Diplomarbeitspräsentation

A Caching System for a Dependency-Aware Scene Graph

Masterstudium:
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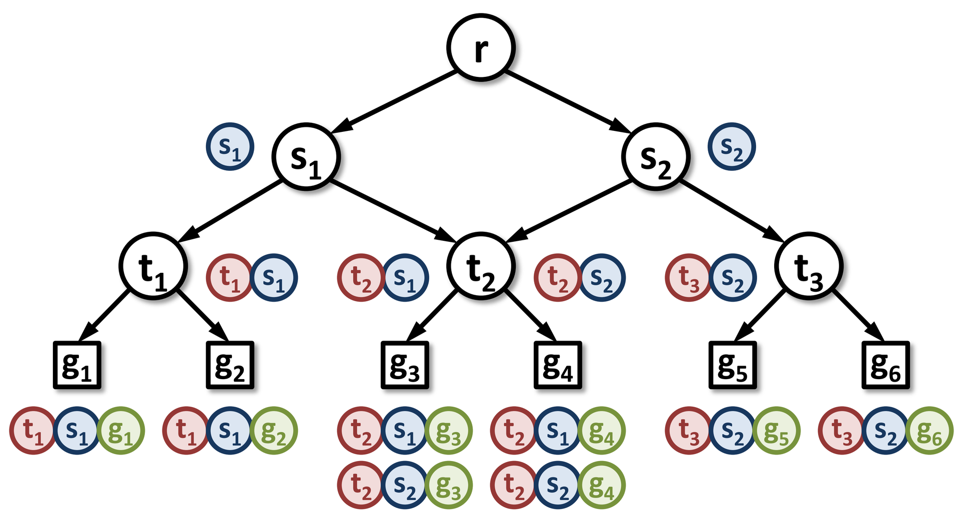
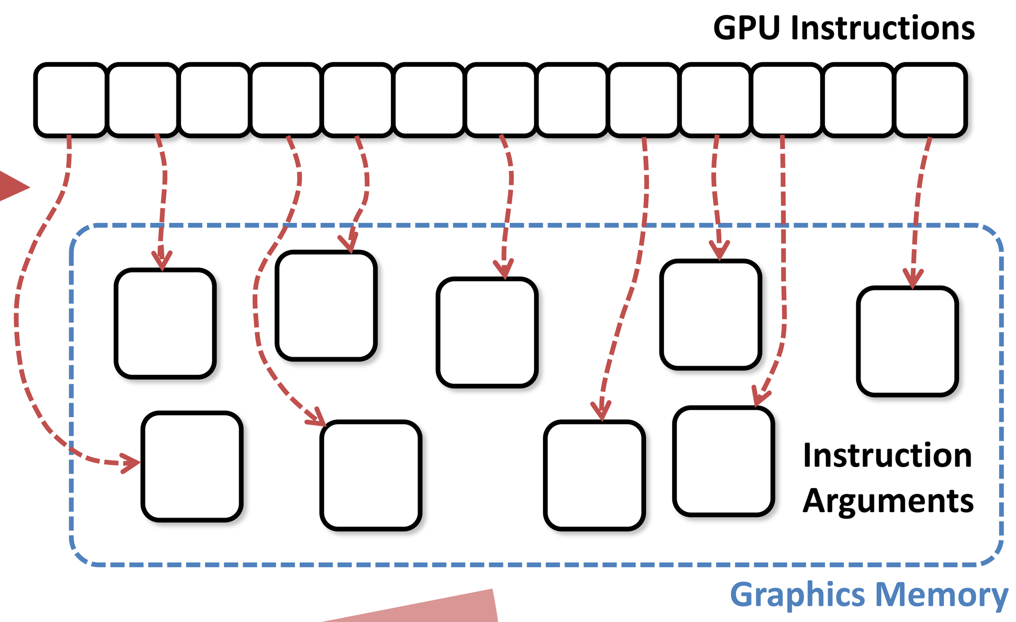
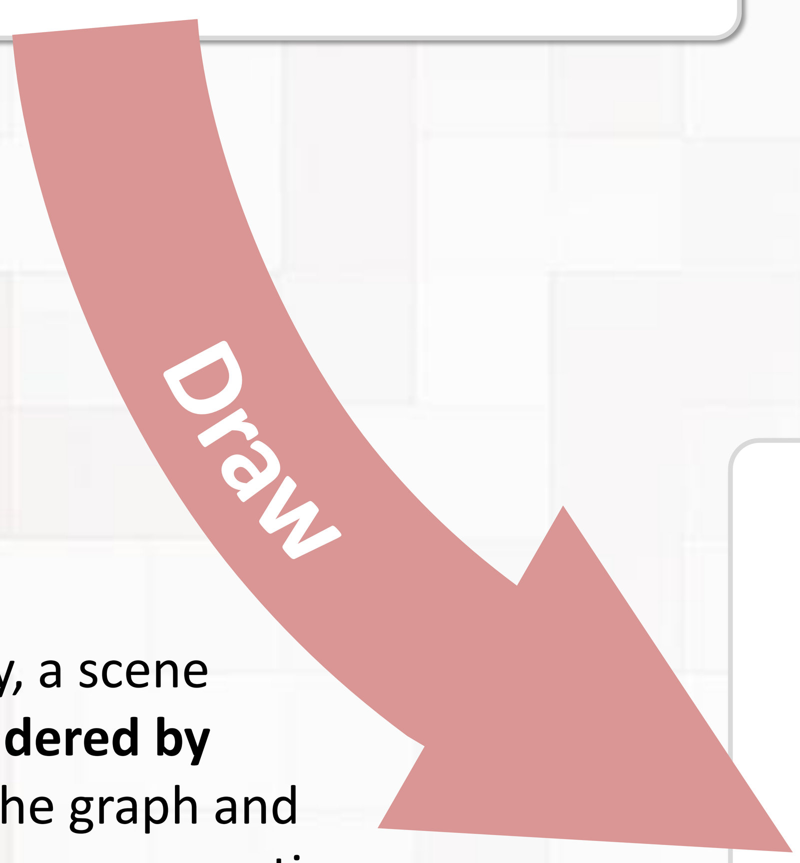
Scene Graphs are a data structure for modelling graphical scenes in the computer. They are based on directed acyclic graphs (DAG) where leaf nodes represent geometric shapes and interior nodes represent shape properties, such as color, texture, or position. These properties are inherited along the edges of the graph.



