Individual Software Project Specification
Adding time to the ART

Existing work:
The Advanced Rendering Toolkit (ART) is a physically-based research-oriented renderer used and maintained by the Computer Graphics Group at MFF CUNI. It consists of command-line tools and an extensive library for photorealistic image synthesis that supports various advanced and non-standard features. Linux and macOS are the operating systems supported by the project. Apart from the Objective-C runtime, libraries utilized in the project include libTIFF, OpenEXR, and littleCMS. There is, as of yet, no support for time-based effects and animation, which are the goal of this project.

Project description:
The project's goal is the addition of animation capability, including animated transforms of shapes and the camera, with effects such as motion blur. Xcode under macOS is the tool used for the main bulk of development, but care will be taken, in development, to ensure continued compatibility with Linux systems. The project will not utilize other external tools or libraries of note, apart from basic text editors and libraries already used in the existing code.

Functionality goal:
The camera should have an open shutter interval, which the user should have the ability to set both from the command line and the scene description file. The user should also be able to set a time-based animated path for any object in the scene graph, possibly also other attributes of the objects (e.g., if the object has an emissive surface, it could be possible to change the intensity based on time). The combination of shutter speed in the camera and the animated paths will enable effects such as motion blur.

Algorithm description:
The camera will have an open shutter interval (shutter speed) provided. The user may also provide any objects in the scene with animated paths (and possibly some other animated attributes). The preprocessing step will be to construct bounding boxes that contain the objects at any point in time as specified by the paths. After that, the open shutter interval will get uniformly sampled, for each ray, by a random number generator. The time sample will set the ray's time, and its position will be adjusted based on the animated path in the camera. Then, when calculating the object intersections, the object's transform will be adjusted by the path with the time provided in the ray to calculate the final intersection. The remainder of the path tracing will remain the same as is.

Project structure:
It is essential to uphold the conventions laid out by ART's existing code and documentation. Unfortunately, the exact layout of the future code is hard to plan out in advance with only basic familiarity with the large codebase and its structure. That means that the layout, which would get introduced here, might be hard to implement while keeping the code clean and readable. This section will be updated when the exact code decomposition is easier to pinpoint.