COMP360: Research & Development: Dissertation

5: Optimisation and Refactoring

Test cases

Three questions

- What makes a good test case?
- What makes a good bug report?
- What does a unit test describe?
- The answer to these three questions is very similar...

Test case

A good test case should include:

- Any assumptions, initial conditions, prerequisites
- A set of steps to follow
- The expected result
- (When the test is carried out) The actual result

Bug report

A good bug report should include:

- Any assumptions, initial conditions, prerequisites
- A set of steps to follow
- The expected result
- The actual result (the bug being that this differs from the expected result)

Unit test

A good unit test should include:

- Code to set up any assumptions, initial conditions, prerequisites
- A function to execute (a set of steps)
- An assertion checking the expected result matches the actual result

How they fit together

- A test case is general — can fit at unit, integration, system or acceptance testing level
- A unit test is essentially an automated test case
- A bug report is suggestive of a new test case that should be added to the test plan

Optimisation

Optimisation

- **Optimisation** is the process of making a program **more efficient** in terms of speed, memory usage etc.
- Optimisation can **increase** or **decrease** software quality, depending on what measure of "quality" is being used

"Rules of optimization:
Rule 1: Don't do it.
Rule 2 (for experts only): Don't do it yet."

— Michael A. Jackson

"Programmers waste enormous amounts of time thinking about, or worrying about, the speed of noncritical parts of their programs, and these attempts at efficiency actually have a strong negative impact when debugging and maintenance are considered. We *should* forget about small efficiencies, say about 97% of the time: **premature optimization is the root of all evil**. Yet we should not pass up our opportunities in that critical 3%."

— Donald Knuth

"Measure twice, cut once."

— Proverb

Levels of Optimisation

- System Level: Utilisation, Balancing and Efficiency
- Algorithmic Level: Focus on removing work
- Micro-Level: Line by line optimising (data structures is a good example here)

Optimisation Pitfalls

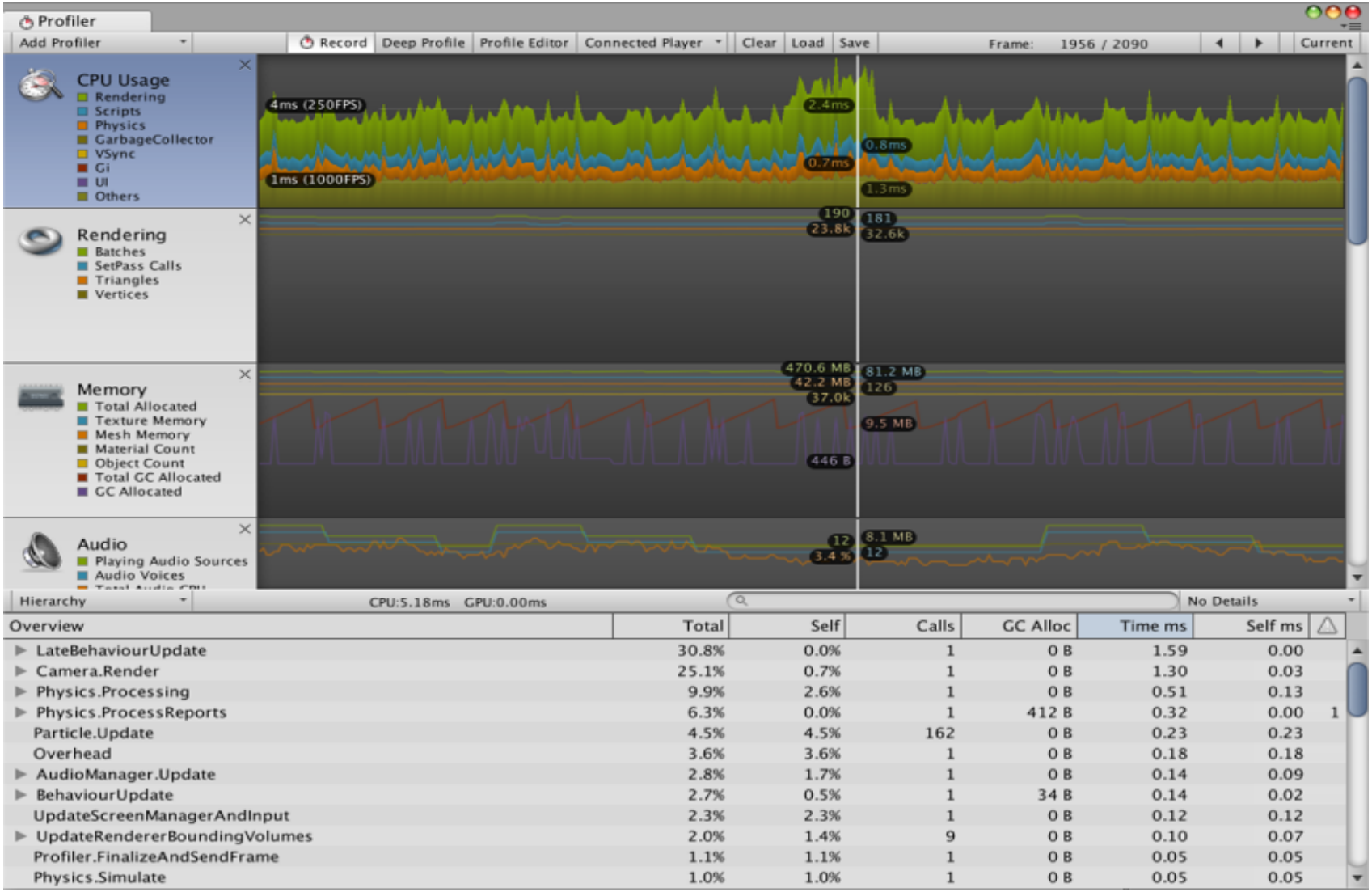
- Assumptions: Always measure!
- Premature Optimisation: Don't optimise with data, or too early in the development process
- Optimisation on Only One Machine: Test on the worst case system
- Optimising Debug Builds
- Trying to second-guess the compiler: in many cases, the compiler is better at micro-level optimisation than you are!

