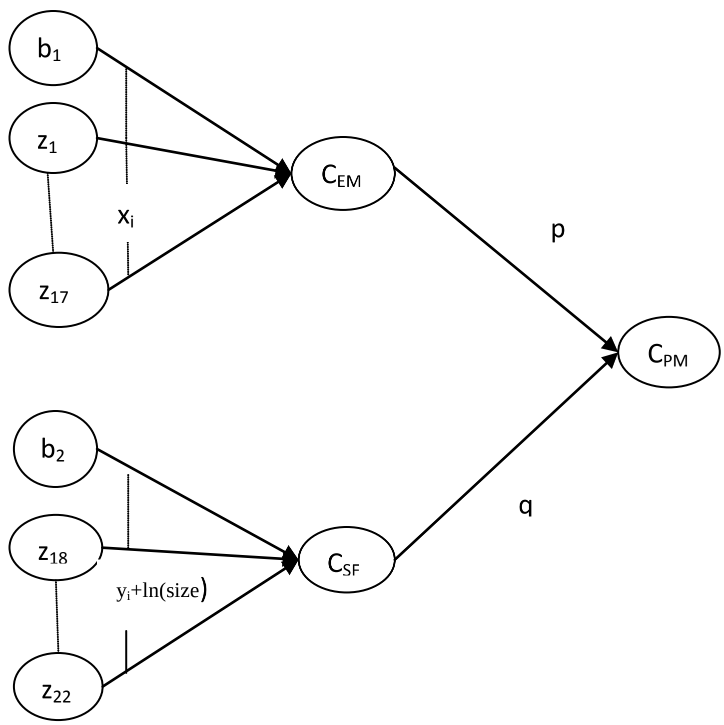

Figure 1 : Neural Network Architecture

b) *Training Algorithm*

The feed forward back propagation procedure is used to train the network by iteratively processing a set of training samples and comparing the network's prediction with the actual value. For each training sample, the weights are modified so as to minimize the error between the networks predicted value and the actual value. The following algorithm is used for training the proposed network and for calculating the new set of weights:

Step 1: Initialize the weights and learning rate α $(0 < \alpha \leq 1)$.

Step 2: Perform steps 3-10 when stopping condition is false.

Step 3: Perform steps 4-9 for each training pair.

Step 4: Each input unit receives input signal and sends it to the hidden unit.

Step 5: Each hidden unit C_{EM} and C_{SF} sums its weighted input signals to calculate net input given by:

$$C_{EM} = b_1 + \Sigma z_i * x_i \qquad \text{for } i=1 \text{ to } 17$$

$$C_{SF} = b_2 + \Sigma z_i * (y_i + \ln(\text{size})) \quad \text{for } i=18 \text{ to } 22$$

Apply sigmoidal activation function over C_{EM} and C_{SF} and send the output signal from the hidden unit to the input of output layer units.

Step 6: The output unit C_{PM}, calculates the net input given by:

$$C_{PM} = C_{EM}*p + C_{SF}*q$$

Apply sigmoidal activation function over C_{PM} to compute the output signal E_{est}.

Step 7: Calculate the error correction term as: $\delta = E_{act} - E_{est}$, where E_{act} is the actual effort from the dataset and E_{est} is the estimated effort from step 6.

Step 8: Update the weights between hidden and the output layer as:

$$p(new) = p(old) + \alpha * \delta * C_{EM}$$

$$q(new) = q(old) + \alpha * \delta * C_{SF}$$

Step 9: Update the weights and bias between input and hidden layers as:

$$x_i(new) = x_i(old) + \alpha * \delta_{EM} * z_i \text{ for } i = 1 \text{ to } 17$$
$$y_i(new) = y_i(old) + \alpha * \delta_{SF} * z_i \text{ for } i = 18 \text{ to } 22$$
$$b_1(new) = b_1(old) + \alpha * \delta_{EM}$$
$$b_2(new) = b_2(old) + \alpha * \delta_{SF}$$

The error is calculated as

$$\delta_{EM} = \delta * p; \quad \delta_{SF} = \delta * q \,;$$

Step 10: Check for the stopping condition. The stopping condition may be certain number of epochs reached or if the error is smaller than a specific tolerance.

