STANDFIRE

Release

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1.2.1 Interfacing with FVS

Use Suppose to generate a keyword file. Or use the following example .key

```
NOSCREEN
RANNSEED           0
!STATS
STDIDENT
STANDFIRE_example
DESIGN           -10       500         5         9
STDINFO          103       140      60.0       0.0       0.0      36.0
INVYEAR         2010
NUMCYCLE          10
TREEDATA
FMIN
END
STATS
SVS                0                   0         0        15
FMIn
Potfire
FuelOut
BurnRept
MortRept
FuelRept
SnagSum
End
PROCESS
STOP
```

If don't have a FVS tree list file, then copy and paste the following text and save it to the same directory where the keyword file lives, give it the same prefix as the `.key` but with a `.tre` extension.

```
1    95        9PP 105     35                           0 0
1    96        0PP 43      17         1                 0 0
1    97        0PP 148     43         2                 0 0
1    98        0PP 49      30         1                 0 0
1    99        9PP 54      30                           0 0
1    100       0PP 100     40         3                 0 0
1    101       0PP 42      30         2                 0 0
1    102       0PP 53      34         1                 0 0
1    103       0PP 97      42         3                 0 0
1    104       0PP 61      35         1                 0 0
1    105       0PP 81      40         1                 0 0
1    106       9PP 80      33                           0 0
1    107       0PP 41      32         2                 0 0
1    108       9PP 71      40                           0 0
1    109       9PP 73      41                           0 0
1    110       9PP 94      35                           0 0
1    111       9PP 103     32                           0 0
```

Once you have a keyword file and a tree list file in the same directory we can start to build a script to do some work.

First we import the Fvsfuels class from the fuels module.

```
>>> from standfire.fuels import Fvsfuels
```

Next create an instance of the class passes the desired variant as an argument and register the keyword file.

```
>>> stand_1 = Fvsfuel("iec")
>>> stand_1.set_keyword("/Users/standfire/fvs_exp/example.key")
TIMEINT not found in keyword file, default is 10 years
```

We get a message telling us that the TIMEINT keyword was not found in the keyword file. No problem, STANDFIRE automatically sets this value to 10 years.

```
>>> stand_1.keywords
{'TIMEINT': 10, 'NUMCYCLE': 10, 'INVYEAR': 2010, 'SVS': 15, 'FUELOUT': 1}
```

Notice the keys in the keywords dictionary. `TIMEINT` is the time interval of the FVS simulation in year, `NUMCYCLE` is the number of cycles, `INVYEAR` is the year of the inventory, and `SVS` and `FUELOUT` are there to check if these keywords are in the keyword file. If the `SVS` and `FUELOUT` keywords are not defined the keyword file then FVS will not calculate tree positions or fuel attributes. So be sure you add these to your keyword file before registering the .key with FVS. You can use *post processors** in Suppose to do so. `TIMEINT`, `NUMCYCLE`, and `INVYEAR` can be manually changed by calling setters for each. For instance, if you only want to calculate fuel attributes for trees during the year of the inventory then simply change the `NUMCYCLE` value in the keyword dictionary.

```
>>> stand_1.set_num_cycle(0)
>>> stand_1.keywords
{'TIMEINT': 10, 'NUMCYCLE': 0, 'INVYEAR': 2010, 'SVS': 15, 'FUELOUT': 1}
```

Now that we have our simulation parameters established, we startup FVS.

```
>>> stand_1.run_fvs()
```

STANDFIRE API Reference

Contents:

