Chrono::Python

Python Interoperability Module

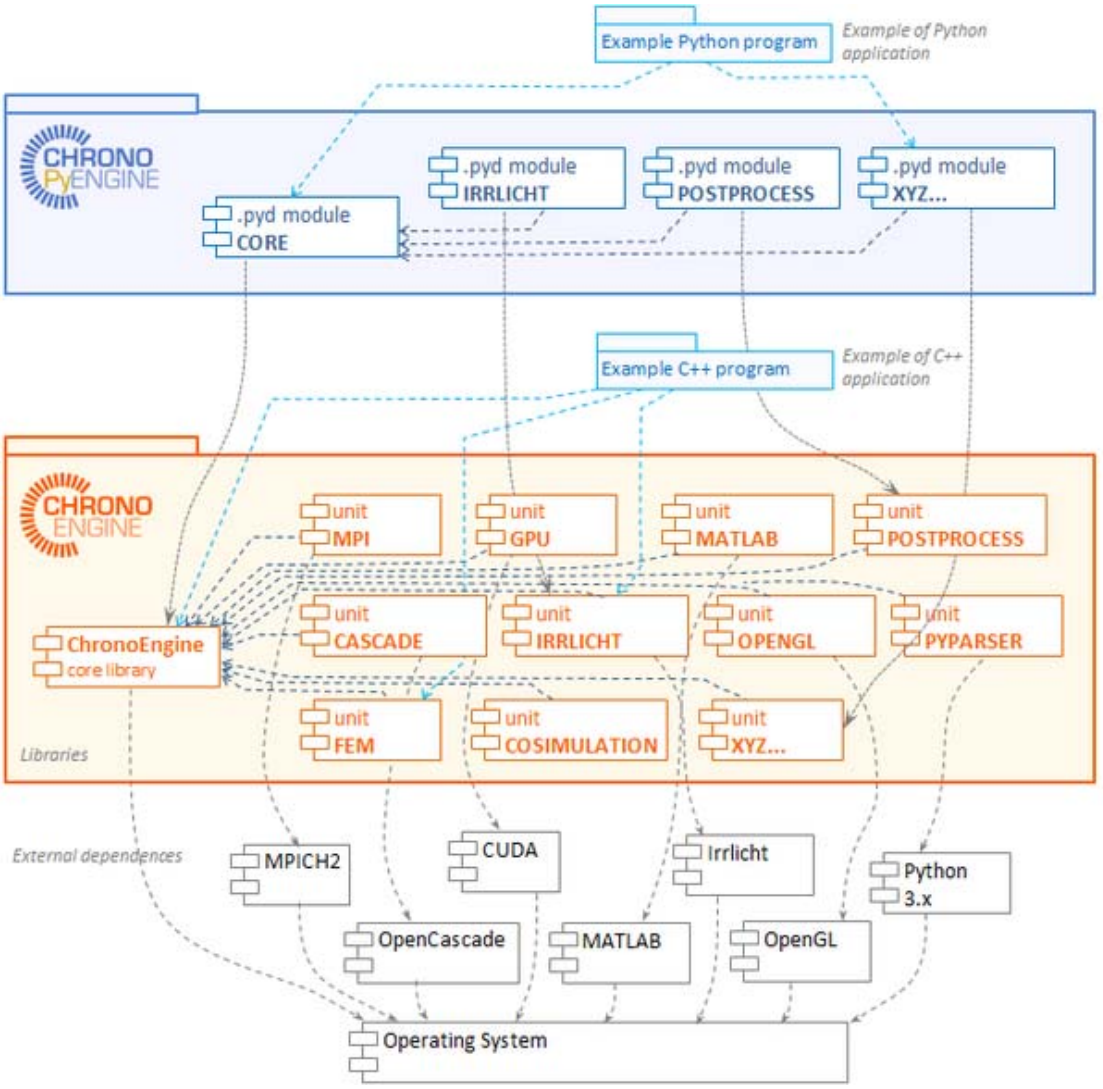
Chrono::Python

- Use Python in Chrono? Yes!
  The **PYTHON module** is a wrapper to Chrono classes and functions