Profilers

Unity Profiler

- The Unity Profiler is built into the engine
- It can be accessed via the **Window** >**Profiler**
- This allows you to profile the following
  - CPU Usage - Scripts, Physics, UI etc
  - Rendering - Batches, Triangles, Vertices
  - Memory - Total, Texture, Mesh, Garbage Collection
  - Audio - Number of Sources, Audio Memory
  - GPU - Deferred Lighting, Transparent, Post Processing

Unity Profiler



Overview	Total	Self	Calls	GC Alloc	Time ms	Self ms
▶ LateBehaviourUpdate	30.8%	0.0%	1	0 B	1.59	0.00
▶ Camera.Render	25.1%	0.7%	1	0 B	1.30	0.03
▶ Physics.Processing	9.9%	2.6%	1	0 B	0.51	0.13
▶ Physics.ProcessReports	6.3%	0.0%	1	412 B	0.32	0.00
Particle.Update	4.5%	4.5%	162	0 B	0.23	0.23
Overhead	3.6%	3.6%	1	0 B	0.18	0.18
▶ AudioManager.Update	2.8%	1.7%	1	0 B	0.14	0.09
▶ BehaviourUpdate	2.7%	0.5%	1	34 B	0.14	0.02
UpdateScreenManagerAndInput	2.3%	2.3%	1	0 B	0.12	0.12
▶ UpdateRendererBoundingVolumes	2.0%	1.4%	9	0 B	0.10	0.07
Profiler.FinalizeAndSendFrame	1.1%	1.1%	1	0 B	0.05	0.05
Physics.Simulate	1.0%	1.0%	1	0 B	0.05	0.05