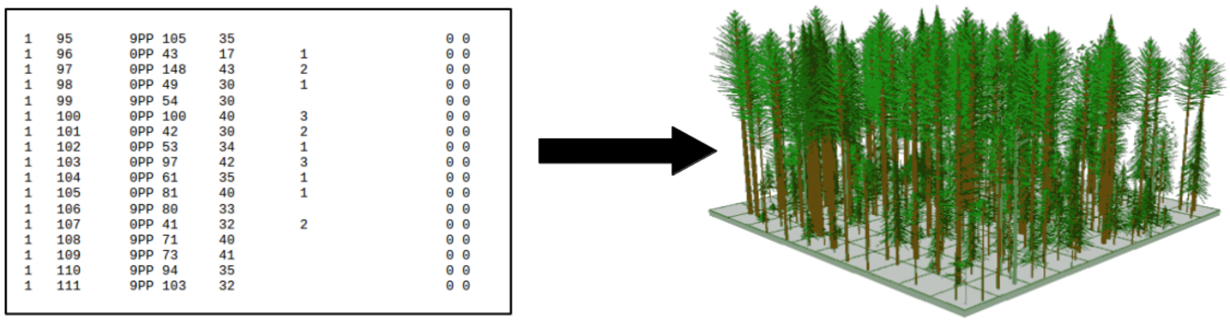
2.1 Fuels module

This module is the interface to FVS. Given a FVS variant name, a keyword file and the corresponding tree file, a user can run a FVS simulation and request various fuels information from individual trees. The Fvsfuels class will also produce the 4 fuels files needed for the Capsis fuel matrix generator.

Currently FVS MC Access database querying not available on all platforms. If a user has a keyword file that points to a MS Access database, then the user can generate a tree file by exporting the Access database to an comma-delimited file and pass it through the Inventory class. The output will be the same inventory present in the mdb file, but formatted to FVS .tre file standards.

Contents:

2.1.1 Fvsfuels



```
1   95        9PP 105    35                                0 0
1   96        0PP 43     17         1                      0 0
1   97        0PP 148    43         2                      0 0
1   98        0PP 49     30         1                      0 0
1   99        9PP 54     30                                0 0
1   100       0PP 100    40         3                      0 0
1   101       0PP 42     30         2                      0 0
1   102       0PP 53     34         1                      0 0
1   103       0PP 97     42         3                      0 0
1   104       0PP 61     35         1                      0 0
1   105       0PP 81     40         1                      0 0
1   106       9PP 80     33                                0 0
1   107       0PP 41     32         2                      0 0
1   108       9PP 71     40                                0 0
1   109       9PP 73     41                                0 0
1   110       9PP 94     35                                0 0
1   111       9PP 103    32                                0 0
```

class `fuels.`**`Fvsfuels`**(*variant*)

Bases: `object`

A Fvsfuels object is used to calculate component fuels at the individual tree level using the Forest Vegetation Simulator. To create an instance of this class you need two items: a keyword file (.key) and tree list file (.tre) with the same prefix as the keyword file. If you don't already have a tree list file then you can use `` `fuels.Inventory` `` class to generate one.

Parameters **`variant`** (*`string`*) – FVS variant to be imported

Example:

A basic example to extract live canopy biomass for individual trees during year of inventory

```
>>> from standfire.fuels import Fvsfuels
>>> stand001 = Fvsfuels("iec")
>>> stand001.set_keyword("/Users/standfire/test/example.key")
TIMEINT not found in keyword file, default is 10 years
>>> stand001.keywords
{'TIMEINT': 10, 'NUMCYCLE': 10, 'INVYEAR': 2010, 'SVS': 15, 'FUELOUT': 1}
```

The keyword file is setup to simulate 100 years at a time interval of 10 years. Lets change this to only simulate the inventory year.

```
>>> stand001.set_num_cycles(0)
>>> stand001.keywords
{'TIMEINT': 10, 'NUMCYCLE': 0, 'INVYEAR': 2010, 'SVS': 15, 'FUELOUT': 1}
>>> stand001.run_fvs()
```

Now we can write the trees data frame to disk

```
>>> stand001.save_trees_by_year(2010)
```

Note: The argument must match one of the available variant in the PyFVS module. Search through standfire/pyfvs/ to see all variants

get_simulation_years()

Returns a list of the simulated years

Returns simulated year

Return type list of integers

get_snags(*year*)

Returns pandas data frame of the snags by indexed year

Parameters **year** (*int*) – simulation year of the data frame to return

Returns data frame of snags at indexed year

Return type pandas dataframe

Note: If a data frame for the specified year does not exist then a message will be printed to the console.

get_standid()

Returns stand ID as defined in the keyword file of the class instance

Returns stand ID value

Return type string

get_trees(*year*)

Returns pandas data frame of the trees by indexed year

Parameters **year** (*int*) – simulation year of the data frame to return

Returns data frame of trees at indexed year

Return type pandas dataframe

Note: If a data frame for the specified year does not exist then a message will be printed to the console.

run_fvs()

Runs the FVS simulation

This method runs a FVS simulation using the previously specified keyword file. The simulation will be paused at each time interval and the trees and snag data collected and appended to the fuels attribute of the Fvsfuels object.

