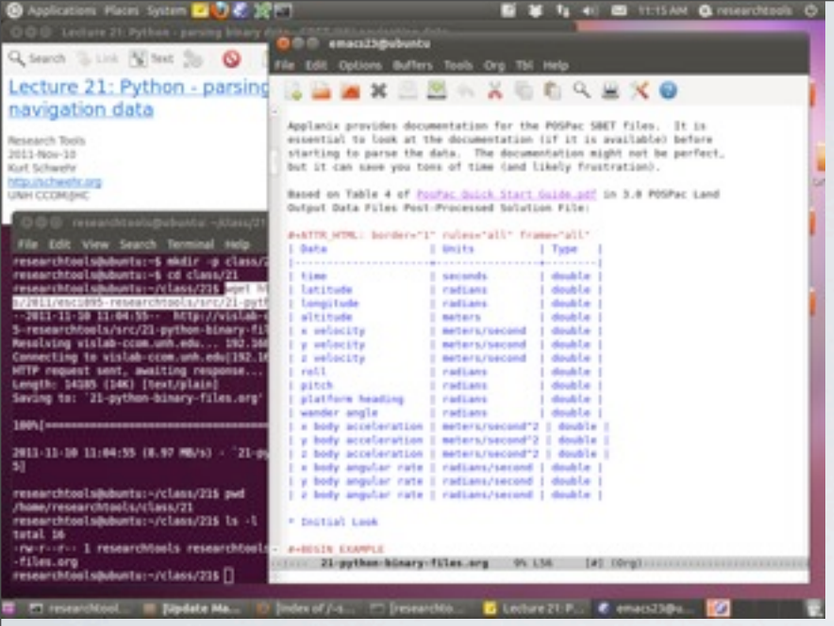
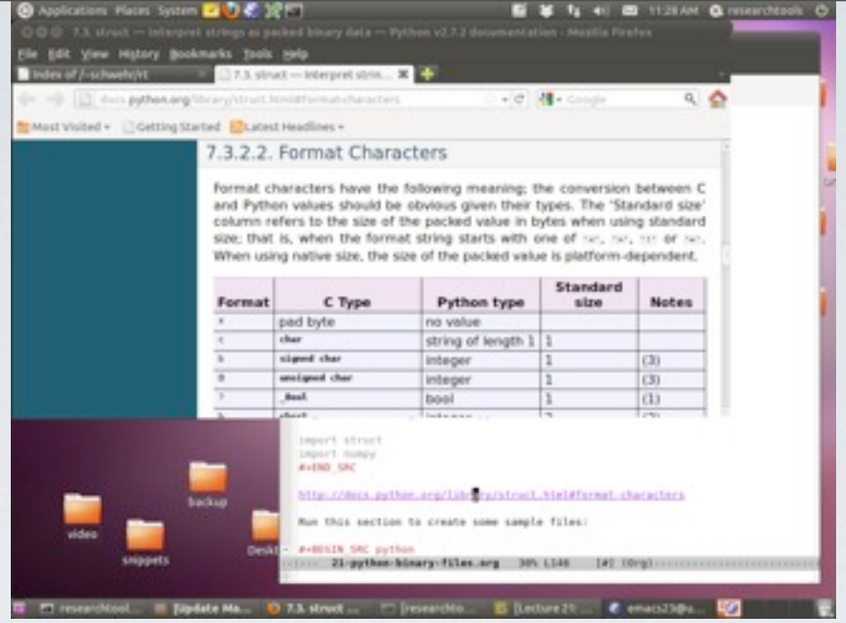
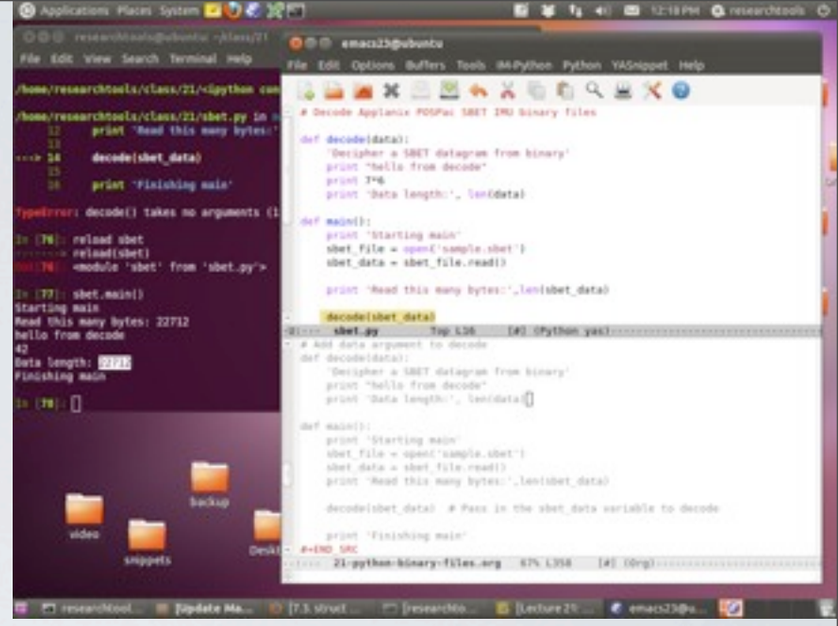






RESEARCH TOOLS 2011

LECTURE 21

2011-Nov-10

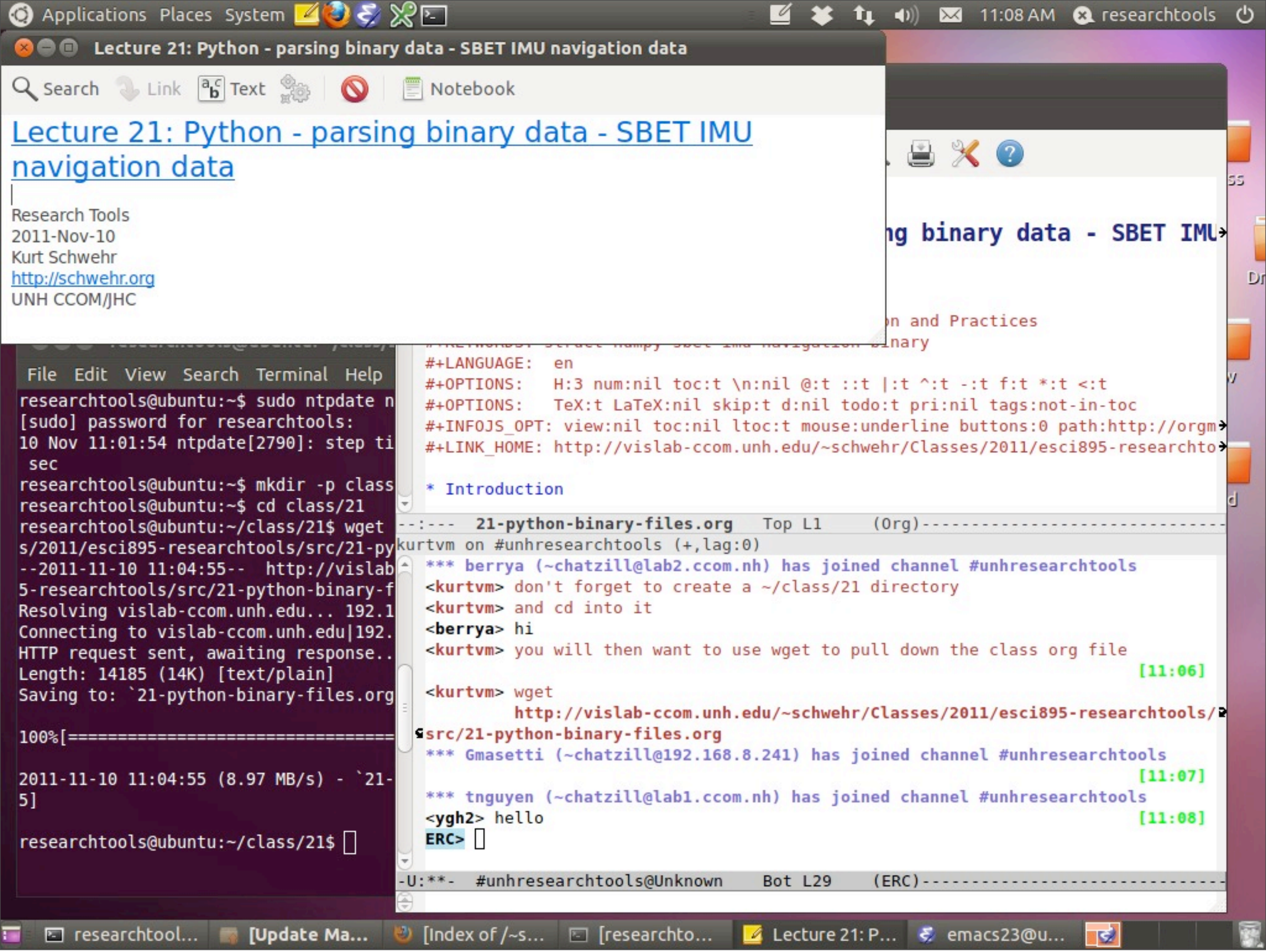
Kurt Schwehr

http://schwehr.org

UNH CCOM/JHC

Parsing binary in Python: SBET IMU navigation files

http://vislab-ccom.unh.edu/~schwehr/Classes/2011/esci895-researchtools/



Thursday, November 10, 11

See also: http://vislab-ccom.unh.edu/~schwehr/Classes/2011/esci895-researchtools/python-binary-files.org

Applications Places System 11:13 AM researchtools

Index of /~schwehr/rt - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Index of /~schwehr/rt

vislab-ccom.unh.edu/~schwehr/rt/

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Lectures:

No.	Date	Title/Notes	Audio	Present	Video	Blog
21	2011-11-10	Python: parsing binary data - SBETs [org]				
20	2011-11-08	BAGs 3, XML Metadata, KML, and GS]		key		
Vid 18	2011-11-08	Python: Reading a HDF5 BAGs - h5py,		key	YouTube H264	
Vid 17	2011-11-07	Emacs, HDF5 BAGs and XML Metadat		key	YouTube H264	
19	2011-11-03	BAGs 2, XML Metadata [org]	mp3	pdf key		comment
18	2011-11-01	BAGs, HDF5 and XML [org]	mp3	pdf key		comment

Open Link in New Tab
Open Link in New Window
Bookmark This Link
Save Link As...
Send Link...
Copy Link Location

```
100%[======================================>] 14,185      --.-K/s   in 0.002s

2011-11-10 11:04:55 (8.97 MB/s) - `21-python-binary-files.org' saved [14185/1418
5]

researchtools@ubuntu:~/class/21$ pwd
/home/researchtools/class/21
researchtools@ubuntu:~/class/21$ ls -l
total 16
-rw-r--r-- 1 researchtools researchtools 14185 2011-11-10 10:46 21-python-binary
-files.org
researchtools@ubuntu:~/class/21$
```

```
 POSPac SBET files.  It is
(if it is available) before
ntation might not be perfect,
ikely frustration).

Guide.pdf in 3.0 POSPac Land
on File:

29     [#] (Org)----------------------------
```

researchtool... [Update Ma... Index of /~sc... [researchto... Lecture 21: P... emacs23@u...