- How to build it:
  - Install Python (suggested v.3.3 or later), 64 bit if you compiled Chrono in 64 bit
  - Install the SWIG tool
  - Enable PYTHON module in Chrono CMake
  - Set directories to Python libs etc. in the Cmake
  - Build Chrono – generating the PYTHON module might require few minutes…

- The **PYTHON module** of Chrono contains
  a) The **ChronoEngine_pyparser.dll** library for parsing Python **from the C++ Chrono side**
  b) The **Chrono::PyEngine .pyd modules** for calling the API **from the Python side**

Chrono::Python



a) Call Python from the C++ side

a) Call Python from the C++ side:

- Use the ChronoEngine_pyparser.dll library

- Create a python engine for parsing:

```
ChPythonEngine my_python;

// figure out what version of Python is run under the hood

my_python.Run("import sys");
GetLog() << "Python version run by Chrono:\n";
my_python.Run("print (sys.version)");
```

- Execute Python instructions:

```
my_python.Run("a =8.6");
my_python.Run("b =4");
my_python.Run("c ='blabla' ");
my_python.Run("print('In:Python - A computation:', a/2)");
```

a) Call Python from the C++ side:

```
// TEST -   fetch a value from a python variable (in __main__ namespace)

GetLog() << "\n\n Chrono::PyEngine Test 3.\n";
double mfval;
my_python.GetFloat("a", mfval);
GetLog() << "In:C++    - Passed float variable 'a' from Python, a=" << mfval << "\n";

// TEST    -   set a value into a python variable (in __main__ namespace)

my_python.SetFloat("d", 123.5);
my_python.Run("print('In:Python - Passed variable d from c++, d=', d)");

// In the previous examples we didn't have any syntax errors.
// In general, it is wise to enclose Python commands in a try-catch block
// because errors are handled with exceptions:

try {
        my_python.Run("a= this_itGoInG_TO_giVe_ErroRs!()");
    }
    catch (ChException myerror) {
        GetLog() << "Ok, Python parsing error caught as expected.\n";
    }
```

a) Call Python from the C++ side:

- Load a mechanical system in a .py file:

```
// load a mechanical system, previously saved to disk from SolidWorks add-in

ChSystem my_system;

    try {

        my_python.ImportSolidWorksSystem(GetChronoDataFile("solid_works/swiss_escapement").c_str(),
                                         my_system);  // note, don't type the .py suffic in filename..

        my_system.ShowHierarchy(GetLog());
    }
```

- How to generate the .py models? → See the Chrono::SolidWorks add-in

b) Use Chrono from the Python side

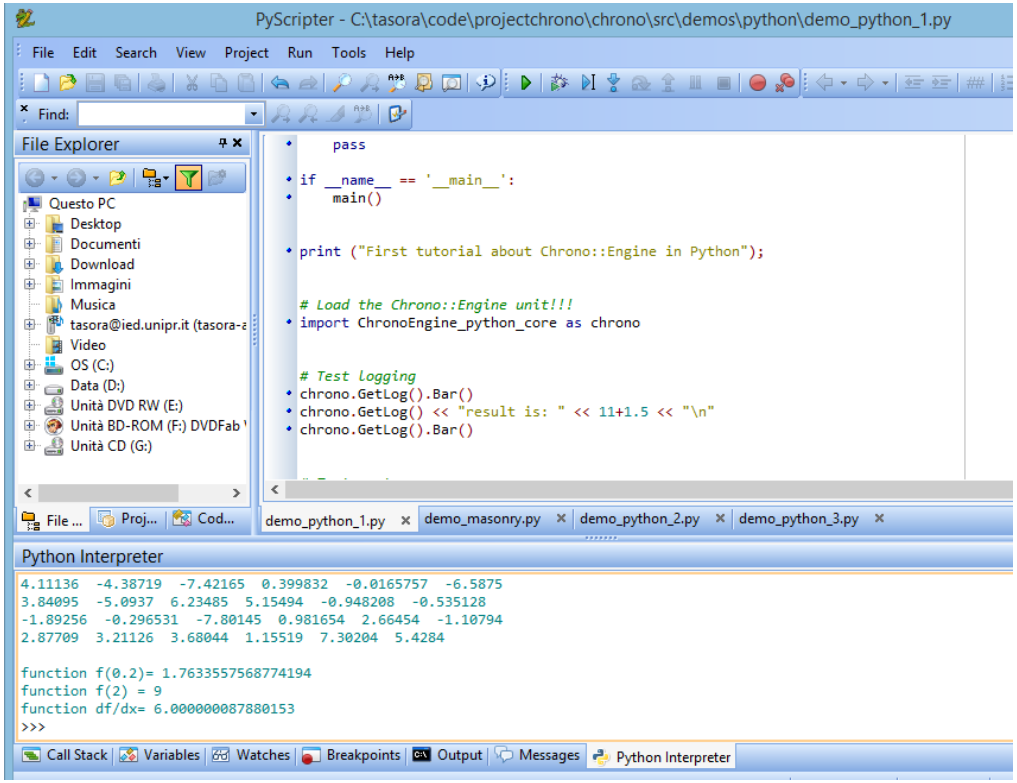
b) Use Chrono from the Python side:

- Have you built Chrono::PyEngine? (see build instructions on the web site)

- Ok, now you can call Chrono API functions from a Python command line!

- Suggested: use PyScripter or similar IDEs for editing/running Python programs →

- Hint: look at .py examples in chrono\src\demos\python



b) Use Chrono from the Python side:

- Important!!! All Python programs must import Chrono::PyEngine Python modules using the import statement:

```
import ChronoEngine_python_core as chrono
```

- Chrono classes will be accessed via the `chrono.xxyyyzzz` Python namespace

- If you use additional modules, for example, add also

```
import ChronoEngine_python_postprocess as postprocess
import ChronoEngine_python_irrlicht    as chronoirr
```

b) Use Chrono from the Python side:

- Let's create a 3D vector object:

```
my_vect1 = chrono.ChVectorD()
```

- Modify the properties of that vector object; this is done using the . dot operator:

```
my_vect1.x =5
my_vect1.y =2
my_vect1.z =3
```

- Some classes have build parameters, for example another vector can be built by passing the 3 coordinates for quick initialization:

```
my_vect2 = chrono.ChVectorD(3,4,5)
```

- Most operator-overloading features that are available in C++ for the Chrono::Engine vectors and matrices are also available in Python, for example:

```
my_vect4 = my_vect1*10 + my_vect2
```

b) Use Chrono from the Python side:

- Member functions of an object can be called using the . dot operator, like in C++:

```
my_len = my_vect4.Length()
print ('vector length =', my_len)
```

- You can use most of the classes that you would use in C++, for example let's play with quaternions and matrices:

```
my_quat = chrono.ChQuaternionD(1,2,3,4)
my_qconjugate = ~my_quat
print ('quat. conjugate =', my_qconjugate)
print ('quat. dot product=', my_qconjugate ^ my_quat)
print ('quat. product=', my_qconjugate % my_quat)
ma = chrono.ChMatrixDynamicD(4,4)
ma.FillDiag(-2)
mb = chrono.ChMatrixDynamicD(4,4)
mb.FillElem(10)
mc = (ma-mb)*0.1;
print (mc);
mr = chrono.ChMatrix33D();   ...
```

b) Use Chrono from the Python side:

Differences respect to the C++ API:

- Not all C++ classes/functions are wrapped in Python

- Templated classes are instanced with type ‘double’ by appending ‘D’ at the name:

PYTHON	**C++**
`chrono.ChVectorD`	`ChVector<double>`
`chrono.ChQuaternionD`	`ChQuaternion<double>`
`chrono.ChMatrix33D`	`ChMatrix33<double>`
`chrono.ChMatrixNMD`	`ChMatrixNM<double>`

b) Use Chrono from the Python side:

Differences respect to the C++ API:

- Shared pointers are handled automatically:

C++:

```
std::shared_ptr<ChLinkLockRevolute> my_link_BC(new ChLinkLockRevolute);
```

PYTHON:

```
my_link_BC = chrono.ChLinkLockRevolute()
```

- Upcasting is automatic, like in C++, but downcasting? There are no dynamic_cast….
  But we added some helper functions called `CastToChClassNameShared()` :

C++:

```
myvis = std::dynamic_pointer_cast<ChVisualization>(myasset);
```

PYTHON:

```
myvis = chrono.CastToChVisualizationShared(myasset)
```