

# JavaScript Travel Time Simulator

## “An Adventure in Programming”

### Introduction

The JavaScript Travel Time Simulator is a web browser calculator which uses JavaScript and HTML to run. The programming is based upon using the hardcopy version of the Jeffreys-Bullen (JB) seismic tables. This calculator shortens the time taken to calculate epicentral distance and the travel times for all the possible seismic phases given the geographic coordinates of the earthquake and station, as well as the focal depth.

### Background

#### Seismology

- » Unidentified Earthquake Onsets (UEOs)

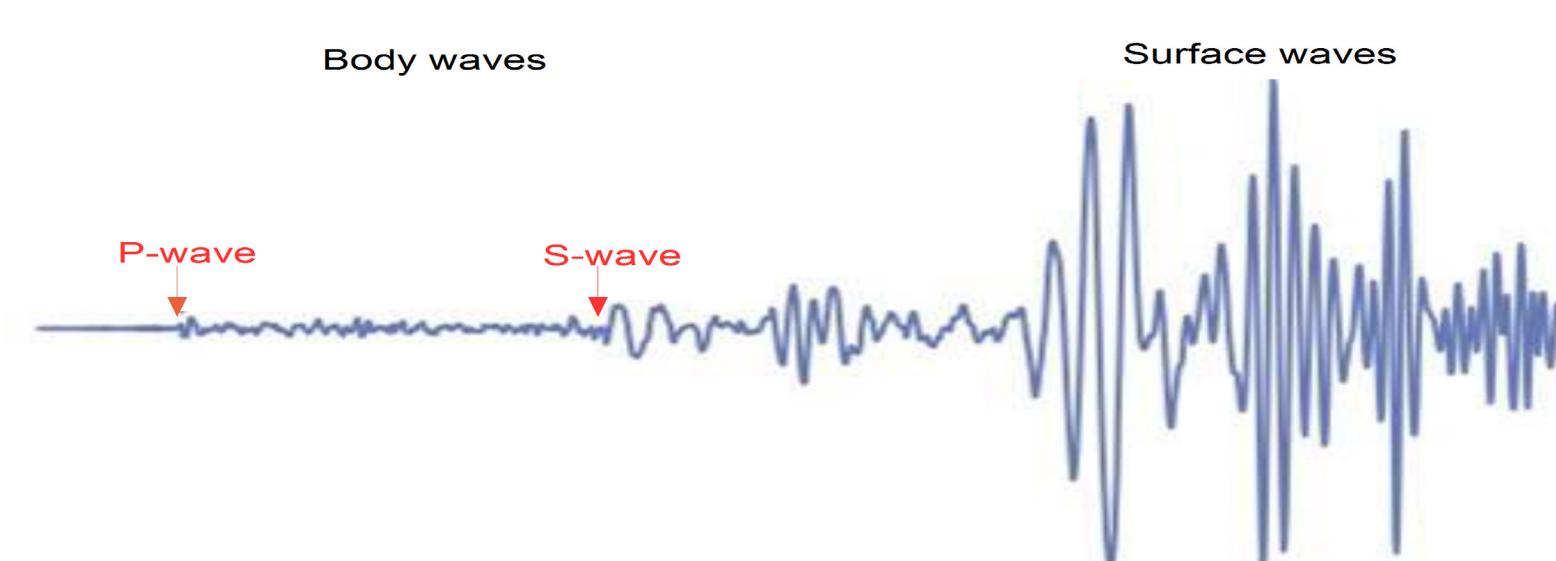


Figure 1: Original diagram belongs to British Geological Survey (Edited 2013)

- » Seismic phases: reflections and refractions off the Earth's surface, outer core, and inner core
  - » Phases chosen in program: P, S, PP, SS, PPP, SSS, PS, PPS, SSP, PcS, and PcP
  - » Epicentral Distance (ED) is the distance between the station and earthquake in degrees along the Earth's surface.
- #### Programming
- » If statements: Asking a yes or no question