Example:

```
>>> from standfire.fuels import Fvsfuels
>>> stand010 = Fvsfuels("iec")
>>> stand010.set_keyword("/Users/standfire/example/test.key")
>>> stand010.run_fvs()
>>> stand010.fuels["trees"][2010]
xloc     yloc     species    dbh      ht     crd     cratio   crownwt0    crownwt1 ...
33.49   108.58    PIPO      19.43    68.31   8.77      25     33.46        4.3
24.3     90.4     PIPO      11.46    56.6    5.63      15      6.55       2.33
88.84   162.98    PIPO      18.63    67.76   9.48      45     75.88       6.89
...
```

save_all()

Writes all data frame in the `fuels` attribute of the class to the specified working directory. Output file are .csv.

save_snags_by_year(*year*)

Writes snag data frame at indexed year to .csv in working directory

save_trees_by_year(*year*)

Writes tree data frame at indexed year to .csv in working directory

set_dir(*wdir*)

Sets the working directory of a Fvsfuels object

This method is called by `Fvsfuels.set_keyword()`. Thus, the default working directory is the folder containing the specified keyword file. If you wish to store simulation outputs in a different directory then use this methods to do so.

Parameters **wdir** (*string*) – path/to/desired_directory

Example:

```
>>> from standfire.fuel import Fvsfuels
>>> test = Fvsfuels("emc")
>>> test.set_keyword("/Users/standfire/test/example.key")
```

Whoops, I would like to store simulation outputs elsewhere...

```
>>> test.set_dir("/Users/standfire/outputs/")
```

set_inv_year(*inv_year*)

Sets inventory year for FVS simulation

Parameters **inv_year** (*int*) – year of the inventory

set_keyword(*keyfile*)

Sets the keyword file to be used in the FVS simulation

Date 2015-8-12

Authors Lucas Wells

This method will initalize a FVS simulation by registering the specified keyword file (.key) with FVS. The working directory of a Fvsfuels object will be set to the folder containing the keyword file. You can manually change the working directory with Fvsfuels.set_dir(). This function will also call private methods in this class to extract information from the keyword file and set class fields accordingly for use in other methods.

Parameters **`keyfile`** (*`string`*) – path/to/keyword_file. This must have a .key extension

Example:

```
>>> from standfire.fuels import Fvsfuels
>>> test = Fvsfuels("iec")
>>> test.set_keyword("/Users/standfire/test/example.key")
```

`set_num_cycles`(*num_cyc*)
Sets number of cycles for FVS simulation

Parameters **`num_cyc`** (*`int`*) – number of simulation cycles

`set_stop_point`(*code=5*, *year=-1*)
Set the FVS stop point code and year

Parameters

- **`code`** (*`integer`*) – stop point code (default=5)
- **`year`** (*`integer`*) – stop point year (default=-1)

Note: year=0 means never stop and year=-1 means stop every cycle

stop point code	Definition
0	Never stop
-1	Stop at every location
1	Stop just before first call to Event Monitor
2	Stop just after first call to Event Monitor
3	Stop just before second call to Event Monitor
4	Stop just after second call to Event Monitor
5	Stop after growth and mort has been computed, but before applied
6	Stop just before the ESTAB routine is called

`set_time_int`(*time_int*)
Sets time interval for FVS simulation

Parameters **`time_int`** (*`int`*) – length of simulation time step

2.1.2 Inventory

class `fuels.`**`Inventory`**
Bases: `object`

This class contains methods for converting inventory data to FVS .tre format

This class currently does not read inventory data from an FVS access database. The FVS_TreeInit database first needs to be exported as comma delimited values. Multiple stands can be exported in the same file, the `formatFvsTreeFile()` function will format a .tre string for each stand. All column headings must be default headings and unaltered during export. You can view the default format by importing this class and typing `FMT`. See the FVS guide [1] for more information regarding the format of .tre files.

