

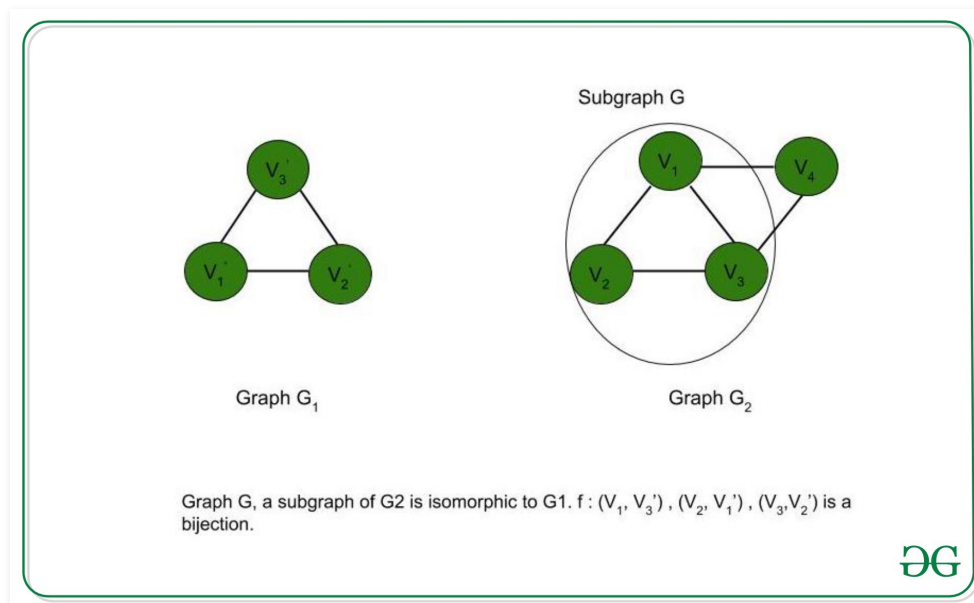


Related Articles

Subgraph Isomorphism Problem: We have two undirected graphs G_1 and G_2 . The problem is to check whether G_1 is isomorphic to a subgraph of G_2 .

Graph Isomorphism: Two graphs A and B are isomorphic to each other if they have the same number of vertices and edges, and the edge connectivity is retained. There is a bijection between the vertex sets of the graphs A and B. Hence, two vertices u, v are adjacent to each other in A if and only if $f(u), f(v)$ are adjacent in B (f is a bijection).

To prove that a problem is NP-Complete, we have to show that it belongs to both NP and NP-Hard Classes. (Since NP-Complete problems are NP-Hard problems which also belong to NP)



class, then it should have polynomial-time verifiability. Given a certificate, we should be able to verify in polynomial time if it is a solution to the problem.

Proof:

1. Certificate: Let G be a subgraph of G_2 . We also know the mapping between the vertices of G_1 and G .
2. Verification: We have to check if G_1 is isomorphic to G or not. (i) Checking if the mapping is a bijection and (ii) Verifying if, for every edge (u, v) in G_1 , there is an edge $(f(u), f(v))$ present in G takes polynomial time.

Therefore, the Subgraph Isomorphism Problem has polynomial time verifiability and belongs to the NP class.

The Subgraph Isomorphism Problem belongs to NP-Hard –A problem L belongs to NP-Hard if every NP problem is reducible to L in polynomial time. To prove that the Subgraph Isomorphism Problem (S) is NP-Hard, we try to reduce an already known NP-Hard problem to S for a particular instance. If this reduction is possible in polynomial time, then S is also an NP-Hard problem. Thus, let us reduce the Clique Decision Problem (C) which is NP-Complete (hence, all the problems in NP can be reduced to C in polynomial time) to the Subgraph Isomorphism Problem. If this reduction is possible in polynomial time, every NP problem can be reduced to S in polynomial time, thereby proving S to be NP-Hard.

Proof: Let us prove that the Clique Decision Problem reduces to the Subgraph Isomorphism Problem in polynomial time.

Let the input to the Clique Decision Problem be (G, k) . The output is true if the graph G contains a clique of size k (a clique of size k is a subgraph of G). Let G_1 be a complete graph of k vertices and G_2 be G , where G_1, G_2 are inputs to the Subgraph Isomorphism Problem. We observe that $k \leq n$, where n is the number of vertices in G ($=G_2$). If $k > n$, then a clique of size k cannot be a subgraph of G . The time taken to create G_1 is $O(k^2) = O(n^2)$ [since $k \leq n$] as the number of edges in a complete graph of size $k = {}^kC_2 = k \cdot (k-1)/2$. G has a clique of size k if and only if G_1 is a subgraph of G_2 (since G_1 itself is a subgraph of G_2).

is true, the Subgraph Isomorphism Problem is true and vice versa. Therefore, the Clique Decision Problem can be reduced to the Subgraph Isomorphism Problem in polynomial time for a particular instance.

Thus, the Subgraph Isomorphism Problem is an NP-Hard Problem

Conclusion:

The Subgraph Isomorphism Problem is NP and NP-Hard. Therefore, the **subgraph isomorphism problem is NP-Complete**.

Attention reader! Don't stop learning now. Get hold of all the important DSA concepts with the [DSA Self Paced Course](#) at a student-friendly price and become industry ready. To complete your preparation from learning a language to DS Algo and many more, please refer [Complete Interview Preparation Course](#).

In case you wish to attend live classes with industry experts, please refer [Geeks Classes Live](#) and [Geeks Classes Live USA](#)

Like 0

Previous

Next

RECOMMENDED ARTICLES

Page : 1 2 3

01 Check if vertex X lies in subgraph of vertex Y for the given Graph

14, Jul 20

05

Proof that Clique Decision problem is NP-Complete

12, Jun 20

- 03

Proof that Clique Decision problem is NP-Complete | Set 2

30, Jun 20
- 07

Proof that Hamiltonian Path is NP-Complete

04, Jun 18
- 04

Proof that traveling salesman problem is NP Hard

03, Jun 20
- 08

Proof that vertex cover is NP complete

03, Aug 18

Article Contributed By :



eshwitha_reddy
@eshwitha_reddy

Vote for difficulty

Current difficulty : [Expert](#)

- Easy
- Normal
- Medium
- Hard
- Expert

Article Tags : [Algorithms-NP Complete](#), [NP Complete](#), [NPHard](#), [Algorithms](#), [Graph](#)

Practice Tags : [Graph](#), [Algorithms](#)

- Improve Article
- Report Issue



5th Floor, A-118,
Sector-136, Noida, Uttar Pradesh - 201305

feedback@geeksforgeeks.org

Company

[About Us](#)
[Careers](#)
[Privacy Policy](#)
[Contact Us](#)
[Copyright Policy](#)

Practice

[Courses](#)
[Company-wise](#)
[Topic-wise](#)
[How to begin?](#)

Learn

[Algorithms](#)
[Data Structures](#)
[Languages](#)
[CS Subjects](#)
[Video Tutorials](#)

Contribute

[Write an Article](#)
[Write Interview Experience](#)
[Internships](#)
[Videos](#)

@geeksforgeeks , Some rights reserved