Details on Given Matlab Functions

1. ComputeTransmissionTime_Students

```
function [iDelta_t_SV, iT_SV] = ComputeTransmissionTime_Students(vEphemeris,
iUser_SoW, f_C1)
%--------------------------------------------------------------------------
% Copyright © ENAC, 2015.
% ENAC : http://www.enac.fr/.
% signav@recherche.enac.fr
%
% This function computes SV PRN signal transmission time in GPS system
% time.
% data (L1 signal).
% Input Variables:
%   1) vEphemeris       SV PRN ephemeris data - 1x29 vector
%   2) iUser_SoW        user time (Second of Week - SoW)
%   3) f_C1             code range measurement
% Output Variables:
%   1) iDelta_t_SV      SV PRN code phase offset [s] (do not include the
%   relativistic correction term)
%   2) iT_SV            signal transmission time in GPS system time [s]
%
% Reference:
%   ICD-GPS-200C, 10 OCT 1993, page 88, page 90
%--------------------------------------------------------------------------
```

2. delta_wgs84_2_local.m

```
function [vXYZl, mTRANSF] = delta_wgs84_2_local(vXYZw, vXYZ0)
%--------------------------------------------------------------------------
% This function transforms the coordinates of a vector in the ECEF frame
% (WGS-84) into the coordinates of that vector into local tangent plane
% (NEU)
%
% Input Variables
%   1) vXYZw     coordinates of the vector in ECEF frame (3x1)
%   2) vXYZ0     center of local tangent plane in ECEF frame (3x1)
%
% Output Variables
%   1) vXYZl     coordinates of the vector in local tangent plane (3x1)
%      vXYZl(1) coordinate in the North direction
%      vXYZl(2) coordinate in the East direction
%      vXYZl(3) coordinate in the Up direction
%   2) mTRANSF   transformation matrix (3x3)
%--------------------------------------------------------------------------
```

3. elevation_azimuth.m

```
function [fElevation, fAzimuth] = elevation_azimuth(pos_origine_XYZ,
pos_satellite_XYZ)
%-------------------------------------------------------------------------
% Copyright © ENAC, 2015.
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%
% This function computes the elevation and azimuth angles between a single
% user position and a vector of satellite positions
% Input Variables
%   pos_origine_XYZ     reference user Earth-fixed position - [x, y, z] (1x3)
%   pos_satellite_XYZ   SV Earth-fixed position - [x, y, z] (1x3)
% Output variables
%   fElevation          SV elevation angle wrt to user - [rad]
%   fAzimuth            SV azimuth angle wrt to user - [rad]
%-------------------------------------------------------------------------
```

4. ExtractData_N.m

```
function [Iono_a, Iono_b, Ephem]=ExtractData_N(HEADER_N, DATA_N)
%-------------------------------------------------------------------------
% Copyright © ENAC, 2015.
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% signav@recherche.enac.fr
%
% This functions extract the ephemeris data after reading the RINEX file
% .nav
% Input Variables
%   1) HEADER_N    cell containing .nav file header
%   2) DATA_N      cell containing .nav file recorded data
%       DATA_N(j).*      jth satellite data
% Output Variables
%   1) Iono_a      Iono correction a-parameters (Iono_a = [a0,a1,a2,a3])
%   2) Iono_b      Iono correction b-parameters (Iono_b = [b0,b1,b2,b3])
%   3) Ephem       Ephemeris recorded data - (Max_Nb_Sat x 29) matrix
%       Ephem(j,:)      jth SV data
%       Ephem(j,1) = SV PRN number
%       Ephem(j,2) = SV health
%       Ephem(j,3) = Epoch Toc - Time of Clock (week #)
%       Ephem(j,4) = Epoch Toc - Time of Clock (second of week)
%       Ephem(j,5) = Epoch Toc - Time of Clock (number of seconds since GPS
date  - NoS)
%       Ephem(j,6) = SV clock bias (af0)
%       Ephem(j,7) = SV clock drift (af1)
%       Ephem(j,8) = SV clock drift rate (af2)
%       Ephem(j,9) = TGD
%       Ephem(j,10) = IODE Issue of Data Ephemeris
%       Ephem(j,11) = IODC Issue of Data, Clock
%       Ephem(j,12) = Toe Time of ephemeris (GPS Week #)
%       Ephem(j,13) = Toe Time of ephemeris (second of week)
```

```
%       Ephem(j,14) = Toe Time of ephemeris (number of seconds since GPS date
- NoS)
%       Ephem(j,15) = e Eccentricity
%       Ephem(j,16) = sqrt(A) Square Root of the Semi-Major Axis
%       Ephem(j,17) = (OMEGA)0 Longitude of ascending node of orbital plane
%       at weekly epoch
%       Ephem(j,18) = i0 Inclination angle at reference time
%       Ephem(j,19) = IDOT
%       Ephem(j,20) = omega Argument of perigee
%       Ephem(j,21) = OMEGA DOT Rate of right ascension
%       Ephem(j,22) = M0
%       Ephem(j,23) = Delta_n
%       Ephem(j,24) = Crs
%       Ephem(j,25) = Crc
%       Ephem(j,26) = Cus
%       Ephem(j,27) = Cuc
%       Ephem(j,28) = Cis
%       Ephem(j,29) = Cic
%--------------------------------------------------------------------------
```

