Developing your own programs in Madagascar

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Writing and adding your own programs

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- Include both seismic and generic data processing tools

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BUT

- Some tasks are not (easily) doable with available tools; some tools may not exist at all
- Need to develop programs for your own purpose

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How are we going to do it?

- Introduce the program design philosophy in Madagascar
- Give an overview of the Madagascar APIs
- Use a concrete example to show how to write, add, and test your own programs in Madagascar

Before we start

Program architecture

- Madagascar programs are task-centric: ONE task per program
- Programs are constructed to run in a pipeline with input from standard in and output to standard out:

```
sfwindow < in.rsf | sf_my_program | sffft > out.rsf
```

- Pass parameters from command line or SConstruct file

Before we start

Where to begin

- Break the problem into several pieces: each performs a single task
- For each task, make sure to check out

  `sfdoc -k keyword`

  or List of programs on ahay.org

Do not waste time reinventing things !

Common programs to use:
e.g. data set manipulation (add, multiply, concatenate...), FFT, bandpass filtering, etc.

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- Write new code that applies FFT, then the filter, and then the inverse FFT
- Write new code that applies the filter, and call an existing library for FFT and its inverse
- Only write the filter program, and use Madagascar programs for FFT and its inverse

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Not task-centric and Xiaoming wastes time researching/ writing/debugging a FFT code

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Not task-centric but Xiaoming uses existing libraries to shorten the development time

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Task-centric coding that can be used in a pipeline, and be applied to any frequency domain data set

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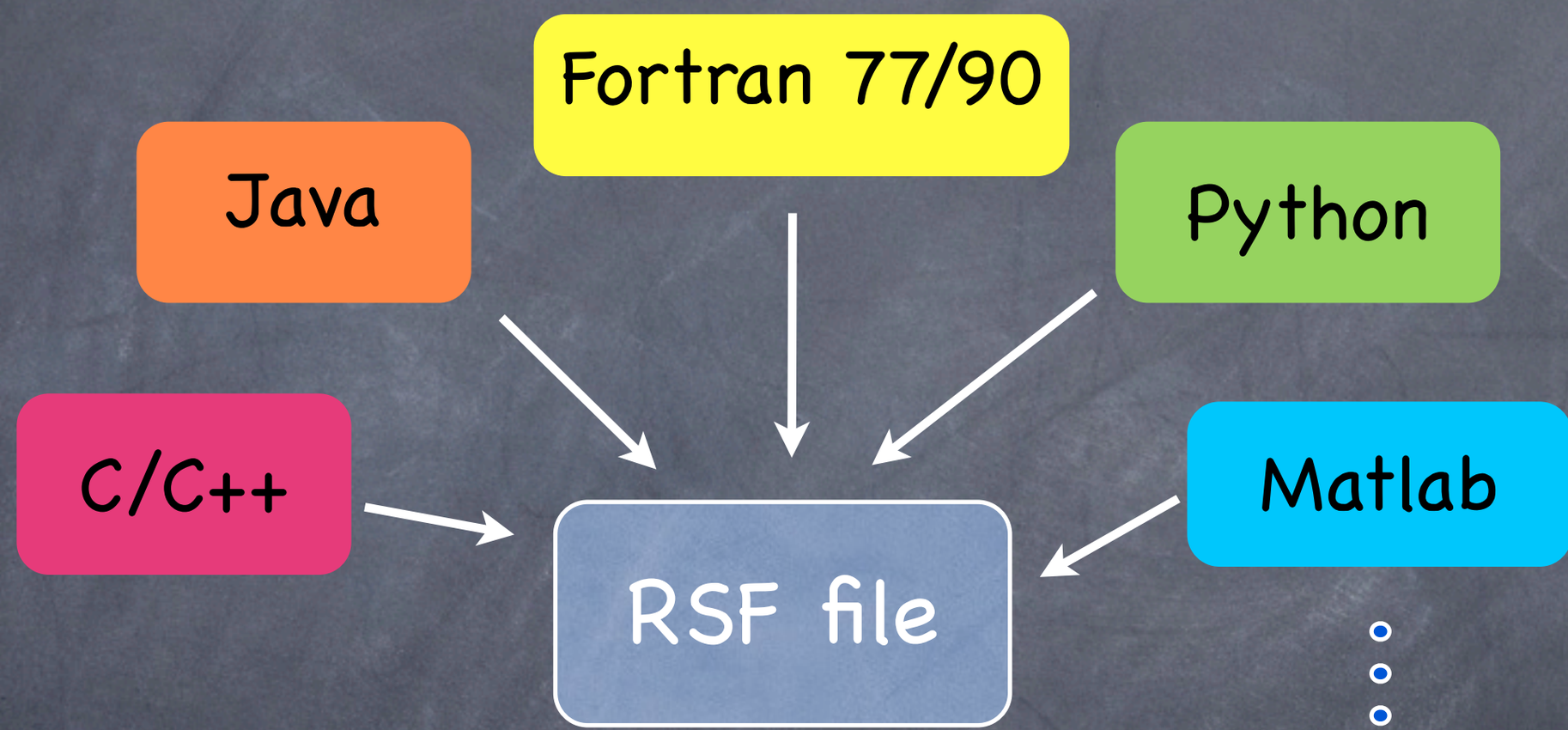
Madagascar APIs



