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# The challenges of releasing the Moana Island Scene

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**Figure 1:** *The Moana Island Scene rendered by Disney's inhouse Hyperion renderer [Wal18].*

**Abstract**

*A tremendous amount of research has been done over the years using the Stanford bunny, the Cornell box and recently somewhat more complicated data sets. Yet, none of these data sets come close to representing the complexity that production houses and film studios handle on a daily basis. In recent years industry members have lamented this lack of realistic examples, and in return academics have requested that more representative examples be made available. Both of these points are valid, which in turn has led to the release of the Moana Island Scene dataset. However, while it sounds simple, the actual release of such data leads to numerous philosophical and practical questions. The goal of this paper is to present some of the challenges associated with releasing production data for academic use.*

## 1. Introduction

Every day in the production of a feature film involves highly complex data sets. Finding examples of complex data sets is therefore easy, but this is only the first of many steps towards making a public release of such data. In this short paper, we begin by considering the questions regarding what should go into a good data set. Next, we will discuss the challenges of making that data usable by the research community and validating its correctness. Finally, we briefly note that distributing very large data sets can pose its own set of challenges.

## 2. Selecting a data set

The first question to consider when wanting to release a data set is: What challenges that data set should embody ? There are many challenges in rendering that are all worthwhile exploring, but it's unlikely that they will all be exposed in a single data set. In choos-





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ing the Moana Island Scene we decided to focus on scene complexity due to proceduralism as well as complex volumetric light transport. However, this scene has only one significant light source (the sun) compared to the many thousand light sources in some of the shots in Pixar's Coco movie. Since there is very little animation, there is also no motion blur to speak of.

The next question is: How representative should the data be ? Most renderers take a scene description as input and produce an image as output. In production, images are often composed from multiple layers where some layers are rendered while other layers are painted or captured. More generically, real data often involve "cheats". Should these be preserved to stay true to the original or should they be replaced by more principled approaches if they present more of a challenge to the research community ?

As an example, the original Moana scene contained layers with painted clouds which could in theory have been replaced by volumetric clouds. Ultimately, we removed these clouds entirely from the scene, and instead refer researchers to a separate cloud data set that we have also made public. However, in the case of the ocean we ended up taking the opposite approach. In the original shot (which was created during pre-production of Moana), the ocean was represented as a surface mesh, and the caustics on the bottom were simply hand painted. Later in the production cycle for Moana, the ocean was treated as a volumetric element and the caustics were rendered. For the public data set we therefore opted to replace the original ocean with a volumetric ocean to be more representative of what was done later in production. Although we have only addressed two issues at this point, it should be noted that the released data set has already diverged from the original. In the end our goal was to keep the visual divergence as small as possible, but any strict comparisons between results obtained with the released data set vs. the original data set are meaningless. Instead the intention is that the data set will serve as a self-contained benchmark with all the decisions that have been baked into it.

In hindsight, it should be noted that while the changes may sound simple, they actually required a substantial amount of work in order to create a visually comparable and pleasing result.

## 3. Making data usable

Given a choice of a scene to make public, a very practical question remains : What constitutes a usable data set ? Real production data relies on many proprietary formats and processes that cannot all be made public. Even if they could, it might make the prospect of using the data set so daunting that very few researchers would be willing to commit the time necessary to get everything working. This leads to a philosophical question : How much effort should the academic community be expected to invest to use real production data ? And what compromises are acceptable in order to lower the barrier of entry to using the data ?

Initially our intention was to simply dump out geometry with baked-in displacements and simplified shaders. This would (at least conceptually) have made the data very easy to use, but this quickly proved to be infeasible. The complete scene contains more than 28 million instances of objects such that 94% of all the geometry is in fact an instance of something else. To simply bake this out would have made the size of the data set explode. It would also have made the data less representative of what is encountered in a production environment because many bottlenecks encountered by researchers would have been due to the lack of information that 28 million objects are really just instances. In conclusion we therefore decided to export information about instancing.

Internally, almost all instances are created procedurally using a proprietary system. Unfortunately, there is no standard interchange format for procedural geometry that can be used to export this information, so ultimately we created an ad hoc JSON based file format for representing instancing information.

