

# Package ‘MFASTR’

April 10, 2017

**Title** The Multiple Filter Automatic Shear Wave Splitting Technique in R

**Version** 0.1.0.0000

**Description** This is a port of the MFAST codes into R. The main functions `do_station_simple` and `do_station_complex` replicate MFAST's usability. Other functions in this package are documented to give advanced users more flexibility.

**URL** <http://mfast-package.geo.vuw.ac.nz/>

**BugReports** <https://github.com/shearwavesplitter/MFASTR>

**Depends** R (>= 2.14), RSEIS, TauP.R, signal

**Suggests** circular

**SystemRequirements** GNU make, Linux

**License**

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 6.0.1.9000

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ak135_alp	<i>The ak135_alp velocity model</i>
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**Description**

The ak135\_alp velocity model

**Usage**

ak135\_alp

**Format**

A TauP.R compatible velocity model

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ak135_taupo	<i>The ak135_taupo velocity model</i>
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**Description**

The ak135\_taupo velocity model

**Usage**

ak135\_taupo

**Format**

A TauP.R compatible velocity model

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anginc	<i>Angle of incidence</i>
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**Description**

Determines the angle of incidence for an event

**Usage**

```
anginc(tvel, trip)
```

**Arguments**

tvel	Velocity model read in by readtvel or a stored model (ak135_alp, ak135_taupo)
trip	Seismogram triplet (output of readtriplet)

**Value**

The angle of incidence at the surface (degrees) and the ray parameter

**Examples**

```
# Determine the angle of incidence for event 2002.054.09.47.lhor2
pathto <- "~/mfast/sample_data/raw_data"
write_sample(pathto)
event <- "2002.054.09.47.lhor2"
triplet <- readtriplet(event, path=pathto)
a <- anginc(ak135_alp, triplet)
```

---

checkcomp	<i>Check components</i>
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---

**Description**

Checks a folder to make sure all three components are present and moves those with missing components to a subdirectory

**Usage**

```
checkcomp(path, E = ".e", N = ".n", Z = ".z")
```

**Arguments**

path	Path to folder
E	Suffix of the east component
N	Suffix of the north component
Z	Suffix of the vertical component

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checkspick	<i>Check S-wave picks</i>
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### Description

Checks a folder to make sure all events have S-wave picks and moves those with missing picks to a subdirectory

### Usage

```
checkspick(path, suffix = "E", header = "t0", E = ".e", N = ".n",
           Z = ".z")
```

### Arguments

path	Path to folder
suffix	Which component to look for the S-pick in (E, N, or Z)
header	Header name of where the S-pick is stored
E	Suffix of the east component
N	Suffix of the north component
Z	Suffix of the vertical component

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createini	<i>Create .ini</i>
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### Description

Creates an MFAST .ini (paramter) file

### Usage

```
createini(path, trip, filts, name, number = 3, E = ".e", N = ".n",
          Z = ".z", nwbeg = 5, fdmin = 0.3, fdmax = 8, t_win_freq = 3,
          tlagmax = 1, Ncmin = 5, Mmax = 15)
```

### Arguments

path	Path to folder
trip	Seismogram triplet (output of readtriplet)
name	Event name (without suffix)
number	Number of best filters to use
nwbeg	number of start times tested
fdmin	Minimum allowed dominant frequency

fdmax	Maximum allowed dominant frequency
t_win_freq	Window to calculate the dominant frequency
tlagmax	Maximum allowed time delay (s)
Ncmin	Minimum number of points in an acceptable cluster
Mmax	maximum number of clusters
A	dataframe of the best filters (output of filter_spread)
suffe	Suffix of east component
suffn	Suffix of north component
suffz	Suffix of vertical component
snrmax	Minimum snr allowed for a good filter
t_win_snr	Window for SNR (s)
t_err	Modification to t_win_snr to account for error in S-pick (s)

