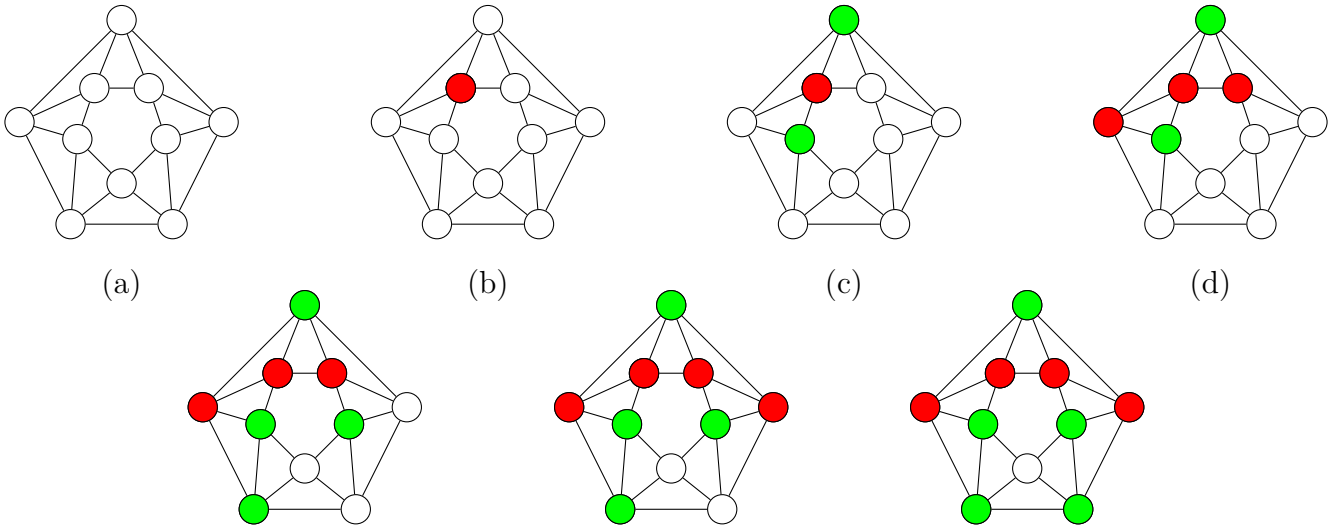
Stop the Fire!
A Hands-On Game about Optimization

You are a member of a firefighting squad that fights large forest fires by dropping fire retardant onto affected areas from two helicopters. Areas that can catch fire are drawn as circles, a.k.a. *nodes*, on a map, and corridors along which fire can spread appear as lines connecting the circles, as in Figure (a) below.

How to play: First, choose a node where the fire will start and make it red to indicate it is burned, as in Figure (b). Then choose two nodes to defend with your two helicopters, such as those shown in green in Figure (c). After a defense round, **all** undefended nodes connected to a burned node by a line will burn, as in Figure (d). We can then move the two helicopters to two other nodes to defend them as in Figure (e), and so on, until all nodes are either burned (red), defended (green), or safe (white), as in Figure (g). Safe nodes do not need to be defended because the fire was contained before getting to them. Your goal is to save as many nodes as possible or, equivalently, minimize the number of nodes that burn.



(a) (b) (c) (d)

(e) (f) (g)

In the example above, 4 nodes got burned and 6 nodes were saved. Starting from Figure (b), it is actually possible to save 7 nodes using two helicopters. Can you see how?

The next page has a large map and a bunch of red and green circles. Use a pair of scissors to cut out the circles, choose a node on the map for your fire to start, and try to save as many nodes as you can using two helicopters (place colored circles on top of the white nodes to make them "burned" or "defended"). How much better could you do if you had three helicopters? What if you only had one? When you are done playing with that map, draw your own maps and keep playing!

Additional Questions for Discussion:

How do you know for sure that your solution is the best possible?

What assumptions or simplifications from a real-life situation were made while solving this problem?

Variations of the game: fire spreads more quickly or more slowly in certain directions, some nodes can be more important than others and get prioritized for protection, etc.

This game is about containing the spread of something undesirable by using limited containment resources. Another example would be trying to contain the spread of a disease by strategically vaccinating certain communities. Can you think of other examples of this sort?

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