The **Scene Graph Caching** system proposed in this work *compiles* the scene graph into a render cache that—when executed—will yield the same output image as rendering the scene graph using the traditional algorithm.

A **Render Cache** is a small program consisting of GPU commands and their arguments. Executing this program will instruct the graphics hardware to produce an output image. **Executing** a render cache is **very efficient** because instruction arguments are already prepared in graphics memory. Like a normal computer program, render caches can be further optimized to run even more efficiently.

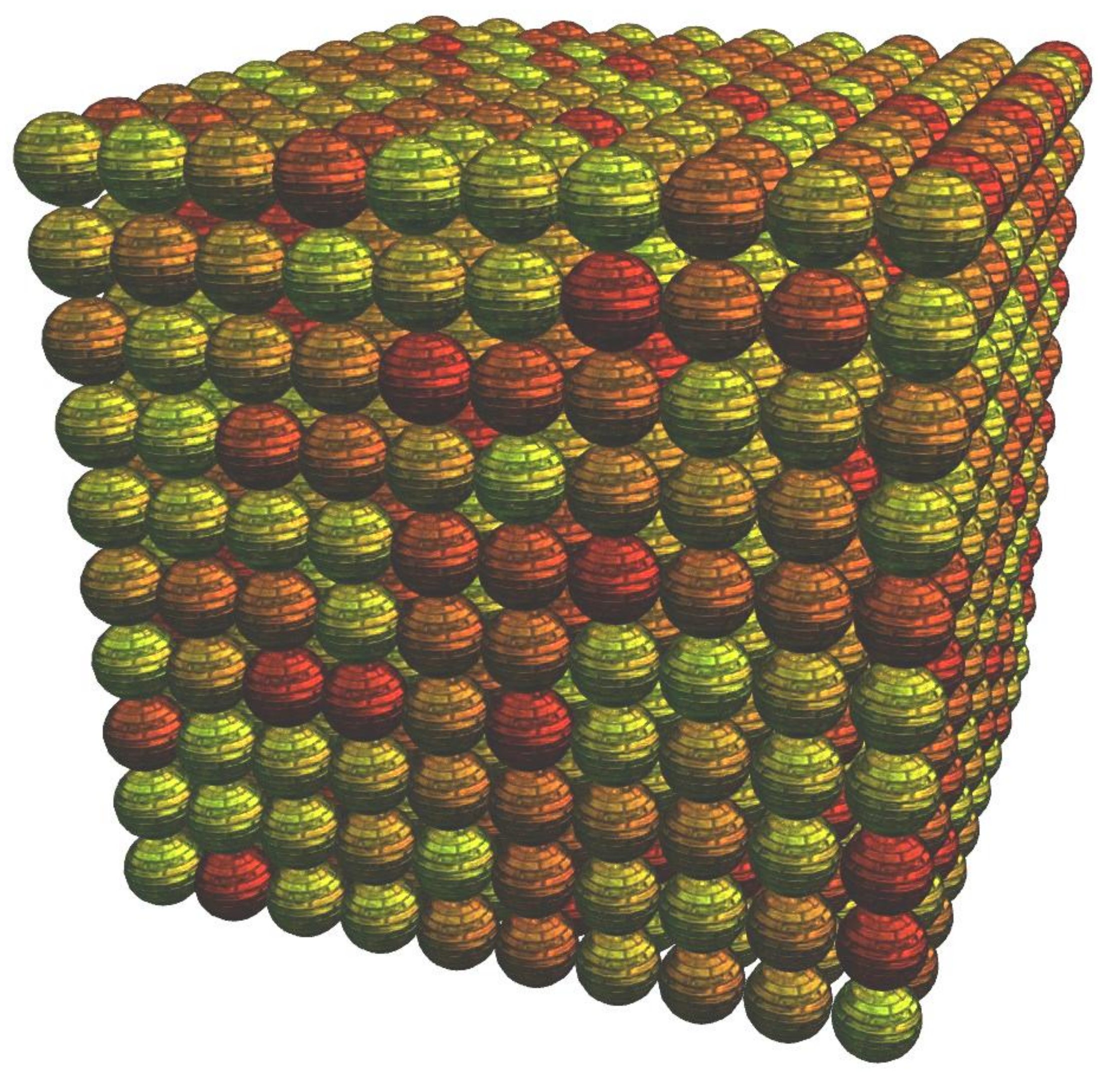


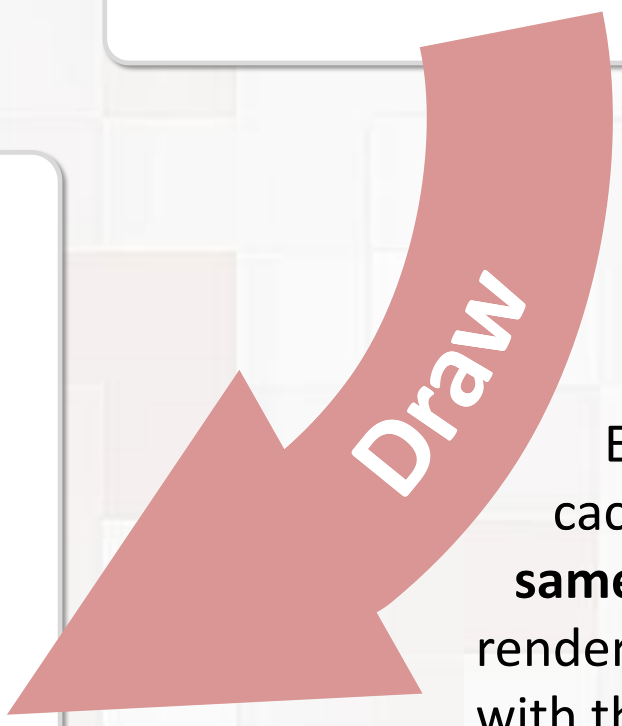


Traditionally, a scene graph is **rendered by traversing** the graph and collecting shape properties along the way. When a leaf nodes is reached, the shape is drawn with the current set of properties.