**Value**

A vector of dominant frequency in the S-wave (maxfreq) for each filter

**Examples**

```
# Create .ini file for event 2002.054.09.47.1hor2
pathto <- "~/mfast/sample_data/raw_data"
write_sample(pathto)
event <- "2002.054.09.47.1hor2"
triplet <- readtriplet(event,path=pathto)
bestfilt <- filter_spread(triplet)
maxfreq <- createini(pathto,triplet,bestfilt,event)
```

cut\_simple

*Simple cut***Description**

A simple routine to cut out portion of a vector signal

**Usage**

```
cut_simple(x, dt, t1, t2, b = 0)
```

**Arguments**

x	vector signal
dt	sample interval
t1	Begin cut time
t2	End cut time

**Value**

A cut vector signal

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do_all_complex	<i>Run MFAST on multiple stations with more options</i>
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**Description**

Run shear wave splitting measurements on multiple folders/stations

**Usage**

```
do_all_complex(path, sheader = "t0", nwbeg = 5, fdmin = 0.3, fdmax = 8,
  t_win_freq = 3, tlagmax = 1, Ncmin = 5, Mmax = 15, snrmax = 3,
  t_win_snr = 3, t_err = 0.02, filtnum = 3, type = "normal",
  filter = NULL, tvelpath = NULL, tvel = ak135_alp, suffe = ".e",
  suffn = ".n", suffz = ".z", no_cores = Inf)
```

**Arguments**

path	Path to folder containing folders with events
sheader	SAC header the S-wave pick is stored in
nwbeg	number of start times tested
fdmin	Minimum allowed dominant frequency
fdmax	Maximum allowed dominant frequency
t_win_freq	Window to calculate the dominant frequency (s)
tlagmax	Maximum allowed time delay (s)
Ncmin	Minimum number of points in an acceptable cluster
Mmax	maximum number of clusters
snrmax	Minimum snr allowed for a good filter
t_win_snr	Window for SNR (s)
t_err	Modification to t_win_snr to account for error in S-pick (s)
filtnum	Number of filters to test
type	Which of the MFAST default settings and filters to use. If a P-wave pick is present, type="verylocal" uses it to set t_win_snr
filter	User defined set of filters (this overrides the filter selected with type).
tvelpath	Path to a .tvel file containing the velocity model (overrides tvel)
tvel	A tvel file read with readtvel (ak135_alp and ak135_taupo are already loaded)
suffe	Suffix of east component
suffn	Suffix of north component
suffz	Suffix of vertical component
no_cores	Number of cores to run measurements on. Set to 1 for verbose mode. Defaults to maximum available.

**Value**

A dataframe containing a summary of all the stations

**Examples**

```
# Run on measurements three folders of the normal sample data
write_sample("~/mfast/sample_data/raw_data")
write_sample("~/mfast/sample_data/raw_data2")
write_sample("~/mfast/sample_data/raw_data3")
do_all_complex(path="~/mfast/sample_data")
```

---

do_all_simple	<i>Run MFAST on multiple folders</i>
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---

**Description**

Run shear wave splitting measurements on more than one folder/station

**Usage**

```
do_all_simple(path, sheader = "t0", type = "normal", filtnum = 3,
  tvelpath = NULL, tvel = ak135_alp, no_cores = Inf)
```

**Arguments**

path	Path to folder containing folders with events
sheader	SAC header the S-wave pick is stored in
type	Which of the MFAST default settings and filters to use
filtnum	Number of filters to test
tvelpath	Path to a .tvel file containing the velocity model (overrides tvel)
tvel	A tvel file read with readtvel (ak135_alp and ak135_taupo are already loaded)
no_cores	Number of cores to run measurements on. Set to 1 for verbose mode. Defaults to maximum available.

**Details**

Component suffixes are determined automatically

**Value**

A dataframe containing a summary of all the stations

## Examples

```
# Run on measurements three folders of the normal sample data
write_sample("~/mfast/sample_data/raw_data")
write_sample("~/mfast/sample_data/raw_data2")
write_sample("~/mfast/sample_data/raw_data3")
do_all_simple(path("~/mfast/sample_data"))
```

