Video Filtering Coursework Report

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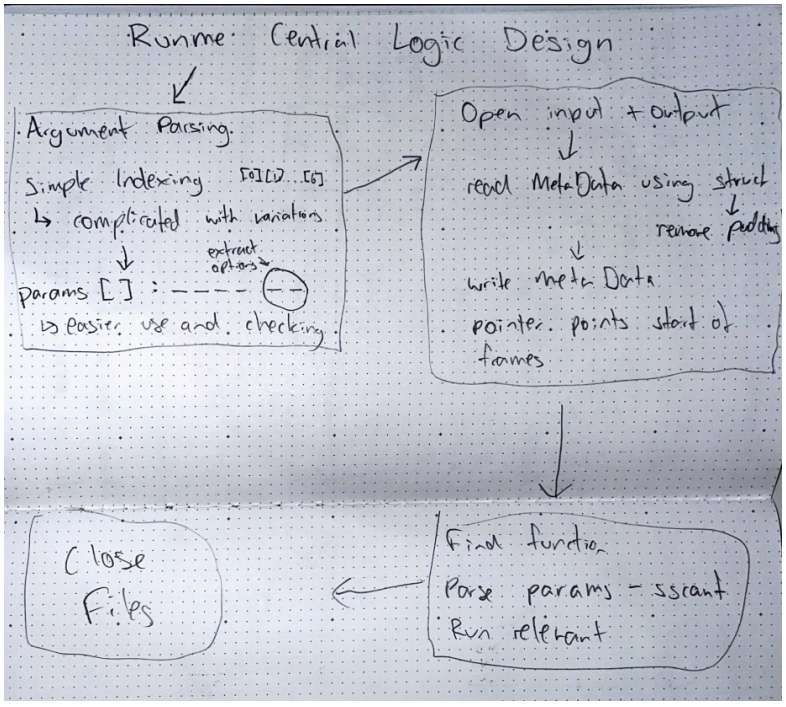
16/01/25

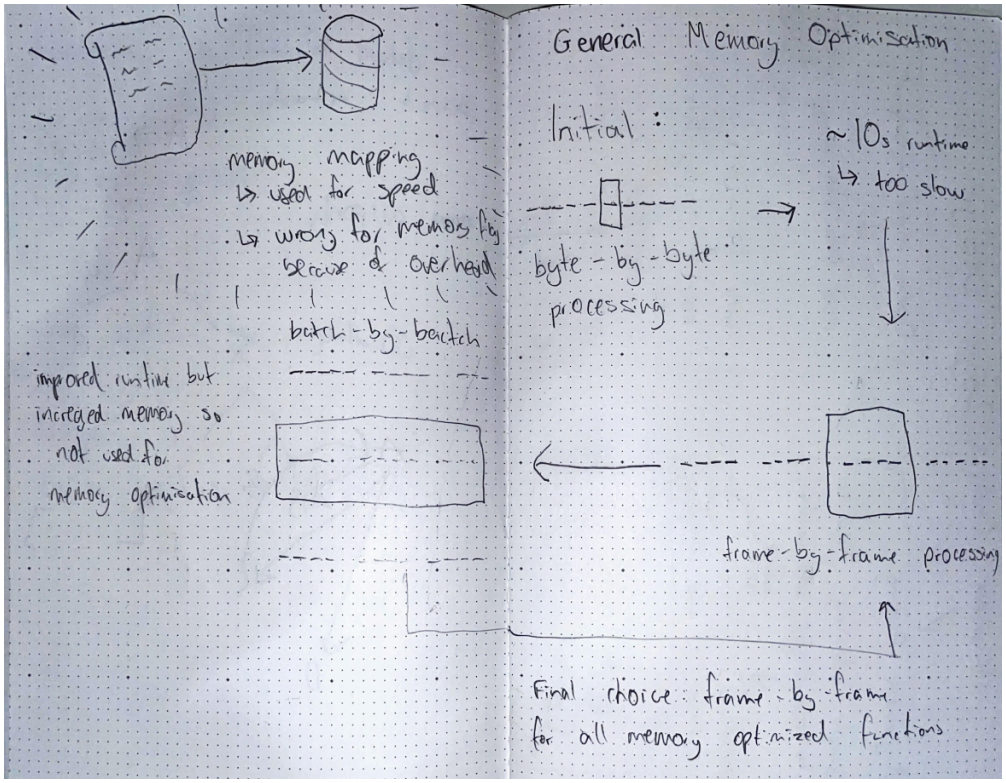
Overarching Design



My overarching design has remained similar to my first approach. I wanted to centralise as much of the functionality as possible to the *runme.c* to reduce redundant code; so the files are opened centrally, the meta data is extracted, parsed and written to the output file, so that all the file pointers are passed in pointing to the beginning of the frame section.
I chose to create a struct for the meta data for readability and maintainability, although I did run into an error where it automatically padded the data to 16 bytes, which I disabled.

