Creating Shareable Models

By: Eric Hutton

CSDMS - Community Surface Dynamics Modeling System

(pronounced ˈsɪstəms)

Image by Flickr user Let There Be More Light

A model can more easily be used by others if it is *readable* and has an *API*

Readable

> **Someone new to your code should be able to give it a quick read a know what's going on.**

Application Programming Interface (API)

> **The interface will allow someone to use it without worrying about implementation details.**

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But before all that though, choose a license and a language

The GNU General Public License is a good choice.

But there are hundreds more. For example,

- MIT
- Apache
- LGPL
- OSL
- GPLv3

As far as languages, C is a good choice.

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Writing readable code mostly means sticking to a standard

The code should speak for itself. It doesn't just mean adding more comments.

Super simple things help:

- Spaces instead of tabs
- Useful variable names – especially for global variables and function names
- Underscores in names – water_density is better than iCantReadThis

In the end though, just be *consistent*.

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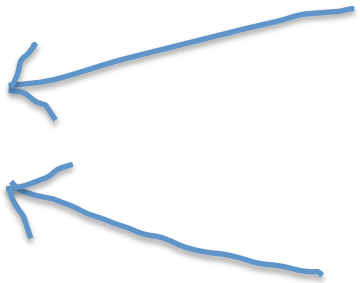
Makefiles and configure scripts help to make code portable

The usual way to compile a software distribution on UNIX is,

```
> ./configure
> make
```



Creates a make file specific to your system

Compiles the code

Compile with `–Wall` compile flag and pay attention to the warnings.

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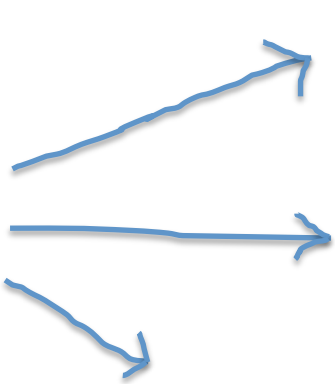
If your code comes with documentation, it is more likely to be used by others



There are tools that help with this

javadoc (Java)

doctest (Python)

Doxygen
(C, C++, Java, Python, Fortran)

These all generate documentation from comments within your code.

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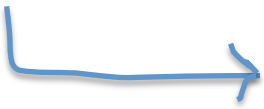
Our models are difficult to couple because of implementation details

Some reasons that models are difficult to link or share:

- Languages
- Time steps
- Numerical schemes
- Complexity

These are all implementation details. The user shouldn't have to worry about these details.



Design an interface!

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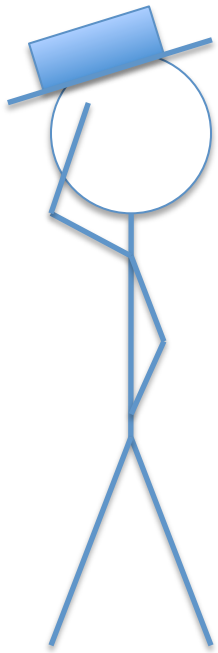
A modeling interface hides implementation details from the application developer

You



A coastal evolution model, say

Lots of crazy, hard to understand code

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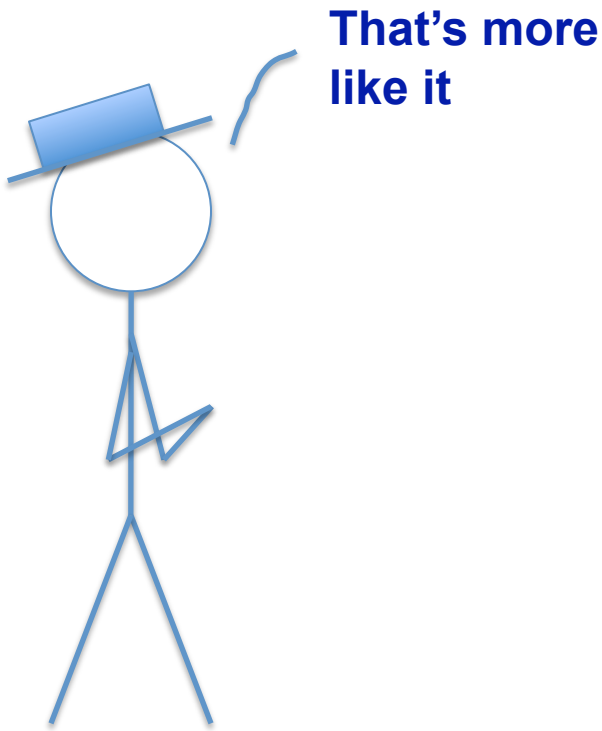
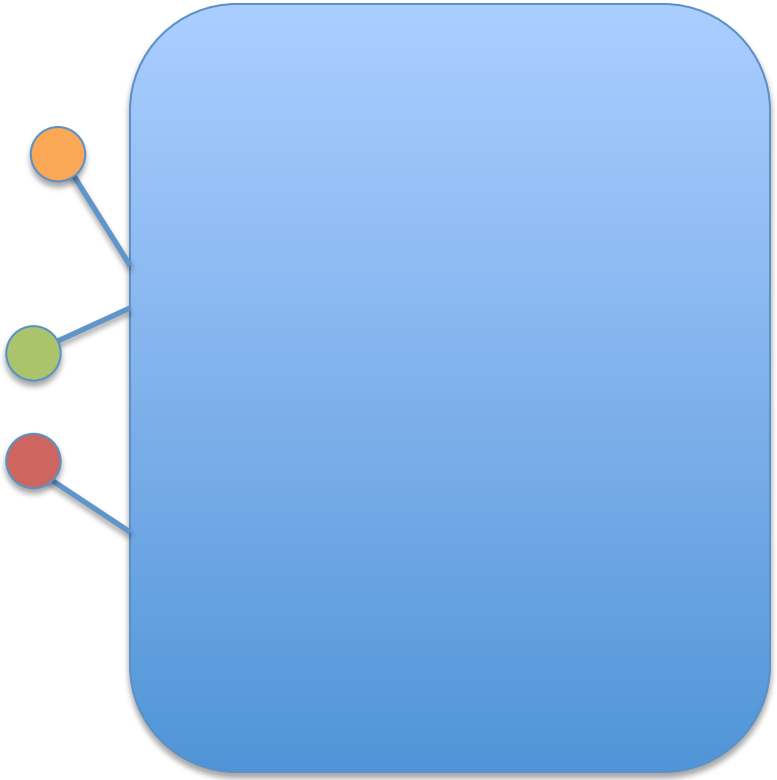
A modeling interface hides implementation details from the application developer

