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Modern Computing and the Environment

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5 min read

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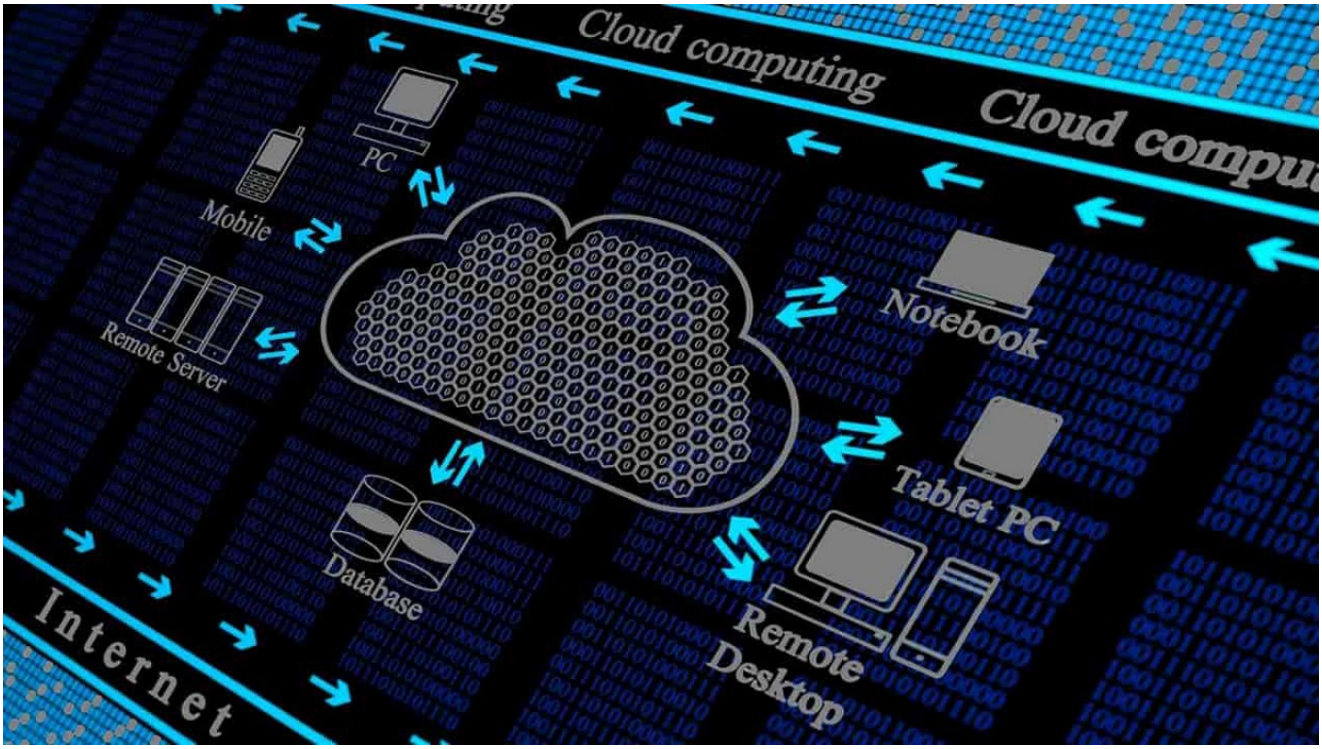
Everything is migrating to the cloud, but at what cost? Is the cloud net zero? With the rising popularity of cloud-based services, our personal computers are doing less processing, but are these processing and storage tasks simply disappearing? They are not, as cloud providers are the ones in charge of doing these tasks ,but to us these operations are completely invisible. This is definitely a problem, as the consumption of cloud services leads to the debauchery and careless usage of cloud services. Every one of those 9 thousand emails on your account occupy and consume resources, they must be stored and maintained somewhere for whenever we want to use them. Those old screenshots backed up on our free cloud storage consume resources too, but we have forgotten about them. Just because we are not directly paying for the maintenance of our data and applications on the cloud does not mean that these are not demanding resources and raising your carbon footprint.

Pollution

More than 3.6 billion people have access to cloud computing services, and this number is on the rise. According to research, cloud computing and intense-computing tasks such as crypto mining are set to produce enough CO_2 emissions to raise the Earth's temperature 2°Celsius by 2050. This is an alarming prediction, and we must act now in order to tackle the inevitable problem of the rise of global interconnectivity and computing energy consumption. Green computing is an engineering paradigm that emphasizes the design, manufacture and maintenance that limits the negative impact to the environment. Green computing addresses the reduction of carbon emissions by tech corporations, manufacturers and end users, but also promotes the usage of renewable resources to achieve sustainability.

Green computing is not a destination, but rather a process that big tech companies have started to engage in. Cloud computing is a very viable and realistic way to reduce carbon emissions and resource misuse. Studies have revealed that moving everyday (and commonly used) applications and software to the cloud would decrease energy usage and emissions by 87%. Cloud solutions have a positive indirect impact as well, as having *everywhere-anytime* solutions enables remote work, thus reducing commuting costs and transportation (car, public transport, aircraft) carbon-emissions significantly. Public transport is a greener alternative to individual car usage, and so are cloud-based solutions over personal work-stations.