---

do\_station\_complex      *Run MFAST with more options*

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## Description

Run shear wave splitting measurements on a folder of events with more options

## Usage

```
do_station_complex(path, sheader = "t0", nwbeg = 5, fdmin = 0.3,
  fdmax = 8, t_win_freq = 3, tlagmax = 1, Ncmin = 5, Mmax = 15,
  snrmax = 3, t_win_snr = 3, t_err = 0.02, filtnum = 3,
  type = "normal", filter = NULL, tvelpath = NULL, tvel = ak135_alp,
  suffe = ".e", suffn = ".n", suffz = ".z", no_cores = Inf)
```

## Arguments

path	Path to folder
sheader	SAC header the S-wave pick is stored in
nwbeg	number of start times tested
fdmin	Minimum allowed dominant frequency
fdmax	Maximum allowed dominant frequency
t_win_freq	Window to calculate the dominant frequency (s)
tlagmax	Maximum allowed time delay (s)
Ncmin	Minimum number of points in an acceptable cluster
Mmax	maximum number of clusters
snrmax	Minimum snr allowed for a good filter
t_win_snr	Window for SNR (s)
t_err	Modification to t_win_snr to account for error in S-pick (s)
filtnum	Number of filters to test
type	Which of the MFAST default settings and filters to use. If a P-wave pick is present, type="verylocal" uses it to set t_win_snr
filter	User defined set of filters (this overrides the filter selected with type).
tvelpath	Path to a .tvel file containing the velocity model (overrides tvel)
tvel	A tvel file read with readtvel (ak135_alp and ak135_taupo are already loaded)



suffe	Suffix of east component
suffn	Suffix of north component
suffz	Suffix of vertical component
no_cores	Number of cores to run measurements on. Set to 1 for verbose mode. Defaults to maximum available.

**Value**

A dataframe containing the summary file

**Examples**

```
# Run on measurements the normal sample data with defaults
write_sample("~/mfast/sample_data/raw_data")
do_station_complex(path("~/mfast/sample_data/raw_data")

# Run measurements with your own defined filters
filt_low <- c(0.1,0.2,0.5)
filt_high <- c(1,2,3)
filtz <- cbind(filt_low,filt_high)
write_sample("~/mfast/sample_data/raw_data")
do_station_complex(path("~/mfast/sample_data/raw_data",filter=filtz)
```

---

do_station_simple	<i>Run MFAST</i>
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**Description**

Run shear wave splitting measurements on a folder of events

**Usage**

```
do_station_simple(path, sheader = "t0", type = "normal", filtnum = 3,
  tvelpath = NULL, tvel = ak135_alp, no_cores = Inf)
```

**Arguments**

path	Path to folder
sheader	SAC header the S-wave pick is stored in
type	Which of the MFAST default settings and filters to use
filtnum	Number of filters to test
tvelpath	Path to a .tvel file containing the velocity model (overrides tvel)
tvel	A tvel file read with readtvel (ak135_alp and ak135_taupo are already loaded)
no_cores	Number of cores to run measurements on. Set to 1 for verbose mode. Defaults to maximum available.

**Details**

Component suffixes are determined automatically

**Value**

A dataframe containing the summary file

**Examples**

```
# Run on measurements the normal sample data
write_sample("~/mfast/sample_data/raw_data")
do_station_simple(path=~mfast/sample_data/raw_data")

# Run on measurements the verylocal sample data where the S-pick is stored in the t5 header
write_sample("~/mfast/sample_data/raw_data",type="verylocal")
do_station_simple(path=~mfast/sample_data/raw_data",type="verylocal",shheader="t5")
```

---

filter_spread	<i>Find best filters</i>
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---

**Description**

Determines the best filters for an event

**Usage**

```
filter_spread(trip, type = "normal", filter = NULL, t_win_snr = 3,
  t_err = 0.05, snrmax = 3)
```

**Arguments**

trip	Seismogram triplet (output of readtriplet)
type	Which of the default filters to use. If a P-wave pick is present, type="verylocal" uses it to set t_win_snr
filter	User defined filters. Overrides filters selected by type (for "verylocal" the P-pick is still used)
t_win_snr	Window for SNR
t_err	Modification to t_win_snr to account for error in S-pick
snrmax	Minimum snr allowed for a good filter