Applications Places System 11:15 AM researchtools

Lecture 21: Python - parsing binary data - SBET IMU navigation data

Search Link Text

Lecture 21: Python - parsing navigation data

Research Tools
2011-Nov-10
Kurt Schwehr
http://schwehr.org
UNH CCOM/JHC

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
researchtools@ubuntu:~$ mkdir -p class/2
researchtools@ubuntu:~$ cd class/21
researchtools@ubuntu:~/class/21$ wget ht
s/2011/esci895-researchtools/src/21-pyth
--2011-11-10 11:04:55--  http://vislab-c
5-researchtools/src/21-python-binary-fil
Resolving vislab-ccom.unh.edu... 192.168
Connecting to vislab-ccom.unh.edu|192.16
HTTP request sent, awaiting response...
Length: 14185 (14K) [text/plain]
Saving to: `21-python-binary-files.org'

100%[======================================

2011-11-10 11:04:55 (8.97 MB/s) - `21-py
5]

researchtools@ubuntu:~/class/21$ pwd
/home/researchtools/class/21
researchtools@ubuntu:~/class/21$ ls -l
total 16
-rw-r--r-- 1 researchtools researchtools
-files.org
researchtools@ubuntu:~/class/21$
```

emacs23@ubuntu

File Edit Options Buffers Tools Org Tbl Help

Applanix provides documentation for the POSPac SBET files. It is essential to look at the documentation (if it is available) before starting to parse the data. The documentation might not be perfect, but it can save you tons of time (and likely frustration).

Based on Table 4 of PosPac Quick Start Guide.pdf in 3.0 POSPac Land Output Data Files Post-Processed Solution File:

```
#+ATTR_HTML: border="1" rules="all" frame="all"
| Data                | Units           | Type   |
|---------------------+-----------------+--------|
| time                | seconds         | double |
| latitude            | radians         | double |
| longitude           | radians         | double |
| altitude            | meters          | double |
| x velocity          | meters/second   | double |
| y velocity          | meters/second   | double |
| z velocity          | meters/second   | double |
| roll                | radians         | double |
| pitch               | radians         | double |
| platform heading    | radians         | double |
| wander angle        | radians         | double |
| x body acceleration | meters/second^2 | double |
| y body acceleration | meters/second^2 | double |
| z body acceleration | meters/second^2 | double |
| x body angular rate | radians/second  | double |
| y body angular rate | radians/second  | double |
| z body angular rate | radians/second  | double |

* Initial Look

#+BEGIN_EXAMPLE
```

--:--- 21-python-binary-files.org 9% L56 [#] (Org)----------

researchtool... [Update Ma... [Index of /~s... [researchto... Lecture 21: P... emacs23@u...

Applications Places System 11:21 AM researchtools

Lecture 21: Python - parsing binary data - SBET IMU navigation data

Search Link Text

Lecture 21: Python - parsing navigation data

Research Tools
2011-Nov-10
Kurt Schwehr
http://schwehr.org
UNH CCOM/JHC

emacs23@ubuntu

File Edit Options Buffers Tools Org Tbl Help

```
#+STARTUP: showall

#+TITLE:     Class 21: Python - parsing binary data - SBET IMU
#+AUTHOR:    Kurt Schwehr
#+EMAIL:     schwehr@ccom.unh.edu
#+DATE:      <2011-11-10 Thu>
#+DESCRIPTION: Marine Research Data Manipulation and Practices
                                                    ation binary

                                                    :t ::t |:t ^:t -:t f:t *:t <:t
                                                    il todo:t pri:nil tags:not-in-toc
                                                    ouse:underline buttons:0 path:http://orgm
                                                    /~schwehr/Classes/2011/esci895-researchto

                                                    sample data.

                                                    sses/2011/esci895-researchtools/python-bi

                                                    on

28      [#] (Org)--------------------------
```

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
researchtools@ubuntu:~/class/21$ pwd
/home/researchtools/class/21
researchtools@ubuntu:~/class/21$ ls -l
total 16
-rw-r--r-- 1 researchtools researchtools 14185 2011-11-10 10:46 21-python-binary
-files.org
researchtools@ubuntu:~/class/21$ curl -O http://vislab-ccom.unh.edu/~schwehr/Cla
sses/2011/esci895-researchtools/examples/21/sample.sbet.bz2
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 22473  100 22473    0     0  1061k      0 --:--:-- --:--:-- --:--:-- 2743k
researchtools@ubuntu:~/class/21$ ls -l
total 40
-rw-r--r-- 1 researchtools researchtools 14185 2011-11-10 10:46 21-python-binary
-files.org
-rw-r--r-- 1 researchtools researchtools 22473 2011-11-10 11:20 sample.sbet.bz2
researchtools@ubuntu:~/class/21$ bunzip2 sample.sbet.bz2
researchtools@ubuntu:~/class/21$ ls -l
total 40
-rw-r--r-- 1 researchtools researchtools 14185 2011-11-10 10:46 21-python-binary
-files.org
-rw-r--r-- 1 researchtools researchtools 22712 2011-11-10 11:20 sample.sbet
researchtools@ubuntu:~/class/21$
```

researchtool... [Update Ma... [Index of /~s... [researchto... Lecture 21: P... emacs23@u...

Applications Places System 11:22 AM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
OD(1)                          User Commands                          OD(1)

NAME
       od - dump files in octal and other formats

SYNOPSIS
       od [OPTION]... [FILE]...
       od [-abcdfilosx]... [FILE] [[+]OFFSET[.][b]]
       od --traditional [OPTION]... [FILE] [[+]OFFSET[.][b] [+][LABEL][.][b]]

DESCRIPTION
       Write an unambiguous representation, octal bytes by default, of FILE to
       standard output.  With more than one FILE argument, concatenate them in
       the  listed  order to form the input.  With no FILE, or when FILE is -,
       read standard input.

       All arguments to long options are mandatory for short options.

       -A, --address-radix=RADIX
              decide how file offsets are printed

       -j, --skip-bytes=BYTES
              skip BYTES input bytes first
 Manual page od(1) line 1
```

```
# H soh   # nak   ### ####?
  ### ##  ##dle   #   )   @
  #  90  83   |   ####### ?
  u   # etx bel  88   e   #
  ### #   2   8  90   #   #
# R   ### $   #   e   ### #
  <   w   u  83   #####   ?
  #  83   4   /   #  9d   ?
#ff  99 etx  84   r dc4   A
#####c3 stx   #   z eot   ##
```

```
#+END_EXAMPLE

Better yet, Octal Dump has a mode that will try to treat the file as
uniform binary data (for example, a series of 4 byte integers).
Since we know that our SBET file will contain a series of 17 doubles
(8 bytes each) in a row, let's try out a sample file that contains the
numbers 0 through 16,

#+BEGIN_SRC sh
wget http://vislab-ccom.unh.edu/~schwehr/Classes/2011/esci895-researchtools/exam→

od -t fD s1.bin
--:---  21-python-binary-files.org   21% L90     [#] (Org)----------------------------
```

backup

video

snippets

Deskt

researchtool... [Update Ma... [Index of /~s... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 11:23 AM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
researchtools@ubuntu:~/class/21$ file *.sbet
sample.sbet: data
researchtools@ubuntu:~/class/21$ man od
researchtools@ubuntu:~/class/21$ od -a sample.sbet  | head
0000000   A   g   p eot   <   q dc4   A   a   H soh  sp nak   a   p   ?
0000020   G   v  us   Q   O   z eot   @   n   h   \   ] dle   '   )   @
0000040   K   G   ? sub   *   `   $   @   R   " dle etx   |   q   o   ?
0000060   j syn   R   M   h   f   G   ? esc   u   * etx bel  bs   e   ?
0000100   7  vt   '   '   |   9   =   ?   ;   o   >   2   8 dle   9   ?
0000120   z   T   = can   q   2   Y   ?   `   R   k   $   )   e   j   ?
0000140   y   E   k  sp   &   X   U   ? stx   <   w   u etx   w   1   ?
0000160   c   B   {   X   t   T nak   ?   m   ; etx   4   /   2  gs   ?
0000200  si   { etb   D   ]   a   {   ?   n  ff  em etx eot   r dc4   A
0000220 dc3 nak   &   c   e   a   p   ?   r   m dc3 stx   1   z eot   @
researchtools@ubuntu:~/class/21$ less sample.sbet
"sample.sbet" may be a binary file.  See it anyway?
```

```
# H soh   # nak   ### ####?
  ### ##  ##dle   #   )   @
  #  90  83   |   ####### ?
  u   # etx bel  88   e   #
  ### #   2   8  90   #   #
# R   ### $   #   e   ### #
  <   w   u  83   #####   ?
  #  83   4   /   #  9d   ?
#ff  99 etx  84   r dc4   A
#####c3 stx   #   z eot   ##
```

```
#+END_EXAMPLE

Better yet, Octal Dump has a mode that will try to treat the file as
uniform binary data (for example, a series of 4 byte integers).
Since we know that our SBET file will contain a series of 17 doubles
(8 bytes each) in a row, let's try out a sample file that contains the
numbers 0 through 16,

#+BEGIN_SRC sh
wget http://vislab-ccom.unh.edu/~schwehr/Classes/2011/esci895-researchtools/exam→

od -t fD s1.bin
--:---  21-python-binary-files.org   21% L90     [#] (Org)----------------------
menu-bar edit copy
```