Example:

```
>>> from standfire import fuels
>>> toDotTree = fuels.Inventory()
>>> toDotTree.read_inventory("path/to/FVS_TreeInit.csv")
>>> toDotTree.format_fvs_tree_file()
>>> toDotTree.save()
```

References

`convert_sp_codes`(*method='2to4'*)
Converts species codes from 4 letter codes to 2 letter codes or vise versa

Parameters **`method`** (*`string`*) – must be either "2to4" or "4to2"

`crwratio_percent_to_code`()
Converts crown ratio from percent to ICR code

ICR code is described in the Essential FVS Guide on pages 58 and 59. This method should only be used if crown ratios values are percentages in the FVS_TreeInit.csv. If you use this method before calling *formatFvsTreeFile()* then you must set the optional argument `cratioToCode` to `False`.

`filter_by_stand`(*stand_list*)
Filters data by a list of stand IDs

Parameters **`stand_list`** (*`python list`*) – List of stand ID to retain in the data. All other stands will be removed

`format_fvs_tree_file`(*cratio_to_code=True*)
Converts data in FVS_TreeInit.csv to FVS .tre format

This methods reads entries in the pandas data frame (`self.data`) and writes them to a formated text string following FVS .tre data formating standards shown in `FMT`. If multiple stands exist in `self.data` then each stand will written as a (key,value) pair in `self.fvsTreeFile` where the key is the stand ID and the value is the formated text string.

Parameters **`cratio_to_code`** (*`boolean`*) – default = True

Note: If the `crwratio_percent_to_code()` methods has been called prior to call this methods, then the `cratio_to_code` optional argument must be set to `False` to prevent errors in crown ratio values.

Example:

```
>>> toDotTree.format_fvs_tree_file()
>>> toDotTree.fvsTreeFile['Stand_ID_1']
5   1  5      0PP  189    65        3                   0  0
5   2  15     0PP  110    52        2                   0  0
5   3  5      0PP  180    64        5                   0  0
5   4  14     0PP  112    56        3                   0  0
5   5  6      0PP  167    60        4                   0  0
5   6  5      0PP  190    60        5                   0  0
5   7  7      0PP  161    62        3                   0  0
```

[1] Gary E. Dixon, Essential FVS: A User's Guide to the Forest Vegetation Simulator Tech. Rep., U.S. Department of Agriculture , Forest Service, Forest Management Service Center, Fort Collins, Colo, USA, 2003.

```
5   8  86    0PP 46     37        1                 0 0
5   9  10    0PP 130    50        2                 0 0
5   10 5     0PP 182    60        3                 0 0
5   11 8     9PP 144    50                          0 0
6   1  16    0PP 107    42        4                 0 0
6   2  109   0PP 41     27        2                 0 0
...
```

get_fvs_cols()

Get list of FVS standard columns

Returns FVS standard columns

Return type list of strings

get_stands()

Returns unique stand IDs

Returns stand IDs

Return type list of strings

Example:

```
>>> toDotTree.get_stands()
['BR', 'TM', 'SW', HB']
```

print_format_standards()

Print FVS formating standards

The FVS formating standard for .tre files as described in the Essenital FVS Guide is stored in `FMT` as a class attribute. This method is for viewing this format. The keys of the dictionary are the column headings and values are as follows: 0 = variable name, 1 = variable type, 2 = column location, 3 = units, and 4 = implied decimal place.

