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Construction of Derivation Trees of Plus Weighted Context Free Grammars

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Abstract: The core of this paper is to construct Derivation Trees of Plus Weighted Context Free Grammars and the bonding between Plus weighted Context Free grammar and Plus weighted Context Free Dendrosystem is established.
Keywords: Trees and Pseudoterms, Plus Weighted Context Free Dendrolanguage Generating System (P-CFDS), Sets of Derivation Trees of Plus Weighted Context Free Grammars.

I. INTRODUCTION

Weighted context free grammars and weighted finite automata were initially introduced in significant articles by Marcel-Paul Schutzenberger (1961) and Noam Chomsky (1963), respectively. Weighted automata and their accompanying algorithm are developed by contemporary spoken-dialog or handheld speech recognition systems to express their concepts and promote successful combination and search [1,7].

If there is connection between context-free grammars and grammars of natural languages, it is undoubtedly, as Chomsky proposes, through some stronger concept like that of transformational grammar. In this framework, it is not the context-free language itself that is of interest, but, rather, the set of derivation trees, i.e., the structural descriptions of markers. From the viewpoint of the syntax directed description of fuzzy meanings, sets of trees rather than the sets of strings are of prime importance.

A plus weighted automata [8,9,10,11] is an automata that deals with plus weights up to infinity. Many algebraic structures of plus weighted automata has been discussed in [8,9,10]. Thus we are motivated to study systems to manipulate plus weighted dendrolanguage generating system which is the generalization of fuzzy Context Free Dendrolanguage generating System. Plus weighted Dendrolanguage generating System can also be extended to max weighted automata cited as [2,3,4,5,6]. This work can be further motivated to work in Labeling of trees in graph theory [13,14,15,16,17,18] with plus weights which will give more focus on the paths it prefer.

This paper comprises of 6 sections including this section phase 2 offers some fundamental ideas which are needed for the succeeding section. Section 3 use the records about trees and Pseudoterms. Section 4 offers with Plus Weighted Dendrolanguage Generating System. Section 5 gives the Normal Form of P-CFDS

II. PRELIMINARIES

In this section we review some basic notations and definitions about grammar and its types.

Definition 2.1

A phrase-structure grammar or grammar is a four tuple G = <V^N , V^N , S, P> Where,

V^N is a set of non-terminal symbols, V^T is a set of terminal symbols called alphabets, S is a special element of V^N and is called the starting symbol, P is the production. Relation on

$(V^T \; V^N)^*$, the set of strings of elements of terminal and non-terminal.

Types of grammars

Type 0 or unrestricted grammar:

A grammar in which there are no restrictions on its productions.

Type 1 or context sensitive grammar:Grammar that contains only productions of the form $\alpha \to \beta$ where $|\alpha| = |\beta|$ and $\alpha \in$ V

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^{N} .Type 2 or context free grammar:Grammar that contains only productions of the form $\alpha \longrightarrow \beta, where\ |\alpha| = |\beta|\ \alpha \epsilon V_N$.Type 3 or regular grammar:

Grammar that contains productions of the form $\alpha \rightarrow \beta$ where $|\alpha| \leq \beta, \alpha \in \mathrm{V_N}$ and β is of the form a or aB where $a \in \mathrm{V_T}$ and $\beta \in \mathrm{V}_N$.

III. TREES AND PSEUDOTERMS

As before, Let ℕ be the set of natural numbers and N* be the set of all strings on ℕ including the null string (). A finite closed subset U of N* is called a finite tree domain if the following conditions hold:

1) q ∈U and q=u v implies uU, where u, v, qN*.

2) q k∈U and j≥k implies qj∈U, where qN*, jkℕ.