You



A coastal evolution model, say



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For our models a useful interface is IRF

I is for *Initialize*

R is for *Run*

F is for *Finalize*

```
int
main()
{
  initialize_stuff();

  run_until_stop_time();

  print_output();

  return SUCCESS;
}
```

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When designing interfaces it is often easiest to start at the end

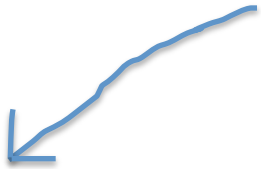
```
int
main()
{
  CEM_state* s = cem_init();
  double *d0, *d1;

  cem_run_until( s, 25. );
  d0 = cem_get_water_depth( s );

  cem_run_until( s, 100. );
  d1 = cem_get_water_depth( s );

  cem_finalize( s );

  return SUCCESS;
}
```

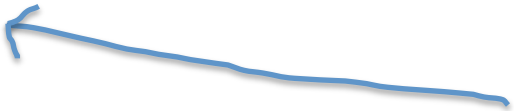


Setup the model run

Run the model for 25 years

Get the water depths

Run the model for an additional 75 years and get water depths



Do whatever needs to be done before quitting

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The initialize step sets up a new model run (instance)

Things that might be done within the initialize method:

- Create a new state for the model
- Allocate memory
- Set initial conditions
- Pretty much anything that is done before the time looping begins

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The finalize step destroys an existing model run (instance)

Things that might be done within the finalize method:

- Free resources
- Close files
- Print final output
- Pretty much anything that is done after the time looping ends

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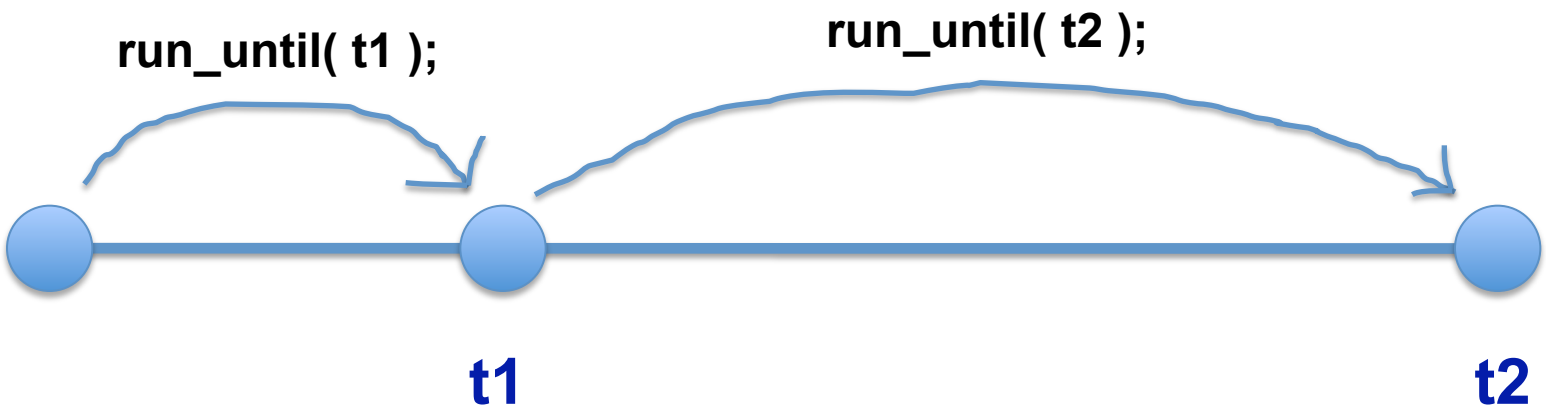
The run step advances the current state of the model forward in time

The run method advances the model from its current state to a future state.



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Oftentimes it is useful to create a data type that holds the current state of the model

This is the hard part.

Identify all of the variables that need to be remembered to advance the model forward in time.

Collect these variables (I generally wrap them in a struct or class). I suppose a common block or a set of global variables would do.

This data structure can then be passed to the various methods of the API.

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Getters and setters are used to interact with the model's state

The state structure should be opaque to the user – that is implementation stuff

Instead, use get and set functions. For instance,

```
get_water_depth( );

set_input_file( "input" );
```

It is up to the API designer to decide what variables are allowed to be get/set.

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Refactoring your code in this way should not change model output

…unless you find (and fix) a bug.

To make sure that you don't add bugs when refactoring,

Make lots of tests

Run these tests often

Keep in mind that output may not be byte-for-byte comparable to your benchmarks

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In conclusion,

Sharing models is good.

Write code that someone else can understand. Pick a standard and stick to it.

Create an API.

- Leave implementation details to the experts.
- Worry about your own model.

Questions?

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