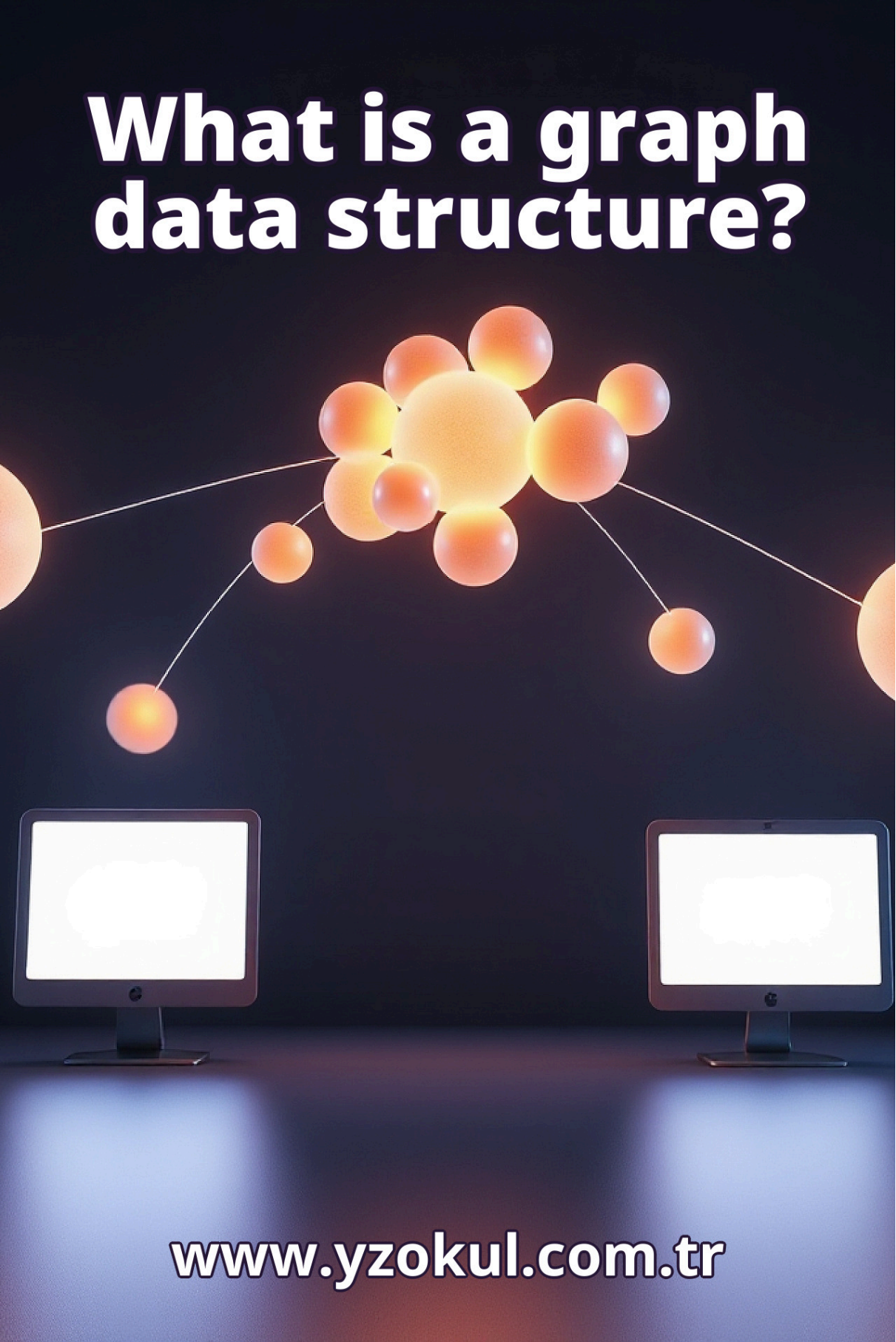
What is a graph data structure?