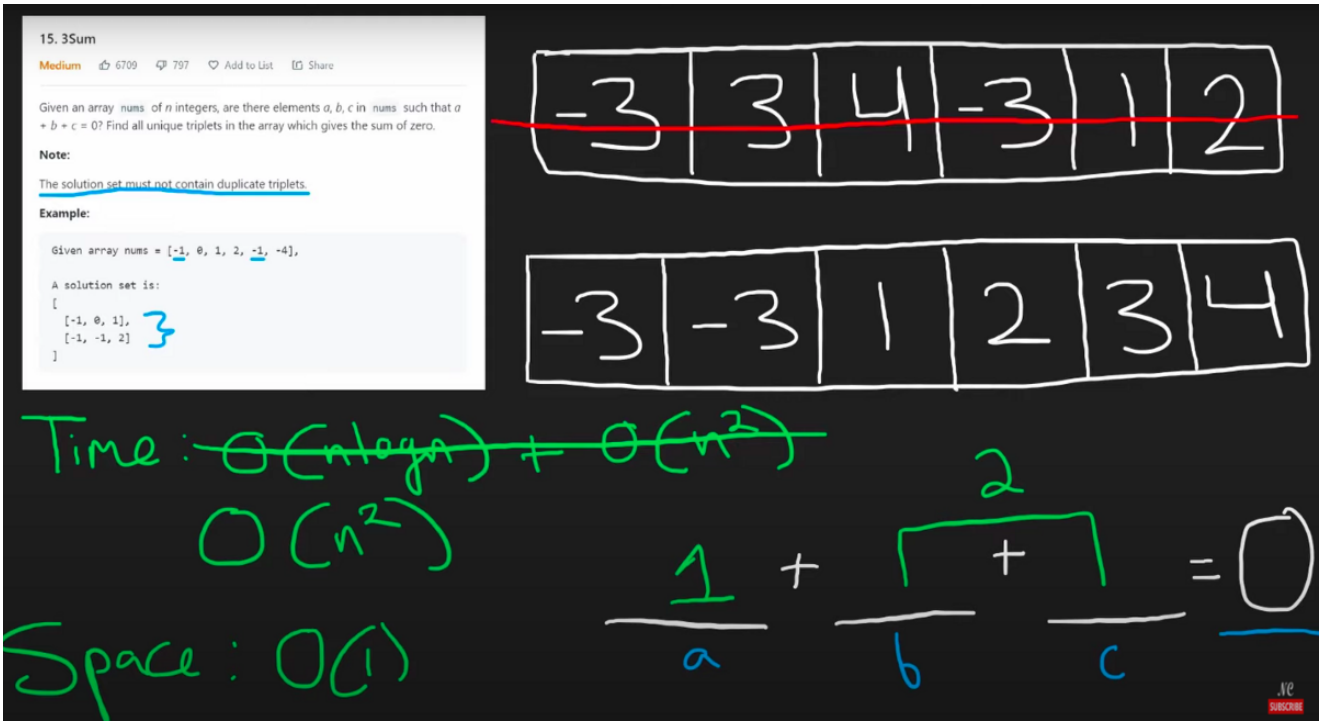
Cloud computing

A cloud-based solution is no guarantee for a perfectly green solution, however. There is still a lot to be improved upon cloud solutions, considering that the cloud is still on its up-and-coming stage. Studies have led to the development of realistic, feasible approaches to improve cloud computing, and one of these is The Green Demand Aware Fog Computing (GDAFC). The goal of this solution is to reduce energy consumption of fog and cloud applications relying upon three main principles: traffic prediction, resource allocation and energy conservation.

Traffic prediction is achieved by building an AI prediction model to predict the future number of incoming requests to fog computing facilities. Resource allocation via dynamic allocation of fog nodes for serving incoming requests. Finally, energy consumption is addressed with a sleep mechanism on fog nodes with varying sleep intervals to further reduce energy consumption without impacting the overall performance of the application or system. The GDAFC is primarily focused on fog computing, but the development of a cloud-compatible solution is feasible. GDAFC's idea of predicting incoming traffic to dynamically allocate the necessary resources to meet computational demands while periodically placing idle nodes to sleep whilst maintaining performance is a great proposal. A cloud version to this solution would definitely reduce resource consumption and contamination, but it will prove to be troublesome to come up with.

End users

Big companies may *pitch-in*, but end users need to avidly try to reduce their online carbon footprint too. Quitting streaming and starting downloading music/content is great for the environment. When streaming music on the Spotify app, you are requesting songs from Spotify's servers each time you listen to a song. This is very inefficient, as listening to the same songs multiple times translates to making the same request multiple times. By downloading songs on your device, you are fetching the songs from the servers just one time. This applies to the content you stream on Netflix and HBOMax too. Surprisingly, everything you *google* generates a CO_2 emission. How many Google searches do we do a day? A lot. Each of these contaminates a lot, as our query is sent from our browser to Google's servers and then Google results' are sent back to us. This process is very contaminating, especially taking into consideration the amount of searches we do per day. One way to reduce this waste is by reusing your searches, or simply *googling* less. When searching for something online, try accessing websites directly from your browsing history, open tabs, bookmarks or synced web pages. This allows you to access the page directly, mitigating the use of Google as an intermediary and lessening your carbon footprint.



Time and Space Complexity Analysis

To wrap everything up, data is being generated and processed at an incredible pace, and computational systems are trying to keep up. Computer systems have increasingly risen in power, but also in contamination output (as a whole). Cloud computing, and its spectrum, has become the green solution to this problem, but it is not enough. Computer engineers must become more conscious of how their solutions impact the environment. Algorithmic evaluation typically consists of time complexity and space complexity, but contamination and pollution should definitely be taken into consideration when analyzing a solution. An algorithm may run in O(n) time and O(1) space, but how much is it contaminating the environment? Is a net-zero solution running in $O(n^2)$ time and O(n) space a better solution? It is definitely challenging putting this factor into scale, but it has become a necessity in the computing realm. Cloud computing is beneficial to the environment, but resource misuse and pollution is an ever existing problem that is everyone's responsibility.