The initial intention of providing baked-in displacements also seemed like a change that would take us too far from the goal of providing a representative data set. We use Catmull-Clark subdivision surfaces and displacement maps extensively throughout our productions, so we decided that this should be reflected in the data. We rely exclusively on Ptex (see [BL08]) for representing both textures and displacement maps, and while this may not be an industry standard we have already provided an open source library to support this which makes it accessible to all researchers.

**Figure 2:** *The ironwood tree consists of close to 18 million polygons after being exported as an OBJ file making it the most complex element in the scene.*

As a final example, we decided to include a complete version of the ironwood tree shown on the left. This tree represents more than 20% of the unique polygons in the scene and required weeks of effort to export into an OBJ file. Originally, much of this geometry was generated procedurally, but even then it was extremely expensive to work with and ultimately this tree was rarely used in the rest of the movie for that very reason. There are undoubtedly better ways in which this tree could have been authored such that it would have been easier to handle, but this illustrates another common trait for production data : It is often “optimized” for artist time rather than compute time.

In most of the cases mentioned above we opted to stay as true as possible to the original data at the expense of some complexity for the researchers using this data. In other cases, particularly for shading networks and shader parameters, we chose to simplify the data to make it feasible to export it at all. The curve primitives are also missing information about varying width, color, and orientation. As a result the palm fronds have lost some of their visual richness in the public version of the dataset.

In the end, the important point to note is that there are many such decisions that have to be made, and there is not necessarily a clear-cut answer regarding what is right and wrong.

## 4. Validation

Given that the original data cannot simply be released as is, an important consideration is whether the exported data is actually correct or not. In many ways the export process is like an authoring process in which mistakes can be introduced. Thus, to ensure correctness of the public data we decided to add a validation step. This consisted of writing a translator from our intermediate formats into the format needed for the pbrt renderer, [PJH16]. Ultimately, this would serve two purposes. On one hand it validated the correctness of the data, and on the other hand it also provided an easy starting point for any student or researcher to start making images. This effectively lowers the barrier of entry to using the data.

The challenge in coming up with a validation framework is that if the data set is difficult to render, then it will also be difficult to find a renderer to validate the data. In this particular case, there were numerous features missing from pbrt before the scene could be rendered. This included support for the Disney BRDF, support for PTex, support for curves, and the ability to handle millions of instances with nested instancing. Matt Pharr was extremely helpful in adding all of these features to pbrt, but the amount of effort required to come up with a validation framework should not be underestimated. At the same time, the value of doing such validation should also not be underestimated. This process uncovered numerous problems that had to be addressed before we felt comfortable releasing the data to the public.

## 5. Distribution

Even with all the data exported in a format that can be consumed by the academic community, one last question remained : What is the best way to distribute the data ? With a total of 265 GB this data set exceeds the size of most open source projects. It would have been nice to provide it through a version control system to allow for changes to be tracked and contributions to be accepted. However, even with git LFS we found this difficult to support due to the sheer size of the data. In the end, we decided to provide three large tar files to enable users to download only the portions of the data set they need. Even with this approach the data set generated 70 TB of download traffic in the first week after release, and at this point the download links have been hit millions of times.

## 6. Initial results

The community reaction to the release of the data set so far has been overwhelmingly positive, and scene translators have been created for a number of renderers and animation packages. Already at SIGGRAPH 2018 the Moana Island Scene was featured as a benchmark on the exhibition floor showing interactive rendering which revealed details that previously may only have been known to a few artists. A lot of discussion has also taken place regarding creating a USD version of the island. However, given the typical timelines for research, it is too early to tell what the real impact will be in terms of research results.

## 7. Conclusion

In conclusion, our experience has been that releasing real data in a way that is useful can be complicated and requires substantial effort. Anyone asking for data or contemplating releasing data should keep this in mind. We had to make many choices along the way and while there is no way to scientifically test if these were the best choices or not, we hope that the Moana Island Scene will help drive research to better handle the levels of complexity we see in production. In the future it is easy to envision other useful data sets, but to justify that effort we are first looking forward to seeing what new results the Moana Island Scene will bring to the community.

**Figure 3:** *Additional close-up views of the island.*

## References

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