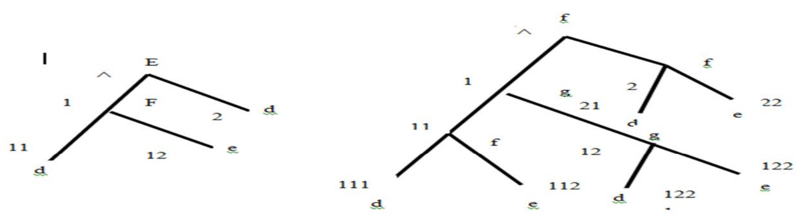
Let U be a finite tree domain. Then the subset U = {q∈U|q.1∉U} is called the leaf node set. A pair (N: T) of finite alphabets N and T, where N∩T=∅ is called a partially ranked alphabet. A tree t on a partially ranked alphabet (N: T) is a function from a finite tree domain U into N∪T, written t: U→(N:T), such that

t (q)N for q∈U/U

t (q)∈T for qU

Of course, a finite tree t: U→(N:T) can be represented by a finite set of pairs (q,t(q)), ie) $\{(q,t(q)) \mid q \in U\}$.

Trees on (N: T) can be represented graphically by constructing a rooted tree (where the successors of each node are ordered), representing the domain of the mapping, and labeling the nodes with elements of $N \cup T$, representing the values of the function. Thus in the following figures there are two examples; as a mapping, the left-hand tree has the domain $U = \{\wedge,1,2,11,12\}$ and the value at 11 is a note also that $\overline{U} = \{2,11,12\}$.



The definition of a tree and the corresponding pictorial representation provide a good basis for intuition for considering tree manipulating systems.

However, the development of the theory is simpler if the familiar linear representation of such trees is considered. Thus, we define the set $D^p_{(N:T)}$ of Pseudoterms on $N \cup T$ as the smallest subset $[N \cup T \cup \{(,)\}]^*$ satisfying the following conditions:

1. $T \subset D^p_{(N;T)}$

2. If $n > 0$ and $B \in N$ and b1,b2 ...bn then $B(b_1, b_2, \ldots b_n \in D^p_{(N;T)}$

(We note that parentheses are not symbols of $N \cup T$)

We consider trees and Pseudoterms to be equivalent formalizations. The translation between the two is the usual one. By way of examples; the trees of the above figure correspond to the following Pseudoterms; $E(F(de)d), f(g(f(de))f(de)$.

This correspondence call be more precise in the following manner:

1. If a Pseudoterms $b^p \in D^p_{(N:T)}$ is atomic (i.e) $b^p = a \in T,$ then the corresponding tree b has domain $\{\wedge\}$ and $b\{\wedge\} = a.$
2. If $b^p = B(b_1^p, \ldots\ldots, b_m^p)$, then b has domain $U_i \leq j\{iq \mid q \in$ domain $(b_i)\} \cup \{\wedge\}, b(n) = B,$ and for q=iq' in the domain of b, $b(q) = b_i(q').$

A plus weighted set T of trees is defined by a membership function $\gamma_T : D_{(N:T)} \to [0,\infty]$ the set of all plus set of trees is denoted by $F[D_{(N:T)}]$.

IV. SETS OF DERIVATION TREES OF PLUS WEIGHTED CONTEXT FREE GRAMMARS

In this section, we define the set of derivation trees of plus weighted context free grammars as plus sets of trees and we characterize them by P-CFDS's.

A. *Definition 4.1*

A Plus Weighted Context Free Dendrolanguage Generating System (P-CFDS) is 6-tuple S= (N_0, N, T, W, P, λ_0) such that the following conditions hold:

1) N_0 is a finite set of symbols whose elements are called non terminal node symbols.
2) N is a finite set of symbols whose elements are called node symbols.
3) T is a finite set of symbols whose elements are called leaf symbols.
4) W weighting space (ie) W=([0,∞),+,·)
5) P is a finite set of plus rewriting rules of the form. $\mu(\lambda, t) = c$

B. *Definition 4.2*

A plus weighted context-free grammars (P-CFG) is a 5-tuple G = (N, T, W, P, S), where,