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You ask: What is a graph data structure? The short answer is that a graph is a set of nodes plus the edges that connect them. Picture three dots joined by two lines: that tiny drawing is already a graph. Nodes are the dots, and edges are the lines between them. This simple idea is the whole foundation, and everything else builds on it.



Start with a simple drawing of dots connected by lines. Each dot is a node, and each line is an edge. Nothing more is needed to begin: nodes plus edges make a graph. You do not need arrows, numbers, or labels yet. Just dots and lines are enough to see the basic structure. This is the simplest possible graph you can draw.



Label the two parts of your picture. The dots are called nodes, and they are also known as vertices. The lines are called edges. Every graph is described by which nodes exist and which pairs of nodes are connected. If you know the list of nodes and the list of edges, you know the whole graph. These two pieces of information are all you need.



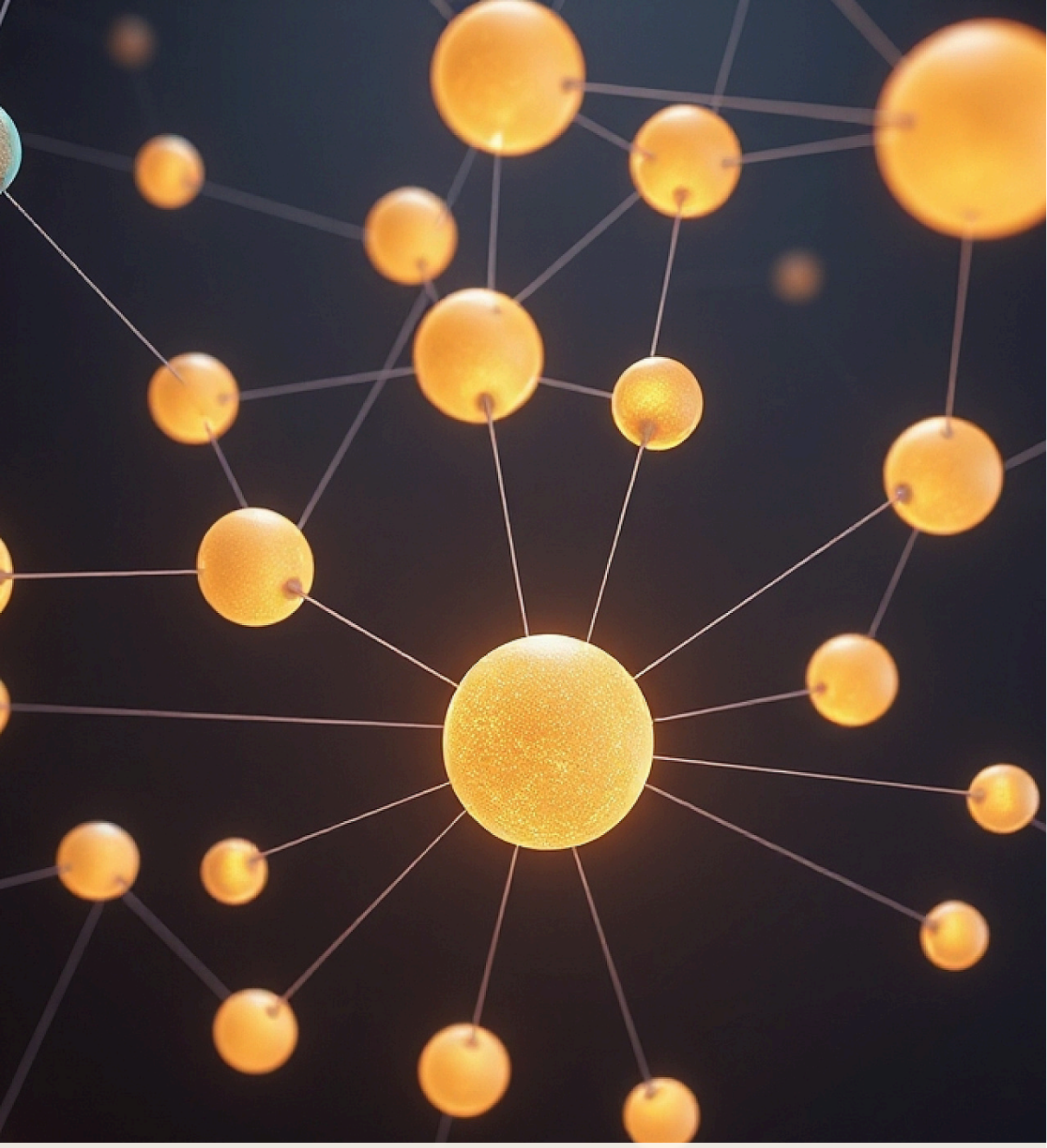
Picture cities as nodes and roads between them as edges. A road map then becomes a graph. This familiar example shows why graphs are useful for describing real connections. You can look at a map and see which cities are directly linked by roads. The graph captures exactly that: which places are connected and which are not. Roads are edges, and cities are nodes.