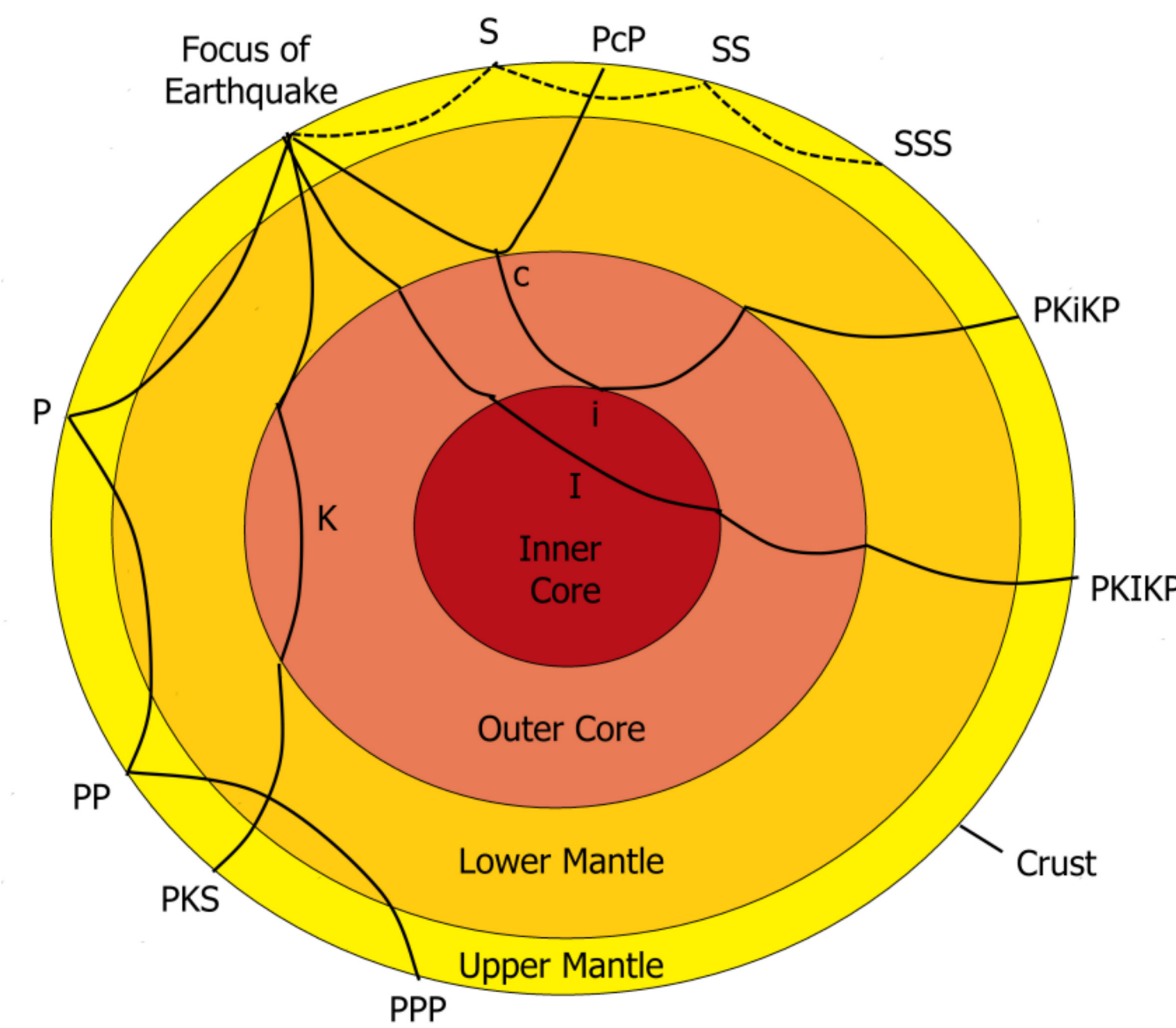


Figure 2: This diagram gives a few possible examples of some of the seismic phases.

- » For loops: Repeating a process
- » 2D arrays: Table (or matrix) with two independent variables

### Methods

#### Programming Logic

- » To describe the logical algorithm of this program a flow chart has been made to show the steps. In this chart squares are inputs/ outputs, trapezoids are arrays, and circles are calculations completed. The purple stars represent safe guards put into the code.
- » The inputs are the station and earthquake coordinates in decimal degrees and the focal depth in kilometers. The outputs are the travel times (TT) for each possible seismic phase in seconds and the ED in degrees.

- » There are two types of arrays, one contains the TT for each phase (11 total) and the other is the requirement array which holds the min and max values for ED for each phase type. This array is used to pick whether or not the individual TT phase array can be used depending on calculated ED.

- » The index array is reset each time it goes through the loop, which is highlighted in green on the chart. This array holds one TT phase array that passed the requirement at a time so that the bilinear interpolation variables may be extracted for the following calculation.

- » There are two mathematical equations used for calculations. The spherical law of cosines for the ED and bilinear interpolation to calculate the TT.

