# The Vacation ~ Trip ~

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The summer vacations were approaching and the Rao family were discussing the various options for getting away from Mumbai.

Dad was in favour of chilling out in the Himalayas. "Let's go trekking near Manali.", was his constant refrain. Mom was more socially concerned.

"We ought to go to Chennai. It has been a long time since the children visited their grandparents.", was her point.

Venkat, the resident teenager, was not keen on going anywhere in the company of his parents. "I am planning to go to Bangalore with my friends and I dont think I'll have time for anything else.", was his only contribution. Nandini, the youngest in the family, quipped in with, "My school is going on a trip to Kanyakumari and I don't want to miss it."
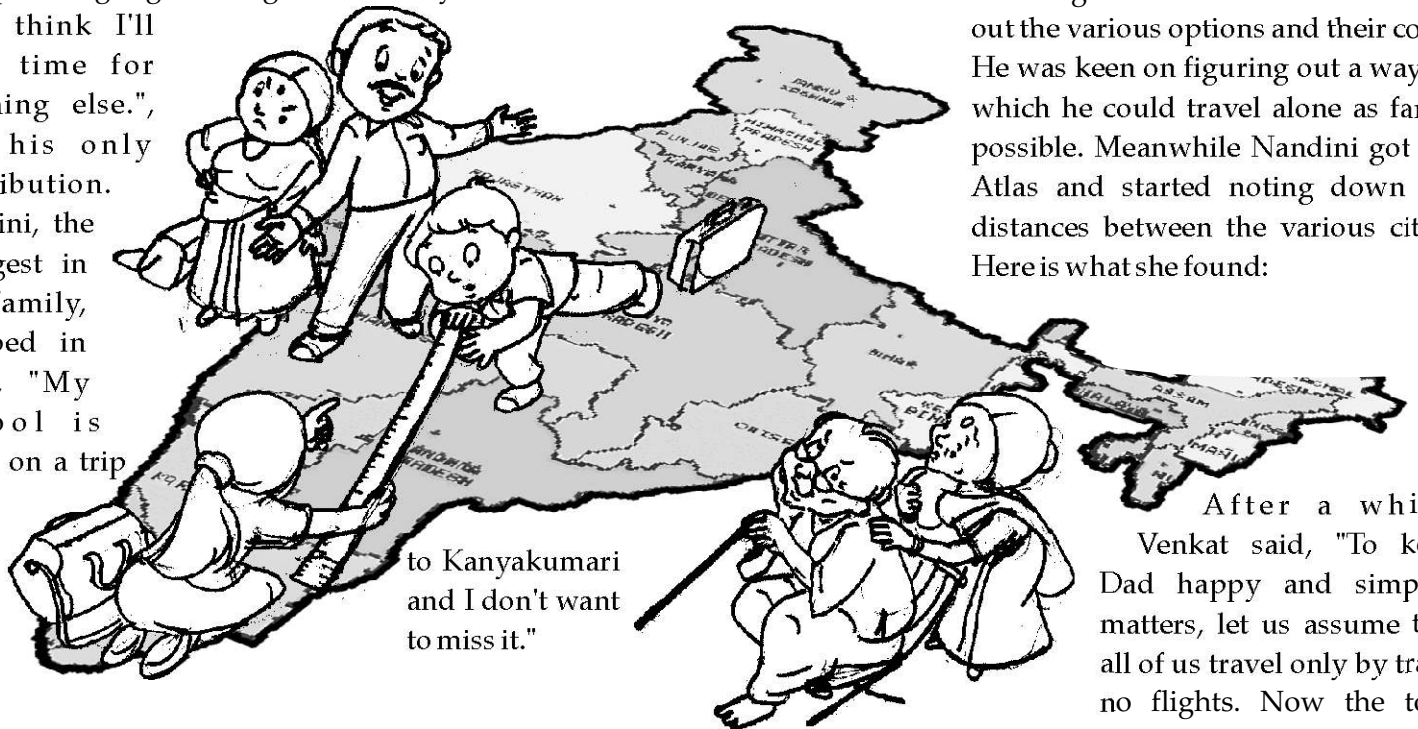
Much to Venkat's chagrin, Dad and Mom were in agreement that it was a long time since they went on a family vacation with everyone being together. Dad said, "Let us all finally meet somewhere and then go to Manali." Mom added, "Yes, we can ask the children's grandparents also to come there from Chennai." "But where do we meet?" said Nandini, puzzled.

"There are a lot of options", said Venkat knowingly. "It would be most convenient for us to reach Manali from Delhi. So let us all meet at Delhi.

From Bangalore, I can either come back to Mumbai or go directly to Delhi. From Kanyakumari, Nandini can either come back to Mumbai with her school or join our grandparents in Chennai. I think she is too young to travel alone to Delhi.", he added with a smirk.

"Suppose I go by flight. It will only be a few hours.", retorted Nandini.