Using this approach, we iterate forward and backward until the terminating condition is satisfied. The variable α used in the above formula is the learning rate, a constant, typically having a value between 0 and 1. The learning rate can be increased or decreased by the expert judgment indicating their opinion of the input effect. In other words the error should have more effect on the expert's indication that a certain input had more contribution to the error propagation or vice versa. For each project, the expert estimator can identify the importance of the input value to the error in the estimation. If none selected by the expert, the changes in the weights are as specified by the learning algorithm. The network should also be trained according to correct inputs. For example, if during estimation ACAP (Analyst Capability) is set as high but after the end of the project, the management realizes that it was nominal or low, then the system should not consider this as a network error and before training the system, the better values of cost factors should be used to identify the estimated cost.

IV. Datasets and Evaluation Criteria

The data sets used in the present study comes from PROMISE Software Engineering Repository data set [16] made publicly available for research purpose. The three datasets used are COCOMO 81 dataset, NASA 93 dataset and COCOMO_SDR.

The COCOMO 81 dataset consists of 63 projects which uses COCOMO model as described in section 2.1. Each project is described by its 17 cost drivers, 5 scale factors, the software size measured in KDSI (Kilo Delivered Source Instructions), the actual effort, total defects and the development time in months. The NASA 93 dataset consists of 93 NASA projects from different centres for various years. It consists of 26 attributes: 17 standard COCOMO-II cost drivers and 5 scale factors in the range Very_Low to Extra_High, lines of code measure (KLOC), the actual effort in person months, total defects and the development time in months.

The COCOMO_SDR dataset is from Turkish Software Industry. It consists of data from 12 projects and 5 different software companies in various domains. It has 24 attributes: 22 attributes from COCOMO II model, one being KLOC and the last being actual effort in man months.

The entire dataset is divided into two sets, training set and validation set in the ratio of 80:20 to get more accuracy of prediction. The proposed model is trained with the training data and tested with the test data.

The evaluation consists in comparing the accuracy of the estimated effort with the actual effort. A common criterion for the evaluation of cost estimation model is the Magnitude of Relative Error (MRE) and is defined as in Eq. 4.

$$MRE = \frac{|Actual\ Effort - Estimated\ Effo}{Actual\ Effort} \qquad (4)$$

The MRE values are calculated for each project in the validation set, while mean magnitude of relative error (MMRE) computes the average of MRE over N projects.

$$MMRE = \frac{1}{N}\sum_{X=1}^{N} MI \qquad (5)$$

Another evaluation criterion is MdMRE, which measures the median of all MRE's. MdMRE is less sensitive to extreme values. It exhibits a similar pattern to MMRE but it is more likely to select the true model if the underestimation is served.

Since MRE, MMRE and MdMRE are the most common evaluation criteria, they are adopted as the performance evaluators in the present paper.

V. Results and Discussion

This section presents and discusses the results obtained when applying the proposed neural network model to the COCOMO 81, NASA 93 and COCOMO_SDR datasets. The model is implemented in Matlab. The MRE, MMRE and MdMRE values are

Global Journal of Computer Science and Technology (D) Volume XIII Issue I Version I Year 2013

calculated for the projects in the validation set for all the three datasets. These values are then compared with the COCOMO model.

Table 3 shows the results and comparison on COCOMO dataset. It also contain results given by Ch. Satyananda Reddy and KVSVN Raju [11] for the corresponding projects. For example, in the case of Project ID 5 it is 7.44 for COCOMO model, 5.08 for the model proposed by Ch. Satyananda Reddy and KVSVN Raju and 4.012 for the proposed model. The Mean Magnitude of Relative Error (MMRE) for the entire validation set is 15.938 for the COCOMO model, 8.745 for the model proposed by Ch. Satyananda Reddy and KVSN Raju and 3.546 for the proposed model. The Median of MRE (MdMRE) for the entire validation set is 12.4 % for the COCOMO model, 9.73% for the model proposed by Ch. Satyananda Reddy and KVSN Raju and 3.67% for the proposed model. Fig. 2 shows the graphical representation of MRE values for the three models for COCOMO 81 dataset. There is a decrement in the relative error using the proposed model. The results obtained thus suggest that the proposed architecture can be applied for accurately predicting the software costs.