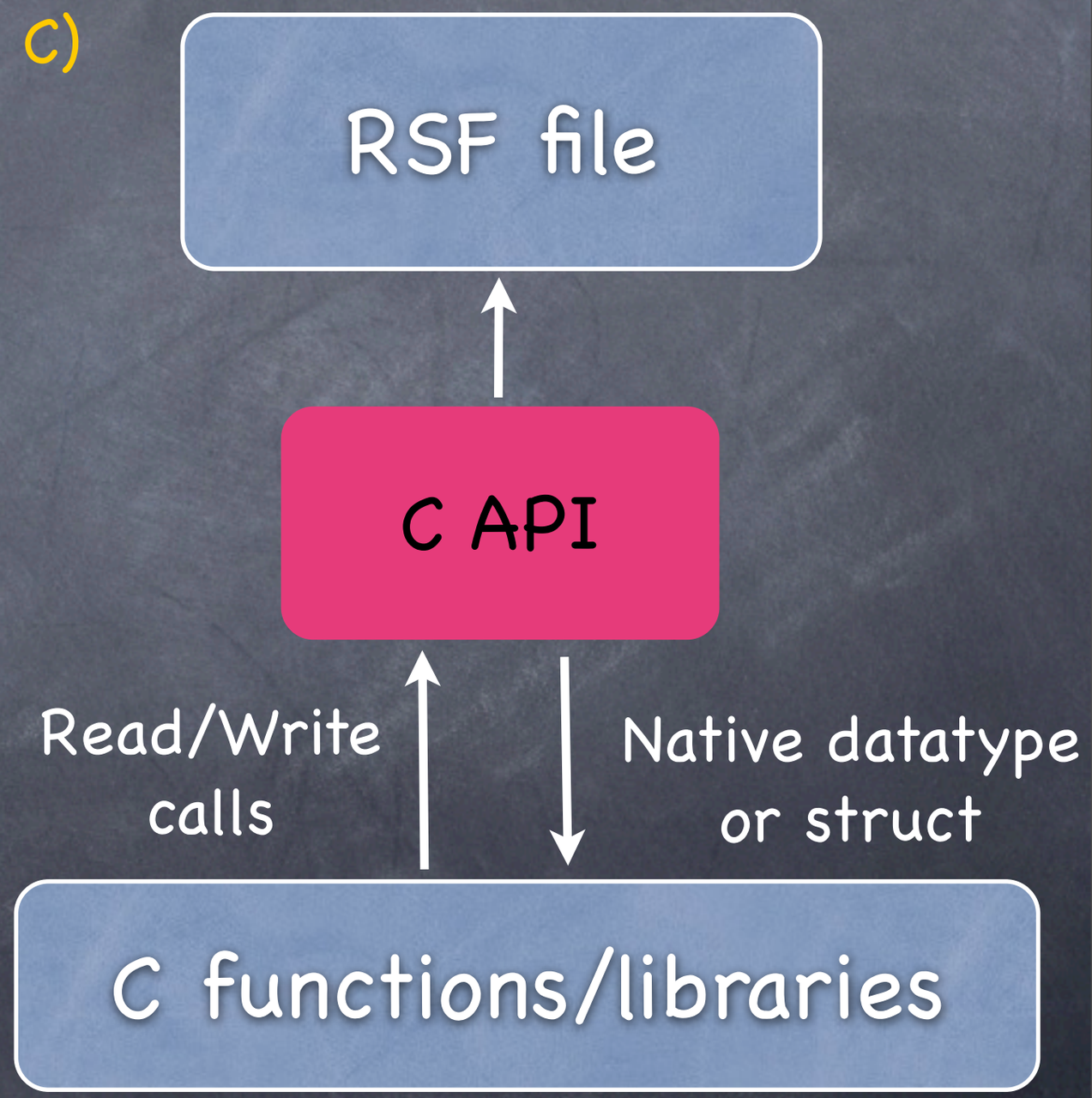
Application Programming Interface (API)