This algorithm is simple but can become a **performance problem** for graphs with large numbers of nodes and edges.

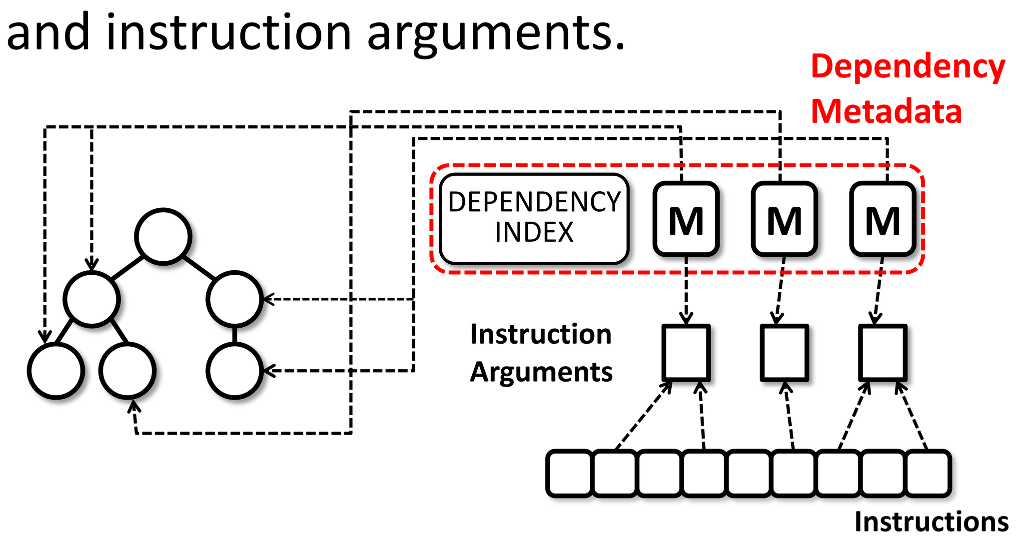
Output Image





Executing the render cache will produce the **same output** image as rendering the scene graph with the regular algorithm. However, the graph does **not** have to be **traversed** and instruction **arguments** only have to be **prepared once** when the cache is built.

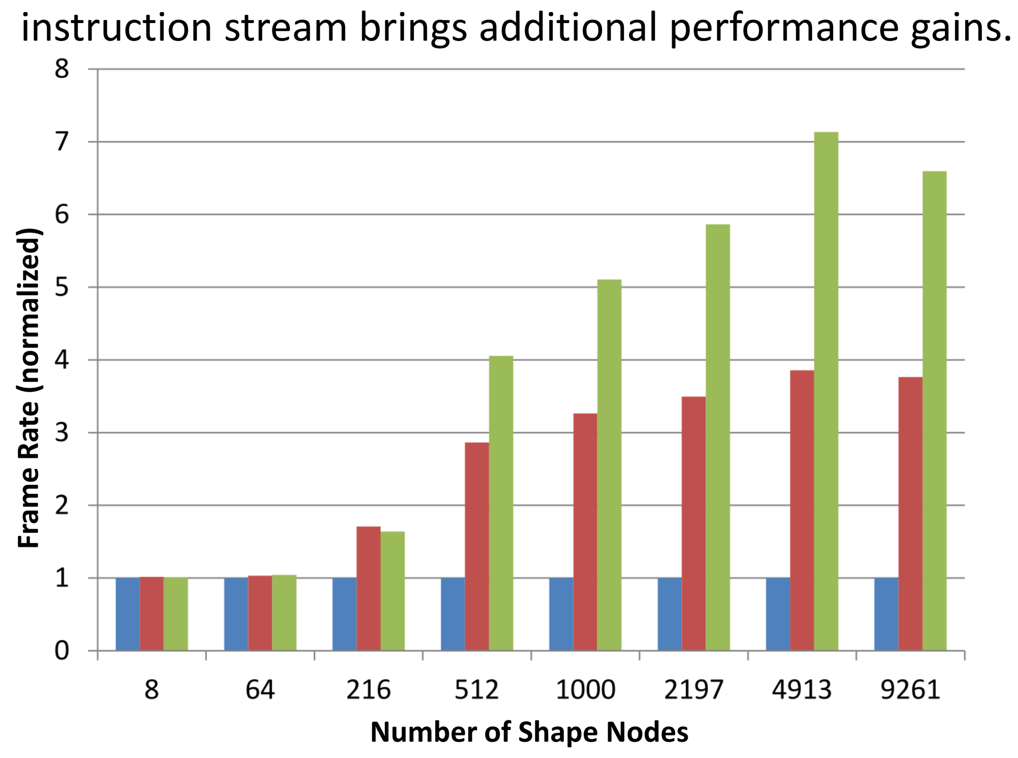
The scene graph caching system creates and maintains metadata on the **data dependencies** between scene graph nodes and instruction arguments.



