

LOST in the Bermuda Triangle

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Abstract

Our research deals with finding the shortest route from Dubai to Miami, without crossing the terrifying Bermuda Triangle.



The problem:

An airplane lost contact with the control tower and vanished from the radar while inside the Bermuda Triangle. The Bermuda (spherical) Triangle is a part of the Atlantic Ocean bounded by Miami, U.S.A., Bermuda Island and San Juan, Puerto Rico. A team of experts will fly from Dubai to Miami to solve the mystery. Help them find the shortest route and estimate its length in km . What is the searching area (in km^2) inside the Bermuda Triangle?

Let's get familiar...

The mythical section of the Atlantic Ocean bounded by Miami, Bermuda and Puerto Rico, also known as The Bermuda Triangle, is considered to be one of the most infamous places on Earth. It is believed that tragedies beyond human understanding have occurred there for centuries. When Christopher Columbus sailed through the area on his first voyage to the New World (America), he witnessed a "great flame of fire", probably a meteor, crashed into the sea one night and that strange light appeared in the distance a few weeks later. Whether you believe the myths brought upon The Triangle are true or not, it is certain that it is a place of great mathematical and physical discoveries.

Solution of the problem

We shall prove that the shortest route the scientists should take is calculated firstly using formulas of the spherical triangle, to then be able to see if we should go by the western or the eastern hemisphere.

What is a spherical triangle?

A spherical triangle is a figure formed on the surface of a sphere by three great circular arcs intersecting pairwise in three vertices. The spherical triangle is the spherical analog of the planar triangle, sometimes called the Euler triangle. A spherical triangle has angles A , B and C (measured in radians at the vertices along the surface of the sphere) and let the sphere on which the spherical triangle sits have radius R . Then, the surface area of the triangle is

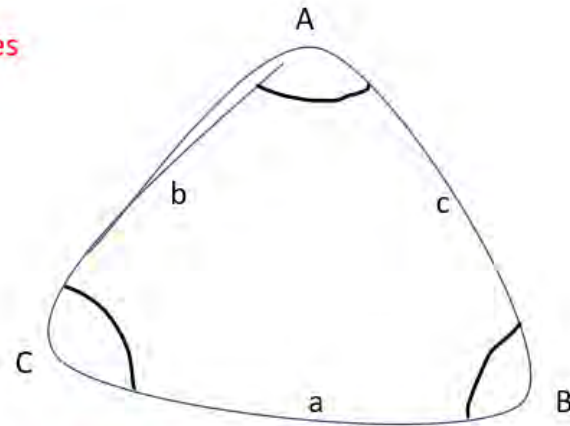
$$A = R^2 [(A + B + C) - \pi]$$

Formulas used

- **Area Δ spheric** = $r^2(\alpha A + \alpha B + \alpha C - \pi)$ \rightarrow radians
 $= r^2(\alpha A + \alpha B + \alpha C - \pi) \frac{\pi}{180}$ \rightarrow decimal degrees

- **Cosine formula:** $\cos a = \cos b * \cos c + \sin b * \sin c * \cos A$

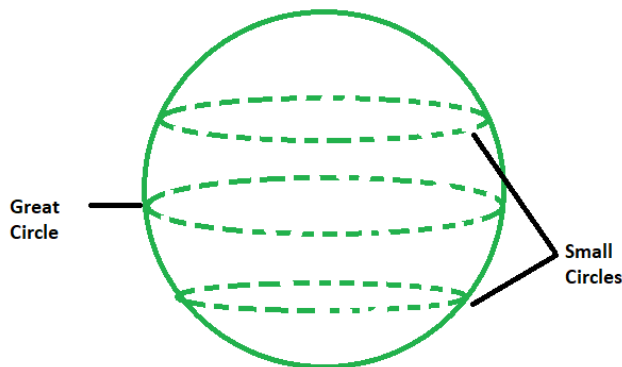
- **Sine formula:** $\frac{\sin a}{\sin A} = \frac{\sin b}{\sin B} = \frac{\sin c}{\sin C}$



- **Great circle distance** = $r * \arccos[\sin \varphi_x * \sin \varphi_y + \cos \varphi_x * \cos \varphi_y * \cos(\theta_x - \theta_y)]$

* φ =longitude and θ =latitude

* Great circle distance is the shortest distance between 2 points on the surface of a sphere, measured along the surface of the sphere (as opposed to a straight line through the sphere's interior)



Step by step...

Firstly, we have to transform the given coordinates in decimal degrees to then be able to calculate it in radius.