backup

video

snippets

Deskt

researchtool... [Update Ma... [Index of /~s... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 11:23 AM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
<C1>g<F0>^D<BC>q^TA<E1>H^A<A0>^U<E1><F0>?G<F6><9F>Q<CF>z^D<C0>n<E8><DC><DD>^P
<A7>)@Kǿ<9A>*<E0>$@R<A2><90><83>|<F1><EF>?<EA>^V<D2><CD><E8>f<C7>?ESCu<AA>^C^G
<88>e<BF><B7>^K<A7>'<FC>9<BD>?<BB><EF><BE>28<90><B9><BF>z<D4>=^X<F1><B2>e<E0>R
<EB>$<A9>e<EA><BF><F9><C5>럐<D8>s^B<wu<83><F7><B1>?<E3>B<FB><D8><F4><U+0515>?m
<BB><83>4/<B2><9D>?^O{^WD<DD><E1>{<BF><EE>^L<99>^C<84>r^TA^S<95><A6><E3>e<E1>
<F0>?<F2><ED>^S^B<B1>z^D<C0><A8>
<99>^ <BF>u)@nZl<E3>^\<D9>$@<DE><F6>q<80>n<9A><F4>?j<E5>>.<DA><E3><CF>?<8A>li(BJ
z?ESCR<EE><98>ᵲ<BA>?`^Y``d<AD><BE><BF>t<AF><8A><B7><81><BD>e^P;␣D<B5><B6>?<A2>
<AD>t^_<F4>y<B3>?1<F1>,<FC>i<E4><FB><BF>{<96>*<E0>>}<93>?ESC<B0>#LE<B3>?<A9><9D>
<F7>z<B8>|i?^Z<B2>A^BLs^TA<BA><AC><9C>}<B2><E1><F0>?<B0><EB>?<87><8A>z^D<C0>
<U+A879><AA><B1><B5>)@<CA>E^Eu<AD><85>$@<95>^E<U+1197A2><F1><BF>ʒ<FE><AA>l<␤<E9>
Z<BA>C<U+1FD5FE2><A4><9B>Q^Cy<BC>?<U+05ED>^LD<E5>,<BD>?.<B4><8A><C9>e<86><A5>J
<BD>Z^R␤<F1><DF>.U\<C1>?<AC>".<B1>A<D0>^A@<E9><80>KY^B<A4><8A><BF><B1>/^O<BE>
<B6><BF><99><CA><F7><C4>P<F7>J?GW<EA>^@^Tt^TAs<C1><<96><FE><E1><F0>?<B2>?<C9>
<E5>`z^D<C0><FC>ᵸZ<AE>)@?i^A<E3><F7>[%@HESC4<C7>2&<F0><BF>^H<D7><E6>Op<D3>ÿ<AF>l
^Y<AC>ʒN?<95><88><CB>*^C'<B7>?3I<C6><E3><94>^<B7>?|Z<B3>oD<C6>e<9F>Iz}<EB><A8>*(
<E1>V^Ko<CC><U+077F>^Wkz^Zv<F4><F3>?IS<9C><91>C<81><BF>A<<9D>%Ù<BF><FE>^] <FB>
<8C>Ab<BF><C0>^\<93><FF><DB>t^TAt<B1><98>mL<E2><F0>?lJ^X<91>;z^D<C0>n<EB>  $
<94><93>)@<DD>^B<9D><AE><F7><EB>$@^XY<80>E<BB>y<E7><BF>$<EC>?^U<AE>?<CC>zώr^S
<8E><BF><8A><D0>^Ay^D{<BA>?<AE>%<CE>o4<B3>?I<D7>El<C1>e<CF><CC><F7>e<E6><E8><BF>
C'<x<8A>h?]<AC>^At<A1>H<FE>?-r<E6><B2><D1><EF>n?<80><BA>i^R#  <89>?<F9>}^_U
^R<A1>u<BF><D4><C1>;<FE><A3>u^TA<E7>Z<B9><E2><F0>?f5ž^Qz^D<C0>^U<A3><BC>nb<C0>)@
^N^S<F3>
sample.sbet
```

```
# H soh   # nak   ### ####?
  ### ##  ##dle   #   )   @
  #  90  83   |   ####### ?
  u   # etx bel  88   e   #
  ### #   2   8  90   #   #
# R   ### $   #   e   ### #
  <   w   u  83   #####   ?
  #  83   4   /   #  9d   ?
#ff  99 etx  84   r dc4   A
#####c3 stx   #   z eot   ##
```

```
#+END_EXAMPLE

Better yet, Octal Dump has a mode that will try to treat the file as
uniform binary data (for example, a series of 4 byte integers).
Since we know that our SBET file will contain a series of 17 doubles
(8 bytes each) in a row, let's try out a sample file that contains the
numbers 0 through 16,

#+BEGIN_SRC sh
wget http://vislab-ccom.unh.edu/~schwehr/Classes/2011/esci895-researchtools/exam→

od -t fD s1.bin
--:---  21-python-binary-files.org   21% L90     [#] (Org)----------------------
menu-bar edit copy
```

backup

video

snippets

Deskt

researchtool... [Update Ma... [Index of /~s... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 11:25 AM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
0000160   c   B   {   X   t   T nak   ?   m   ; etx   4   /   2  gs   ?
0000200  si   { etb   D   ]   a   {   ?   n  ff  em etx eot   r dc4   A
0000220 dc3 nak   &   c   e   a   p   ?   r   m dc3 stx   1   z eot   @
researchtools@ubuntu:~/class/21$ less sample.sbet
"sample.sbet" may be a binary file.  See it anyway?
researchtools@ubuntu:~/class/21$ wget http://vislab-ccom.unh.edu/~schwehr/Classe
s/2011/esci895-researchtools/examples/21/s1.bin
--2011-11-10 11:24:40--  http://vislab-ccom.unh.edu/~schwehr/Classes/2011/esci89
5-researchtools/examples/21/s1.bin
Resolving vislab-ccom.unh.edu... 192.168.3.3
Connecting to vislab-ccom.unh.edu|192.168.3.3|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 136 [application/octet-stream]
Saving to: `s1.bin'

100%[======================================>] 136         --.-K/s   in 0s

2011-11-10 11:24:40 (11.3 MB/s) - `s1.bin' saved [136/136]

researchtools@ubuntu:~/class/21$ file s1.bin
s1.bin: data
researchtools@ubuntu:~/class/21$ ls -l s1.bin
-rw-r--r-- 1 researchtools researchtools 136 2011-11-10 10:09 s1.bin
researchtools@ubuntu:~/class/21$ od -t fD s1
```

```
# H soh   # nak   ### ####?
  ### ##  ##dle   #   )   @
  #  90  83   |   ####### ?
  u   # etx bel  88   e   #
  ### #   2   8  90   #   #
# R   ### $   #   e   ### #
  <   w   u  83   #####   ?
  #  83   4   /   #  9d   ?
#ff  99 etx  84   r dc4   A
#####c3 stx   #   z eot   ##
```

```
ry to treat the file as
 4 byte integers).
 a series of 17 doubles
le file that contains the
```

```
#+BEGIN_SRC sh
wget http://vislab-ccom.unh.edu/~schwehr/Classes/2011/esci895-researchtools/exam
od -t fD s1.bin
#+END_SRC

#+BEGIN_EXAMPLE
0000000     0.000000000000000e+00    1.000000000000000e+00
0000020     2.000000000000000e+00    3.000000000000000e+00
0000040     4.000000000000000e+00    5.000000000000000e+00
0000060     6.000000000000000e+00    7.000000000000000e+00
0000100     8.000000000000000e+00    9.000000000000000e+00
--:---  21-python-binary-files.org   22% L114    [#] (Org)----------------------
menu-bar edit copy
```

backup

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snippets

Deskt

researchtool... [Update Ma... [Index of /~s... [researchto... [Lecture 21: ... emacs23@u...

Thursday, November 10, 11

Applications Places System 11:26 AM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
researchtools@ubuntu:~/class/21$ ls -l s1.bin
-rw-r--r-- 1 researchtools researchtools 136 2011-11-10 10:09 s1.bin
researchtools@ubuntu:~/class/21$ od -t fD s1.bin
0000000   0.000000000000000e+00   1.000000000000000e+00
0000020   2.000000000000000e+00   3.000000000000000e+00
0000040   4.000000000000000e+00   5.000000000000000e+00
0000060   6.000000000000000e+00   7.000000000000000e+00
0000100   8.000000000000000e+00   9.000000000000000e+00
0000120   1.000000000000000e+01   1.100000000000000e+01
0000140   1.200000000000000e+01   1.300000000000000e+01
0000160   1.400000000000000e+01   1.500000000000000e+01
0000200   1.600000000000000e+01
0000210
researchtools@ubuntu:~/class/21$ ipython
Python 2.7.1+ (r271:86832, Apr 11 2011, 18:05:24)
Type "copyright", "credits" or "license" for more information.

IPython 0.10.1 -- An enhanced Interactive Python.
?         -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help      -> Python's own help system.
object?   -> Details about 'object'. ?object also works, ?? prints more.