1) N is a set of nonterminal symbols.
2) T is a set of terminal symbols.
3) P is a set of plus production rules.
4) S is a initial nonterminal symbol.
5) W is a weighted space. (ie) W = ($[0,\infty),+,$) "+" usual addition "." usual multiplication

for a derivation, $q_0 (=S) \overset{c_1}{\Rightarrow} q_1 \overset{c_2}{\Rightarrow} \ldots\ldots \overset{c_m}{\Rightarrow} q_m (=q)$

under a plus context free grammar G, we define a derivation tree with a degree of membership as follows:

1. For $q_0 (=S), (\alpha^{q_0};1) = (\{(\wedge, S)\};1)$
2. Suppose that ($\alpha^{q_{i-1}};c)$ is given for some I and that $q_{i-1} \overset{c}{\Rightarrow} q_i$ is realized by $B \overset{c_i}{\to} E_1, E_2, \ldots\ldots E_k$ ($G_i \in N \cup T$) with $q_{i-1} = xBy$ and $q_i = xE_1E_2\ldots\ldots E_k y$ (It is assume that the symbol B replaced by $E_1, E_2, \ldots E_k$ corresponds to a leaf node v in $\overline{U}\alpha^{q_{i-1}}$). Then ($\alpha^{q_i};c'$) is given by,

$$\alpha^{q_i} = \alpha^{q_{i-1}} \cup \{(v.i, G_i) \setminus 1 \le i \le k, (v,B) \in \alpha^{xBy}, v \in \overline{U}\alpha^{q_{i-1}}\},$$

Where $\overline{U}\alpha^{q_{i-1}}$ is the leaf node set of $\alpha^{q_i} - 1$ and by $c' = c \wedge c_i$.

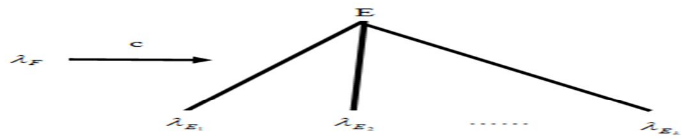
Let D_G be a plus set of trees on (N; T) defined by the above procedure for all possible derivations of a plus weighted context free grammar G . Then D_G is called a plus set of plus weighted derivation trees of G.

C. *Theorem 4.3*

For any given P-CFG, G = (N, T, P^G , S), there exists an P-CFDS, G = (N^{0}, N^{S}, T^{S}, P^{S}, λ_0), which generates the plus set D_G of plus derivation trees of G.

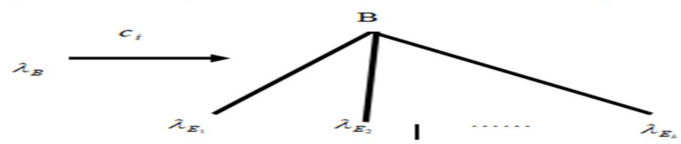
Proof:

Set $N_0 = \{\lambda_F \mid F \in N\}$, $N_S = N$ $T_S = T$ and $\lambda_0 = \lambda_S$ Determine P_S as follows: If $q_{i-1} \overset{c}{\Rightarrow} q_i$ is realized by $F \overset{c}{\rightarrow} E_1, E_2, \ldots\ldots E_k$ is in P, then



is contained in P_s if $E_i = b \in T$, then $\lambda_{E_i} = b$.

