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## 2 Introduction – The Concepts of Sunshine

Orbtimes is a GNU/Linux command line utility that provides sun illumination data given inputs of timezone, geographic latitude and longitude, and daylight savings offset. If these data are not provided by command line argument, orbtimes will make a guess at the values based solely on the system timezone. It provides answers – Is it day or night? Twilight?. When was sunrise? sunset? Where is the sun now?

The utility provides real-time information about the sun – events, position, and queries. Events are sunrise/set, twilight. Other events such as solar eclipses are not currently supported. Sun's position is with respect to the local topocentric plane, Azimuth degrees clockwise from North and Altitude degrees above the horizon. Hence, the Sun rises in the East azimuth about 90 degrees, and sets in the West about 270 degrees, with the altitude varying from about zero degrees at sunrise and sunset, to about 90 degrees at local noon.

Queries can be quite general and sun responds with a true/false return. With queries, one can define day as sunrise>sunset and night as sunset>sunrise. Or one could define day as altitude>0.

```
$ ./orbtimes -query "sunrise>sunset" 1>2 /dev/null $ if [ $? -eq 0 ]; then echo "It is night."; else echo "It is day." > &2; fi
```

It is day.

### 3 An Example

Calling `orbtimes` with no arguments, `orbtimes` references the current system time, and makes educated guesses of location, timezone, and daylight savings time. `Orbtimes` prints results in an informational display:

Or one can call `Orbtimes` with arguments as follows,

example: `orbtimes -daylight 1 -location "36.048202N 114.950131W 0ft" -timezone -8.0`

## 4 Inputs

### 4.1 `-ascii-art (-A)`

Prints out more attractive information.

### 4.2 `-date (-D)`

Override the use of NOW time with a user specified date. Format is ISO 8601 date format year-month-date with month either specified numeric, or month name. Example: "1969-july-20".

### 4.3 `-daylight (-d)`

Input a daylight savings value in hours, if you don't want Orbtimes guessing at a value. Hence, to enforce regular hours, one can specify `-daylight 0`. Using `-daylight 1` will effectively move orbtimes one time zone eastward. So, in the U.S., use `"-daylight 1"` in the spring, and in the fall, `"-daylight 0"`. Or, one can let Orbtimes guess using U.S. convention for daylight savings hours.

### 4.4 `-timezone (-t)`

If Orbtimes is called without arguments, it guesses as much as it can for location and timezone based on the Posix timezone system. Posix timezone TZ is measured in seconds west of greenwich. Orbtimes guesses the system location has longitude TZ/240 degrees west of Greenwich and sets the timezone to -TZ/15 hours. Hence, Los Angeles, is TZ=28800, so longitude is 120W, and timezone is -8 hours.

### 4.5 `-location (-l)`

geographic location. latitude, longitude, elevation. Elevation can hasten the onset of sunrise, and delay sunset, lengthening the day, and shortening the night's duration. However, it can have little affect. So, for a pronounced summit like Maui, Hawaii, this is true, but for a collection of summits in like Las Vegas, Nevada it has comparatively little affect. It really is relative change in elevation that makes the difference.

### 4.6 `-twilight (-T)`

Specify the angle index used for twilight calculations. The default value is for civil twilight (1). One can raise the index to nautical twilight (2), astronomical twilight (3), and general twilight (4). If using general twilight, specify the additional argument `-twilight_angle` with angle in radians.

### 4.7 `-twilight_angle (-e)`

Used with option `-twilight`. angle in radians. So to specify a civil twilight angle of six degrees use 0.1047197551196597.

#### **4.8 `—query (-q)`**

Specify a query to run. See chapter on the query parser.

#### **4.9 `—help (-H)`**

print out help information for the user.

#### **4.10 `—verbose (-v)`**

controls amount of information printed. You can get more information printed by calling successively, for example “./orbtimes -v”, “./orbtimes -vv”, “./orbtimes -vvv”.

#### **4.11 `—check (or —selftest) (-c)`**

this will perform a series of tests to verify proper operation of the program.

#### **4.12 `—version (-V)`**

Print out orbtimes version number.

## 5 Outputs

### 5.1 Topocentric Position: Azimuth, Altitude

Azimuth specified in degrees clockwise from north, and altitude in degrees above the horizon. Hence the cardinal compass points, East is 90 degrees, West is 270 degrees. In a typical day, the azimuth varies from about 90 at sunrise, to 270 at sunset. And the elevation vary from 0 at sunrise and sunset, with 90 at noon. Negative elevations correspond with position of the sun at night. Hence, a definition of night is elevation  $< 0$ .

### 5.2 Equation of Time, declination (dec), ecliptic longitude (lamba)

Here is an analemma I generated for Las Vegas, NV of the year 2016. There is a lot of literature on this going back thousands of years. Wwhen the shadow is shortest separated the day from morning (AM) to afternoon (PM). Noon should be 12:00. However, it isn't. The difference is the "equation of time". And declination measures the length of the shadow. " The declination of the Sun, delta, is the angle between the rays of the Sun and the plane of the Earth's equator." See [https://en.wikipedia.org/wiki/Position\\_of\\_the\\_Sun](https://en.wikipedia.org/wiki/Position_of_the_Sun) The ecliptic longitude is the observed position of Sun about the ecliptic plane.

### 5.3 Julian day

Julian days are just the number of days elapsed from a start date. By convention, this start date is Noon Universal Time on January 1, 4713 BC. see <http://aa.usno.navy.mil/data/docs/JulianDate.php> In practical applications, Julian day (1900) is also sometimes used with a start date of Noon December 31, 1899. Fractional Julian days can include the actual time. see [https://en.wikipedia.org/wiki/Julian\\_day](https://en.wikipedia.org/wiki/Julian_day)

## 6 Query Parser

One can form queries from the following primitives: `is_nighttime`, `is_daytime`, `sunrise`, `sunset`, `azimuth`, `altitude`, `now`, `month`, `dow`, `year`, `jan`, `feb`, `mar`, `apr`, `may`, `jun`, `jul`, `aug`, `sep`, `oct`, `nov`, `dec`. Queries are created using the parser with support for `>` `=` `<`.

## 7 Use with Linux

Orbtimes is a Linux command line utility. One can pipe its output through the grep filter. For example, one early morning I saw a bright East star which I surmised must be Venus. Piping output through grep confirms my guess, Venus is fairly high in the sky and with an Eastern azimuth, `./orbtimes -orbs -daylight=1 -vv | grep azimuth`



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