Compare a one-way road with a two-way road. An edge can have a direction or not. An arrow on an edge means the edge is directed: you can travel only the way the arrow points. A plain line means the edge is undirected: you can travel both ways. Directed edges model one-way streets, while undirected edges model two-way streets.



See that an edge can hold a number, such as the distance between two cities. These numbers are called weights, and they describe something about the connection. For example, a road edge might carry the number 50 to mean 50 kilometers. Weights let a graph store extra information about each link. The graph still has nodes and edges, but now edges have values.



Map people as nodes and friendships as edges. A social network then becomes a graph. You see that the same dots-and-lines idea describes who knows whom. Each person is a node, and each friendship is an edge connecting two people. This shows that graphs are not just for roads; they also describe human relationships. The structure is the same: nodes and edges.



Picture computers or web pages as nodes and the connections between them as edges. The internet is a graph. This shows that graphs also describe technical networks, not just roads and friendships. When one computer connects to another, that is an edge. When a web page links to another page, that is also an edge. The internet is a huge graph of connections.



Look at several small graphs side by side. Notice how differently the nodes can be connected. Some graphs are sparse: they have few edges compared to the number of nodes. Others are dense: they have many edges. Both are valid graphs. The pattern of connections can vary widely, and that variety is what makes graphs so useful.