#### Developing the Arrays “The Data”

- » The TT phase arrays were created using excel to interpolate the allowance tables given in the JB tables so that they were already corrected for focal depth. The focal depth values were converted from the fractional values given in the JB tables to kilometers as well. So the TT arrays have column values of kilometers and row values of ED in degrees.

### Result

The result of the project is a web browser calculator which can be found under the tools on the Geology Page of the University of Wisconsin - River Falls website.

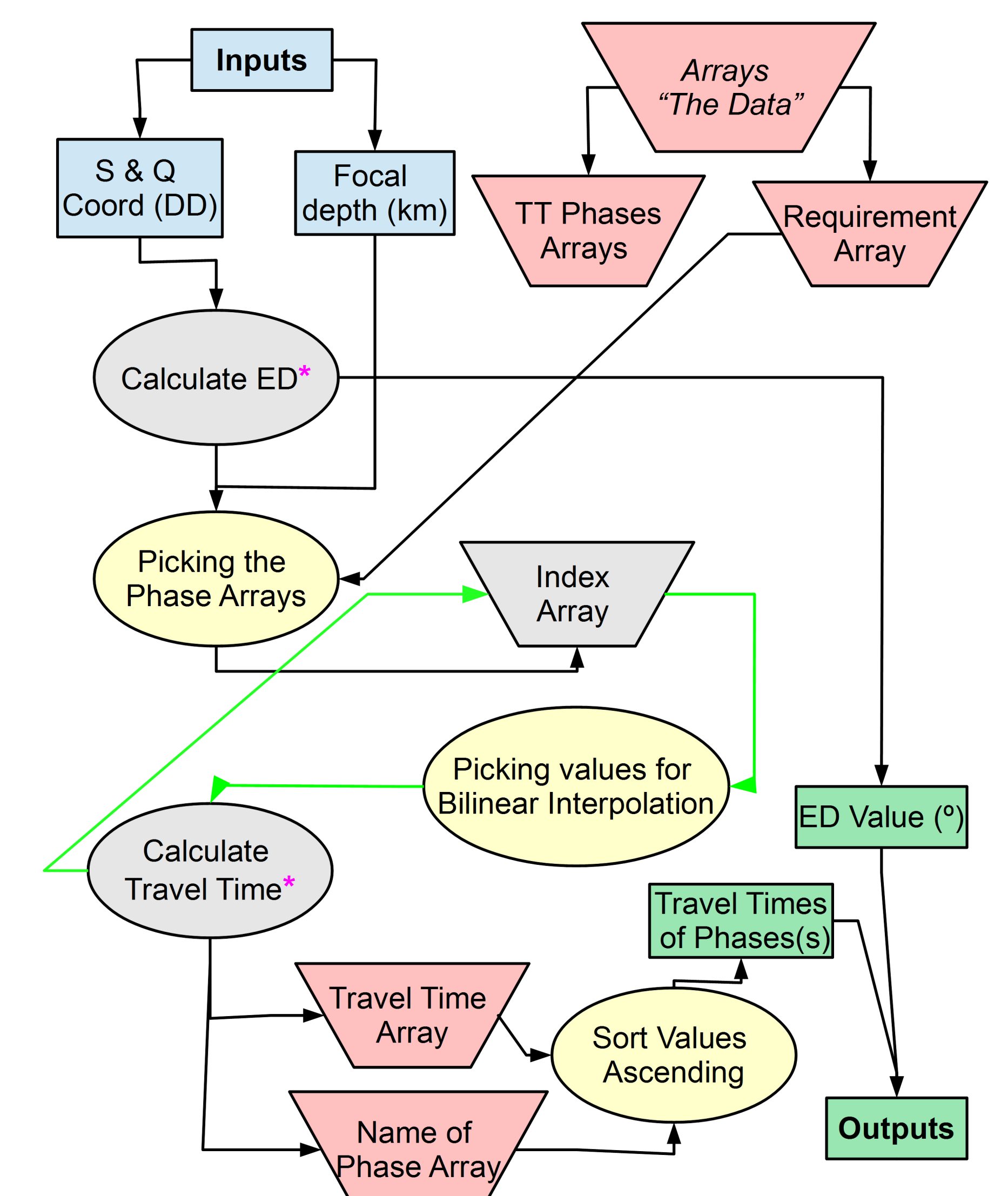


Figure 3: This diagram is a flow chart demonstrating the logical algorithm for the program.

### Discussion

While interpolating the JB allowance tables no extrapolation of the data was done. A few additions to still be added to this program would be to add more seismic phases, create a dropdown menu for inputting coordinates of seismic station, and creating a seismogram animation as well.

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Tamara J Cook

UNIVERSITY OF WISCONSIN River Falls