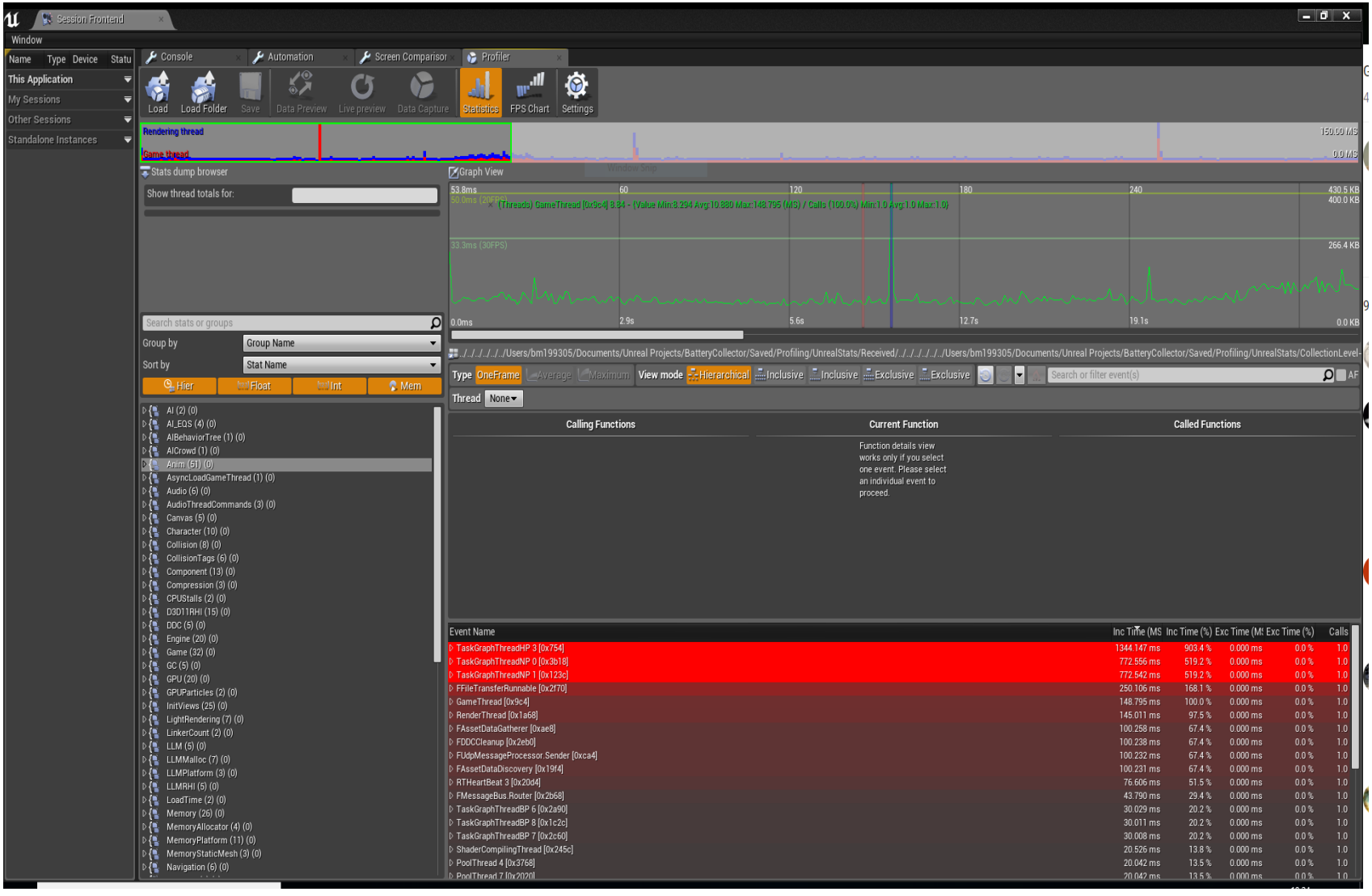
Unity Profiler: Hints & Tips

- You can remove items from the profiler graph by click on the colour box
- Enabling **Deep Profile** will add a significant overhead to larger games
  - Surround you code with **Profiler.BeginSample** & **Profiler.EndSample** this will appear in the Profiler
- You should consider Profiling a development build as the Editor adds significant overheard

Unreal Profiler

- The Unreal Profiler is built into the engine
- It can accessed via **Window** $>$**Developer Tools** $>$**Session Frontend**
- Allows us to profile all major systems including CPU (code) and GPU