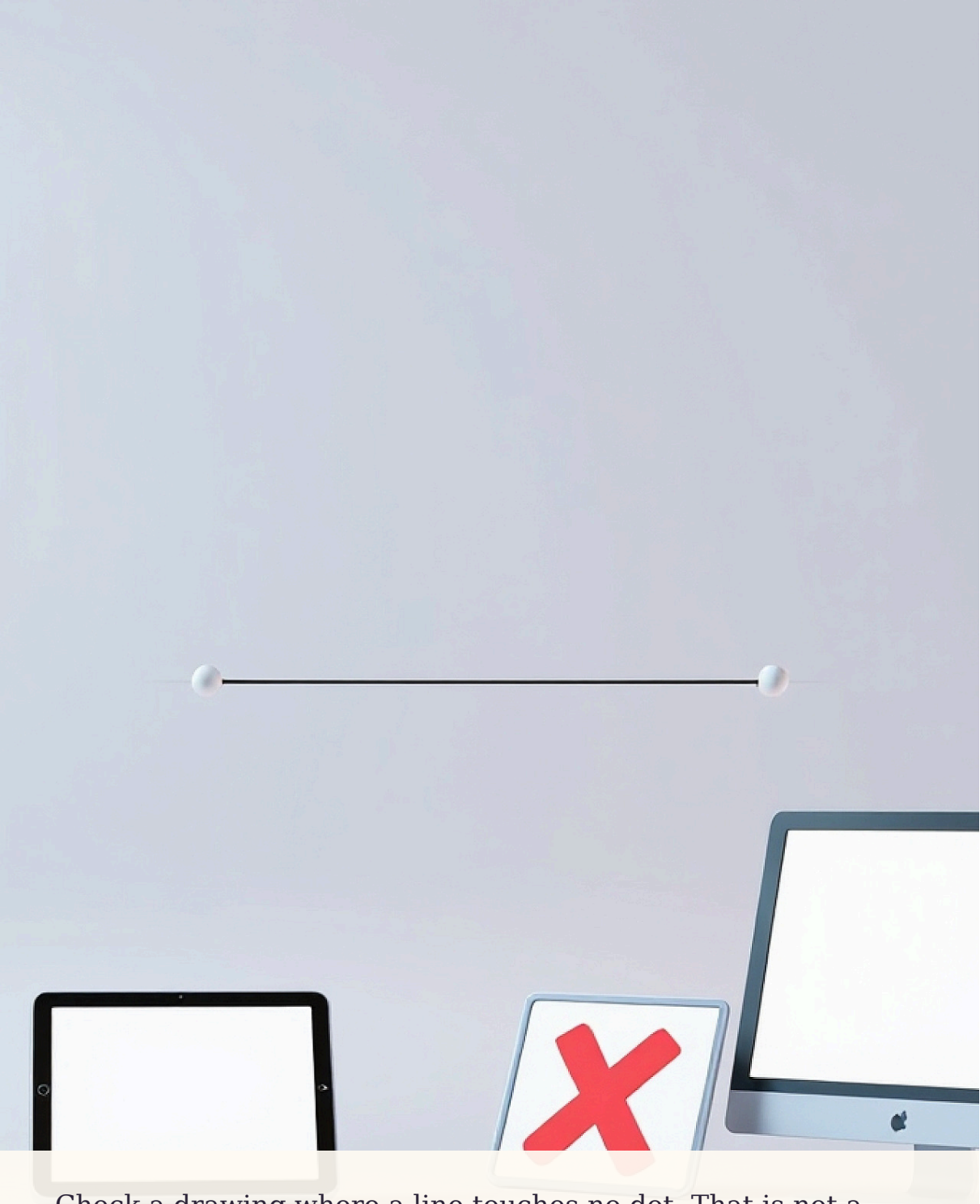
Follow edges around a loop that returns to where it started. That loop is called a cycle. A graph is allowed to contain cycles. For example, you can go from city A to B, then B to C, then C back to A. That is a cycle of three nodes. Cycles are common in real networks like roads and friendships.



Compare a tree with a general graph. A tree branches without loops: there is exactly one path between any two nodes. A general graph can loop back on itself and have many paths. Trees are a special, more restricted kind of graph. Every tree is a graph, but not every graph is a tree. Keep this difference in mind.



See a node with no edges at all. That node is isolated. Also see a group of nodes all reachable from one another; that group is connected. A graph can have lonely nodes and separate connected pieces. For example, a social network might have a person with no friends, and several separate groups of friends. Both are allowed in a graph.