5. ExtractData_O.m

```
function [mEpoch, Nb_Epoch, vNb_Sat, Total_Nb_Sat, mTracked, mC1, mL1, mD1,
mS1]=ExtractData_O(DATA_O, nEpoch_max)
%--------------------------------------------------------------------------
% Copyright © ENAC, 2015.
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%
% This functions extract the ephemeris data after reading the RINEX file
% .nav
% Input Variables
%   1) HEADER_O    cell containing .obs file header
%   2) DATA_O      cell containing .obs file recorded data
%       DATA_O(i).*      ith epoch data
% Output Variables
%   1) mEpoch      Time - (Nb_Epoch x 6)
%       mEpoch(i,:) = [GPS week #, time(second of week - SoW), time (number
%       of seconds since GPS date - NoS), YYYY, MM, DD, hh, mm, sec]
%   2) Nb_Epoch    Number of samples to process
%   3) vNb_Sat     Number of tracked satellites - (Nb_Epoch x 1)
%       vNb_Sat(i) = number of tracked satellites at epoch i
%   4) Total_Nb_Sat  Total number of tracked satellites
%   5) mTracked    Matrix of booleans that indicates when satellites
%   are tracked - (Nb_Epoch x 32)
%       mTracked(i,j) = 1, if PRN j is tracked at epoch i
%       mTracked(i,j) = 0, otherwise
%   6) mC1         L1 C/A code pseudorange - (Nb_Epoch x 32)
%       mC1(i,j) = code pseudorange of PRN j satellite at epoch i
%   7) mL1         L1 Carrier phase - (Nb_Epoch x 32)
%       mL1(i,j) = carrier phase of PRN j satellite at epoch i
%   8) mD1         L1 Doppler frequency - (Nb_Epoch x 32)
%       mL1(i,j) = doppler frequency of PRN j satellite at epoch i
%   9) mS1         L1 SNR value as given by Rx - (Nb_Epoch x 32)
%       mS1(i,j) = SNR value of PRN j satellite at epoch i
```

```
%-------------------------------------------------------------------------
```

6. SelectEphemeris.m

```
function [vEphemeris] = SelectEphemeris(Ephem,iPRN,iUser_NoS)
%-------------------------------------------------------------------------
% Copyright � ENAC, 2015.
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% signav@recherche.enac.fr
%
% This function select the ephemeris set that best fits SV iPRN at time
% iUser_NoS.
% Input Variables
%   1) Ephem        ephemeris recorded data - (Max_Nb_Sat x 27) matrix
%   2) iPRN         SV PRN #
%   3) iUser_Nos    user time (Number of Seconds since GPS date - NoS)
% Output Variables
%   1) vEphemeris   best fitting ephemris data - (1x29) matrix
%-------------------------------------------------------------------------
```

7. SV_Position_and_ClockCorrection_Students.m

```
function [vSatellite_xyz, fSV_ClockCorr] =
SV_Position_and_ClockCorrection_Students(vEphemeris, iT_SV, iUser_SoW,
iDelta_t_SV)
%-------------------------------------------------------------------------
% Copyright © ENAC, 2015.
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%
% This function computes SV PRN Earth-fixed position and SV PRN clock
% correction (in meter), from ephemeris data.
% Input Variables:
%   1) vEphemeris       satellite ephemeris data - 1x29 vector
%   2) iT_SV            signal transmission time in GPS system time [s]
%   3) iUser_SoW        user time (Second of Week - SoW)
%   4) iDelta_t_SV      SV PRN code phase offset [s] (do not include the
%   relativistic correction term)
% Output Variables:
%   1) vSatellite_xyz   satellite position in rectangular coordinates in
%   ECEF - 1x4 vector
%       vSatellite_xyz(1)      x coordinate
%       vSatellite_xyz(2)      y coordinate
%       vSatellite_xyz(3)      z coordinate
%   2) fSV_ClockCorr           SV PRN clock correction [m]
%
% Reference:
%   ICD-GPS-200C, 10 OCT 1993, page 98
%-------------------------------------------------------------------------
```

8. xyz_2_lla_PVT.m

```
function vLLH = xyz_2_lla_PVT(vXYZ)
%--------------------------------------------------------------------------
% This function transforms the rectangular coordinates (x,y,z) of a point in
% ECEF frame to the geodetic coordinates (Latitude, Longitude, Height
% above the reference ellipsoid)
%
% Input Variables
% 1) vXYZ     point rectangular coordinates - x,y,z (1x3)
%
% Output Variables
% 2) vLLH     point geodetic coordinates - [Lat [rad], Lon [rad], H [m]] (1x3)
%--------------------------------------------------------------------------
```