$R_{\pi}(\text{rad}) \rightarrow 360^{\circ}$ (decimal degrees) * $1 \text{ rad} \approx 57.30^{\circ}$ (decimal degrees)

$$1^\circ = 60' = 3600''$$

$$a^\circ b' c'' = \left(a + \frac{b}{60} + \frac{c}{3600} \right)^\circ$$

For example: an angle of $25^\circ 40'$ (Miami) is equivalent to

$$25 + \frac{40}{60} = \boxed{25,67^\circ}$$

Then, to be able to calculate decimal degrees in radius, we deduct

$$180^\circ \dots\dots\dots \pi$$

$$25,67^\circ \dots\dots\dots x \quad \rightarrow \quad \boxed{\frac{25.67^\circ}{180^\circ}}$$

We apply the same reasoning to calculate the longitude (φ) for the other 2 destinations. The latitude (θ) is represented by coordinates from the eastern wester hemisphere.

Miami ($25^\circ 40' N, 80^\circ 15' W$)

- Dubai ($25^\circ 40' N, 56^\circ 00'E$)
- San Juan ($18^\circ 24'N, 63^\circ 3'W$)

1. Miami ($25^\circ 40' N, 80^\circ 15' W$)

$$25^\circ 40' = 25^\circ + \frac{40}{60} = 25.67^\circ$$

$$80^\circ 15' = 80^\circ + \frac{15}{60} = 80.25^\circ$$

2. Dubai ($25^\circ 40' N, 56^\circ 00'E$)

$$\text{Dubai: } 25^\circ 40' = 25,67^\circ$$

$$56^\circ 00' = 56^\circ$$

3. San Juan ($18^\circ 24'N, 63^\circ 3'W$)

$$\text{San Juan: } 18^\circ 24' = 18,4^\circ$$

$$63^\circ 3' = 63,05^\circ$$

After finding the latitude and longitude equivalent to every coordinate, we proceeded to calculate the distance between each city that borders the Triangle, using this formula.

We shorten the names by using the first capital letters of their names, Therefore, Miami is M, San Juan is S and Dubai is D.

$$\begin{aligned} d(D,M) &= 12624 \text{ km} \\ d(D,B) &= 11020 \text{ km} \\ d(D,S) &= 11810 \text{ km} \end{aligned}$$

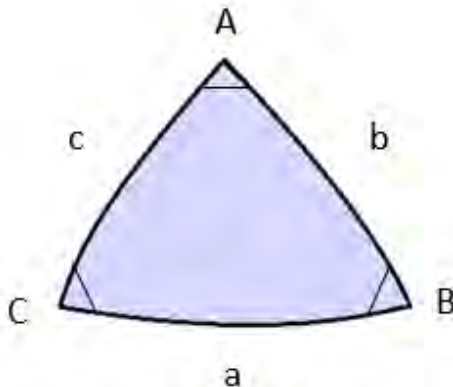
$$d(x,y) = R \arccos(\sin \varphi x)$$

Using an online software to fact check, we are approved that the distances resulted are correct, therefore, the shortest route is from Dubai to Miami.

The area of the spherical triangle

After finding out the shortest route, the team of experts need to explore their surroundings. For this, they have to calculate the area of the spherical triangle.

$$\begin{aligned} A &= \frac{\pi}{180} * r^2 (\alpha A + \alpha B + \alpha C - \pi) = \frac{\pi}{180} * 6378^2 (74,76 + 50,9 + 56,14 - \pi) \\ &\approx 1,26843978 \text{ Km}^2 \end{aligned}$$



Interesting facts about the bermuda triangle

- When did it become infamous?

In 1964, Vincent Gaddis wrote an article about the 'Deadly Bermuda Triangle' in the American pulp magazine Argosy, and he was the first person to define the boundary of the triangle where instances of disappearances fell into a pattern.

- Christopher Columbus account.

The mystery of the Bermuda Triangle has been documented even by the Italian explorer Christopher Columbus, who wrote about the malfunctioning of his compass and reported to have seen a fireball in the sky.

- Theories about the disappearances.

There are many theories behind why so many ships, planes and voyagers must have lost their way in the Bermuda Triangle. One of them says that there are special magnetic fields in the region that cause unknown physical forces. Another theory says that a continent named 'Atlantis' sank into the region, which caused the mysterious events. There is another theory that assumes the presence of unknown chemicals in the water of the Atlantic Ocean

- Yachts and planes go missing every year.

In the last 100 years, more than 1000 lives have been lost in the triangle. There is no evidence left of disappearances and people believe that an evil force thrives there and they also call it the 'Devil's triangle'.

- The disappearance of the Mary Celeste

Mary Celeste was an American merchant ship that disappeared mysteriously in 1872. The ship was found abandoned off the coast of Africa, while it was set to sail from New York to Genoa.

- 300 people vanished.

The earliest account of disappearance goes back to September 17, 1950, when a ship called Sandra vanished with 300 people on board, with no traces left.

- The disappearance of Flight 19.

Even though it was a long time back, the case of Flight 19 still haunts people. In 1945 a group of U.S. Navy pilots went on training within Flight 19 and lost all contact with the land in the Bermuda Triangle.

- Actually...

The Bermuda Triangle has heavy daily traffic that travels perfectly safely through the area.

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