Improving reflection layer in cppyy using Cling

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Introduction

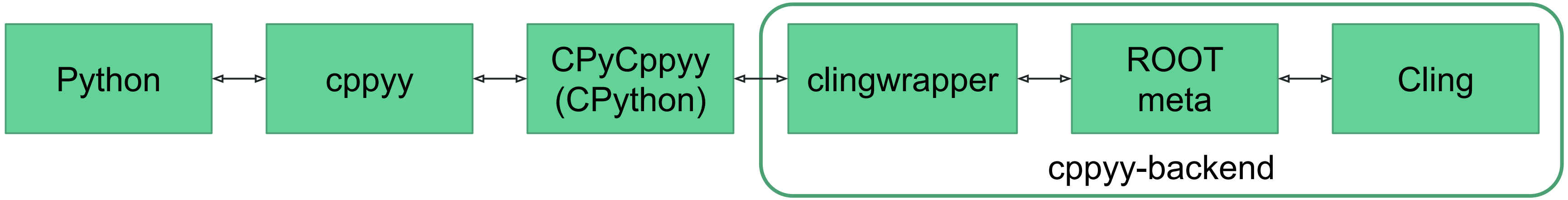
cppyy: Generates Python C++ binding at runtime, automatically

Cling: interactive C++ interpreter

ROOT meta: A layer in ROOT that provides reflection

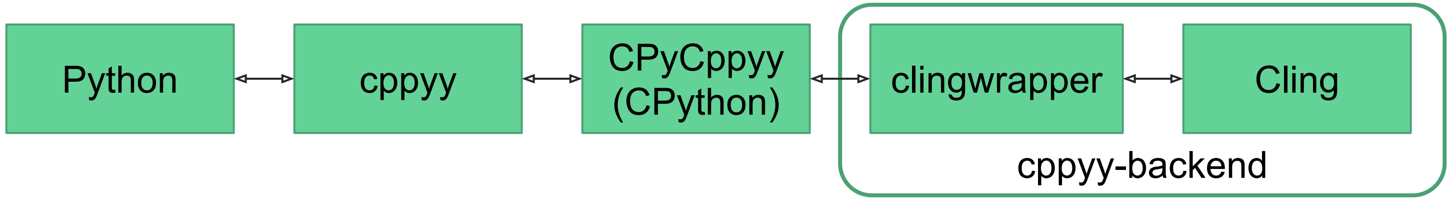
```
>>> a = 10
>>> type(a)  # Reflection in Python
<type 'int'>
```

```
import cppyy
s = cppyy.gbl.std.string("Hello World!!")
```



Problem Statement

Convert cppyy-backend to use Cling directly instead of ROOT meta and use it in cppyy



Why?: ROOT meta adds unnecessary code bloat and the performance of cppyy can be improved using Cling

Ultimately we want a cppyy-style python language interop but the ROOT meta dependency of cppyy is unnecessary. So we aim to make a libInterop library without such dependency and add it to llvm mainline

Current Approach

1) Look at CPyCppyy top level functions and list the requirements. E.g. Functions like `CreateScopeProxy` need to lookup C++ classes, namespaces, etc. so we need to have an API that can lookup these easily.

Current implementation:

```
PyObject* CPyCppyy::CreateScopeProxy(const
std::string& name, PyObject* parent, const
unsigned flags) {
  // search for the scope using ROOT meta
  //
  // if its a namespace return a proxy
  // without any further details
  //
  // if its a class return a proxy with all
  // details of the class:
  //     base classes, data members, functions
  //     etc.
}
```

Intended implementation:

```
PyObject* CPyCppyy::CreateScopeProxy(const
std::string& name, PyObject* parent, const
unsigned flags) {
  // lookup the name through Cling
  //
  // if the name is a class or namespace return
  // a proxy with the name (without any
  // internal details)
}
```

Current Approach

2) Optimize wherever possible. E.g.:

   a) CPyCppyy creates snapshots of classes because it depends on ROOT meta, Cling lookups are O(1) so lazy lookups are better.

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   b) cppyy-backend is made with iteration in mind, i.e., a call is first made to get the number of items in a scope and then the user can access these items using indexes. Cling uses a direct access approach and the user can look for items using their name.

Using ROOT meta:

```
const Cppyy::TCppIndex_t nDataMembers = Cppyy::GetNumDatamembers(scope);
for (Cppyy::TCppIndex_t idata = 0; idata < nDataMembers; ++idata) {
    ...
}
```

Using Cling:

```
Decl* D = cling::utils::Lookup::Named(Sema, name);
```

Current Approach

3) Replace the functions in cppyy-backend with their Cling counterparts. These can vary in functionality to a great extent.

   For e.g.: functions such as `GetNumDatamembers` might not be required in the cppyy-backend as we will no longer be iterating over the data members of a class.

Extended Approach

An extended approach involves emulating the current functions in cppyy-backend using Cling. This will be required if the library for D and C++ interoperability requires the API to support iterations.

⚠️ Emulating the current API might be detrimental to performance

```
class C {
    int a;            1
    bool f();
    enum Time {
        morning,      2
        evening       3
    };
};
```

```
GetNumDatamembers("C");
// Returns 3
```

```
size_t GetNumDatamembers(std::string name)
{
    // lookup name through Cling
    //
    // get the DeclContext DC of the class
    //
    // for each Decl in DC check if its a
    // member variable or enum and increase
    // counter
    //
    // return counter
}
```

Goals

- The goal for this month is to convert the functions in ProxyWrappers.cxx to use Cling. This will allow cppyy to run simple examples properly.

- A stretch goal will be to shift clingwrapper.cxx to use CMake and statically link with Cling

Blockers

Input from the D representative is needed to figure out how much of the cppyy-backend API can be modified.

Thank you

Any questions?