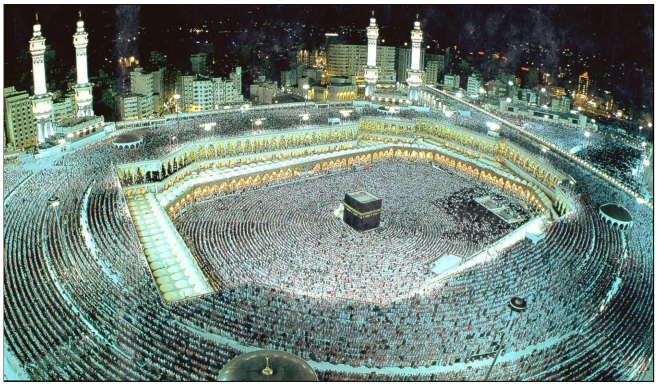
Determining the Sacred Direction of Islam



Introduction

Five times each day more than a billion Muslims around the globe face Mecca as they perform their daily prayers. The compass direction of the qibla, the sacred direction of Islam, is thus of the greatest importance for every Muslim (Qurʾān, sūra 2:142–152).

The determination of the qibla has been studied in the past by many astronomers, geographers and mathematicians from the Islamic world. Already in the early 9^{th} century, sophisticated mathematical solutions were developed based on spherical trigonometry and the geographical knowledge of that period. The most commonly adopted algorithm was based on the great-circle path (or shortest distance path) connecting the observer with the Kʿba in Mecca and determining its angle relative to the meridian. Extensive tables were prepared for each latitude and longitude of the known world and special curves were laid out on astrolabes, quadrants and sundials to assist the devout in determining the hour of the day when the sun is in the direction of the qibla.

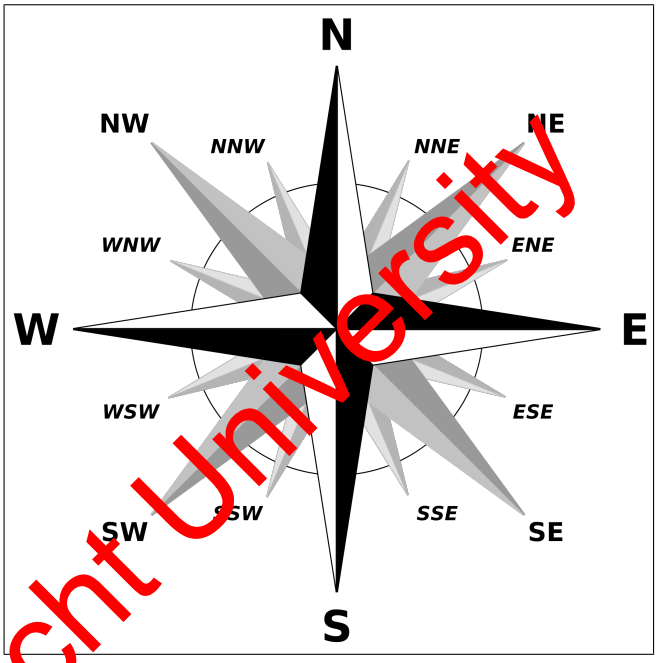
In this workshop we will determine the qibla for several terrestrial locations by first using an approximate method and then two exact methods.

An Approximate Method

Included with this workshop is a map of the Earth drawn in the Mercator projection, a commonly used map projection for showing the geographical or political divisions of our world. On this map mark the positions of the following cities:

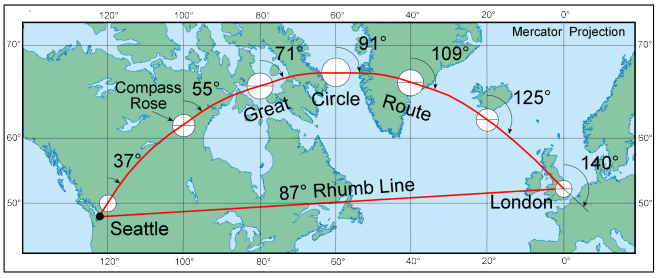
- Cairo
- Cape Town
- Istanbul
- London
- Los Angeles
- Rabat
- Singapore
- Tehran
- Your hometown

Connect each location through a straight line with Mecca and measure the compass direction of this line relative to North or use the following diagram.



The Exact Method

Although the Mercator map projection is very useful for many purposes it is not a true representation of our Earth which is spherical in shape, not flat. Furthermore, straight lines on a Mercator map are lines of constant compass direction (also known as rhumb lines) but these are not great-circle (or shortest-distance) paths. In order to obtain the true direction of the qibla the roundness of our world must be taken into account.



From spherical trigonometry one can prove that the exact value for the qibla is given by the following formula

$$\tan q = \frac{\sin(\lambda_M - \lambda)}{\cos\phi \tan\phi_M - \sin\phi\cos(\lambda_M - \lambda)}$$

where $(\phi,\ \lambda)$ is the latitude and longitude of your location, and $(\phi_M,\ \lambda_M = 21.42^\circ,\ 39.83^\circ)$ is the latitude and longitude of the Kaʿba. The qibla angle q is here reckoned from the North in clockwise direction.