In [1]: logstart -o -r log-cass-21.py
```

```
000000000e+00
000000000e+00
000000000e+00
000000000e+00
000000000e+00
000000000e+01
000000000e+01
000000000e+01
```

backup

video

snippets

Deskt

```
#+BEGIN_SRC python
logstart -o -r log-class-21.py

import struct
import numpy
#+END_SRC

http://docs.python.org/library/struct.html#format-characters

Run this section to create some sample files:

#+BEGIN_SRC python
--:---  21-python-binary-files.org   30% L134    [#] (Org)----------------------------
```

researchtool... [Update Ma... [Index of /~s... [researchto... [Lecture 21: ... emacs23@u...

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal H

```
In [1]: logstart -o -r log-cass-21
Activating auto-logging. Current s
Filename       : log-cass-21.py
Mode           : backup
Output logging : True
Raw input log  : True
Timestamping   : False
State          : active

In [2]: !head log-cass-21.py
#log# Automatic Logger file. *** T
#log# DO NOT CHANGE THIS LINE OR T
#log# opts = Struct({'__allownew':
#log# args = []
#log# It is safe to make manual ed
#log#-----------------------------
!head log-cass-21.py

In [3]: import struct

In [4]: import numpy

In [5]:
```

emacs23@ubuntu

File Edit Options Buffers Tools Org Tbl Help

```
#+BEGIN_EXAMPLE
0000000     0.000000000000000e+00    1.000000000000000e+00
0000020     2.000000000000000e+00    3.000000000000000e+00
0000040     4.000000000000000e+00    5.000000000000000e+00
0000060     6.000000000000000e+00    7.000000000000000e+00
0000100     8.000000000000000e+00    9.000000000000000e+00
0000120     1.000000000000000e+01    1.100000000000000e+01
0000140     1.200000000000000e+01    1.300000000000000e+01
0000160     1.400000000000000e+01    1.500000000000000e+01
0000200     1.600000000000000e+01
0000210
#+END_EXAMPLE

* Reading binary data in python

#+BEGIN_SRC sh
ipython
#+END_SRC

Setup:

#+BEGIN_SRC python
logstart -o -r log-class-21.py

import struct
import numpy
#+END_SRC

http://docs.python.org/library/struct.html#format-characters

Run this section to create some sample files:

#+BEGIN_SRC python
```

--:--- 21-python-binary-files.org   30% L145   [#] (Org)----------

researchtool... [Update Ma... [Index of /~s... [researchto... [Lecture 21: ... emacs23@u...

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7.3. struct — Interpret strings as packed binary data — Python v2.7.2 documentation - Mozilla Firefox

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docs.python.org/library/struct.html#format-characters

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7.3.2.2. Format Characters

Format characters have the following meaning; the conversion between C and Python values should be obvious given their types. The 'Standard size' column refers to the size of the packed value in bytes when using standard size; that is, when the format string starts with one of `'<'`, `'>'`, `'!'` or `'='`. When using native size, the size of the packed value is platform-dependent.

Format	C Type	Python type	Standard size	Notes
x	pad byte	no value		
c	**char**	string of length 1	1	
b	**signed char**	integer	1	(3)
B	**unsigned char**	integer	1	(3)
?	**_Bool**	bool	1	(1)
h	**short**	integer	2	(3)

video backup snippets Deskt

```
import struct
import numpy
#+END_SRC

http://docs.python.org/library/struct.html#format-characters

Run this section to create some sample files:

#+BEGIN_SRC python
--:---  21-python-binary-files.org   30% L146    [#] (Org)----------
```

researchtool... [Update Ma... 7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

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```
In [5]: import struct

In [6]: open('c-65.bin','w').write(struct.pack('c','z'))

In [7]: open('b-120.bin','w').write(struct.pack('b',120 ))

In [8]: open('B-121.bin','w').write(struct.pack('B',121 ))

In [9]: open('B-series.bin','w').write(struct.pack('10B',*range(115,125) ))

In [10]: open('i-nine.bin','w').write(struct.pack('i',9))

In [11]: open('d-pi.bin','w').write(struct.pack('d',math.pi))
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)

/home/researchtools/class/21/<ipython console> in <module>()

NameError: name 'math' is not defined

In [12]: open('d-1.bin','w').write(struct.pack('d',1.0))

In [13]: open('d-series.bin','w').write(struct.pack('10d',*range(10)))
```

characters

range(115,125)))

))

range(10)))

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Open B-series.bin in emacs. Try this emacs command:

M-x hexl-mode

Open another terminal and run this:

#+BEGIN_SRC sh

--:--- 21-python-binary-files.org   35% L162   [#] (Org)----------

menu-bar edit copy

researchtool... [Update Ma... 7.3. struct —... [researchto... [Lecture 21: ... emacs23@u...

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```
NameError                                 Traceback (most recent call last)

/home/researchtools/class/21/<ipython console> in <module>()

NameError: name 'math' is not defined

In [12]: open('d-1.bin','w').write(struct.pack('d',1.0))

In [13]: open('d-series.bin','w').write(struct.pack('10d',*range(10)))

In [14]:

In [15]: !file *.bin
B-121.bin:    very short file (no magic)
B-series.bin: ASCII text, with no line terminators
b-120.bin:    very short file (no magic)
c-65.bin:     very short file (no magic)
d-1.bin:      data
d-pi.bin:     empty
d-series.bin: data
i-nine.bin:   data
s1.bin:       data

In [16]:
```

emacs23@ubuntu

File Edit Options Buffers Tools Org Tbl Help

characters

range(115,125)))

))

range(10)))

Open B-series.bin in emacs. Try this emacs command:

M-x hexl-mode

Open another terminal and run this:

#+BEGIN_SRC sh

--:--- 21-python-binary-files.org   35% L162   [#] (Org)----------

menu-bar edit copy

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researchtool... [Update Ma... 7.3. struct —... [researchto... [Lecture 21: ... emacs23@u...

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7.3. struct — Interpret strings as packed binary data — Python v2.7.2 documentation — Mozilla Firefox

File Edit View History Bookmarks Tools

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Most Visite

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
c-65.bin:     very short file (no magic)
d-1.bin:      data
d-pi.bin:     empty
d-series.bin: data
i-nine.bin:   data
s1.bin:       data

In [16]: ls -l
total 76
-rw-r--r-- 1 researchtools researchtools 14185 2011-11-10 10:46 21-python-binary
-files.org
-rw-r--r-- 1 researchtools researchtools     1 2011-11-10 11:31 b-120.bin
-rw-r--r-- 1 researchtools researchtools     1 2011-11-10 11:31 B-121.bin
-rw-r--r-- 1 researchtools researchtools    10 2011-11-10 11:31 B-series.bin
-rw-r--r-- 1 researchtools researchtools     1 2011-11-10 11:31 c-65.bin
-rw-r--r-- 1 researchtools researchtools     8 2011-11-10 11:31 d-1.bin
-rw-r--r-- 1 researchtools researchtools     0 2011-11-10 11:31 d-pi.bin
-rw-r--r-- 1 researchtools researchtools    80 2011-11-10 11:31 d-series.bin
-rw-r--r-- 1 researchtools researchtools     4 2011-11-10 11:31 i-nine.bin
-rw-r--r-- 1 researchtools researchtools   837 2011-11-10 11:32 log-cass-21.py
-rw-r--r-- 1 researchtools researchtools   136 2011-11-10 10:09 s1.bin
-rw-r--r-- 1 researchtools researchtools 22712 2011-11-10 11:20 sample.sbet

In [17]:
```

emacs23@ubuntu

File Edit Options Buffers Tools Org Tbl Help

characters

range(115,125)))

range(10)))

Open B-series.bin in emacs. Try this emacs command:

M-x hexl-mode

Open another terminal and run this:

#+BEGIN_SRC sh

--:--- 21-python-binary-files.org   35% L157   [#] (Org)----------

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7.3. struct — Interpret strings as packed binary data — Python v2.7.2 documentation — Mozilla Firefox

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File Edit View Search Term

```
c-65.bin:      very short file
d-1.bin:       data
d-pi.bin:      empty
d-series.bin:  data
i-nine.bin:    data
s1.bin:        data

In [16]: ls -l
total 76
-rw-r--r-- 1 researchtools re
-files.org
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re

In [17]:
```

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File Edit Options Buffers Tools Operate Mark Regexp Immediate Subdir Help

```
  /home/researchtools/class/21:
  total used in directory 84 available 10818672
  drwxr-xr-x  2 researchtools researchtools  4096 2011-11-10 11:31 .
  drwxr-xr-x 18 researchtools researchtools  4096 2011-11-10 11:04 ..
  -rw-r--r--  1 researchtools researchtools 14185 2011-11-10 10:46 21-python-bin
ary-files.org
  -rw-r--r--  1 researchtools researchtools     1 2011-11-10 11:31 b-120.bin
  -rw-r--r--  1 researchtools researchtools     1 2011-11-10 11:31 B-121.bin
  -rw-r--r--  1 researchtools researchtools    10 2011-11-10 11:31 B-series.bin
  -rw-r--r--  1 researchtools researchtools     1 2011-11-10 11:31 c-65.bin
  -rw-r--r--  1 researchtools researchtools     8 2011-11-10 11:31 d-1.bin
  -rw-r--r--  1 researchtools researchtools     0 2011-11-10 11:31 d-pi.bin
  -rw-r--r--  1 researchtools researchtools    80 2011-11-10 11:31 d-series.bin
  -rw-r--r--  1 researchtools researchtools     4 2011-11-10 11:31 i-nine.bin
  -rw-r--r--  1 researchtools researchtools   837 2011-11-10 11:32 log-cass-21.p
y
  -rw-r--r--  1 researchtools researchtools   136 2011-11-10 10:09 s1.bin
  -rw-r--r--  1 researchtools researchtools 22712 2011-11-10 11:20 sample.sbet
```

-U:%%- 21 All L7 [#] (Dired by name)----------

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researchtool... [Update Ma... 7.3. struct —... [researchto... [Lecture 21: ... emacs23@u...

