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Original Article

An Algorithmic Exploration Of Dominating Set And Independent Dominating Set

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ABSTRACT

Objectives: This paper presents an algorithmic investigation into the identification and analysis of dominating sets and independent dominating sets in simple graphs. **Methods:** A dominating set and an independent dominating set are found in the following definitions (i) A set S ⊆ V is a dominating set of a graph G if every vertex v ∈ V is either an element of S or is adjacent to an element of S. (ii) An independent dominating set of G is a set that satisfies both dominating and independent in G. **Findings:** The possibilities of a dominating set and an independent dominating set are found in Python programming language. **Novelty:** The Python programming language to implement algorithms that precisely identify dominating sets and independent dominating sets in simple graphs.

Keywords: Domination – Independent Domination- python program code.

INTRODUCTION

The development of algorithms provides systematic and efficient solutions to a wide range of problems across different domains. Algorithms are a fundamental concept in computer science and critical for advancing technology and solving complex challenges. Through the paper, the graph G = (V, E) means a simple, finite, undirected, and connected graph. A set S ⊆ V is a dominating set of a graph G if every vertex $v \in S$ either an element of S or is adjacent to an element of S [4]. In 1958[1], Berge defined the concept of the domination number of a graph, calling this as "coefficient of External Stability". In 1962[3], Ore used the name "dominating set" and "domination number" for the same concept. In 1977[2] Cockayne and Hedetniemi made an interesting and extensive survey of the results known at that time about dominating sets in graphs. They have used the notation γ (G) for the domination number of a graph. The domination number of G, denoted by γ (G), is the minimum size of a dominating set. A set is independent (or stable) if no two vertices are adjacent. An independent dominating set of G is a set that is both dominating and independent in G. The independent domination number and the notation i(G) were introduced by Cockayne and Hedetniemi in [5,6] is the minimum size of an independent dominating set. The independence number of G, denoted α(G), is the maximum size of an independent set in G. It follows immediately that γ (G) ≤ i(G) ≤ α(G). A dominating set of G of size γ (G)is called a γ -set, while an independent dominating set of G of size i(G)is called an i-set [7].

2. RESULT AND DISCUSSION

2.1. An algorithm on Dominating set of any simple graph using Python language:

```
class MyGraph:
 def __init__(self, num_vertices):
    self.V = num_vertices
    self.adj = []
    for i in range(num_vertices):
       self. adj.append([])
 def add_my_edge(self, v1, v2):
    self.adj[v1].append(v2)
    self.adj[v2].append(v1)
```

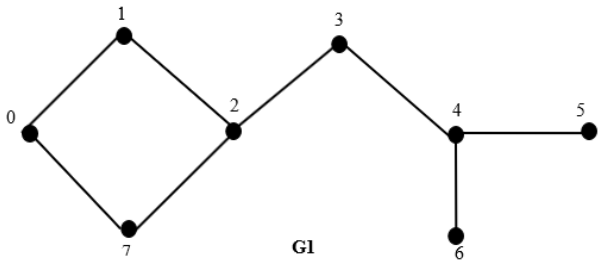
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

```
    def is_my_dominating(self, dom_set):
        for i in range(self.V):
            if i not in dom_set:
                flag = False
                for j in self.adj[i]:
                    if j in dom_set:
                        flag = True
                        break
                if not flag:
                    return False
        for i in dom_set:
            for j in dom_set:
                if i != j and j in self.adj[i]:
                    return False
        return True
    def find_my_dominating_sets(self):
        all_sets = []
        for i in range(1 << self.V):
            dom_set = []
            for j in range(self.V):
                if i & (1 << j):
                    dom_set.append(j)
            if self.is_my_dominating(dom_set):
                all_sets.append(dom_set)
        return all_sets
g = MyGraph(8)
g.add_my_edge(0, 1)
g.add_my_edge(0, 7)
g.add_my_edge(1, 2)
g.add_my_edge(2, 7)
g.add_my_edge(2, 3)
g.add_my_edge(3, 4)
g.add_my_edge(4, 5)
g.add_my_edge(4, 6)
dom_sets = g.find_my_dominating_sets()
print(dom_sets)
```

Output:

[[0,2,4], [0,2,5,6], [0,3,5,6], [1,4,7], [1,3,5,6,7]]

Manual output:



The possible dominating sets of G1 are: {[0,2,4], [0,2,5,6], [0,3,5,6], [1,4,7], [1,3,5,6,7]}

2.2 An algorithm on Independent Dominating set using Python language

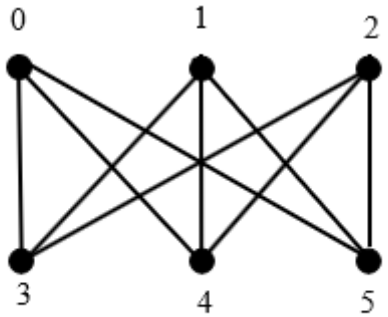
```
class MyGraph:
    def __init__(self, num_nodes):
        self.num_nodes = num_nodes
        self.adj_list = []
        for node in range(num_nodes):
            self.adj_list.append([])
    def add_my_edge(self, node1, node2):
        self.adj_list[node1].append(node2)
        self.adj_list[node2].append(node1)
    def is_my_independent_set(self, my_set):
        for node1 in my_set:
            for node2 in my_set:
```

```
            if node1 != node2 and node2 in self.adj_list[node1]:
                return False
        return True
    def is_my_dominating_set(self, my_set):
        covered = my_set.copy()
        for node1 in my_set:
            for node2 in self.adj_list[node1]:
                covered.append(node2)
        covered_set = set(covered)
        return len(covered_set) == self.num_nodes
    def find_my_independent_dominating_sets(self):
        all_sets = []
        for i in range(1 << self.num_nodes):
            my_set = []
            for j in range(self.num_nodes):
                if i & (1 << j):
                    my_set.append(j)
            if self.is_my_independent_set(my_set) and self.is_my_dominating_set(my_set):
                all_sets.append(my_set)
        return all_sets
g = MyGraph(6)
g.add_my_edge(0, 3)
g.add_my_edge(0, 4)
g.add_my_edge(0, 5)
g.add_my_edge(1, 3)
g.add_my_edge(1, 4)
g.add_my_edge(1, 5)
g.add_my_edge(2, 3)
g.add_my_edge(2, 4)
g.add_my_edge(2, 5)
ids = g.find_my_independent_dominating_sets()
print(ids)
```

Output:

[[0,1,2], [3,4,5]]

Manual output:



G2

The possible independent dominating sets of G2 are: {[0,1,2], [3,4,5]}

CONCLUSION

This paper presents an algorithm developed to determine the possibilities of dominating and independent dominating sets for simple graphs, implemented using Python programming.

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