**Value**

A dataframe of the filters sorted by SNR\*bandwidth

**Examples**

```
# Define your own set of filters
filt_low <- c(0.1,0.2,0.5)
filt_high <- c(1,2,3)
filtls <- cbind(filt_low,filt_high)
write_sample("~/mfast/sample_data/raw_data")
triplet <- readtriplet("2002.054.09.47.lhor2",path("~/mfast/sample_data/raw_data")
bestfilt <- filter_spread(triplet,filter=filtls)
```

---

grade	<i>Grade .summ file</i>
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---

**Description**

Grades a .summ file (do\_station automatically grades)

**Usage**

```
grade(path, minsnr = 3, tlagmax = 1, minl = 0)
```

**Arguments**

path	Path to .summ file to be graded
minsnr	Minimum SNR allowed for an AB+ grade
tlagmax	Maximum time delay allowed for an AB+ grade
minl	Minimum lambdamax allowed for a AB+ grade

**Examples**

```
# (Re)grade LHOR2.75.summ
write_sample("~/mfast/sample_data/raw_data")
do_station_simple(path("~/mfast/sample_data/raw_data")
pathto <- "~/mfast/sample_data/raw_data/LHOR2.summ_files/LHOR2.75.summ"
grade(pathto)
```

---

logfiles	<i>Parse results</i>
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---

**Description**

Parses output of shear wave splitting measurement for a set of filters (used to build .summ files)

**Usage**

```
logfiles(path, name, trip, filtlist, maxfreqv, comment = "MFASTR", anginc)
```

Arguments

path	Path to folder
name	Name of event
trip	Seismogram triplet (output of readtriplet)
filtlist	Dataframe of the best filters to be used (output of writesac_filt)
maxfreqv	Vector of dominant frequency in the S-wave (maxfreq) for each filter(output of create_ini)
comment	Optional comment
anginc	Angle of indidence (output of anginc)

Value

A dataframe containing the results for that event

Examples

```
# Run shear wave splitting measurement on event 2002.054.09.47.1hor2 and parse the results
pathto <- "~/mfast/sample_data/raw_data"
write_sample(pathto)
event <- "2002.054.09.47.1hor2"
triplet <- readtriplet(event,path=pathto)
a <- anginc(ak135_alp,triplet)
bestfilt <- filter_spread(triplet)
maxfreq <- createini(pathto,triplet,bestfilt,event)
f <- writesac_filt(pathto,triplet,event,bestfilt)
run_mfast(pathto,event,f)
res <- logfiles(pathto,event,triplet,f,maxfreq,anginc=a)
```

---

mean.weighted	<i>Weighted axial mean</i>
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---

Description

The mean of a weighted axial variable

Usage

```
## S3 method for class 'weighted'
mean(vec, weights = NULL)
```

Arguments

vec	A vector of axis (degrees)
weights	A vector of weights of the same length as vec

Value

The mean axis (degrees) and the Pythagorean length

---

readtriplet	<i>Read a SAC format siesmogram triplet</i>
-------------	---

---

## Description

Reads, cuts, and loads S-wave pick into the t5 header using RSEIS/JSAC.seis as a workhorse

## Usage

```
readtriplet(event, path = ".", E = ".e", N = ".n", Z = ".z",
  header = "t0", pheader = "a")
```

## Arguments

event	Event name
path	Path to folder
header	Name of header containing the S-wave pick
pheader	Name of header containing the P-wave pick
suffe	Suffix of east component
suffn	Suffix of north component
suffz	Suffix of vertical component

## Details

The S-wave pick must be stored on at least the east component and the P-wave pick (if present) must be stored on the vertical component

## Value

A list containing dataframes for each of the three components with signal and header information

## Examples

```
# Read in 2002.054.09.47.1hor2
pathto <- "~/mfast/sample_data/raw_data"
write_sample(pathto)
event <- "2002.054.09.47.1hor2"
triplet <- readtriplet(event,path=pathto)
```

---

readtvel	<i>Read .tvel</i>
----------	-------------------

---

**Description**

Reads a .tvel file and saves it in an RSEIS compatible format

**Usage**

```
readtvel(name)
```

**Arguments**

name	Name and path of .tvel file
------	-----------------------------

**Value**

RSEIS compatible dataframe containing the velocity model

**Examples**

```
path <- "~/mfast/velocity/ak135_taupo.tvel"
model <- readtvel(path)
write_sample("~/mfast/sample_data/raw_data")
do_station_simple(path="~/mfast/sample_data/raw_data", tvel=model)
```