Table 4 shows the results and comparison on NASA 93 dataset. Here also, there is a decrease in the relative error using the proposed model. For example, the relative error calculated for Project ID 30 is 8.81 for COCOMO model, and 3.34 for our proposed model. The relative error calculated for Project ID 62 is 13.2 for COCOMO model, and 5.00 for our proposed model. The Mean Magnitude of Relative Error (MMRE) for the entire validation set is 12.746 and 4.349 for the COCOMO model and our proposed model respectively. The MdMRE for the entire validation set is 13.43% for the COCOMO model and 4.46% for our proposed model. Fig. 3 shows the graphical representation of MRE values for the two models.

For COCOMO_SDR dataset, COCOMO II model performs very poorly. For Project ID 1, it has estimated effort as 2241.4 whereas the actual effort is 1 and with our proposed model it is 1.24. Similarly, for Project ID 2 COCOMO II effort is 901.6; its actual effort is 2 and the estimated is 1.95. Table 5 shows the estimated effort and their MRE values using the proposed model on COCOMO_SDR dataset. MMRE value for the estimated effort is 6.34. The MdMRE for the entire validation set is 4.62% for the proposed model. Fig. 4 shows the bar graph representation of actual effort values and estimated effort values with the proposed model for COCOMO_SDR. The bar graph shows that the estimated effort is very close to the actual effort.

The results obtained thus, suggest that the proposed model outperformed the COCOMO model and the model given by Ch. Satyananda Reddy and KVSN Raju in terms of all the discussed evaluation criteria i.e, MRE, MMRE and MdMRE. It can be applied for accurately predicting the software costs.

Table 3 : Comparison of MRE for the three models on COCOMO 81

S.No	Project ID	MRE(%) using COCOMO model	MRE(%) using Model proposed by Satyananda Reddy	MRE(%) using proposed model
1	5	7.44	5.08	4.012
2	12	19.83	6.8	3.98
3	30	6.49	3.24	1.77
4	38	50.98	15.34	3.59
5	40	12.4	11.1	4.16
6	45	5.35	4.59	4.01
7	47	16.4	10.06	3.46
8	59	8.66	4.92	3.67
9	61	13.1	12.5	3.86
10	62	6.22	9.73	2.97
11	63	19.95	12.84	3.53

Table 4 : Comparison of MRE on NASA93

S.No	Project ID	MRE(%) using COCOMO model	MRE(%) using proposed model
1.	1	9.33	3.90
2.	5	8.84	3.39
3.	15	16.75	4.25
4.	25	14.09	4.11
5.	30	8.81	3.34
6.	42	13.9	5.00
7.	54	13.67	4.89
8.	60	11.78	4.93
9.	62	13.2	5.00
10.	75	17.09	4.68

Table 5 : Comparison of effort on COCOMO_SDR

S.No.	Project ID	Actual Effort	Estimated Effort	MRE (%)
1	1	1	1.24	24
2	2	2	1.95	2.5
3	3	4.5	4.33	3.77
4	4	3	2.90	3.33
5	5	4	3.83	4.25
6	6	22	20.37	7.4
7	7	2	1.90	5
8	8	5	4.8	4
9	9	18	16.77	6.8
10	10	4	3.8	5
11	11	1	1.06	6
12	12	2.1	2.03	3.33