Unreal Profiler



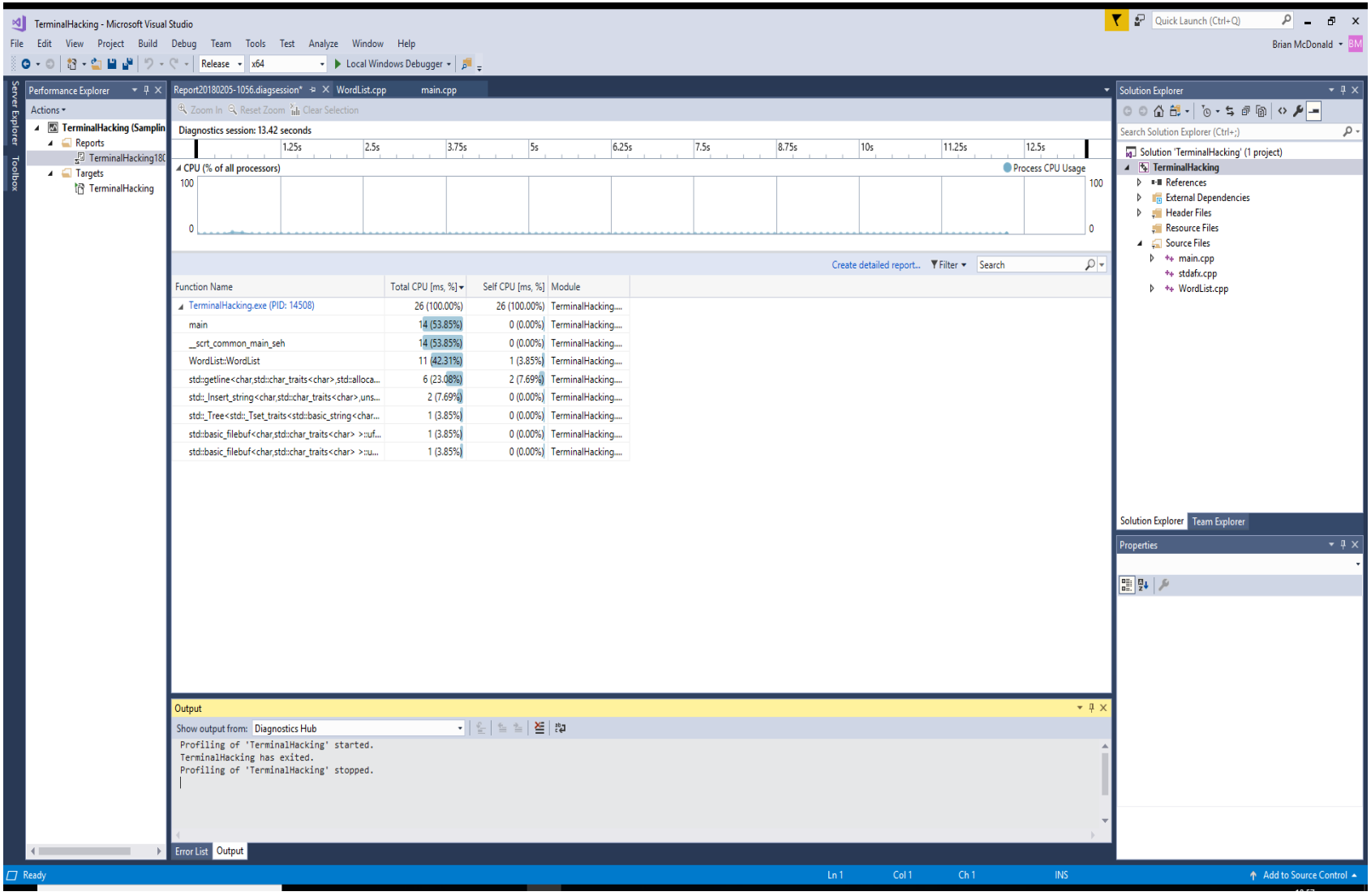
Unreal Profiler: Hints & Tips

- `https://www.unrealengine.com/en-US/blog/how-to-improve-game-thread-cpu-performance`
- A few interesting things from this link
  - To identify the bottleneck (GPU or CPU), run **stat unit** on a **non-debug build**
  - If the **Frame Time** is very close to **GPU Time**, then the GPU is the bottleneck
  - If the **Frame Time** is very close to **Game Time**, then your code is the bottleneck
  - In the profiler **GameThread** entry, find the **FTickFunctionTask** - this shows every actor and component that is ticking
  - Another thing to track is **Blueprint Time**, switch inclusive view and locate it, then switch back to hierarchical view
  - **SkinnedMeshComp Tick** & **TickWidgets** can also be bottleneck

Visual Studio Profiler

- `https://docs.microsoft.com/en-us/visualstudio/profiling/beginners-guide-to-performance-profiling`
- Switch your application to a release build
- To run the profiler, select **Debug** >**Performance Profiler** and then click on **Performance Wizard**
- The profiler will run and start collecting data
- Close the application to start analysing the data

Visual Studio Profiler



Visual Studio: Hints & Tips

- Click on **Create Detailed Report** in the summary view, this will generate a report on your application
- In this report **Show Hot Lines** will show the code paths which do the most work
- You will not be able to do much about the *.dll calls, you should look at your own functions in here

Code smells

Code smells

- "Code smells" are a useful guideline for refactoring
- Warning signs that code needs to be refactored
- `https://blog.codinghorror.com/code-smells/`
- See also "How to write unmaintainable code" `https://github.com/Droogans/unmaintainable-code`