Since the process of obtaining ($\alpha^{q_i}; c'$) from ($\alpha^{q_{i-1}}, c$) in the definition D_G corresponds to the application of the rule

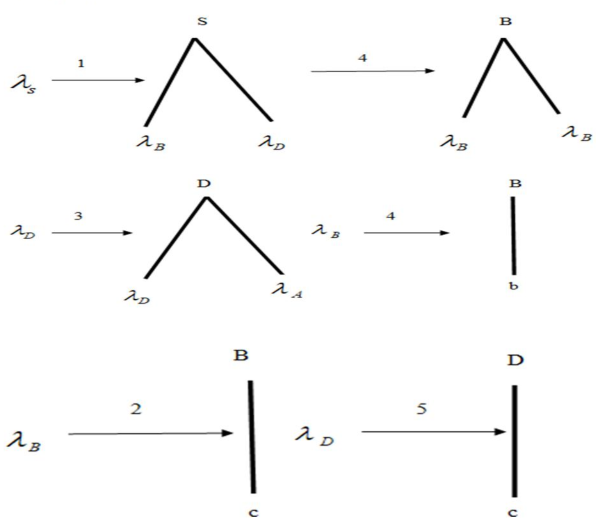


P-CFDS, S, it follows that $D_G = D(s)$.

Example 4.4: Consider the P-CFG given by the following rules:

$$S \overset{1}{\rightarrow} BD,\ B \overset{4}{\rightarrow} BD,\ D \overset{3}{\rightarrow} DB,\ B \overset{4}{\rightarrow} b,\ B \overset{2}{\rightarrow} c,\ D \overset{5}{\rightarrow} c.$$

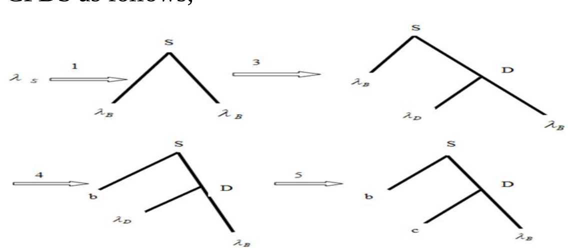
For this P-CFG, construct an P-CFDS determined by the following rules:

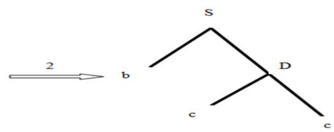


for the derivation of P-CFG,

$$S \overset{1}{\Rightarrow} BD \overset{3}{\Rightarrow} BDB \overset{4}{\Rightarrow} bDA \overset{5}{\Rightarrow} bcB \overset{2}{\Rightarrow} bcc$$

its derivation tree is generated by the P-CFDS as follows;





We now consider the converse of theorem we prove that for an

P-CFDS, s there exists a P-CFG. G corresponding to s in the sense of theorem below. Let $h:[N \cup T\{(,)\}]^* \to T$ be a homomorphism defined by h(b) = b for b in T and h(F) = n for $F \notin T$.

D. Lemma 4.5

Let S be an P-CFDS. Then the plus set P(D(S)) of Pseudoterms of D(S) is a plus weighted context free language.
proof:

Let S = (N^0, N, T, P, λ_0) be an P-CFDS construct an P-CFG,

G = (N^G, T^G, P^G, S^G) as follows:

set $N^G = N^0$, $T^G = N \cup T \cup \{(,)\}$, $S^G = \lambda_0$ and determine P^G as follows

If $\lambda \xrightarrow{c} t$ is in p, then $\lambda \xrightarrow{c} P(t)$ is in P^G. From the above construction, it follows that L(G) = P(D(S)).

E. Theorem 4.6

For any P-CFDS, s, h(P(D(S))) is a plus context - free language on T.
Proof: The proof follows by lemma and the fact that a homomorphic image of a plus weighted context - free language.

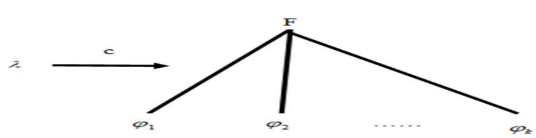
F. Theorem 4.7

Every P-CFDL is a projection of the plus set of derivation trees of an P-CFG.
proof:

Let S = (N^0, N, T, P, λ_0) be a normal P-CFDS. Consider the

P-CFG, G = (N^G, T^G, P^G, S^G), where,
$N^G = N_0 \times (N \cup T)$, $T_G = \{\langle f, b\rangle | b \in T\}$ and where f is a new symbol not in N_0, $S_G = \{<\lambda_0, F> | F \in N \cup T\}$.

