encryption standard. The results obtained from the test indicate that Memetic Algorithm is more a powerful technique for the handling of the cryptanalysis of SDES.

R.Thamilselvanet al [8] In this paper tha author has presented a Genetic Tabu Search Algorithm for the Job Shop Scheduling (JSS). The GTA algorithm is compared with the Genetic Algorithm and Tabu Search algorithm. The result shows that the GTS is better than the existing problem GA, TS. The algorithm showed a very good result for the number

b) Expert Judgement
c) Top- down
d) Bottom-up
e) Estimation by analogy

3.3 Algorithmic (Parametric) Model

Algorithmic model uses mathematical equations for cost estimation. These mathematical equations are based on research, historical data and number of inputs such as Source Lines of Codes(SLOC), number of functions to perform, and other cost drivers such as language, design methodology, skill-levels, risk assessments, etc. There are a lot of algorithmic models have been developed so far such as COCOMO model, Putnam model and function points based model.

3.4 Expert Judgement Method:

process models, reengineering, reuse driven approaches, and object oriented approaches. COCOMOII has three sub models: Application Composition, Early Design and Post Architecture model.

(i) **Application Composition Model:** This model is used to estimate effort and schedule on projects which uses Integrated Computer Aided Software Engineering Tools for rapid application development. It uses object points for sizing.

(ii) **Early Design Model:** This model involves the exploration of software and system architectures and concepts of operation. It is based on function point (or lines of code when available) and contains 7 scale factors and 5 effort multipliers.

(iii) **Post Architecture Model:** This model is the detailed extension of early design model and estimates for the entire development lifecycle. It is used when top level design is complete and detailed information about the project is available. It uses source of lines of codes and/or function points for sizing, a set of 17 effort multipliers and 5 scale factors[2]

COCOMOII model describes 17 cost drivers in Product, Personnel, Computer and Project categories and also 5 scale factors .[9]

Table 1: Cost drivers for COCOMO-II PA model [9] [10]

Cost Drivers	*Description*	*Type*
RELY	Required software reliability	Product
DATA	Data base Size	Product
RUSE	Developed for Reusability	Product
DOCU	Documentation needs	Product
CPLX	Product complexity	Product
TIME	Execution Time Constraints	Computer
STOR	Main Storage Constraints	Computer
PVOL	Platform Volatility	Computer
ACAP	Analyst Capability	Personnel
PCAP	Programmer Capability	Personnel
APEX	Application Experience	Personnel
PLEX	Platform Experience	Personnel
LTEX	Language ad tool experience	Personnel
PCON	Personnel Continuity	Project
TOOL	Use of Software Tools	Project
SITE	Multi site Development	Project
SCED	Required development schedule	Project

Table 2: Scale factors for COCOMO II PA model [9][10]

Scale Factors	Description
PREC	Precedentedness
FLEX	Development Flexibility
RESL	Risk Resolution
TEAM	Team Cohesion
PMAT	Process Maturity

In COCOMOII, effort can be calculated by the following equation:

$$\text{Effort (PM)} = A\times (\text{SIZE})^{E} \times \Pi_i EM_i \text{........ [10]} \quad (1)$$

Where A is the multiplicative constant with value 2.94 that scales the effort according to project conditions.

Size – COCOMOII expresses size of project in thousands of Source Line Of Code (SKLOC). [11]

EM_i - are Effort Multipliers where i =1, 2, 3….17.

E – is an exponent which is aggregated of five Scale Factors that describe relative economies and diseconomies of scale that are encountered for software projects of dissimilar magnitudes. [11]

$$E = B + 0.01\sum_j SF_j \text{ where j=1 to 5 ....[11]} \quad (2)$$

B is a multiplicative constant whose value is 0.91

The development time (TDEV) of the project is derived from the equation:

$$TDEV = C*(Effort)^{F} \text{ ....[10]} \quad (3)$$

C is a multiplicative constant whose value is 3.67 and the coefficient F can be determined by following equation:

$$F = D + 0.2*0.01* \sum_j SF_j \text{..............[10](4)}$$

where D=0.28

Or

$F = D + 0.2*(E-B)$

When all the scale factors and effort multipliers are taken with their nominal values, then the equation of effort and duration are:

$$\text{Effort} = 2.94 \times (\text{Size})^{1.1} \text{...........[10](5)}$$

$$\text{Duration: } TDEV = 3.67 \times (\text{Effort})^{3.18} \text{........[10](6)}$$

COCOMOII is an industry standard and having clear and effective calibration process by combining Delphi techniques with algorithmic cost estimation techniques (Bayesian approach) and having backward compatibility with Rosetta Stone. The main disadvantage of COCOMOII model is that it based on waterfall model and most of the extensions are still experimental and not fully calibrated till now. [11]

5. Comparative Study

Various optimization techniques have been used earlier in the proposed model such as genetic algorithm, particle swarm optimization, neural network and many more but they have some disadvantages associated with them, that is why they cannot produce better results than tabu search.