Qibla-finding software embedded in webpages and apps for smartphones and similar devices is usually based on this formula.

With the help of an inflatable terrestrial globe and a string we will now determine the qibla for the following locations:

- Cairo
- Cape Town
- Istanbul
- London
- Los Angeles
- Rabat
- Singapore
- Tehran
- Your hometown

An Ingenious Instrument for Finding the Exact Qibla

In recent years a small number of finely engraved brass instruments, dating from the $17/18^{\text{th}}$ century and of Persian origin, have been found from which the exact direction of the qibla can be obtained in a very simple graphical way. These instruments are based on a sophisticated retro-azimuthal projection of the Earth centred on Mecca in which the longitude meridians are mapped as vertical lines and the latitude parallels are drawn as segments of an ellipse.

With the help of a modern reconstruction of this instrument included with this workshop determine again the qibla for the following locations:

- Cairo
- Cape Town
- Istanbul
- London
- Los Angeles
- Rabat
- Singapore
- Tehran
- Your hometown

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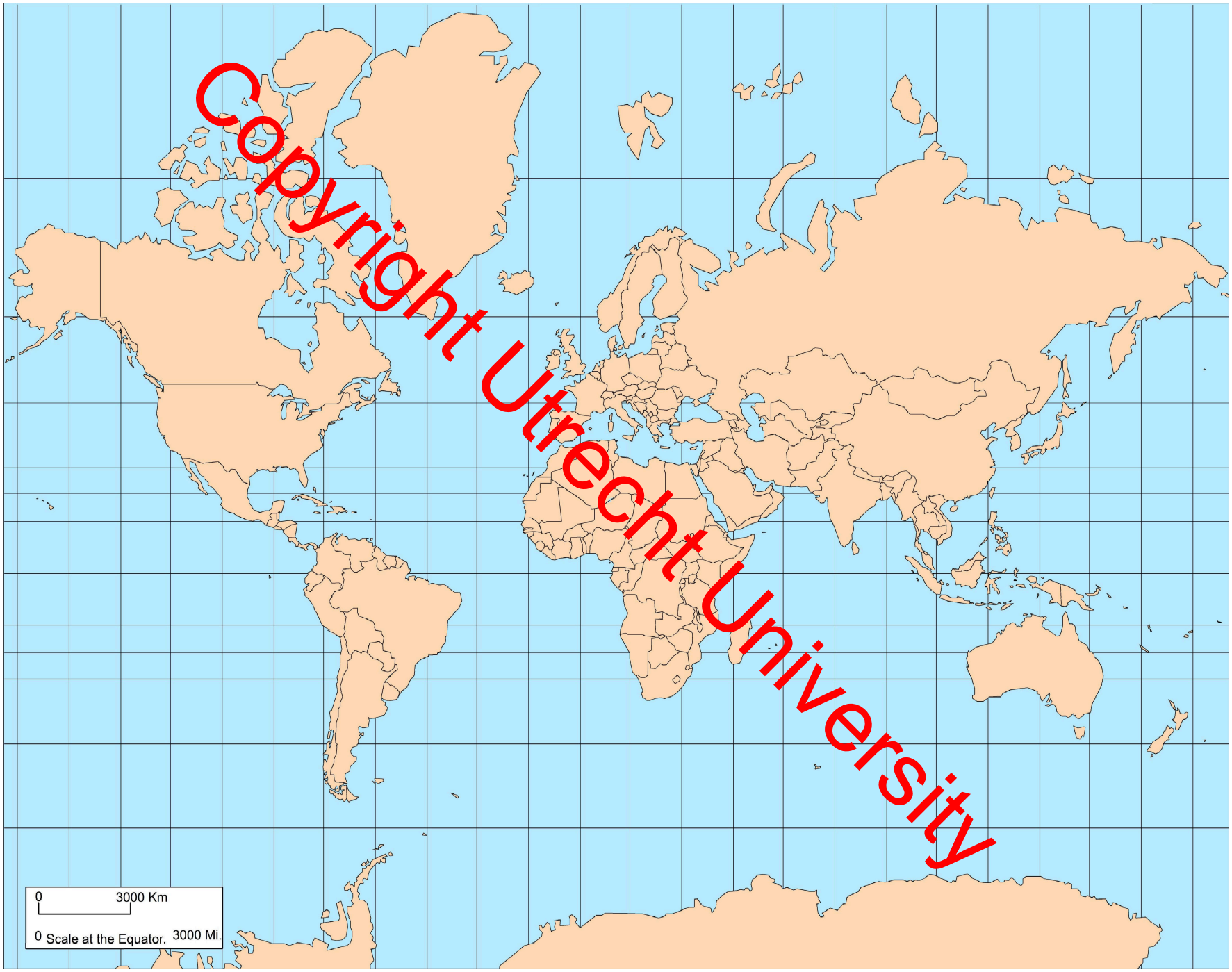
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