Detailed Statistics

Content:

3Delight statistics are divided in groups of related information. For example, the "Ray Tracer" group contains all statistics that affect ray tracer operations. The following table lists all the groups as well as their JSON legalized names and comments.

Group	JSON name	Description
Render Option	`render_options`	Contains global rendering options that have been (usual) set by the user.
System	`system`	Contains options related to the system/hardware on which the image has been rendered.
Profiling	`profiling`	Contains timings for different parts of the renderer.
Memory	`memory`	Contains information and memory profiling for different structures in the renderer.
Texture Cache	`texture_cache`	The texture cache plays an important part in the overall performance of *3Delight*. The cache is needed since available physical memory is usually much less than the space taken by all the textures for a certain render. The role of this cache is to keep and manage the texture data needed for rendering.
Ray Tracer	`ray_tracer`	Contains data related to all operations of the ray tracer.
REYES	`reyes`	Contains data related to the workings of the REYES rendering engine.

Statistics Description

The following table goes through every statistic available in every group.

' * ' = deprecated.

Keyword	Type	Units	Description
			System
`time_to_first_pixel`	real	secs	Time it take for the first pixel to appear.
network_traffic	table		
disk_traffic	table		

load_average	[real, real, real]		Load average is a gauge of how many processes are on average, concurrently demanding CPU attention. The three numbers are averages for 1, 5 and 15 minutes. Very detailed description of load averages can be obtained on Linux manpages of **`uptime`**. A good technical overview can be found here and good vulgarization can be found here.
Profiling			
timings	table	time	Time taken to produce the image, for a wide range of timed categories. Different categories are explained in Profiling Categories.
memory_profile	table	M	Memory used to produce the image, for a wide range of categories.
peak_virtual_memory	real	M	The peak virtual memory while rendering. Note that 3Delight could consume large amounts of virtual memory on 64 bits machines. This doesn't mean that it will actually uses all the virtual space it allocated (far from it).
peak_resident	real	M	Peak resident memory as computed by 3Delight.
peak_from_malloc	real	M	Peak as returned from system allocator.
system_time	[real, real, real]		
cpu_usage	[real, real, real]		CPU usage in %.
Network Cache			
cache_size	real	GB	As specified by the user.
used_size	real	GB	Amount of space already used.
number_of_copied_files	integer		Total number of files copied to that cache during this rendering session
number_of_failed_copies	integer		Copies that failed for system reasons (space, permissions, etc ...)
number_of_copies_avoided	integer		Copies avoided because files already in cache
number_of_rejected_files	integer		Files not copied because cache is full
*number_of_copies_avoided_kb	integer	Kb	Same as `number_of_copies_avoided` but in Kb.
data_not_cached	integer	Kb	Data not cached due to lack of space.
data_copied	integer	Kb	Total amount of data that has been copied to the cache during the rendering sessions.
Textures			
number_of_maps	integer		Total number of maps (textures, shadow maps, deep shadow maps, etc ...) managed.
number_of_texture_maps	integer		
number_of_shadow_maps	integer		
number_of_deep_shadow_maps	integer		
number_of_invalid_maps	integer		
number_of_file_open_operations	integer		Total number of file open operations performed during a rendering session. Should be relatively low thanks to caching. Could be high on systems configured with not enough file descriptors.
*number_of_map_requests	integer		Total number of maps requested
texture_access_statistics	table		
texture_ids	group		List of texture ids needed to understand `texture_access_statistics`