"So what do we do?", said Mom, dismayed and seeing visions of her children being lost in various airports and railway stations.

"Well, it depends on what we are trying to optimize. The shortest path for each of us would be to take a flight, but that would be very expensive. On the other hand, we can keep the expenses reasonable by taking the train and traveling along the shortest route to Delhi." said Dad, merrily adding to the chaos. "I think it would be simplest if we all meet here in Mumbai and then go together." said Mom, firmly ignoring other remarks.

Venkat got onto the Internet to check out the various options and their costs. He was keen on figuring out a way by which he could travel alone as far as possible. Meanwhile Nandini got her Atlas and started noting down the distances between the various cities. Here is what she found:

After a while, Venkat said, "To keep Dad happy and simplify matters, let us assume that all of us travel only by train; no flights. Now the total expenses are directly proportional to the total distance travelled by all of us. The total distance will be minimum if each of us takes the shortest path to the destination."

"So Mom and Dad should travel to Delhi from Mumbai and I should go there directly from Bangalore. Since Nandini cannot travel directly from Kanyakumari to Delhi, she has to either join Dad and Mom in Mumbai, or join our grandparents in Chennai. It can be easily

seen that it would be shorter for her to go to Chennai rather than returning to Mumbai. I have already verified on the Internet that all the tickets that we need are still available.", he concluded.

Cities	Distance
Mumbai-Delhi	1407 km
Bangalore-Mumbai	998 km
Bangalore-Delhi	2061 km
Bangalore-Chennai	331 km
Chennai-Mumbai	1329 km
Chennai-Delhi	2095 km
Kanyakumari-Chennai	683 km
Kanyakumari-Bangalore	681 km
Kanyakumari-Mumbai	1630 km
Kanyakumari-Delhi	2742 km

Everyone was impressed with Venkat's logic. Nandini who had been following Venkat closely, now looked at the map and said quietly, "Venkat, there is a shorter path for me than going through Chennai. That is to join you in Bangalore and go to Delhi with you!". Before Venkat could think of any arguments against this idea, she added, "To keep Mom happy, let us assume that we also want to minimize the distance for which children are required to travel alone." "So now we see that the shortest path is for both me and Venkat to join our grandparents in Chennai and come with them to Delhi.", she finished sweetly. Guess which plan they finally settled upon?

Interestingly, a similar situation often happens in computer networking.

Computers on the Internet are not directly connected to each other but inter-connected using devices called Routers. When we send email or download a file, the contents are usually split into many packets and given to the routers. It is the job of these routers to forward each packet from its source to its final destination. In order to do this, each router needs to know the "best" route that a packet should take for a given destination.

One way to compute these routes is called the Shortest Path Algorithm. In this technique, the routers are represented as nodes or points in a graph (similar to the cities in the above figure). The link or connection between two routers is represented as edges or lines between the nodes in the graph (similar to the route between any two cities in the example). Since different links may have different costs associated with them,

each edge is labeled with the cost of the link. In our example, the cost is the distance between the cities. Now the shortest path between any source and destination is the one along which the sum of the costs is minimum.

Even in complex graphs, the shortest path from a source to any destination can be found by moving away from the source in a step-wise manner.

The routers in a computer network communicate with each other to exchange the information on the cost of the various links. Each router then uses this information to determine the route for reaching any destination. While this may sound simple, a lot of intricacies have to be considered.
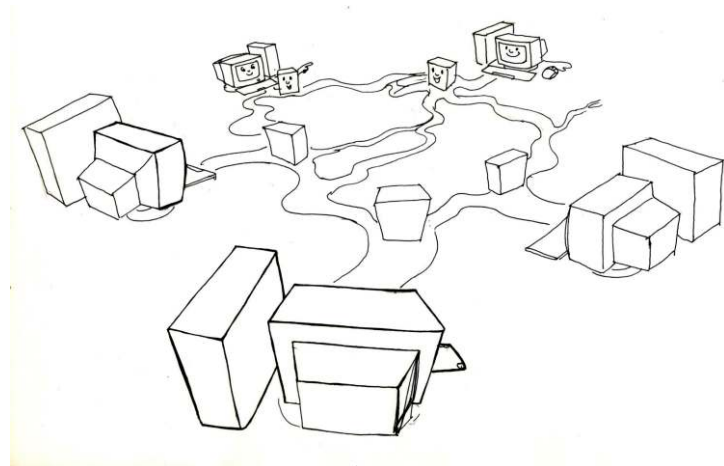
For example, what if the shortest route to a destination is overloaded? What if one of the links break temporarily? How should the routers try to find an alternate route?

Algorithm: A step-by-step computational procedure for solving a problem in a finite number of steps.

Protocol: A standard agreed upon procedure for regulating communication between two entities, especially data transmission between computers.

Some interesting related websites are:
http://www.mapsofindia.com/
http://www.indianrail.gov.in/
http://mathworld.wolfram.com/