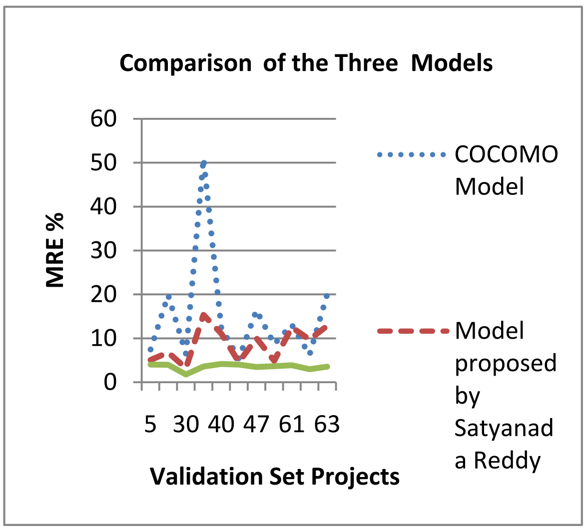

Figure 2 : Comparison of the Models on COCOMO dataset

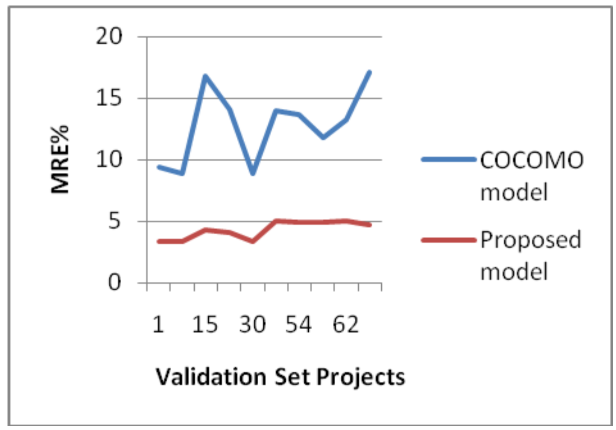

Figure 3 : Comparison of the Models on NASA93 dataset

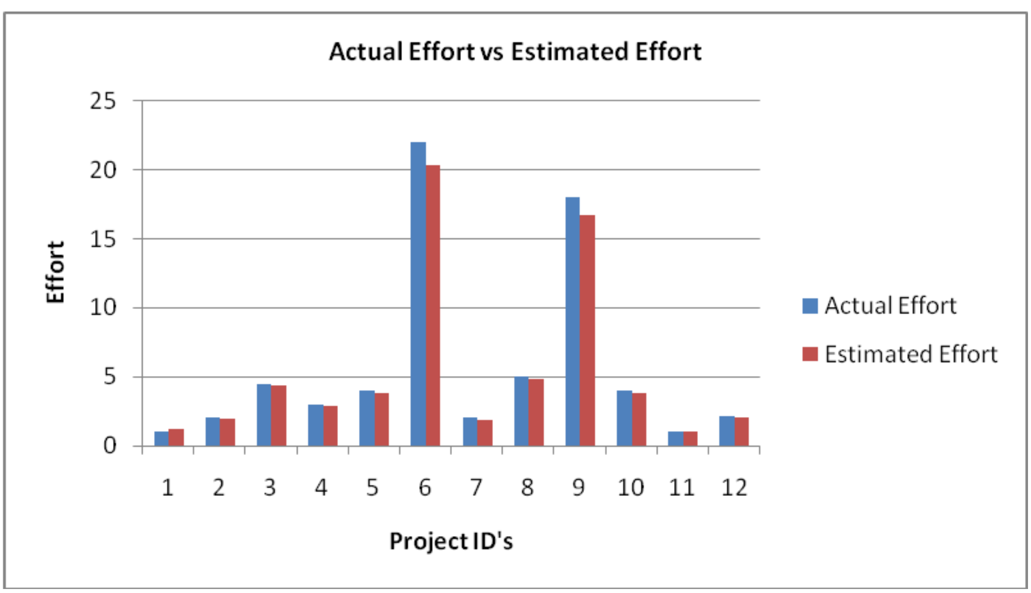

Figure 4 : Comparison of Actual vs. Estimated effort on COCOMO_SDR dataset

VI. Conclusion

Software development cost estimation is a challenging task for both the industrial as well as academic communities. The accurate predictions during the early stages of development of a software project can greatly benefit the development team. There are several effort estimation models that can be used in forecasting software development effort.

In the paper, Feed Forward Back Propagation model of neural network is used which maps the COCOMO model. The model used identity function at the input layer and sigmoidal function at the hidden and output layer. The model incorporates COCOMO dataset and COCOMO NASA 2 dataset to train and to test the network. Based on the experiments performed, it is observed that the proposed model outscored COCOMO model and the model proposed by Ch. Satyananda Reddy and KVSN Raju. Future research can replicate and confirm this estimation technique with other datasets for software cost estimation. Furthermore, the utilization of other neural networks architecture can also be applied for estimating software costs. This work can also be extended using Neuro Fuzzy approach.

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18. **Pick a good study spot:** To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. **Think technically:** Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Administration Rules Listed Before Submitting Your Research Paper to Global Journals Inc. (US)

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

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Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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ISSN 9754350