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File Edit View Search Term

```
c-65.bin:      very short file
d-1.bin:       data
d-pi.bin:      empty
d-series.bin:  data
i-nine.bin:    data
s1.bin:        data

In [16]: ls -l
total 76
-rw-r--r-- 1 researchtools re
-files.org
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re

In [17]:
```

emacs23@ubuntu

File Edit Options Buffers Tools Minibuf Help

```
stuvwxyz{|
```

```
-U:---  B-series.bin    All L1      [#] (Fundamental)----------
M-x hexl-mode
```

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researchtool... [Update Ma... 7.3. struct —... [researchto... [Lecture 21: ... emacs23@u...

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File Edit View Search Term

```
c-65.bin:      very short file
d-1.bin:       data
d-pi.bin:      empty
d-series.bin:  data
i-nine.bin:    data
s1.bin:        data

In [16]: ls -l
total 76
-rw-r--r-- 1 researchtools re
-files.org
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re

In [17]:
```

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snippets

Deskt

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File Edit Options Buffers Tools Minibuf Help

```
 87654321  0011 2233 4455 6677 8899 aabb ccdd eeff  0123456789abcdef
00000000: 7374 7576 7778 797a 7b7c                    stuvwxyz{|
```

-U:--- **B-series.bin** All L1 [#] (Hexl)----------


```
 87654321  0011 2233 4455 6677 8899 aabb ccdd eeff  0123456789abcdef
00000000: 7374 7576 7778 797a 7b7c                    stuvwxyz{|
```

-U:--- **B-series.bin** All L1 [#] (Hexl)----------

M-x man

researchtool... [Update Ma... 7.3. struct —... [researchto... [Lecture 21: ... emacs23@u...

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7.3. struct — Interpret strings as packed binary data — Python v2.7.2 documentation — Mozilla Firefox

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File Edit View Search Term

```
c-65.bin:      very short file
d-1.bin:       data
d-pi.bin:      empty
d-series.bin:  data
i-nine.bin:    data
s1.bin:        data

In [16]: ls -l
total 76
-rw-r--r-- 1 researchtools re
-files.org
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re

In [17]:
```

backup

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snippets

Deskt

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File Edit Options Buffers Tools Help

```
 87654321  0011 2233 4455 6677 8899 aabb ccdd eeff  0123456789abcdef
00000000: 7374 7576 7778 797a 7b7c                    stuvwxyz{|
```

-U:--- **B-series.bin** All L1 [#] (Hexl)----------

```
ASCII(7)                  Linux Programmer's Manual                 ASCII(7)

NAME
       ascii - the ASCII character set encoded in octal, decimal, and hexadec-
       imal

DESCRIPTION
       ASCII is the American Standard Code for Information Interchange.  It is
       a  7-bit code.  Many 8-bit codes (such as ISO 8859-1, the Linux default
       character set) contain ASCII as their lower  half.   The  international
       counterpart of ASCII is known as ISO 646.

       The following table contains the 128 ASCII characters.

       C program '\X' escapes are noted.
```

-U:%%- ***Man ascii*** {ASCII(7) page 1 of 1} Top L12 [#] (Man)----------

researchtool... [Update Ma... 7.3. struct —... [researchto... [Lecture 21: ... emacs23@u...

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Applications Places System 11:38 AM researchtools

7.3. struct — Interpret strings as packed binary data — Python v2.7.2 documentation — Mozilla Firefox

File Edit View History Bookmarks Tools

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File Edit View Search Term

```
c-65.bin:      very short file
d-1.bin:       data
d-pi.bin:      empty
d-series.bin:  data
i-nine.bin:    data
s1.bin:        data

In [16]: ls -l
total 76
-rw-r--r-- 1 researchtools re
-files.org
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re
-rw-r--r-- 1 researchtools re

In [17]:
```

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File Edit Options Buffers Tools Help

```
 87654321  0011 2233 4455 6677 8899 aabb ccdd eeff  0123456789abcdef
00000000: 7374 7576 7778 797a 7b7c                    stuvwxyz{|
```

-U:--- **B-series.bin** All L1 [#] (Hexl)----------

C program '\X' escapes are noted.

Oct	Dec	Hex	Char	Oct	Dec	Hex	Char
000	0	00	NUL '\0'	100	64	40	@
001	1	01	SOH (start of heading)	101	65	41	A
002	2	02	STX (start of text)	102	66	42	B
057	47	2F	/	157	111	6F	o
060	48	30	0	160	112	70	p
061	49	31	1	161	113	71	q
062	50	32	2	162	114	72	r
063	51	33	3	163	115	73	s
064	52	34	4	164	116	74	t
065	53	35	5	165	117	75	u
066	54	36	6	166	118	76	v

-U:%%- ***Man ascii*** {ASCII(7) page 1 of 1} 8% L17 [#] (Man Isearch)---------

-U:%%- ***Man ascii*** {ASCII(7) page 1 of 1} 55% L71 [#] (Man Isearch)---------

I-search: 73

researchtool... [Update Ma... 7.3. struct —... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 11:44 AM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
-rw-r--r-- 1 researchtools researchtools     4 2011-11-10 11:31 i-nine.bin
-rw-r--r-- 1 researchtools researchtools   837 2011-11-10 11:32 log-cass-21.py
-rw-r--r-- 1 researchtools researchtools   136 2011-11-10 10:09 s1.bin
-rw-r--r-- 1 researchtools researchtools 22712 2011-11-10 11:20 sample.sbet

In [17]: sbet_file = open('sample.sbet')

In [18]: sbet_data = sbet_file.read()

In [19]: whos
Variable    Type      Data/Info
-----------------------------
numpy       module    <module 'numpy' from '/us<...>n2.7/numpy/__init__.pyc'>
sbet_data   str       ...
sbet_file   file      <open file 'sample.sbet', mode 'r' at 0x93c8548>
struct      module    <module 'struct' from '/u<...>ib/python2.7/struct.pyc'>

In [20]: type (sbet_data)
Out[20]: <type 'str'>

In [21]: len(sbet_data)
Out[21]: 22712

In [22]: struct.unpack
```

Help

a file, but in our case, we want
e.

```
#+END_SRC

#+BEGIN_SRC python
struct.unpack('d',sbet_data[0:8])
# (334959.0048233234,)

struct.unpack('d',sbet_data[0:8])[0]
# 334959.0048233234
#+END_SRC

#+BEGIN_SRC python
struct.unpack('dd',sbet_data[8:24])
```

--:--- 21-python-binary-files.org 41% L198 [#] (Org)----------

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researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 11:45 AM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
Out[21]: 22712

In [22]: struct.unpack?
Type:           builtin_function_or_method
Base Class:     <type 'builtin_function_or_method'>
String Form:    <built-in function unpack>
Namespace:      Interactive
Docstring:
    Unpack the string containing packed C structure data, according to fmt.
    Requires len(string) == calcsize(fmt).


In [23]: struct.unpack('d', sbe
sbet_data  sbet_file

In [23]: struct.unpack('d', sbet_data)
---------------------------------------------------------------------------
error                                     Traceback (most recent call last)

/home/researchtools/class/21/<ipython console> in <module>()

error: unpack requires a string argument of length 8

In [24]: struct.unpack('d', sbet_data[:8)
```

l Help

a file, but in our case, we want
le.

```
#+END_SRC

#+BEGIN_SRC python
struct.unpack('d',sbet_data[0:8])
# (334959.0048233234,)

struct.unpack('d',sbet_data[0:8])[0]
# 334959.0048233234
#+END_SRC

#+BEGIN_SRC python
struct.unpack('dd',sbet_data[8:24])
```

--:--- 21-python-binary-files.org   41% L198   [#] (Org)----------

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researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 11:47 AM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
In [24]: struct.unpack('d', sbet_data[:8])
Out[24]: (334959.0048233234,)

In [25]: !

In [26]: ls
21-python-binary-files.org  B-series.bin  d-pi.bin      log-cass-21.py
b-120.bin                   c-65.bin      d-series.bin  s1.bin
B-121.bin                   d-1.bin       i-nine.bin    sample.sbet

In [27]: data_file = open('d-series.bin')

In [28]: data = data_file.read()

In [29]: len(data)
Out[29]: 80

In [30]: struct.unpack('d',data[:8])
Out[30]: (0.0,)

In [31]: struct.unpack('dd',data[:8*2])
Out[31]: (0.0, 1.0)

In [32]: struct.unpack('ddddddddddd',data[:8*2])
```

Help

```
#+BEGIN_SRC python
struct.unpack('2d',sbet_data[8:24])
(1.0549522638507869, -2.559965741819528)
#+END_SRC

#+BEGIN_SRC python
struct.unpack('17d',sbet_data[0:8*17])
Out[38]:
(334959.0048233234,
 1.0549522638507869,
 -2.559965741819528,
 12.826300557342815,
```

--:--- 21-python-binary-files.org 43% L190 [#] (Org)----------

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researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 11:51 AM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
In [36]: struct.unpack('17d',sbet_data[:17*8])
Out[36]:
(334959.0048233234,
 1.0549522638507869,
 -2.559965741819528,
 12.826300557342815,
 10.437825046453915,
 0.998228318178983,
 0.18282804536664027,
 -0.0026283394812042344,
 0.11416603057936824,
 -0.09985686530029529,
 -0.40154673926674145,
 -0.8249097558096672,
 -0.3413483211034812,
 0.07018300645653144,
 0.021320176833628756,
 0.029000032024608147,
 -0.006807197876212325)

In [37]: x,y = -1, 999
```

Help

```
#+BEGIN_SRC python
time, latitude, longitude, altitude, \
    x_vel, y_vel, z_vel, \
    roll, pitch, platform_heading, wander_angle, \
    x_acceleration, y_acceleration, z_acceleration, \
    x_angular_rate, y_angular_rate, z_angular = struct.unpack('ddddddddddddddddd
#+END_SRC

#+BEGIN_SRC python
field_names = ('time', 'latitude', 'longitude', 'altitude', \
          'x_vel', 'y_vel', 'z_vel', \
          'roll', 'pitch', 'platform_heading', 'wander_angle', \
          'x_acceleration', 'y_acceleration', 'z_acceleration', \
          'x_angular_rate', 'y_angular_rate', 'z_angular')
```