Example:

```
>>> toDotTree.print_format_standards()
{'Plot_ID'        : ['ITRE',       'integer',  [0,3],   None,      None],
 'Tree_ID'        : ['IDTREE2',    'integer',  [4,6],   None,      None],
 'Tree_Count'     : ['PROB',       'integer',  [7,12],  None,      None],
 'History'        : ['ITH',        'integer',  [13,13], 'trees',   0   ],
 'Species'        : ['ISP',        'alphanum', [14,16], None,      None],
 'DBH'            : ['DBH',        'real',     [17,20], 'inches',  1   ],
 'DG'             : ['DG',         'real',     [21,23], 'inches',  1   ],
 'Ht'             : ['HT',         'real',     [24,26], 'feet',    0   ],
 'HtTopK'         : ['THT',        'real',     [27,29], 'feet',    0   ],
 'HTG'            : ['HTG',        'real',     [30,33], 'feet',    1   ],
 'CrRatio'        : ['ICR',        'integer',  [34,34], None,      None],
 'Damage1'        : ['IDCD(1)',    'integer',  [35,36], None,      None],
 'Severity1'      : ['IDCD(2)',    'integer',  [37,38], None,      None],
 'Damage2'        : ['IDCD(3)',    'integer',  [39,40], None,      None],
 'Severity2'      : ['IDCD(4)',    'integer',  [41,42], None,      None],
 'Damage3'        : ['IDCD(5)',    'integer',  [43,44], None,      None],
 'Severity3'      : ['IDCD(6)',    'integer',  [45,46], None,      None],
 'TreeValue'      : ['IMC',        'integer',  [47,47], None,      None],
 'Prescription'   : ['IPRSC',      'integer',  [48,48], None,      None],
 'Slope'          : ['IPVARS(1)', 'integer',  [49,50], 'percent', None],
 'Aspect'         : ['IPVARS(2)', 'integer',  [51,53], 'code',    None],
 'PV_Code'        : ['IPVARS(3)', 'integer',  [54,56], 'code',    None],
 'TopoCode'       : ['IPVARS(4)', 'integer',  [57,59], 'code',    None],
 'SitePrep'       : ['IPVARS(5)', 'integer',  [58,58], 'code',    None],
 'Age'            : ['ABIRTH',    'real',     [59,61], 'years',   0   ]}
```

See page 61 and 62 in the Essential FVS Guide.

read_inventory (*fname*)

Reads a .csv file containing tree records.

The csv must be in the correct format as described in `FMT`. This method check the format of the file by calling a private method `_is_correct_format()` that raises a value error.

Parameters **fname** (*string*) – path to and file name of the Fvs_TreeInit.csv file

Example:

```
>>> from standfire import fuels
>>> toDotTree = fuels.Inventory()
>>> toDotTree.readInventory("path/to/FVS_TreeInit.csv")
>>> np.mean(toDotTree.data['DBH'])
9.0028318584070828
```

The `read_inventory()` method stores the data in a pandas data frame. There are countless operations that can be performed on these objects. For example, we can explore the relationship between diameter and height by fitting a linear model

```
>>> import statsmodels.formula.api as sm
>>> fit = sm.ols(formula="HT ~ DBH", data=test.data).fit()
>>> print fit.params
Intercept    19.688167
DBH           2.161420
dtype: float64
>>> print fit.summary()
OLS Regression Results
==============================================================================
Dep. Variable:                     Ht   R-squared:                       0.738
Model:                            OLS   Adj. R-squared:                  0.736
Method:                 Least Squares   F-statistic:                     351.8
Date:                Tue, 07 Jul 2015   Prob (F-statistic):           3.77e-38
Time:                        08:32:02   Log-Likelihood:                -407.10
No. Observations:                 127   AIC:                             818.2
Df Residuals:                     125   BIC:                             823.9
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
coef    std err          t      P>|t|      [95.0% Conf. Int.]
------------------------------------------------------------------------------
Intercept     19.6882      1.205     16.338      0.000        17.303    22.073
DBH            2.1614      0.115     18.757      0.000         1.933     2.389
==============================================================================
Omnibus:                        2.658   Durbin-Watson:                   0.995
Prob(Omnibus):                  0.265   Jarque-Bera (JB):                2.115
Skew:                          -0.251   Prob(JB):                        0.347
Kurtosis:                       3.385   Cond. No.                         23.8
==============================================================================
```

Read more about pandas at http://pandas.pydata.org/

save (*outputPath*)

Writes formated fvs tree files to specified location

If multiple stands exist in the FVS_TreeInit then the same number of files will be created in the specified directory. The file names will be the same as the Stand_ID with a `.tre` extension.

Parameters **`outputPath`** (*`string`*) – directory to store output .tre files

---

Note: This method will throw an error if it is called prior to the `format_fvs_tree_file()` method.