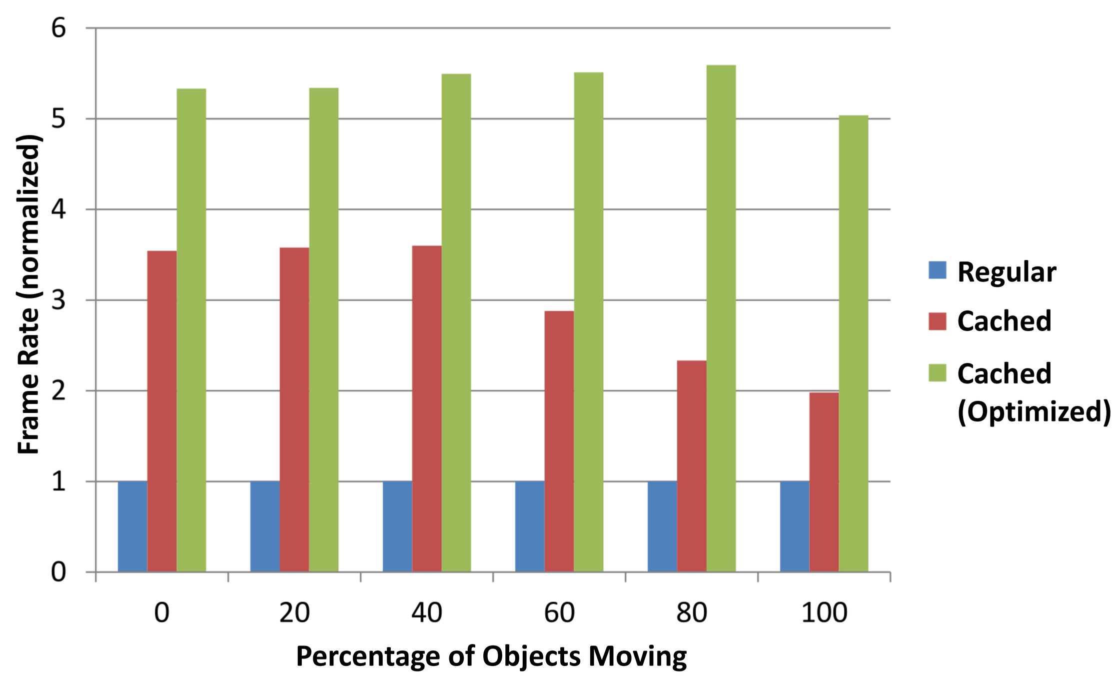
This allows the system to update the render cache **incrementally** as long as the structure of the scene graph does not change. This way **animated scenes** containing moving objects can be cached too.

Performance Test Results

The graph on the left shows results from a static scene with approx. 800.000 triangles distributed over a **varying number of shape nodes** (x-axis).
Although the GPU workload is roughly the same for all configurations, using render caches can be up to **4 times as fast** for higher node counts. Optimizing the instruction stream brings additional performance gains.



The graph on the right shows normalized frame rates from a scene with a **varying percentage** of **moving** objects.
Updating the render caches **incrementally** enables the system to sustain performance gains when the scene contains **dynamic content**. With optimized (multi-core) cache updates, the **speedup** is nearly **constant** for all percentages of objects moving every frame.



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