1.If



is in P, then

$<\lambda, F> \xrightarrow{c} <\varphi_1, F_1><\varphi_2, F_2> \ldots\ldots\ldots <\varphi_K, F_K>$ is in P_G, where $F_i \in N \cup T$,

1. If $\lambda \xrightarrow{c} b$ is in P, then the rule. $<\lambda, b> \xrightarrow{c} <f, b>$

is in P_G.

It follows that if (t; c) is a fuzzy derivation tree of this grammar,
$(\phi(t); c)$, a projection of (t; c) is a plus tree generated by the

P-CFDS, S, where $\phi(t)$ is defined, in terms Pseudoterms as follows:

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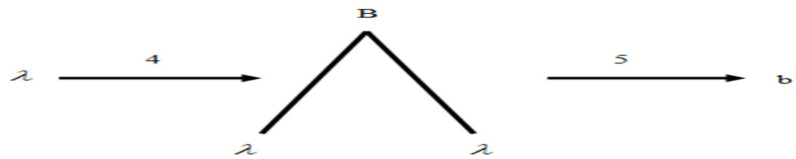
1) $\phi[<\lambda,b>(<f,b>)]=b$

2) $\phi[<\lambda,F>(P(t_1).........P(t_k))]=F(\phi(P(t_1)]......\phi[P(t_k)])$.

G. Example 4.8

Consider the P-CFDS given by the following rules:



For this P-CFDS, define a P-CFG by the following rule:

$<\lambda,B>\overset{4}{\rightarrow}<\lambda,B><\lambda,B>$

$<\lambda,B>\overset{4}{\rightarrow}<\lambda,B><\lambda,b>$

$<\lambda,B>\overset{4}{\rightarrow}<\lambda,b><\lambda,B>$

$<\lambda,B>\overset{4}{\rightarrow}<\lambda,b><\lambda,b>$

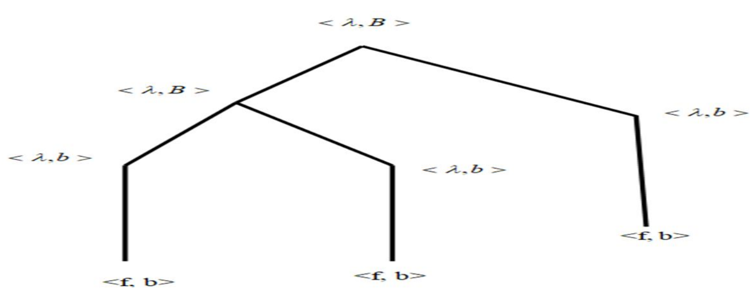
$<\lambda,b>\overset{5}{\rightarrow}<f,b>$

For example, the plus derivation,

$<\lambda,b>\overset{4}{\Rightarrow}<\lambda,B><\lambda,b>\overset{4}{\Rightarrow}<\lambda,b><\lambda,b><\lambda,b>$

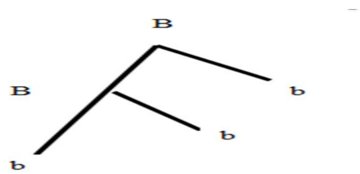
$\overset{5}{\Rightarrow}<f,b><f,b><f,b>$

has a derivation tree.



and its degree of membership is 4.

The projection of this tree defined in the proof of theorem



which is contained in the P-CFDL generated by the given P-CFDS.

V. CONCLUSION

In this paper Sets of Derivation Trees of Plus Weighted Context Free Grammars is introduced and Every P-CFDL is a projection of the plus set of derivation trees of an P-CFG is proved with suitable illustrations. Further this topic can be extended to verify the algebraic properties of plus weighted derivation trees.