`set_FVS_variant`(*var*)

Sets FVS variant. This is need if converting from USDA plant symbols (PSME) to alpha codes (DF). If so, then all stand you wish to process must be of the same FVS variant

Parameters **`var`** (*`string`*) – FVS variant ('iec', 'emc' ...)

2.1.3 FuelCalc

class `fuels.`**`FuelCalc`**(*trees*)

Bases: `object`

This class implements various fuel calculation based on the FVS output.

Parameters **`trees`** (*`comma-delimited file or pandas data frame of tree list`*) – FVS output tree list

`calc_bulk_density`()

Calculates crown bulk density based on crown volume and biomass weight

`calc_crown_volume`()

Calculates crown volume based on geometry and crown dimensions

`cone_volume`(*r*, *h*)

Returns the volume of a cone

param r radius

type r float

param h height

type h float

return volume

rtype float

$$\pi r^2$$

rac{h}{3}

`convert_units`(*from_to=1*)

Convert all units in data frame

Parameters **`from_to`** (*`integer`*) – 1 = english to metric; 2 = metric to english (default=1)

Note: if this method is called more than once on the same instance of a data frame with the same conversion code a warning will be printed to the console

---

cylinder_volume(*r*, *h*)

Returns the volume of a cylinder

Parameters

- **r** (*float*) – radius
- **h** (*float*) – height

Returns volume

Return type float

$$\pi r^2 h$$

frustum_volume(*R*, *h*, *r=0.5*)

Returns the volume of a frustum

param r small (top) radius

type r float

param h height

type h float

param R big (bottom) radius

type R float

return volume

rtype float

rac{pi h}{3}(R^2+rR+r^2)

get_crown_base_ht()

Calculates crown base height for each tree based on crown ratio and tree height. This value is added to the data frame

$$h - (c_{ratio} h)$$

get_crown_ht()

Calculates crown height for each trees based on crown ratio. This value is added to the data frame

$$c_{ratio} h$$

get_species_list()

Return set of species existing in trees file supplied to constructor

Returns unique list of species

Return type list

Note: This methods is useful when assigning geometries by species. A user can first retrieve the species list then use it to assigne crown geometries

rectangle_volume(*w*, *h*)

Returns the volume of a rectangle

Parameters

- **w** (*float*) – width
- **h** (*float*) – height

Returns volume

Return type float

$$wwh$$

save_trees (*save_to*)
Write trees data frame to specified directory

Parameters **save_to** (*string*) – directory and filename of file to save

set_crown_geometry (*sp_geom_dict*)
Appends crown geometry to each tree in the data frame conditional on species.

Parameters **sp_geom_dict** (*python dictionary*) – dictionary of species specific crown geometries

Example

```
>>> sp_dict = {'PIPO' : 'cylinder', 'PSME' : 'frustum'}
>>> fuels.set_crown_geometry(sp_dict)
```

2.2 Capsis module

This module is a Python wrapper for the Capsis Standfire suite. Currently Capsis' role in Standfire is to distribute the fuels present in the files generated by Fvsfuels. Capsis uses a pre-generated FDS grid file (.xyz) to place canopy and surface in a user defined domain. Capsis provides many options for placing these fuels. The pertenant arguments can be controlled through the Capsis RunConig class. The Execute class is used to run Capsis. An up-to-date Java installation is required since Capsis run on a Java Virtual Machine.

Contents:

2.2.1 RunConfig

class capsis.**RunConfig** (*run_directory*)
Bases: object

The Capsis RunConfig class is used to configure a capsis run.

Parameters **run_directory** – desired path for Capsis run

Run_directory type string

*Example:#

```
>>> import capsis
>>> config = capsis.RunConfig('/path/to/capsis_run/')
>>> config.set_x_size(200)
>>> config.set_y_size(145)
>>> config.set_svs_base('stand_0001')
>>> config.set_crown_space(1.5)
>>> config.set_show3d('true')
>>> config.save_config()
```

save_config()
This method uses the defined parameters to generate Capsis input files

set_crown_space(*space*)
Set the distance between crown for Capsis intervention

Parameters **space** – crown spacing in meters

Space type float

set_path(*path*)
Sets path to Capsis run directory

Parameters **path** (*string*) – path to Capsis run directory

set_prune_height(*prune*)
Set the prunning height (vertical spacing between ground and crown) for a Capsis intervention

Parameters **prune** – prunning height

Prune type float

set_show3D(*value*)
Set the boolean value of the show3D parameter in the Capsis run file. If true, Capsis will open a 3D displaying the simulation domain.

