CPPPY in BioDynaMo

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About Me

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My name is Anton Dekov and I'm a high-school student with an interest in technology and system programming. My goal through my internship at Compiler Research, is to get more real practical experience in the field and to see what potentially awaits me if I decide I want to continue my education in it.

About BioDynaMo

BioDynaMo is a powerful platform for agent based modeling (the simulations consist of autonomous agents that have their own state and behaviours) which has its core written in C++ for its high performance.

The problem

- While C++ is excellent for the performance it provides, Python is often preferred due to its ease of use, vast ecosystem of data science libraries. Creating and developing new agents currently requires writing code in C++ which can be a barrier for some users.

The solution

- The project aims to integrate cppyy, an automatic Python-C++ bindings generator, with BioDynaMo. This will enable a hybrid modeling environment where users can call existing C++ agents from Python and also create new agents in Python that inherit directly from C++ base classes. This combines the performance of C++ with the accessibility, flexibility and libraries of Python

The projects main goals

- Demonstrate a pre-existing, compiled C++ BioDynaMo agent that can be loaded and its methods can be called from a Python script.
- Create a new agent class written entirely in Python that inherits from a C++ BioDynaMo agent.
- Test the newly made class in a BioDynaMo simulation.
- Polish and document everything.

Estimated project timeline:

WEEKS	Tasks	Deliverables
Week 1	Set up BioDynaMo and cppyy	A working workspace for the project
Week 2	Study BioDynaMo agent code from demos and pick one simple agent to focus on	Additional knowledge helpful to the project and a target agent
Week 3	Write a simple C++ class	A working C++ class in

	and load it with cppyy as a test.	python made with cppyy
Week 4	Attempt to load the BioDynaMo library in Python with cppyy and debug loading issues.	A BioDynaMo python script (may still need debugging and not be fully loading.
Week 5/6	Successfully instantiate a C++ agent from Python and call its basic methods.	A Python script that loads a C++ agent and prints its location
Week 7	Buffer week	Fixing bugs and potentially catching up to schedule
Week 8	Research cppyy's inheritance documentation and create a simple test of Python inheriting from C++	Working example of Python inheritance from C++
Week 9/10	Working with BioDynaMo specific types like Double3, AgentUid etc. Test passing and returning these types between Python and C++	Understanding BioDynaMo's complex types and possibly writing a file with helper functions for type conversion.
Week 11	Focus on method overriding	Python agent with overridden methods
Week 12/13	Combine everything and making a fully functioning BioDynaMo agent in Python inheriting from C++	Working example of Python class inheriting from C++ agent (most likely "MyCell()") with method override
Week 14	Test the newly made Python agent by adding it to a BioDynaMo simulation	A smoothly running BioDynaMo simulation that includes our new python class
Week 15	Polish everything, add	Polishing the final

	comments, organise the repository and create a README	result and adding documentation