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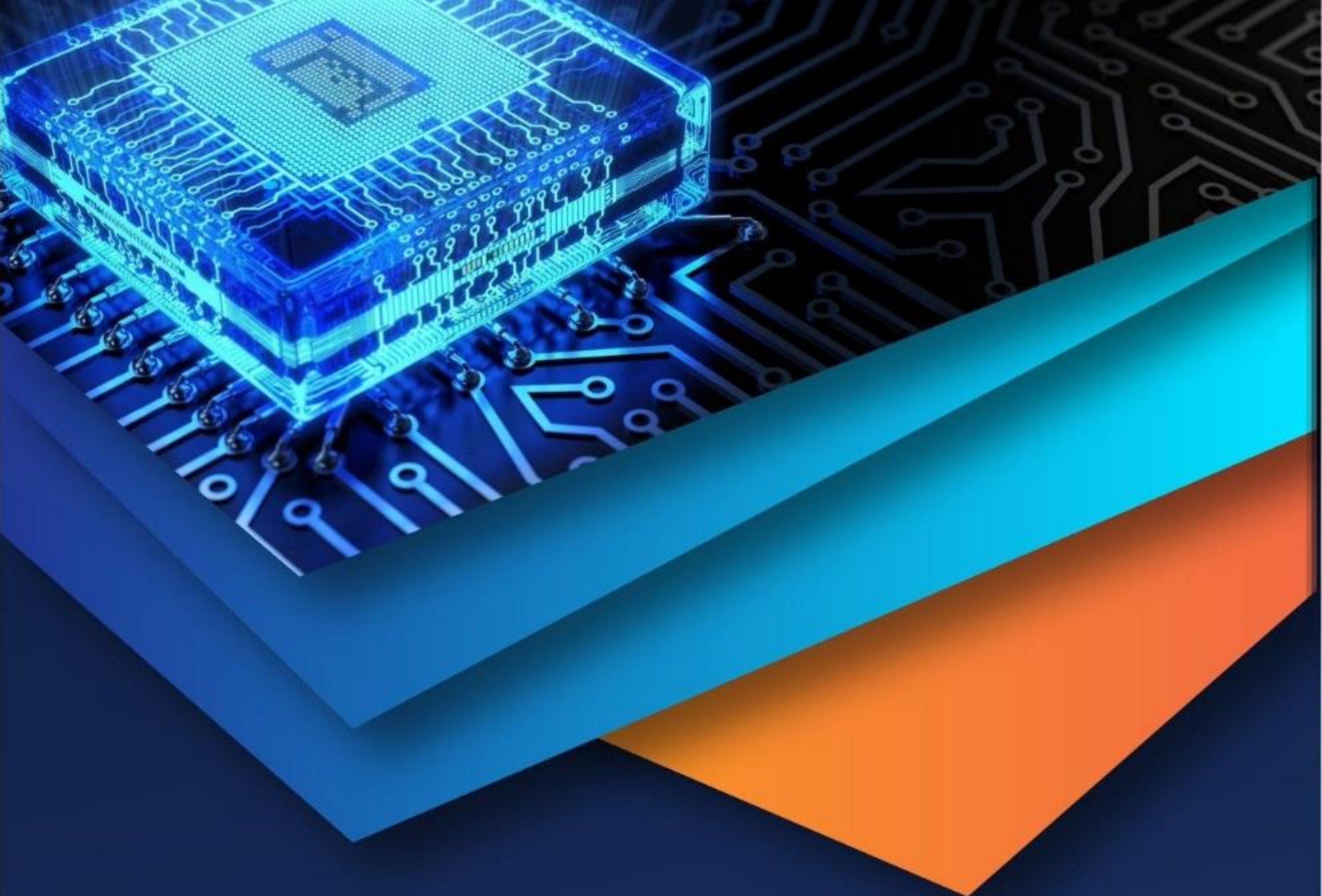

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