Texture Cache			
cache_size	real	GB	Size of RAM texture cache.
footprint_of_textures	real		The texture footprint is the total amount of data seen by the cache during a render. It's the size the cache should be made to hold everything needed in memory. This is a good metric of how much data a scene is using. Note that the cache does not have to be that large to be fully efficient in most cases.
footprint_of_misc		G	Same as `footprint_for_textures` but applies to other textures such as 3D textures (brick maps).
pressure	real		The cache pressure is the ratio between the footprint and the amount of data actually loaded into the cache, counting data which is loaded more than once because it was flushed. For example, at 2 each texture tile is loaded on average twice, which is actually not that bad. At 10, we're loading each tile 10 times, which is not that good anymore. A pressure of 1 indicates a fully efficient cache. This number is directly proportional to the *texture loading* time described in the Profiling section above. If the pressure goes from 4 to 2 then loading time will be halved.
pressure_from_textures	real		Pressure from 2D textures.
pressure_from_misc	real		Pressure from other kind of textures (such as 3D textures).
Scene			
number_of_objects	integer		Total number of high level objects passed to renderer.
number_of_attributes	integer		Number of RenderMan attributes needed to describe the scene.
number_of_transforms	integer		Number of transforms in the scene.
primitive_compression_ratio	real		While rendering, *3Delight* uses a compression algorithm for geometric primitives residing in memory. This statistic indicates the compression ratio.
saved_memory	real	Mb	Memory saved thanks to compression.
REYES			
number_of_mps	integer		Total number of micro polygons generated to produce the image.
average_mps_per_grid	integer		Average number of micro polygons per grid.
grids_projected	integer		Total number of grids projected to screen.
grids_shaded	integer		Total number of grids that have been shaded. Some projected grids might not need shading after projection because they are rejected by visibility culling.
grids_displaced	integer		Total number of displaced grids.
number_of_primitives	integer		Total number of low-level primitives.
number_of_rejected_primitives			Total number of low-level primitives that have been efficiently rejected because they were are not seen in the image.
number_of_non_empty_buckets	integer		
average_items_per_bucket	integer		Average number of items (primitive, grid, particle, etc ...) in a bucket.
maximum_items_in_a_bucket	integer		Maximum items found in a single bucket.
distribution_of_micropolygon_area	histogram		An histogram representing the distribution of the area of micro-polygons. Distributions skewed towards lower values mean slower renders.
distribution_of_fragment_lists	histogram		Depth complexity.

number_of_trimming_operations	integer		Number of trim curves operations. Non zero when scene contains NURBS and trim curves.
maximum_mp_area	real		Maximum micro polygon area in the scene.
mininum_mp_area	real		Minimum micro polygon area in the scene.
average_mp_area	real		Average micro polygon area in the scene.
*curves_grouping_efficiency	real		Internal.
Ray Tracer			
number_of_rays	integer		Total number of traced rays.
number_of_shader_calls	integer		Total number of shader calls.
travelled_distance	real	camera space units	Total travelled distance for all traced rays.
number_of_arealight_probes	integer		Total number of ray probes for area light sampling.
average_objects_in_ray_path	real		Average number of objects any each ray crosses during scene traversal. Higher values lead to slower render. Values close to a hundred can be seen when rendering fur or hair.
number_of_patch_intersection_tests	integer		Total count of intersection tests with the lowest level geometrical primitives in 3Delight.
space_partition_efficiency	real		Proportion of rays hitting an object after they enter a space partition leaf.
bounding_volume_efficiency	real		Proportion of rays hitting an objects they they enter objet's bounding volume.
average_ray_packet_size	real		
approximations	real		Percentage of intersection tests that used geometric approximations.
cache_pressure	real		Pressure on displaced geometry cache.
distribution_of_ray_depth	histogram		
distribution_of_shading_groups	histogram		Represents the distribution of shading group sizes. Histograms skewed to lower values represent less efficient shading.
distribution_of_ray_types	table		A table describing how many rays were traced, per type (specular, diffuse, transmission, ...). *Note that this is a table, not an histogram.*
distribution_of_shader_calls	table		Describes how many shader calls were performed, per ray type.
bbox_intersections	(real, integer)		(bounding box intersection per ray, total bbox intersection)
Point Based Subsurface Scattering			
distribution_of_lookup_depth	histogram		An histogram representing the lookup depth in the hierarchical structure used to store the point-based scene representation. Histograms skewed to lower values mean faster renders. A technical statistic that is not really telling for an artist.
Space Partitioner			
number_of_nodes	integer		Total number of nodes (internal and leafs) in the space partitioner.

motion_density	real		
motion_segments	integer		
tree_depth	integer		Maximum leaf node depth in the space partitioner.
number_of_rays	integer		Total number of rays that went through the space partitioner.
average_leafs_per_ray	real		Average number of leaves a ray encounters during tress traversal.
average_internal_nodes_per_ray	real		Average number internal nodes a ray encounters during tree traversal.
*average_depth_per_leaf	real		
average_objects_per_leaf	real		
average_packet_size_at_root	real		Ray packet size when packet is entering the root of the tree
average_packet_size_at_leaf	real		Ray packet size when packet is entering a leaf of the tree
number_of_bbox_intersections	integer		
number_of_bbox_intersections_per_ray	real		It is useful to compare this number with the `average_objects_in_ray_path`
Point-Based Global Illumination			
number_of_queries	integer		Total number of lookups in the point-based representation of the scene.
number_of_elements_per_query	real		Average number of elements considered for each query. Higher numbers usually indicate slower queries/renders.
Point-Based Subsurface Scattering			
number_of_nodes	integer		Total number of nodes (internal and leaf) in data structure (tree) used for point-based subsurface scattering.
tree_depth	integer		
number_of_queries	integer		
number_of_leaf_computations	integer		Number of subsurface computation performed using the leafs of the tree.
number_of_hierarchical_computations	integer		Number of subsurface computation performed using higher (aggregate) tree levels. Using such *aggregate* computations accelerate overall render time.
minimum_visited_leafs_per_query	integer		
maximum_visited_leafs_per_query	integer		
average_visited_leafs_per_query	integer		
Photon Maps			
number_of_photons	integer		Total number of traced photons.