- A set of rules or interface that software programs follow to communicate with each other
- Specifies routines, data structures and the protocols used for communicate between the consumer program and the implementer program of the API

Overview of C API

Strength of Madagascar API (here C)

- Interoperable
  - Common RSF file structure
  - Defines standard for data exchange
  - Enables pipelining with other programs
- Improves development efficiency
  - Access RSF C function/libraries
  - Encapsulate many tasks (e.g. predefined data I/O subroutines)
- Enhances usability
  - Common program documentation style
  - Helps other people use your code
  - Helps you use other people's code



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- Compile and install it in Madagascar
- Test it with various SConstruct Flow() and Plot() rules or command lines

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```
RSFSRC/book/rsf/school2012/cpp_code

RSFSRC/book/rsf/school2012/test
```

Task

Apply the soft thresholding to an 1-D data set

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Apply the soft thresholding to an 1-D data set

Soft thresholding function:

$$S(x) = \begin{cases} x - \mu & x \geq \mu \\ 0 & |x| < \mu \\ x + \mu & x \leq -\mu \end{cases}$$

used for denoising. μ is the thresholding parameter.

Apply $S(\cdot)$ to the data componentwisely

Madagascar program in C++

~/cpp_code/Mtest.cc

```
// Soft thresholding for 1-D data

#include<rsf.hh>

int main(int argc, char** argv)
{
  // Initialize RSF
  sf_init(argc,argv);


  // Get input
  iRSF input;
  int n1;
  input.get("n1",n1);

  // Read data
  std::valarray<float> fdata(n1);
  input >> fdata;
```

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n1 is the data size

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```

access the C++ interface

initialize the internally stored table of command-line arguments

declare the input file
n1 is the data size

data is stored using the valarray template class from the standard C++ library

Madagascar program in C++

~/cpp_code/Mtest.cc

```
// Get parameter
iRSF par(0);
float mu;
par.get("mu",mu);
// threshold value


// Soft thresholding
for (int i=0; i<n1; i++) {
  if (fdata[i]<=-mu)
    fdata[i]=fdata[i]+mu;
  else if (fdata[i]>=mu)
    fdata[i]=fdata[i]-mu;
  else
    fdata[i]=0;
}
```

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the command-line parameter is also handled as iRSF object, initialized to zero

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the main part of the program loop over all components to apply the soft thresholding function

Madagascar program in C++

~/cpp_code/Mtest.cc

```
  // Set output
  oRSF output;

  // Write data
  output << fdata;

  exit(0);
}
```

Madagascar program in C++

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```
  // Set output
  oRSF output;

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  output << fdata;

  exit(0);
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```

declare the output file
if size different from input
output.put("n1",n1)...

Madagascar program in C++

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// Set output
oRSF output;

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```

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if size different from input
output.put("n1",n1)...

Basic flow of a Madagascar program

read data and parameters

↓

process data

↓

write data to output

Build programs to Madagascar 1

- Create a directory YourName under RSFSRC/user
- cd to YourName and copy Mtest.cc and SConstruct files under cpp_code to the directory YourName

this SConstruct file is for compiling (like a makefile), different from the one for managing data processing flows

Build programs to Madagascar 2

- `cd RSFSRC/user/YourName` and `scons` to compile locally with debugging flags, generating an executable file `sftest`
- `cd RSFSRC` and `scons install` to compile globally with optimization flags and install the program in Madagascar

Need to install the C++ interface to complete these steps

```
./configure API=c++
scons install
```

Test programs in Madagascar

- Now the program should be installed in Madagascar, type `sftest` in terminal to see its documentation
- `cd RSFSRC/book/rsf/school2012/test` and test the program using the `SConstruct` file there or command line

Use what you learned yesterday to view and modify the results

Further information

- http://ahay.org/wiki/Guide_to_madagascar_API
  a simple example written in different APIs
- http://ahay.org/wiki/Adding_new_programs_to_Madagascar
- http://ahay.org/wiki/Contributing_new_programs_to_Madagascar
- http://www.ahay.org/RSF/book/rsf/manual/manual_html/
  a full reference of the C API