--:--- 21-python-binary-files.org 46% L238 [#] (Org)----------

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researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 11:52 AM researchtools

researchtools@ubuntu: ~/class/21

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```
 -0.8249097558096672,
 -0.3413483211034812,
 0.070183006456531 44,
 0.0213201768336287 56,
 0.0290000320246081 47,
 -0.0068071978762123 25)

In [37]: x,y = -1, 999

In [38]: whos
Variable    Type      Data/Info
-----------------------------
data        str       ?@<...>@ @"@
data_file   file      <open file 'd-series.bin', mode 'r' at 0x93c8910>
numpy       module    <module 'numpy' from '/us<...>n2.7/numpy/__init__.pyc'>
sbet_data   str       g qA H ?G Q z n<...>?  r b Q '
sbet_file   file      <open file 'sample.sbet', mode 'r' at 0x93c8548>
struct      module    <module 'struct' from '/u<...>ib/python2.7/struct.pyc'>
x           int       -1
y           int       999

In [39]:
```

l Help

```
#+BEGIN_SRC python
time, latitude, longitude, altitude, \
    x_vel, y_vel, z_vel, \
    roll, pitch, platform_heading, wander_angle, \
    x_acceleration, y_acceleration, z_acceleration, \
    x_angular_rate, y_angular_rate, z_angular = struct.unpack('ddddddddddddddddd
#+END_SRC

#+BEGIN_SRC python
field_names = ('time', 'latitude', 'longitude', 'altitude', \
               'x_vel', 'y_vel', 'z_vel', \
               'roll', 'pitch', 'platform_heading', 'wander_angle', \
               'x_acceleration', 'y_acceleration', 'z_acceleration', \
               'x_angular_rate', 'y_angular_rate', 'z_angular')
```

--:--- 21-python-binary-files.org 46% L238 [#] (Org)----------

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snippets

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researchtools@ubuntu: ~/class/21

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```
error: unpack requires a string argument of length 136

In [40]: time, latitude, longitude, altitude, \
    ....:     x_vel, y_vel, z_vel, \
    ....:     roll, pitch, platform_heading, wander_angle, \
    ....:     x_acceleration, y_acceleration, z_acceleration, \
    ....:     x_angular_rate, y_angular_rate, z_angular = struct.unpack('ddddddddd
ddddddddd',data[0:17*8])
---------------------------------------------------------------------------
error                                     Traceback (most recent call last)

/home/researchtools/class/21/<ipython console> in <module>()

error: unpack requires a string argument of length 136

In [41]: time, lat, long, alt, x_vel, y_vel, z_vel, roll, pitch, heading, wander
, x_accel, y_accel, z_accel, x_ang, y_ang, z_ang = struct.unpack('17d',sbet_data
[:17*8])

In [42]: del data

In [43]:
```

Help

```
, \

wander_angle, \
 z_acceleration, \
 z_angular = struct.unpack('ddddddddddddddddd',data[0:17*8])


'longitude', 'altitude', \
, \
m_heading', 'wander_angle', \
leration', 'z_acceleration', \
lar_rate', 'z_angular')
```

--:--- 21-python-binary-files.org 46% L241 [#] (Org)----------

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video snippets backup Deskt

researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
In [41]: time, lat, long, alt, x_vel, y_v
, x_accel, y_accel, z_accel, x_ang, y_ang
[:17*8])

In [42]: del data

In [43]: whos
Variable    Type      Data/Info
-----------------------------
alt         float     12.8263005573
data_file   file      <open file 'd-serie
heading     float     -0.0998568653003
lat         float     1.05495226385
long        float     -2.55996574182
numpy       module    <module 'numpy' fro
pitch       float     0.114166030579
roll        float     -0.0026283394812
sbet_data   str       ??g??q?A?H???G??
sbet_file   file      <open file 'sample.
struct      module    <module 'struct' fr
time        float     334959.004823
wander      float     -0.401546739267
x           int       -1
x_accel     float     -0.82490975581
x_ang       float     0.0213201768336
x_vel       float     10.4378250465
y           int       999
y_accel     float     -0.341348321103
y_ang       float     0.0290000320246
y_vel       float     0.998228318179
z_accel     float     0.0701830064565
z_ang       float     -0.00680719787621
z_vel       float     0.182828045367

In [44]:
```

snippets

emacs23@ubuntu

File Edit Options Buffers Tools Org Tbl Help

```
 1.0549522638507869,
 -2.559965741819528,
 12.826300557342815,
 10.437825046453915,
 0.998228318178983,
 0.18282804536664027,
 -0.0026283394812042344,
 0.11416603057936824,
 -0.09985686530029529,
 -0.40154673926674145,
 -0.8249097558096672,
 -0.3413483211034812,
 0.07018300645653144,
 0.021320176833628756,
 0.029000032024608147,
 -0.006807197876212325)
#+END_SRC


#+BEGIN_SRC python
time, latitude, longitude, altitude, \
    x_vel, y_vel, z_vel, \
    roll, pitch, platform_heading, wander_angle, \
    x_acceleration, y_acceleration, z_acceleration, \
    x_angular_rate, y_angular_rate, z_angular = struct.unpack('ddddddddddddddddd
#+END_SRC

#+BEGIN_SRC python
field_names = ('time', 'latitude', 'longitude', 'altitude', \
          'x_vel', 'y_vel', 'z_vel', \
          'roll', 'pitch', 'platform_heading', 'wander_angle', \
          'x_acceleration', 'y_acceleration', 'z_acceleration', \
          'x_angular_rate', 'y_angular_rate', 'z_angular')
```

--:--- 21-python-binary-files.org 46% L244 [#] (Org)----------

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
x_vel       float     10.4378250465
y           int       999
y_accel     float     -0.341348321103
y_ang       float     0.0290000320246
y_vel       float     0.998228318179
z_accel     float     0.0701830064565
z_ang       float     -0.00680719787621
z_vel       float     0.182828045367

In [44]: zip?
Type:            builtin_function_or_method
Base Class:      <type 'builtin_function_or_method'>
String Form:     <built-in function zip>
Namespace:       Python builtin
Docstring:
    zip(seq1 [, seq2 [...]]) -> [(seq1[0], seq2[0] ...), (...)]

    Return a list of tuples, where each tuple contains the i-th element
    from each of the argument sequences.  The returned list is truncated
    in length to the length of the shortest argument sequence.


In [45]: zip( ['x','y'], [1,2])
Out[45]: [('x', 1), ('y', 2)]

In [46]: dict(  zip( ['x','y'], [1,2]) )
Out[46]: {'x': 1, 'y': 2}

In [47]: field_names = ('time', 'latitude', 'longitude', 'altitude', \
    ....:               'x_vel', 'y_vel', 'z_vel', \
    ....:               'roll', 'pitch', 'platform_heading', 'wander_angle', \
    ....:               'x_acceleration', 'y_acceleration', 'z_acceleration', \
    ....:               'x_angular_rate', 'y_angular_rate', 'z_angular')

In [48]:
```

l Help

```
nder_angle, \
_acceleration, \
_angular = struct.unpack('ddddddddddddddddd
ngitude', 'altitude', \
heading', 'wander_angle', \
ration', 'z_acceleration', \
r_rate', 'z_angular')
a[0:8*17])
```

snippets

--:--- 21-python-binary-files.org 49% L249 [#] (Org)----------

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researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 11:59 AM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
In [45]: zip( ['x','y'], [1,2])
Out[45]: [('x', 1), ('y', 2)]

In [46]: dict(  zip( ['x','y'], [1,2]) )
Out[46]: {'x': 1, 'y': 2}

In [47]: field_names = ('time', 'latitude', 'longitude', 'altitude', \
   ....:               'x_vel', 'y_vel', 'z_vel', \
   ....:               'roll', 'pitch', 'platform_heading', 'wander_angle', \
   ....:               'x_acceleration', 'y_acceleration', 'z_acceleration', \
   ....:               'x_angular_rate', 'y_angular_rate', 'z_angular')

In [48]: field_names
Out[48]:
('time',
 'latitude',
 'longitude',
 'altitude',
 'x_vel',
 'y_vel',
 'z_vel',
 'roll',
 'pitch',
 'platform_heading',
 'wander_angle',
 'x_acceleration',
 'y_acceleration',
 'z_acceleration',
 'x_angular_rate',
 'y_angular_rate',
 'z_angular')

In [49]: values = struct.unpack('17d',sbet_data[:8*17])

In [50]:
```

l Help

```
nder_angle, \
_acceleration, \
_angular = struct.unpack('ddddddddddddddddd
ongitude', 'altitude', \
heading', 'wander_angle', \
ration', 'z_acceleration', \
_rate', 'z_angular')
a[0:8*17])
```

snippets

--:--- 21-python-binary-files.org 49% L257 [#] (Org)----------

researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 11:59 AM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
 'z_vel',
 'roll',
 'pitch',
 'platform_heading',
 'wander_angle',
 'x_acceleration',
 'y_acceleration',
 'z_acceleration',
 'x_angular_rate',
 'y_angular_rate',
 'z_angular')

In [49]: values = struct.unpack('17d',sbet_data[:8*17])

In [50]: values
Out[50]:
(334959.0048233234,
 1.0549522638507869,
 -2.559965741819528,
 12.826300557342815,
 10.437825046453915,
 0.998228318178983,
 0.18282804536664027,
 -0.0026283394812042344,
 0.114166603057936824,
 -0.099856866530029529,
 -0.40154673926674145,
 -0.8249097558096672,
 -0.3413483211034812,
 0.070183006456531144,
 0.021320176833628756,
 0.029000032024608147,
 -0.006807197876212325)

In [51]: dict( zip(field_names,) )
```