number_of_interactions	integer		Total number of photon/surface interactions.
number_of_global_photons	integer		Number of photons stored in *global* photon maps.
number_of_caustic_photons	integer		Numbe of photons stored in *caustic* photon maps.
average_bounces	real		Average number of bounces a photon does before terminating or exiting scene.
average_diffuse_depth	real		Average depth of photons stored in the *global* photon map.
average_caustics_depth	real		Average depth if photons stored in the *specular* photon map.

Profiling Categories

This statistic block gives several timings about the render. Each task shows the wall clock time it took in the total render time. Follows a description for all possible tasks.

Task	Description
raytracer init	This task includes all the work that needs to be done before starting the space parition. Basically this means iterating through all scene objects and prepare structures for the upcoming render.
ray tracer instance init	This task counts the time that is spent on optimizing instances (when "shared instances" are enabled).
space partition init	This task counts the time it takes 3Delight to build the space partitioner (a BVH-like structure). The time spent here will go proportionally with the scene size.
surface shaders	Counts the amount of time the renderer is spending inside surface shaders. Complex shaders (as generated, for example, by comlexe shading networks in *Maya* or *Softimage)* will lead to higher times in this task.
light shaders	Counts the time spent in light shaders.
volume shaders	Counts the time spent in volume shaders.
displacement shaders	Counts the time spent in displacement shaders.
imager shaders	Counts the time spent in imager shaders.
RSL plugins	Counts the time spent in custom RSL plug-ins.
shadowmap filtering	Counts the time spent filtering shadow maps to render shadows.
dsm filtering	Same as for shadow map filtering but for deep shadow maps.

`texture filtering`	Counts the time spent filtering texture maps. If this times seems too high compared to total render time (>10%) it could be one of the following reasons: 1. Textures are not properly mip-mapped. Running **`tdlmake`** is mandatory for good performance. 2. Texture lookups are done with very narrow "width". This can only happen in custom shaders. 3. There is simply a very large amount of textures in the scene.
`point cloud filtering`	Counts the time spent filtering point clouds for point-based color bleeding.
`brick map filtering`	Counts the time spent filtering brick maps.
`texture loading`	Counts the time spent loading texture tiles. Since *3Delight* has a caching system for texture loading this time should be marginal compared to the total render time. If not, this probably means that the texture cache is not large enough (read the *Texture Cache* s ection).
`shadow map loading`	Counts the time spent loading shadow map tiles.