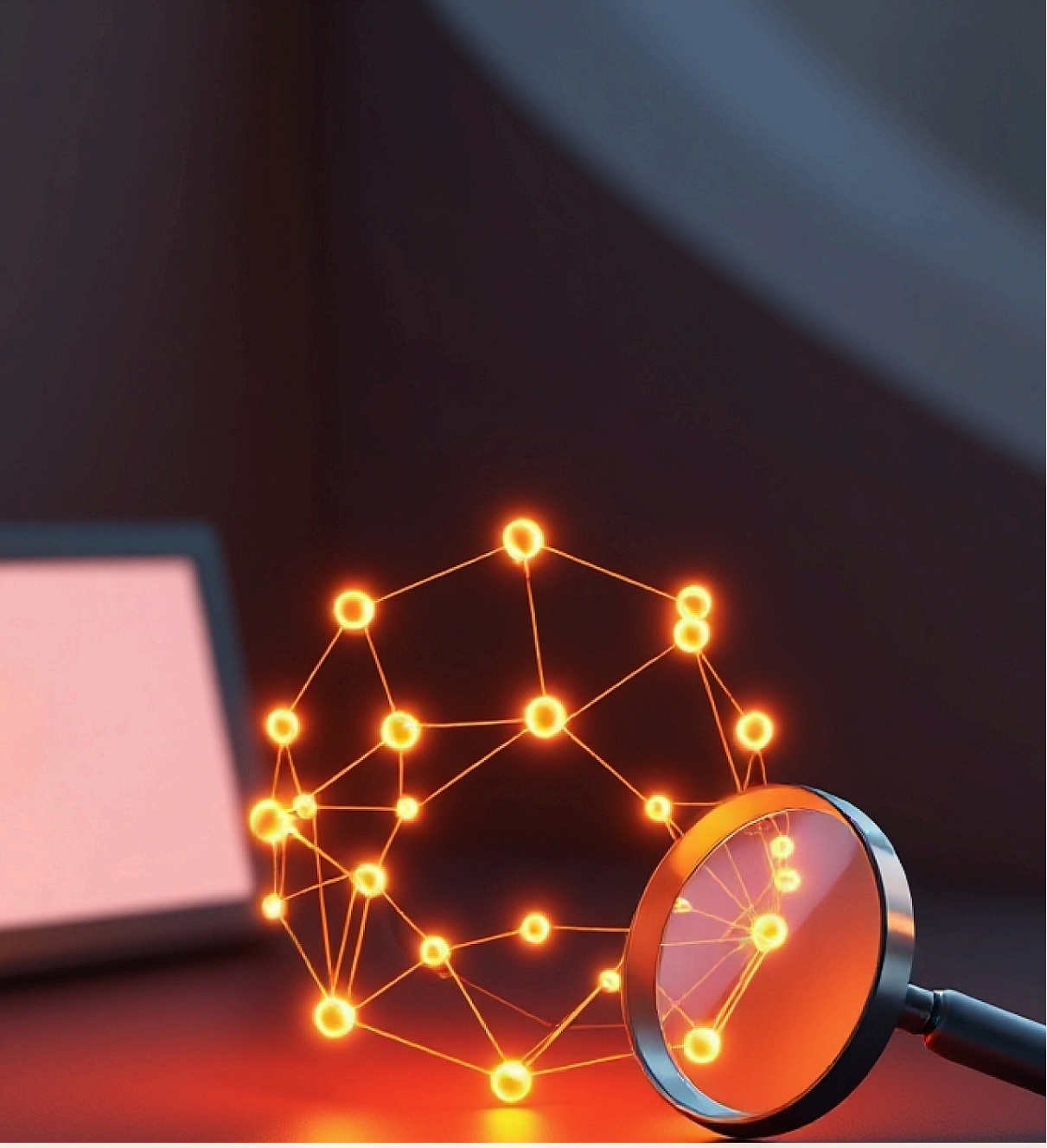
Check a drawing where a line touches no dot. That is not a valid edge. Every edge must connect two existing nodes. An edge cannot float on its own or connect to nothing. If you see a line without dots at both ends, it is a mistake. Always make sure each edge has a node at each end.



Trace a one-way edge and see that you cannot travel it backwards. Before assuming a connection works both ways, check whether the edge has an arrow. If it does, the connection is one-way only. For example, a one-way street edge cannot be used in the reverse direction. Direction matters, so always look for arrows.



Spot a loop in a drawing and confirm it is still a graph, just not a tree. Do not assume that all graphs branch cleanly like trees. Many graphs contain cycles, and that is perfectly normal. A graph with a cycle is still a valid graph. The presence of a loop only means it is not a tree.



Review the whole answer: a graph is nodes joined by edges. Edges may be directed or undirected and may carry values called weights. Graphs can have cycles and many connection patterns, unlike trees. Roads, friendships, and the internet are all graphs. Remember that nodes and edges are the two building blocks of every graph. That is what a graph data structure is.