---

rms	<i>Root mean square</i>
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---

**Description**

Simple routine to determine root mean square value of a signal

**Usage**

```
rms(x)
```

**Arguments**

x	Vector signal
---	---------------

**Value**

RMS value

---

run_mfast	<i>Run splitting measurement</i>
-----------	----------------------------------

---

**Description**

Runs shearwave splitting measurements on a set of filtered SAC files

**Usage**

```
run_mfast(path, name, filtlist)
```

**Arguments**

path	Path to folder
name	Name of event
filtlist	A dataframe of the best filters to be used (output of writesac_filt)

**Examples**

```
# Run shear wave splitting measurements on event 2002.054.09.47.1hor2
pathto <- "~/mfast/sample_data/raw_data"
write_sample(pathto)
event <- "2002.054.09.47.1hor2"
triplet <- readtriplet(event,path=pathto)
bestfilt <- filter_spread(triplet)
maxfreq <- createini(pathto,triplet,bestfilt,event)
f <- writesac_filt(pathto,triplet,event,bestfilt)
run_mfast(pathto,event,f)
```

---

snr	<i>S-wave SNR</i>
-----	-------------------

---

**Description**

Determine the signal to noise ratio around the S-wave pick (workhorse of filter\_spread)

**Usage**

```
snr(E, N, s, p = -12345, dt, t_win_snr = 3, t_err = 0.05, b = 0,
    type = "normal")
```

Arguments

E	Vector signal of the east component
N	Vector signal of the north component
s	S-wave pick time
p	P-wave pick time
dt	Sample interval
t_win_snr	Window for SNR (s)
t_err	Modification to t_win_snr to account for error in S-pick (s)
type	If type is set to "verylocal" then the P-wave pick (if present) is used to set t_win_snr

Value

Signal to noise ratio around the S-wave pick

---

writesac_filt	<i>Write filtered SAC files</i>
---------------	---------------------------------

---

Description

Writes out filtered waveforms ready to have shear wave splitting measured

Usage

```
writesac_filt(path, trip, name, filtlist, number = 3, E = ".e", N = ".n",  
              Z = ".z")
```

Arguments

path	Path to folder
trip	Event triplet (output of readtriplet)
name	Name of the event
filtlist	Dataframe of the best filters (output of filter_spread)
number	Number of best filters to use
E	Suffix of the east component
N	Suffix of the north component
Z	Suffix of the vertical component #return A dataframe of the filters that have been written



## Examples

```
# Write out three best filters for event 2002.054.09.47.1hor2
pathto <- "~/mfast/sample_data/raw_data"
event <- "2002.054.09.47.1hor2"
write_sample(pathto)
triplet <- readtriplet(event)
bestfilt <- filter_spread(triplet)
f <- writesac_filt(pathto,triplet,event,bestfilt)
```

---

writesac_filtsmp	<i>Simple write</i>
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---

## Description

Write out an event with a chosen filter

## Usage

```
writesac_filtsmp(path, trip, name, low, high, E = ".e", N = ".n",
  Z = ".z", n = 1)
```

## Arguments

path	Path to folder
trip	Event triplet (output of readtriplet)
name	Name of the event
low	Low frequency cut-off
high	High frequency cut-off
E	Suffix of the east component
N	Suffix of the north component
Z	Suffix of the vertical component
n	Number for suffix .f <sub>n</sub> (e.g .fb2)

---

write_sample	<i>Sample data</i>
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---

**Description**

Writes out MFAST sample data

**Usage**

```
write_sample(path, type = "normal")
```

**Arguments**

path	Path to folder
type	"normal" or "verylocal" sample data

**Examples**

```
# Write out MFAST sample events
write_sample("~/mfast/sample_data/raw_data")

# Write out MFAST verylocal sample events
write_sample("~/mfast/sample_data/raw_data", type="verylocal")
```

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