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C R

RAPL - documentation

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Short description:

R.A.P.L. - Reykjanes Automatic Picking and Location is a computer program designed for automatic location of seismic events on Reykjanes peninsula (SW Iceland). The code could be used for any other region but the algorithms and parameters have been tested for this specific setting. Also a certain directory structure and naming convention is supposed so it could be easily applied to existing data structure.

First the MSEED waveform files are loaded and three component data for each station are processed to search for possible P and S phases using polarization analysis and STA/LTA ratio. In the next step the program tries to associate phases to obtain groups that are related to the same seismic event. Minimum 3 S phases and 1 P phase has to be found to form an event. The individual events are then located and local magnitude is estimated.

Installation:

The program is written in MATLAB and compiled for 64-bit unix OS. To run the executable MATLAB Runtime version 9.13 must be installed, for details see <https://www.mathworks.com/products/compiler/matlab-runtime.html>.

Running:

`rapl(parameter_file,year,day)` - the most important parameters are set in parameter file `.par` which is plain text file, but for routine use it is supposed to be set once and only year and day changes

Prerequisites:

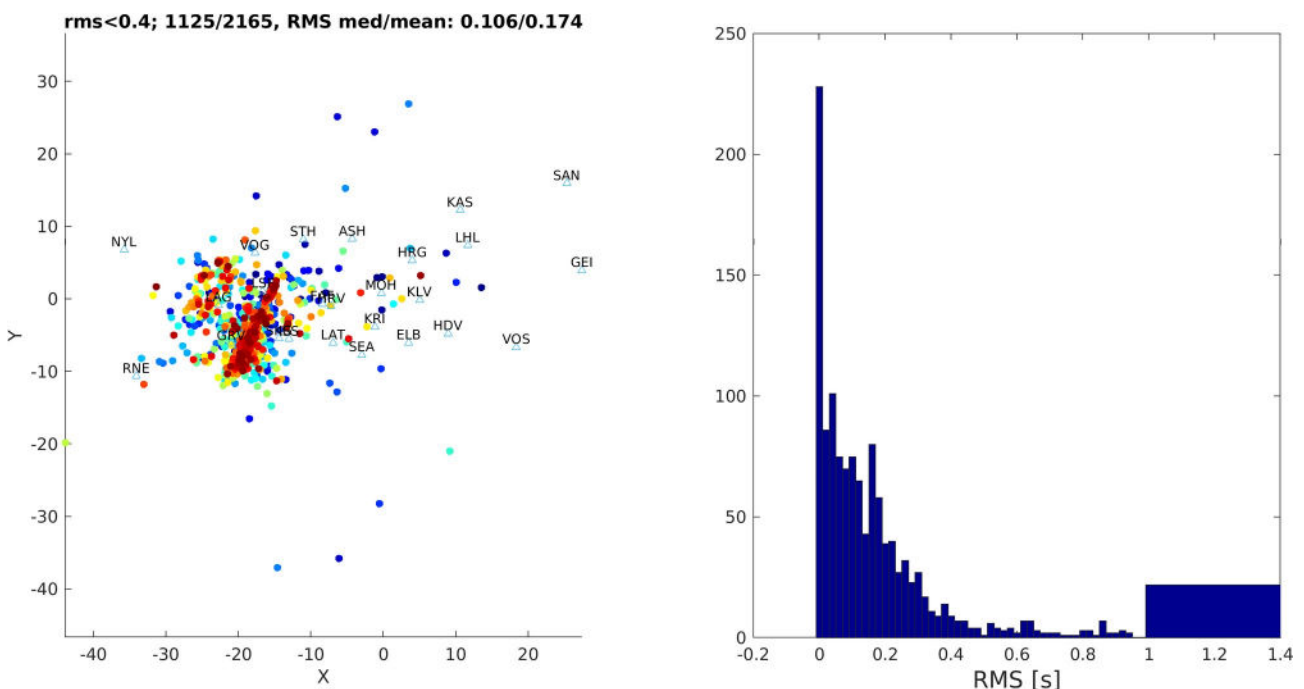
The waveform data has to be in MSEED format in a directory named by year with subdirectories named by sequential day number (julian days). Three files with Z,N,E components must be present and following naming convention must be used: StationCode_ChannelCode_Year_Day_00_00_00 for example: ASH_CHZ_2024_005_00_00_00.

Outputs:

AutoLocations.txt - list of event locations see Format description section

AutoPicks.txt - list of event locations including Format description section

locations.png - map of epicenters and histogram of estimated location errors



Example of locations.png - map of epicenters on the left, location error histogram on the right

Files included:

rapl - main executable file

run_rapl.sh - shell script to set up runtime environment

reyknet.par - parameter file

stations.txt - input station file

eeagrants.png - EEA logo

waveforms/2024/014 - a directory with one day of waveform files, serves as a working example for test run of the program

Format description:

stations file:

CODE X Y Z SENSITIVITY MAGNITUDE_CORR PATH

CODE - 3-4 letter code of the station

X ,Y, Z - Cartesian coordinates of the station

SENSITIVITY - sensor sensitivity in V/m/s

MAGNITUDE_CORR - magnitude correction

PATH - directory with mseed waveform files. It is assumed that it contains subdirectory named by year with subdirectories named by sequential day number (julian days). Three files with Z,N,E components is expected, following the naming convention

StationCode_ChannelCode_Year_Day_00_00_00 for example: ASH_CHZ_2024_005_00_00_00.

example:

```
ASH -4314 8317 65 400 0.56 /media/datajem/arch/reykjanet
FAF -8437 -647 163 400 -0.38 /media/datajem/arch/reykjanet
HRG 3965 5371 198 400 0.16 /media/datajem/arch/reykjanet
```

parameter file:

- comments, lines ignored by the program

value :variable_name - variables defined in parameter file are lines starting with a value followed by a variable name preceded by a colon

example:

```
# filter passband - lower corner frequency, upper corner frequency
4,35 :passband
```

location file:

2 header lines - first line lists the main parameters used for location, second line is actual header for columns in each event line

variable number of event lines - each starts with Ev, then a space separated location data follow: year, month, day, hour, minute (all in two-digit format), second (decimal number), X, Y, Z (Cartesian coordinates of the hypocenter, in km), local magnitude, magnitude error, ratio, RMS, number of P used for location, number of S used for location

example:

```
s-p:5.0 maxdep:10.0 v_ap:10.0 s-sFact:1.5 grossErr:2 matchPS:0 onlyP:0 Vp:5.50
Vs/Vp:1.70 masterDet:0
yy mm dd HH MM SS X0 Y0 Z0 ML Merr Rat RMS nP nS
Ev 24 02 14 01 24 30.059 -18.17 -4.88 8.25 0.84 0.00 16.77 0.000 3 1
Ev 24 02 14 01 42 21.901 -14.21 -3.68 8.54 0.26 0.15 11.77 0.006 3 2
Ev 24 02 14 02 00 57.435 -18.31 -5.42 7.36 0.43 0.38 11.97 0.021 3 2
```

picks file:

one header line - lists the main parameters used for location

set of event lines followed by phase lines

event line - each starts with Ev, then a space separated location data follow: year, month, day, hour, minute (all in two-digit format), second (decimal number), X, Y, Z (Cartesian coordinates of the hypocenter, in km), local magnitude, magnitude error, ratio, RMS, number of P used for location, number of S used for location

phase line - CODE (3-4 letter station code), time of P phase onset (number of days from year 0, NaN for no P pick), time of S phase onset (number of days from year 0, NaN for no S pick), S-wave amplitude, weight (always equal to 1.000, not used in this version)

example:

s-p:5.0 maxdep:10.0 v_ap:10.0 s-sFact:1.5 grossErr:2 matchPS:0 onlyP:0 Vp:5.50
Vs/Vp:1.70 masterDet:0

Ev 24 02 14 01 24 30.059 -18.17 -4.88 8.25 0.84 0.00 16.77 0.000 3 1

ASH	NaN	NaN	NaN	1.000
FAF	NaN	NaN	NaN	1.000
HRG	NaN	NaN	NaN	1.000
KLV	NaN	NaN	NaN	1.000
LSF	739296.05870218	NaN	NaN	1.000
SEA	NaN	NaN	NaN	1.000
ELB	NaN	NaN	NaN	1.000
LAT	NaN	NaN	NaN	1.000
ISS	739296.05870106	NaN	NaN	1.000
GEI	NaN	NaN	NaN	1.000
LHL	NaN	NaN	NaN	1.000
LAG	739296.05870208	739296.05871667	0.22000000	1.000
HDV	NaN	NaN	NaN	1.000
STH	NaN	NaN	NaN	1.000
MOH	NaN	NaN	NaN	1.000
SKG	NaN	NaN	NaN	1.000
HRV	NaN	NaN	NaN	1.000
KRI	NaN	NaN	NaN	1.000
KAS	NaN	NaN	NaN	1.000
NYL	NaN	NaN	NaN	1.000
RNE	NaN	NaN	NaN	1.000
SAN	NaN	NaN	NaN	1.000
VOG	NaN	NaN	NaN	1.000
VOS	NaN	NaN	NaN	1.000
GRV	NaN	NaN	NaN	1.000

Ev 24 02 14 01 42 21.901 -14.21 -3.68 8.54 0.26 0.15 11.77 0.006 3 2

ASH	NaN	NaN	NaN	1.000
FAF	NaN	NaN	NaN	1.000
HRG	NaN	NaN	NaN	1.000
KLV	NaN	NaN	NaN	1.000
LSF	739296.07110713	739296.07112157	0.30000000	1.000
SEA	NaN	NaN	NaN	1.000
ELB	NaN	NaN	NaN	1.000
LAT	NaN	NaN	NaN	1.000
ISS	739296.07110468	NaN	NaN	1.000

GEI	NaN	NaN	NaN	1.000
LHL	NaN	NaN	NaN	1.000
LAG	NaN	NaN	NaN	1.000
HDV	NaN	NaN	NaN	1.000
STH	NaN	NaN	NaN	1.000
MOH	NaN	NaN	NaN	1.000
SKG	NaN	NaN	NaN	1.000
HRV	739296.07111014	739296.07112625	-0.18000000	1.000
KRI	NaN	NaN	NaN	1.000
KAS	NaN	NaN	NaN	1.000
NYL	NaN	NaN	NaN	1.000
RNE	NaN	NaN	NaN	1.000
SAN	NaN	NaN	NaN	1.000
VOG	NaN	NaN	NaN	1.000
VOS	NaN	NaN	NaN	1.000
GRV	NaN	NaN	NaN	1.000

Usage:

To run the rapl executable an automatically generated shell script run_rapl.sh provided by MATLAB Compiler toolbox is recommended.

```
./run_rapl.sh <mcr_directory> <argument_list>
```

As RAPL itself requires three arguments (parameter_file,year,day) there must be four in total, i.e. in following order: path to MCR directory, parameter file name including path, year and day to be analyzed.

example:

```
./run_rapl.sh /usr/local/MATLAB/MATLAB_Runtime/R2022b/ ./reyknet.par 2024 14
```