Example JSON Output and Parsing

Follows is an example of JSON file output by 3Delight.


```
{
    "textures": {
        "number_of_map_requests": 2,
        "number_of_maps": 1,
        "number_of_environment_maps": 1,
        "number_of_texture_maps": 0,
        "number_of_deep_shadow_maps": 0,
        "number_of_shadow_maps": 0,
        "number_of_invlid_maps": 0,
        "texture_access_statistics": {
            "columns": {
                "refs": [
                    1179710
                ],
                "id": [
                    1
                ],
                "mipmap_min": [
                    0
                ],
                "footprint": [
                    13664256
                ],
                "mipmap_max": [
                    10
                ]
            }
        },
        "number_of_file_open_operations": 1,
        "texture_ids": {
            "id": 1
        }
    },
    "render_options": {},
    "system": {
        "network_traffic": {
            "columns": {
                "operation": [
                    "read",
                    "write"
                ],
```

```
            "total_mb": [
                6.5827980041503906,
                6.5808382034301758
            ],
            "transfer_rate": [
                962.96930803571433,
                962.6826171875
            ]
        }
    },
    "load_average": [
        1.7587890625,
        1.60693359375,
        1.5478515625
    ],
    "time_to_first_pixel": 0.0
},
"point_based_gi": {
    "number_of_elements_per_query": 0.0,
    "number_of_queries": 0.0
},
"profiling": {
    "cpu_usage": [
        323.58533957300125,
        4.0109569189157455,
        327.59629649191703
    ],
    "system_time": [
        23.096786999999999,
        0.28629299999999996,
        7.1377730000000001
    ],
    "timings": {
        "columns": {
            "task": [
                "other",
                "ReadArchive",
                "raytracer init",
                "raytracer instance init",
                "space partition init",
                "raytracing",
                "surface shaders",
                "surface shaders (opacity)",
                "light shaders",
                "volume shaders",
                "displacement shaders",
                "imager shaders",
                "RSL plugins",
                "shadowmap filtering",
                "texture filtering",
                "dsm filtering",
                "point cloud filtering",
                "brick map filtering",
                "shadowmap loading",
                "texture loading",
                "RtxPlugin",
                "dsm loading",
                "point cloud loading",
                "brick map loading",
                "point cloud occlusion",
                "display drivers",
                "sampling",
                "particle sampling",
                "screen filtering",
                "REYES",
                "eyesplit",
                "subsurface init",
                "subsurface eval",
                "procedural expansion",
                "shader recompilation",
                "trimming",
```

```
                "volume shader grouping",
                "photon tree creation",
                "point cloud writing",
                "raytrace hider",
                "error reporting",
                "file access (netcache)",
                "DEBUG 1",
                "DEBUG 2",
                "DEBUG 3"
            ],
            "time": [
                0.79713633333333289,
                0.45662449999999971,
                0.073952999999999963,
                0.0,
                0.0081679999999999999,
                4.7672314166666556,
                0.48777950000000014,
                0.0052614999999999997,
                0.14790499999999995,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.063149750000000004,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.29331975000000005,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.0,
                0.011049999999999999,
                0.0,
                0.0025062499999999998,
                0.0,
                0.0,
                0.0
            ]
        }
    }
},
"texture_cache": {
    "size": 0.984375,
    "pressure_from_textures": 1.0,
    "pressure": 1.0,
    "footprint_of_textures": 0.012725830078125,
    "pressure_from_misc": 0.0,
    "footprint_of_misc": 0.0
},
"scene": {
    "number_of_objects": 9,
    "number_of_attributes": 12,
```

```
    "saved_memory": 0.50068800000000002,
    "primitive_compression_ratio": 1.5388098955154419,
    "number_of_transforms": 10
},
"memory": {
    "peak_resident": 136.73267200000001,
    "memory_profiling": {
        "columns": {
            "peak": [
                288,
                0,
                792,
                2791968,
                0,
                5227604,
                0,
                0,
                0,
                0,
                0,
                0,
                2232,
                13677600,
                0,
                0,
                0,
                104130,
                7320,
                11199544,
                8173,
                5476,
                0,
                0,
                0,
                0,
                0,
                1086064,
                0,
                534688,
                297000,
                2928096
            ],
            "item": [
                "unprocessed gprim",
                "gprim",
                "gprim (polygons)",
                "gprim (subdiv)",
                "gprim (curves)",
                "gprim variables",
                "particles",
                "topology data",
                "crack elimination geo",
                "grid",
                "shaded grid",
                "grid AOV",
                "texture objects",
                "texture cache",
                "hider and visible points",
                "image data",
                "buffered display data",
                "shader code",
                "shader instance",
                "shader variables",
                "attributes",
                "transform",
                "subsurface",
                "point based occlusion",
                "point cloud",
                "photon map",
                "inline archive",
                "ray tracer",
```

```
        "ray tracer cache",
        "space partition",
        "diffuse ray cache",
        "misc"
    ],
    "current": [
        288,
        0,
        792,
        2790720,
        0,
        2502740,
        0,
        0,
        0,
        0,
        0,
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        2232,
        13677600,
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        0,
        0,
        104130,
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        8173,
        5476,
        0,
        0,
        0,
        0,
        0,
        1086064,
        0,
        534688,
        1736720,
        3694048
    ],
    "category_peak": [
        78392,
        0,
        792,
        2799864,
        0,
        5252364,
        0,
        0,
        0,
        0,
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        13677600,
        0,
        0,
        0,
        104130,
        7320,
        11979836,
        8173,
        5624,
        0,
        0,
        0,
        0,
        0,
        1086064,
        0,
        534688,
        1736720,
```

```
                3694048
            ]
        }
    },
    "peak_from_malloc": 70.071376000000001
},
"space_partition": {
    "number_of_bbox_intersections_per_ray": 34.664260406427871,
    "motion_segments": 1.0,
    "average_packet_size_at_leaf": 7.9934654661822959,
    "average_internal_nodes_per_ray": 1.4410851029784899,
    "number_of_rays": 874940.0,
    "number_of_nodes": 12325.0,
    "motion_density": 0.0081135902636916835,
    "tree_depth": 20.0,
    "number_of_bbox_intersections": 30329148.0,
    "average_depth_per_leaf": 14.221807561252637,
    "average_leafs_per_ray": 0.30643701282373648,
    "average_packet_size_at_root": 55.055373772967528,
    "average_objects_per_leaf": 1.6947914976472498
},
"ray_tracer": {
    "distribution_of_shading_groups": {
        "divisions": [
            1.0,
            2.0,
            4.0,
            8.0,
            16.0,
            32.0
        ],
        "scale": "logarithmic",
        "type": "histogram",
        "hits": [
            3889,
            1334,
            1771,
            1157,
            864,
            627,
            1175
        ]
    },
    "approximations": 32.631661953810301,
    "average_ray_packet_size": 4.2809678096469224,
    "number_of_rays": 875164.0,
    "distribution_of_ray_types": {
        "columns": {
            "type": [
                "Specular",
                "Transmission",
                "Diffuse",
                "Light",
                "Camera",
                "Hair",
                "Subsurface"
            ],
            "count": [
                125483.0,
                300586.0,
                0.0,
                0.0,
                422912.0,
                0.0,
                26183.0
            ],
            "percentage": [
                14.338226892331038,
                34.346248246043025,
                0.0,
                0.0,
```