Help

```
nder_angle, \
_acceleration, \
_angular = struct.unpack('ddddddddddddddddd

ongitude', 'altitude', \

heading', 'wander_angle', \
ration', 'z_acceleration', \
r_rate', 'z_angular')

a[0:8*17])
```

snippets

--:--- 21-python-binary-files.org 49% L257 [#] (Org)----------

researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
 -0.8249097558096672,
 -0.3413483211034812,
 0.070183006456531 44,
 0.0213201768336287 56,
 0.0290000320246081 47,
 -0.0068071978762123 25)

In [51]: dict( zip(field_names, values) )
Out[51]:
{'altitude': 12.826300557342815,
 'latitude': 1.0549522638507869,
 'longitude': -2.559965741819528,
 'pitch': 0.114166030579368 24,
 'platform_heading': -0.099856865300295 29,
 'roll': -0.0026283394812042344,
 'time': 334959.0048233234,
 'wander_angle': -0.401546739266741 45,
 'x_acceleration': -0.8249097558096672,
 'x_angular_rate': 0.0213201768336287 56,
 'x_vel': 10.437825046453915,
 'y_acceleration': -0.3413483211034812,
 'y_angular_rate': 0.0290000320246081 47,
 'y_vel': 0.998228318178983,
 'z_acceleration': 0.070183006456531 44,
 'z_angular': -0.0068071978762123 25,
 'z_vel': 0.182828045366640 27}

In [52]: dict( zip(field_names[:4], values[:4]) )
Out[52]:
{'altitude': 12.826300557342815,
 'latitude': 1.0549522638507869,
 'longitude': -2.559965741819528,
 'time': 334959.0048233234}

In [53]:
```

```
l Help

nder_angle, \
_acceleration, \
_angular = struct.unpack('ddddddddddddddddd

ngitude', 'altitude', \

heading', 'wander_angle', \
ration', 'z_acceleration', \
_rate', 'z_angular')

a[0:8*17])
```

snippets

--:--- 21-python-binary-files.org 49% L263 [#] (Org)----------

researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

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researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
 'latitude': 1.05495226385078 69,
 'longitude': -2.559965741819528,
 'pitch': 0.114166030579368 24,
 'platform_heading': -0.099856865300295 29,
 'roll': -0.002628339481204 2344,
 'time': 334959.0048233234,
 'wander_angle': -0.401546739266741 45,
 'x_acceleration': -0.8249097558096672,
 'x_angular_rate': 0.021320176833628756,
 'x_vel': 10.437825046453915,
 'y_acceleration': -0.3413483211034812,
 'y_angular_rate': 0.029000032024608147,
 'y_vel': 0.998228318178983,
 'z_acceleration': 0.070183006456531 44,
 'z_angular': -0.006807197876212325,
 'z_vel': 0.182828045366640 27}

In [52]: dict( zip(field_names[:4], values[:4]) )
Out[52]:
{'altitude': 12.826300557342815,
 'latitude': 1.05495226385078 69,
 'longitude': -2.559965741819528,
 'time': 334959.0048233234}

In [53]: sbet_values = dict( zip(field_names, values) )

In [54]: type(sb
sbet_data    sbet_file    sbet_values

In [54]: type(sbet_values)
Out[54]: <type 'dict'>

In [55]: import math

In [56]: math.
```

Help

```
_rate', 'z_angular')

a[0:8*17])

values))

it in a new dictionary key
(sbet_values['latitude'])

ng sbets
```

snippets

#+BEGIN_SRC python

--:--- 21-python-binary-files.org 53% L271 [#] (Org)----------

researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 12:03 PM researchtools

researchtools@ubuntu: ~/class/21

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```
38: _ip.magic("whos ")
39: time, lat, long, alt, x_vel, y_vel, z_vel, roll, pitch, heading, wander, x_a
ccel, y_accel, z_accel, x_ang, y_ang, z_ang = struct.unpack('17d',data[:17*8])
40:
time, latitude, longitude, altitude, \
    x_vel, y_vel, z_vel, \
    roll, pitch, platform_heading, wander_angle, \
    x_acceleration, y_acceleration, z_acceleration, \
    x_angular_rate, y_angular_rate, z_angular = struct.unpack('ddddddddddddddddd
',data[0:17*8])
41: time, lat, long, alt, x_vel, y_vel, z_vel, roll, pitch, heading, wander, x_a
ccel, y_accel, z_accel, x_ang, y_ang, z_ang = struct.unpack('17d',sbet_data[:17*
8])
42: del data
43: _ip.magic("whos ")
44: #?zip
45: zip( ['x','y'], [1,2])
46: dict(  zip( ['x','y'], [1,2]) )
47:
field_names = ('time', 'latitude', 'longitude', 'altitude', \
          'x_vel', 'y_vel', 'z_vel', \
          'roll', 'pitch', 'platform_heading', 'wander_angle', \
          'x_acceleration', 'y_acceleration', 'z_acceleration', \
          'x_angular_rate', 'y_angular_rate', 'z_angular')
48: field_names
49: values = struct.unpack('17d',sbet_data[:8*17])
50: values
51: dict( zip(field_names, values) )
52: dict( zip(field_names[:4], values[:4]) )
53: sbet_values = dict( zip(field_names, values) )
54: type(sbet_values)
55: import math
56: _ip.magic("history ")

In [57]:
```

Help

```
_rate', 'z_angular')

a[0:8*17])

values))

it in a new dictionary key
(sbet_values['latitude'])

ng sbets
```

snippets

#+BEGIN_SRC python

--:--- 21-python-binary-files.org 53% L271 [#] (Org)----------

researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

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```
        'roll', 'pitch', 'platform_heading', 'wander_angle', \
        'x_acceleration', 'y_acceleration', 'z_acceleration', \
        'x_angular_rate', 'y_angular_rate', 'z_angular')
48: field_names
49: values = struct.unpack('17d',sbet_data[:8*17])
50: values
51: dict( zip(field_names, values) )
52: dict( zip(field_names[:4], values[:4]) )
53: sbet_values = dict( zip(field_names, values) )
54: type(sbet_values)
55: import math
56: _ip.magic("history ")

In [57]: math.degrees?
Type:           builtin_function_or_method
Base Class:     <type 'builtin_function_or_method'>
String Form:    <built-in function degrees>
Namespace:      Interactive
Docstring:
    degrees(x)

    Convert angle x from radians to degrees.


In [58]: math.degrees(sbe
sbet_data    sbet_file    sbet_values

In [58]: math.degrees(sbet_values['longitude'])
Out[58]: -146.6752327043359

In [59]: sbet_values['long_deg'] = math.degrees(sbet_values['longitude'])

In [60]: sbet_values['lat_deg'] = math.degrees(sbet_values['latitude'])

In [61]:
```

l Help

r_rate', 'z_angular')

a[0:8*17])

values))

it in a new dictionary key

(sbet_values['latitude'])

ng sbets

snippets

#+BEGIN_SRC python

--:--- 21-python-binary-files.org 53% L271 [#] (Org)----------

researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

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```
In [58]: math.degrees(sbe
sbet_data    sbet_file    sbet_values

In [58]: math.degrees(sbet_values['longitude'])
Out[58]: -146.6752327043359

In [59]: sbet_values['long_deg'] = math.degrees(sbet_values['longitude'])

In [60]: sbet_values['lat_deg'] = math.degrees(sbet_values['latitude'])

In [61]: sbet_values
Out[61]:
{'altitude': 12.826300557342815,
 'lat_deg': 60.444312306421736,
 'latitude': 1.0549522638507869,
 'long_deg': -146.6752327043359,
 'longitude': -2.559965741819528,
 'pitch': 0.114166603057936824,
 'platform_heading': -0.099856866530029529,
 'roll': -0.0026283394812042344,
 'time': 334959.0048233234,
 'wander_angle': -0.40154673926674145,
 'x_acceleration': -0.8249097558096672,
 'x_angular_rate': 0.0213201768336287 56,
 'x_vel': 10.437825046453915,
 'y_acceleration': -0.3413483211034812,
 'y_angular_rate': 0.029000032024608147,
 'y_vel': 0.998228318178983,
 'z_acceleration': 0.07018300645653144,
 'z_angular': -0.0068071978762123 25,
 'z_vel': 0.182828045366640 27}

In [62]:
```

Help

```
_rate', 'z_angular')

a[0:8*17])

values))

it in a new dictionary key
(sbet_values['latitude'])

ng sbets
```

snippets

#+BEGIN_SRC python

--:--- 21-python-binary-files.org 53% L271 [#] (Org)----------

researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
In [58]: math.degrees(sbe
sbet_data    sbet_file    sbet_values

In [58]: math.degrees(sbet_values['longit
Out[58]: -146.6752327043359

In [59]: sbet_values['long_deg'] = math.d

In [60]: sbet_values['lat_deg'] = math.de

In [61]: sbet_values
Out[61]:
{'altitude': 12.826300557342815,
 'lat_deg': 60.444312306421736,
 'latitude': 1.0549522638507869,
 'long_deg': -146.6752327043359,
 'longitude': -2.559965741819528,
 'pitch': 0.11416603057936824,
 'platform_heading': -0.099856866530029529
 'roll': -0.0026283394812042344,
 'time': 334959.0048233234,
 'wander_angle': -0.40154673926674145,
 'x_acceleration': -0.8249097558096672,
 'x_angular_rate': 0.0213201768336287 56,
 'x_vel': 10.437825046453915,
 'y_acceleration': -0.3413483211034812,
 'y_angular_rate': 0.029000032024608147,
 'y_vel': 0.998228318178983,
 'z_acceleration': 0.070183006456531 44,
 'z_angular': -0.0068071978762123 25,
 'z_vel': 0.18282804536664027}

In [62]:
```

snippets

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File Edit Options Buffers Tools IM-Python Python YASnippet Help

```
# Decode Applanix POSPac SBET IMU binary files

def decode():
    print "hello from decode"
```