Parameters **value** – Truth value of the show3D parameter

Value type boolean

set_srf_cbh(*shrub_cbh*, *herb_cbh*)

set_srf_cover(*shrub_cover*, *herb_cover*)

set_srf_dead_load(*shrub_load*, *herb_load*, *litter_load*)

set_srf_dead_mc(*shrub_mc*, *herb_mc*, *litter_mc*)

set_srf_dead_svr(*shrub_svr*, *herb_svr*, *litter_svr*)

set_srf_height(*shrub_ht*, *herb_ht*, *litter_ht*)

set_srf_live_load(*shrub_load*, *herb_load*)

set_srf_live_mc(*shrub_mc*, *herb_mc*)

set_srf_live_svr(*shrub_svr*, *herb_svr*)

set_svs_base(*base_name*)
Sets the base file name for FVS/SVS fuel output files

Parameters **base_name** (*string*) – base file name for fuel output files

Note: Only the tree.csv file is required. If snags, cwd and scalar files exist in the same directory they will be used by Capsis when writing WFDS fuel inputs.

set_x_offset(*offset*)
Set the x offset of the area of analysis

Parameters **offset** – x offset of the AOA

Offset type integer

set_x_size(*x_size*)
Sets scene x dimension

Parameters **`x_size`** (*`integer`*) – size of scene in the x domain (meters)

Note: *x_size* must be greater than or equal to 64 meters

`set_y_offset`(*offset*)

Set the y offset of the area of analysis

Parameters **`offset`** – y offset of the AOA

Offset type integer

`set_y_size`(*y_size*)

Sets scene y dimension

Parameters **`y_size`** (*`integer`*) – size of scene in the y domain (meters)

Note: *y_size* must be greater than or equal to 64 meters

`set_z_size`(*z_size*)

Sets scene z dimension

Parameters **`z_size`** (*`integer`*) – size of scene in the z domain (meters)

Note: *z_size* must be greater than or equal to tallest tree in domain

2.2.2 Execute

class `capsis.`**`Execute`**(*path_to_run_file*)

Bases: `object`

This class executes capsis according to the configuration from RunConfig. Capsis execution is platform agnostic

2.3 WFDS module

The wfds module is for configuring and running WFDS simulations. Use the WFDS class to setup the run. The WFDS class inherits the Mesh class, so meshes can be dealt with there.

Contents:

2.3.1 Mesh

class `wfds.`**`Mesh`**(*x*, *y*, *z*, *res*, *n*)

Bases: `object`

The Mesh class can be used to easily and quickly create FDS meshes.

Parameters

- **`x`** – X dimension of the simulation domain
- **`y`** (*`integer`*) – Y dimension of the simulation domain
- **`z`** (*`integer`*) – Z dimension of the simulation domain

- **res** (*integer*) – 3-space resolution prior to mesh stretching
- **n** – Number of meshes

X type integer

N type integer

Example:

```
>>> import wfds
>>> mesh = wfds.mesh(160,90,50,1,9)
>>> mesh.stretch_mesh([3,33], [1,31], axis='z')
>>> print mesh.format_mesh()
```

format_mesh()

Formats mesh for WFDS input file

Returns formated WFDS mesh

Return type string

stretch_mesh(*CC*, *PC*, *axis='z'*)

Apply stretching to the mesh along the specified axis

Parameters

- **CC** (*python list*) – computation coordinates
- **PC** (*python list*) – physical coordinates

Note: CC and PC must have equal number of elements

Example

```
>>> mesh = Mesh(200, 150, 100, 1, 1)
>>> mesh.stretch_mesh([3,33], [1,31], axis='z')
>>> print mesh.format_mesh()
```