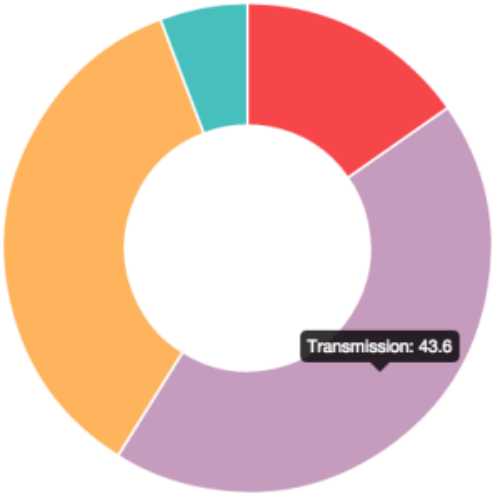
```
            48.323742749930297,
            0.0,
            2.9917821116956365
        ]
    }
},
"bbox_intersection": [
    1.5752442439733148,
    2781979.0
],
"space_partition_efficiency": 16.348005064125616,
"travelled_distance": 1881734.8848779108,
"number_of_shader_calls": 306832.0,
"number_of_patch_intersection_tests": 1766062.0,
"number_of_arealight_probes": 0.0,
"distribution_of_shader_calls": {
    "columns": {
        "type": [
            "Specular",
            "Transmission",
            "Diffuse",
            "Light",
            "Camera",
            "Hair",
            "Subsurface"
        ],
        "count": [
            50588.0,
            157918.0,
            0.0,
            0.0,
            78705.0,
            0.0,
            19621.0
        ],
        "percentage": [
            16.487198206184491,
            51.467252437816136,
            0.0,
            0.0,
            25.650844761954421,
            0.0,
            6.3947045940449492
        ]
    }
},
"average_objects_in_ray_path": 3.6606990232687817,
"bounding_volume_efficiency": 29.65598036762016,
"cache_pressure": 0.0,
"distribution_of_ray_depth": {
    "divisions": [
        0.0,
        1.0,
        2.0,
        3.0,
        4.0,
        5.0,
        6.0,
        7.0,
        8.0
    ],
    "scale": "linear",
    "type": "histogram",
    "hits": [
        422912,
        304513,
        108011,
        30381,
        9347,
        0,
        0,
```

```
                0,
                0,
                0
            ]
        }
    }
}
```

To be continued ...

Embedding Statistics Into HTML Documents

It is easy to use the JSON output format to generate nice rendering of statistics. The following example code uses HTML, Chart.js and *JavaScript* to generate a pie chart representing the percentage for each ray type.



Example pie chart generate using JSON statistics, HTML and Javascript.