-U:--- **sbet.py** All L5 [#] (Python yas)----------

```
#+END_SRC

* Creating sbet.py - module for reading sbets

Open sbet.py and add this:

#+BEGIN_SRC python
# Decode Applanix POSPac SBET IMU binary files

def decode():
    print "hello from decode"
#+END_SRC

in ipython:

#+BEGIN_SRC python
```

--:--- **21-python-binary-files.org** 57% L283 [#] (Org)----------

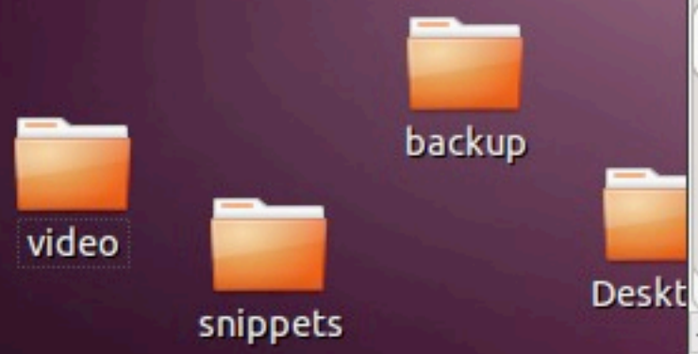
Wrote /home/researchtools/class/21/sbet.py

Applications Places System 12:13 PM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
sbet.__class__          sbet.__init__
sbet.__delattr__        sbet.__name__
sbet.__dict__           sbet.__new__
sbet.__doc__            sbet.__package__
sbet.__file__           sbet.__reduce__
sbet.__format__         sbet.__reduce_ex__
sbet.__getattribute__   sbet.__repr__

In [64]: sbet.decode()
hello from decode

In [65]: import sbet

In [66]: sbet.decode()
hello from decode

In [67]: reload sbet
-------> reload(sbet)
Out[67]: <module 'sbet' from 'sbet.py'>

In [68]: sbet.decode()
hello from decode
42

In [69]:
```



emacs23@ubuntu

File Edit Options Buffers Tools IM-Python Python YASnippet Help

```
# Decode Applanix POSPac SBET IMU binary files

def decode():
    print "hello from decode"
    print 7*6

def main():
    print 'Starting main'
    print 'Finishing ma
```

-U:**- sbet.py All L9 [#] (Python yas)----------

```
    print "hello from decode"
    print 7*6

def main():
    print 'Starting main'
    sbet_file = open('sample.sbet')
    sbet_data = sbet_file.read()
    print 'Finishing main'
#+END_SRC

in python:

#+BEGIN_SRC python
reload(sbet)
# load or reload happening
```

--:--- 21-python-binary-files.org 64% L338 [#] (Org)----------

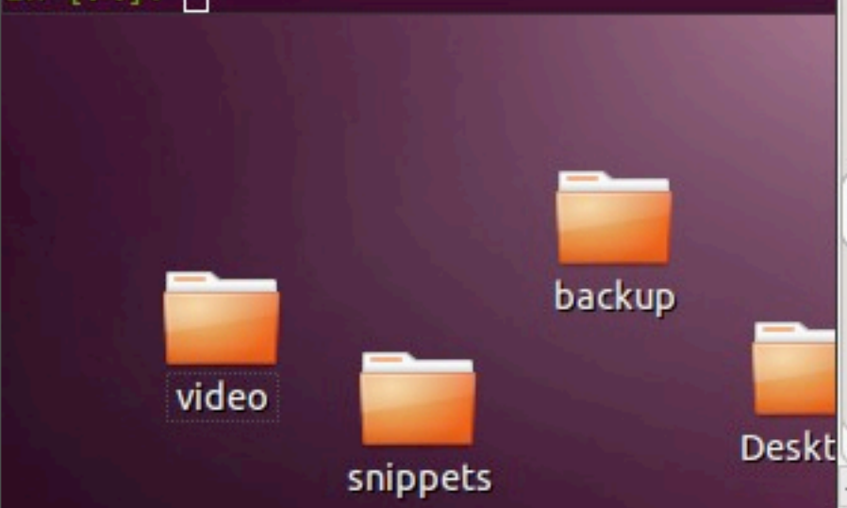
researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...

Applications Places System 12:15 PM researchtools

researchtools@ubuntu: ~/class/21

File Edit View Search Terminal Help

```
TypeError: reload() takes exactly one arg

In [71]: reload
Out[71]: <built-in function reload>

In [72]: reload sbet
-------> reload(sbet)
Out[72]: <module 'sbet' from 'sbet.py'>

In [73]: sbet.
sbet.__builtins__       sbet.__init__
sbet.__class__          sbet.__name__
sbet.__delattr__        sbet.__new__
sbet.__dict__           sbet.__package__
sbet.__doc__            sbet.__reduce__
sbet.__file__           sbet.__reduce_ex__
sbet.__format__         sbet.__repr__
sbet.__getattribute__   sbet.__setattr__
sbet.__hash__           sbet.__sizeof__

In [73]: sbet.main()
Starting main
Finishing main

In [74]:
```



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```
# Decode Applanix POSPac SBET IMU binary files

def decode():
    print "hello from decode"
    print 7*6

def main():
    print 'Starting main'
    sbet_file = open('sample.sbet')
    sbet_data = sbet_file.read()
    print 'Finishing main'
```

-U:--- **sbet.py** All L10 [#] (Python yas)----------

```
# Add data argument to decode
def decode(data):
    'Decipher a SBET datagram from binary'
    print "hello from decode"
    print 'Data length:', len(data)

def main():
    print 'Starting main'
    sbet_file = open('sample.sbet')
    sbet_data = sbet_file.read()
    print 'Read this many bytes:',len(sbet_data)

    decode(sbet_data)  # Pass in the sbet_data variable to decode

    print 'Finishing main'
#+END_SRC
```

--:--- **21-python-binary-files.org** 67% L362 [#] (Org)----------

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```
Starting main
Finishing main

In [74]: reload sbet
-------> reload(sbet)
Out[74]: <module 'sbet' from 'sbet.py'>

In [75]: sbet.main()
Starting main
Read this many bytes: 22712
---------------------------------------
TypeError

/home/researchtools/class/21/<ipython con

/home/researchtools/class/21/sbet.py in m
     12     print 'Read this many bytes:'
     13
---> 14     decode(sbet_data)
     15
     16     print 'Finishing main'

TypeError: decode() takes no arguments (1

In [76]:
```

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File Edit Options Buffers Tools IM-Python Python YASnippet Help

```
# Decode Applanix POSPac SBET IMU binary files

def decode():
    print "hello from decode"
    print 7*6

def main():
    print 'Starting main'
    sbet_file = open('sample.sbet')
    sbet_data = sbet_file.read()

    print 'Read this many bytes:',len(sbet_data)

    decode(sbet_data)

    print 'Finishing main'
```

-U:--- sbet.py All L6 [#] (Python yas)

```
# Add data argument to decode
def decode(data):
    'Decipher a SBET datagram from binary'
    print "hello from decode"
    print 'Data length:', len(data)

def main():
    print 'Starting main'
    sbet_file = open('sample.sbet')
    sbet_data = sbet_file.read()
    print 'Read this many bytes:',len(sbet_data)

    decode(sbet_data)  # Pass in the sbet_data variable to decode

    print 'Finishing main'
#+END_SRC
```

--:--- 21-python-binary-files.org 67% L362 [#] (Org)

Wrote /home/researchtools/class/21/sbet.py

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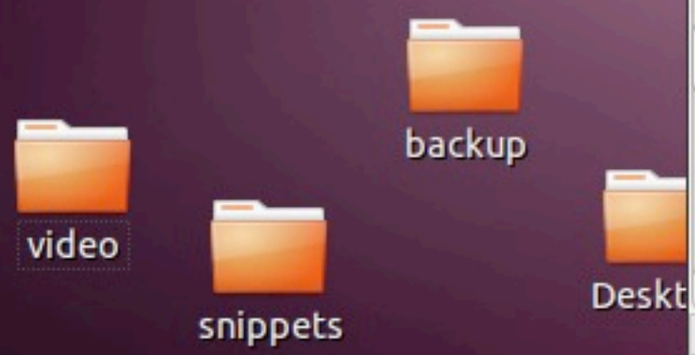
```
/home/researchtools/class/21/<ipython con
/home/researchtools/class/21/sbet.py in m
     12     print 'Read this many bytes:'
     13
---> 14     decode(sbet_data)
     15
     16     print 'Finishing main'

TypeError: decode() takes no arguments (1

In [76]: reload sbet
-------> reload(sbet)
Out[76]: <module 'sbet' from 'sbet.py'>

In [77]: sbet.main()
Starting main
Read this many bytes: 22712
hello from decode
42
Data length: 22712
Finishing main

In [78]:
```



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```
# Decode Applanix POSPac SBET IMU binary files

def decode(data):
    'Decipher a SBET datagram from binary'
    print "hello from decode"
    print 7*6
    print 'Data length:', len(data)

def main():
    print 'Starting main'
    sbet_file = open('sample.sbet')
    sbet_data = sbet_file.read()

    print 'Read this many bytes:',len(sbet_data)

    decode(sbet_data)
-U:---  sbet.py        Top L16     [#] (Python yas)----------
# Add data argument to decode
def decode(data):
    'Decipher a SBET datagram from binary'
    print "hello from decode"
    print 'Data length:', len(data)

def main():
    print 'Starting main'
    sbet_file = open('sample.sbet')
    sbet_data = sbet_file.read()
    print 'Read this many bytes:',len(sbet_data)

    decode(sbet_data)  # Pass in the sbet_data variable to decode

    print 'Finishing main'
#+END_SRC
--:---  21-python-binary-files.org   67% L358    [#] (Org)----------
```

researchtool... [Update Ma... [7.3. struct ... [researchto... [Lecture 21: ... emacs23@u...