2.3.2 WFDS

class wfds.**WFDS**(*x*, *y*, *z*, *res*, *n*, *fuels*)

Bases: *wfds.Mesh*

This class configures a WFDS simulation. This is a subclass of Mesh and meshes are dealt with implicitly

Example:

```
>>> import wfds
>>> fds = wfds.WFDS(160, 90, 50, 1, 9, fuels)
```

create_ignition(*start_time*, *end_time*, *x0*, *x1*, *y0*, *y1*)

Places an ignition strip at the specified location and generates fire at the specified HRR for the specified duration

Parameters

- **start_time** (*integer*) – start time of the igniter fire

- **`end_time`** (*`integer`*) – finish time of teh igniter fire
- **`x0`** (*`float`*) – starting x position of the ignition strip
- **`x1`** (*`float`*) – ending x position of the ignition strip
- **`y0`** (*`float`*) – starting y position of the ignition strip
- **`y1`** (*`float`*) – ending y position of the ignition strip

Note: Ignition ramping is dealt with implicitly to avoid ‘explosions’

`create_mesh`(*stretch=False*)

Call the *stretch_mesh()* method of the Mesh class

Parameters **`stretch`** – to stretch or not to strecth

Stretch type False or stretch arguments

Note: See *Mesh.stretch_mesh()* for setting the mesh arguments

`save_input`(*file_name*)

Save the input file. Include the desired directory in the string

Parameters **`file_name`** (*`string`*) – path to and name of input file (.txt not .fds please)

`set_hrrpua`(*hrr*)

Set the heat release rate per unit area for the ignition strip

Parameters **`hrr`** (*`integer`*) – heat release rate per unit area (kW/m^2)

`set_init_temp`(*temp*)

Set the initial temperature of the simulation

Parameters **`temp`** (*`float`*) – temperature (celcius)

`set_run_name`(*name*)

`set_simulation_time`(*sim_time*)

Set the duration of the simulation

Parameters **`sim_time`** (*`float`*) – duration of the simulation (s)

`set_wind_speed`(*U0*)

Set the inflow wind speed

Parameters **`U0`** (*`float`*) – inflow wind speed (m/s)

2.3.3 Execute

class `wfds.`**`Execute`**(*input_file*, *n_proc*)

Bases: `object`

The Execute class runs the WFDS input file (platform agnostic)

Parameters

- **`input_file`** (*`string`*) – path to and name of input file
- **`n_proc`** (*`integer`*) – number of processors

2.3.4 Generate Binary Grid

class `wfds.`**`GenerateBinaryGrid`**(*x*, *y*, *z*, *res*, *n*, *f_name*, *stretch=False*)

Bases: *`wfds.Mesh`*

This class is for generating binary FDS grid. Usefull for Capsis. Inherits the mesh class.

Note: See the wfds.Mesh() class for details

2.4 Metrics module

This module contains class for calculating various metrics. These metrics are specific to the WFDS configurations used in Standfire, i.e. They probably won't work on all WFDS output direcotries.

Lots of work to do here. Work in progress.

Contents:

2.4.1 Rate of Spread

class `metrics.`**`ROS`**(*wdir*, *fuel_1*, *fuel_2*, *x_diff*)

Bases: `object`

Calculates rate of spread (m/s)

# TODO: make subclass that reads the vegout files. Current each class reads them.

`get_first_burn_time`(*fuel*)

Returns the time when the fuel begins to burn

Parameters **`fuel`** – The fuel that burns first

`get_ros`()

Returns the rate of spread in meters per second

2.4.2 Mass Loss

class `metrics.`**`MassLoss`**(*wdir*)

Bases: `object`

Calculates dry mass consumption

`get_total_mass_loss`()

`get_tree_files`()

`read_tree_mass`()

2.4.3 Wind Profile

class `metrics.`**`WindProfile`**(*wdir*, *slice_file*, *t_start*, *t_end*, *t_step*)

Bases: `object`

Calculates wind profile

get_wind_profile()

2.4.4 Heat Transfer

class metrics.**HeatTransfer**(*wdir*)

Bases: `object`

Calculates crown heat transfer

get_tree_files()

read_tree_conv()

read_tree_rad()

CHAPTER 3

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