5.1 Genetic algorithm

genetic algorithm is an adaptive heuristic search algorithm based on the evolutionary idea of natural selection and genetics. It uses random search technique to solve optimization problems. However, it is not random by nature instead it exploit the historical information to direct the search into the region of better performance within the search space. It is based on the principle of Charles Darwin's "survival of the fittest". It is characterized by a parallel search of thestate space as against a point-by-point search by the conventional optimization techniques. The parallel search is achieved by keeping a set of possible solutions to the optimization problem, called population. An individual in the population is a string of symbols and is an abstract representation of the solution. The symbols are called genes and each string of genes is termed a chromosome. The individuals in the population are evaluated by some fitness measure. The population of chromosomes evolves from generation to the next through the use of two types of genetic operators: (1) unary operators such as mutation and inversion which alter the genetic structure of a single chromosome, and (2) higher-order operator, referred to as crossover which consists of obtaining new individual by combining genetic material from two selected parent chromosomes. Then the new population is selected out of the individuals of the current population and its offsprings. Based on the fitness value, two individuals (parents) are selected at a time from the population. The genetic operators (crossover and mutation) are applied on the selected parents to generate new possible solutions called offsprings.[12]

Disadvantages of Genetic Algorithm

- The main problem of genetic algorithm is premature convergence which does not allow it to access whole solution space constraining it to converge to a local optimum.
- The problem of choosing the various parameters like the size of the population, mutation rate, cross over rate, the selection method and its strength.
- Have trouble finding the exact global optimum.

5.2 Neural Network

Neural network is a computing system made up of a number of highly interconnected processing elements, which process information by their dynamic state response to external inputs. It is basically made upof layers and each layer consists of interconnected nodes which contains an activation function. Patterns (input) are presented to the network through 'input layer', which communicates to one or more 'hidden layers' where the actual processing is done via a system of weighted connections. The hidden layers then connected to the output layers to give output. In neural network, the computational steps are not sequential. There are no complex central processors, rather there are many simple ones which generally do nothing more than take the weighted sum of their inputs from other processors. NNs do not execute programed instructions; they respond in parallel (either simulated or actual) to the pattern of inputs presented to it. There are also no separate memory addresses for storing data. Instead, information is contained in the overall activation 'state' of the network. 'Knowledge' is thus represented by the network itself, which is quite literally more than the sum of its individual components.[13]

Disadvantages of Neural Network

- The main disadvantage is, they are black box i.e. the knowledge of internal working is never known.
- Secondly to fully implement a neural network architecture would require a lot of computational resources.

5.3 Particle Swarm Optimization

Particle swarm optimization (PSO) is a population based stochastic optimization technique developed by Dr. Eberhart and Dr. Kennedy in 1995, inspired by social behavior of bird flocking or fish schooling.PSO shares many similarities with evolutionary computation techniques such as Genetic Algorithms (GA). The system is initialized with a population of random solutions and searches for optima by updating generations. However, unlike GA, PSO has no evolution operators such as crossover and mutation. In PSO, the potential solutions, called particles, fly through the problem space by following the current optimum particles. Each particle keeps track of its coordinates in the problem space which are associated with the best solution (fitness) it has achieved so far. (The fitness value is also stored.) This value is called *pbest*. Another "best" value that is tracked by the particle swarm optimizer is the best value, obtained so far by any particle in the neighbors of the particle. This location is called*lbest*. When a particle takes all the population as its topological neighbors, the best value is a global best and is called *gbest*.The particle swarm optimization concept consists of, at each time step, changing the velocity of (accelerating) each particle toward its p*best* and *lbest* locations (local version of PSO). Acceleration is weighted by a random term, with separate random numbers being generated for acceleration toward *pbest* and *lbest* locations.[14]

Disadvantages of particle swarm optimization:

- This technique suffers from partial optimism, which causes the less exact at the regulation of its speed and its direction.
- Also the method cannot work on the problems of scattering and optimization.

5.4 Tabu Search

Tabu search which is proposed by Fred Glover in 1986 is a metaheuristic technique which can be superimposed on other procedures toprevent them from being trapped into locally optimal solutions. Tabu search has obtained optimal and nearly optimal solutions to various problems ranging from scheduling to telecommunications and from character recognition to neural network. It employs local search technique for finding optimum solutions. Local search technique takes a potential solution of a problem and then find its neighbours which are basically similar but having a minute difference in their details. Through these neighbours we can find out an improved solution. But this technique has a problem of becoming stuck at suboptimal solutions or on plateaus where many solutions are equally fit. Tabu search overcome the problem of this technique by using memory structures that describes the visited solutions and a set of rules. The basic principle of tabu search is to pursue the search whenever a local optimum is encountered by allowing non-improving moves. If any solution is previously visited or violating any rule is considered as "tabu" so that the solution will not considered repeatedly.

Tabu Search algorithm starts with an initial solution to the problem, calls it a current solution, and further create its neighbourhood (a collection of solutions which can be easily reached from current solution) and tries to find out a best solution from its neighbourhood. It then designates the best solution as the current solution and starts the search process again. The search process gets terminate when some stopping criteria has been met, for example execution time, prespecified iteration counts, solution quality etc. In order to prevent repeatedly considering a solution that has been recently visited a list has been maintained called tabu list which contains a list of neighbour generated moves that has been considered forbidden and are ignored while searching the neighbourhood of a solution. Once a move enters in tabu list, it remains there for a pre-specified number of tabu search iterations (known as tabu tenure of the move). After the completion of tabu tenure of the move, it can be reached again while searching in the neighbourhood. The list of tabu moves changes continuously during the execution of the search, making tabu search an adaptive memory searchalgorithm. When the stopping criteria met, we get current solution as the best solution.[15]

Advantages of Tabu Search

- It can be applied to both discrete and continuous solution spaces.

- For larger and more difficult problems tabu search obtains solutions that rival and often surpass the best solutions previously found by other approaches.
- it is deterministic and chooses the best option available to improve a solution.
- Handles large, poorly understood search spaces easily.
- Overcome the problem of premature convergence of GA.
- Tabu search can produce better results in less computed time other than GA, PSO and NN.

6. Conclusion

Various optimization techniques have been studied which can be applied on COCOMOII model for optimizing its coefficients a, b, c, d and to achieve predicted effort value as accurate to the given real effort value. The best technique among them is the Tabu Search because it is a very simple and powerful approach which can be superimposed on COCOMOII model and can produce better results.

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