

Google's new vacation app:

This article is about how the graph theory has evolved and how the Google has used to built a new vacation app. Before 18<sup>th</sup> century Russian seaport named for a place where Russian leaders have installed nuclear missiles. But in the 18<sup>th</sup> century the city became a math problem with named Konigsberg in the German kingdom. The problem was, Konigsberg is lengthening across the banks of Pregel, river included two islands in the middle of the river. Seven bridges connected these islands and rest of the city. Every one wondered if they could walk across all bridges only once.

Then, in 1736, a mathematician Leonhard Euler showed it as impossible to walk across all bridges only once. And the solution provided was each landmass is touched by odd number of bridges. He also said that if it is touched by even number of bridges, it could have possible to walk continuously through all bridges without repeating. This solution was called as Geometry of Place or Geometrian Situs. It was the origin of our traditional Graph Theory.

In 2016, Google has built an app called "Trips". It would automatically plan our trips in the world's big cities. If we say, we are in Paris for eight hours it would suggest us the trip plan of the best places to visit in Paris for enjoying. Technically, they have used mass of data (having reviews written by other visitors in the past) and Euler's theory. The app used graph theory to provide a solution for a trip. They have considered each place as a node and the route between them as an edge, based on the available time they have calculated best path that covers many places to visit leaving sufficient time to enjoy each place. Another math problem travelling sales person (TSP) also answered through Graph Theory. Not just a Google, other organizations such as Facebook, Amazon also changed their way through the analysis of large massive data with the math around 280-years old.

In my opinion, Euler theorem has opened doors to many applications origin even for a graph theory. It has helped us to solve problems, which were called impossible before.

Graph Theory found Main Character in Game of Thrones:

Game of Thrones is a very interesting, famous television series. Fans have long quarreled about who the real main character of Game of Thrones is. Since, every time a character gets notable it's being killed. The question is answered through graph theory. Andrew J. Beveridge, an associate professor in mathematics used developed a graph using the characters in series and built a network based on interaction the roles had. Every time new characters introduced into series a new node would be created in graph and with in the 15 words of interaction with other a new edge (connection) would establish. The more they interact the edge weight between the two characters will be increased. Criteria they have used to find out the hero of series is the role which has connected most of the other nodes and how important it is in the network. Based on this analysis they have confirmed the main character of the Game of Thrones series.

In conclusion, Game of thrones is series where each one elected for a prominent position would be killed. It is naturally hard to predict who is the real hero of the thrones series but graph theory has simplified and provided the good answer for the general question simply made Game of thrones into network of thrones.

### 3. Rutgers math professor used Numbers to fight in the war on terror

This is an article about how a math's professor has provided solutions against social problems such as terrorism, child trafficking, cyber attacks etc., Fred S. Robert is a math professor in at Rutgers University. He had a doctorate from Stanford in mathematics. He has used many mathematical models to provide solutions. Rutgers is taking front step in Homeland security, using analysis of numbers and data provided solutions for issues such as "what's the best way to deploy radiation detectors to find dirty bomb?", "Where do we place coast guard vessels to cover widest area?" and "Is there a way to defeat child sex trafficking through online ads?". Robert considers these as big math problems.

To address the "dirty bomb" issue, CCICADA has collected all the data from Homeland Security department, analyzed and sorted through algorithms. As per Robert analysis, the larger no of vehicles and radiation detectors it would need at least 4000 vehicles equipped with nuclear detection system. But there were only 3000 police cabs available so they have decided to equip the licensed cabs.

Similar issue with coast guard vessels, they have analyzed the data and provided how to keep detectors Again a math problem, child sex trafficking, they have sorted all the online ads using coded algorithms, phone numbers and geographic locations.

A theoretical exercise by the university is, two students devise checking points in an airport using game theory randomized algorithms. Where they have developed algorithms how to assign security guards to access points.

In conclusion, math has provided the best solution for many of the major problems. I astonished on knowing math could solve the problem of cyber attacks and social crimes. We could apply math concepts to any problem to analyze it better.

Videos:

#### 1. Complex doesn't always equals Complexity:

Here the presenter trying to explain, complex is not always equals complexity. He says, point of view on complexity is varies from each other. He has taken different examples to talk about. One example is, food web (map of feeding links) in the mountains of California. He used this example to explain several key insights of complexity by learning about nature. He says, information, good visualization and new queries never asked before towards the problem would provide solution. In the food web example, if the ecologist want to study the effect of one species on another. He recommended, plot a graph between the species based on their food habitation that would easy to analyze. And also says if we want to study effect of one species on another it is highly important to study all the relevant links that matters most instead of ignoring them. He has considered another case of US government to increase the popular support for Afghanistan government. He converted the complex picture to a network with nodes with connected edges then analyzed.

In my opinion, it's more about motivating to solve complex problems. I am happy to know that complex problems are able to analyze easily with graphs.

## 2. Graph Theory in Public policies and Public safety:

In the video, graphs are being used to analyze the relationship among the people how they are connected, with whom they are being connected and how they are influenced. In the analysis, each person is represented as a node and relationship is notated as an edge (connection), concept of graph coloring is used to separate the people into different categories such as smokers, non-smokers and moderate smokers. Graphs are used to understand the public health problem to provide a better solution. Graph weight concept being used to understand how deeply people are getting influenced. Cluster is group of nodes; closely related people are shown under a same cluster in a network drawn that shows they are having friendly zone influencing one another. People under same cluster are studied as having similar health habits.

It is very good advantage of graphs. In conclusion, people would observe neighbors actions, might get impacted and follow the same actions; all the social networks would built on theory of graph.

## 3. Networks:

The video is about what a network is and its few applications. Network connects the different nodes and it's alive since it changes frequently. It would keep us connected forming a new connection when ever is required. Google search uses network mechanism behind its search results. When a new word is searched it would create a connection to several searches and gathers the information. What Google will do to make the search simple is, it gathers and stores the related information at one place (connected in graph) using math functions such as hash that enhances the results. When node is connected to multiple nodes then it grows, we call it as Hub. We can look at on another example for network is a Google map.

I would say, the video has basic information about what a network is and its usage in real time applications. Though it's familiar information, interesting to know how the Google uses network concept behind a search function.