Memory Optimisation

Throughout my design it has proved that reading frame by frame guarantees less than a KB of program memory, regardless of the number of frames, however if frames had significantly higher resolution it may break the 1kb boundary. In the graphs below my memory optimised functions are featured. It is interesting they are generally quite fast, likely because of the minimal overhead, important for the small file I tested.

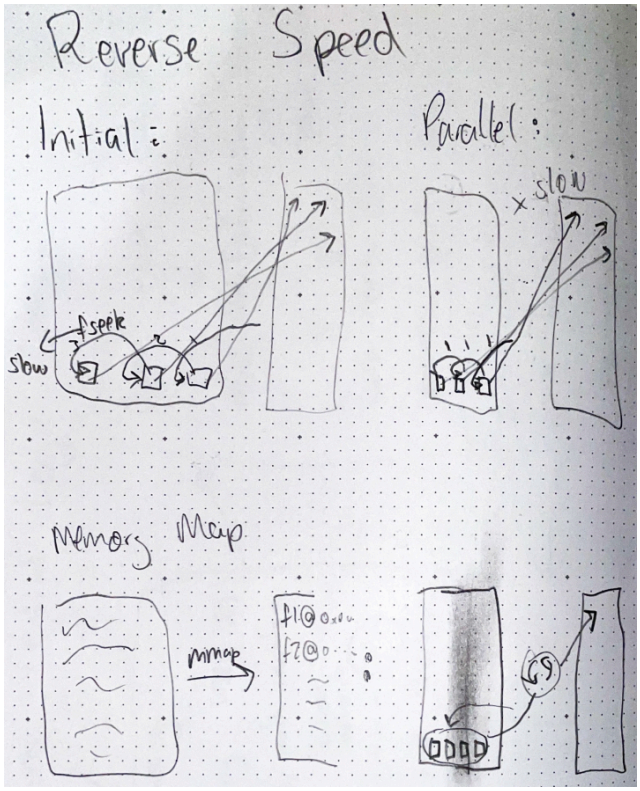


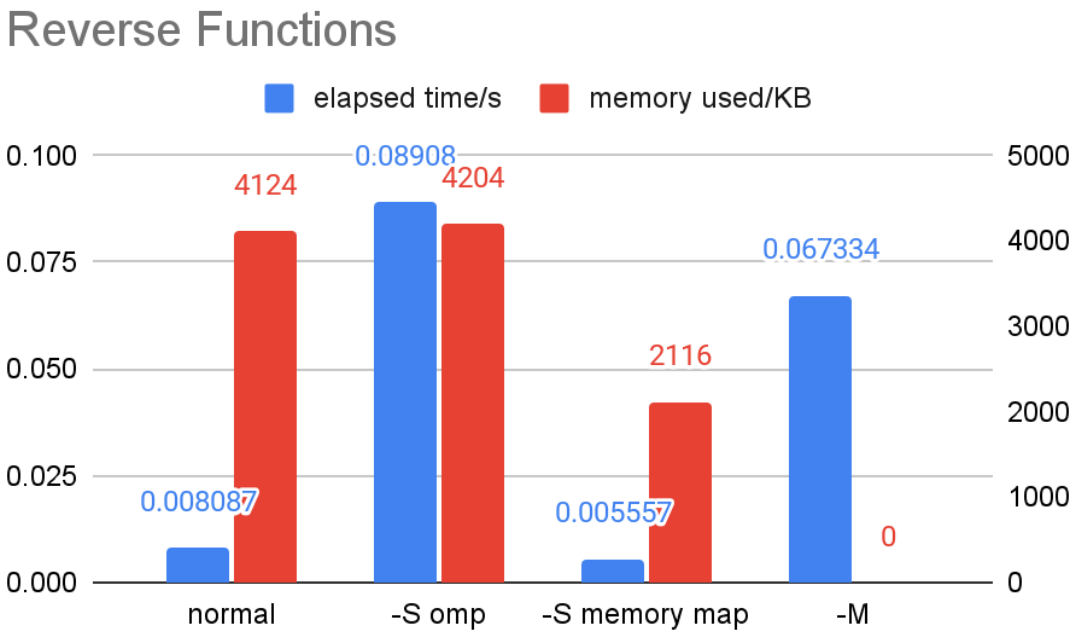
Speed Optimisation

reverse

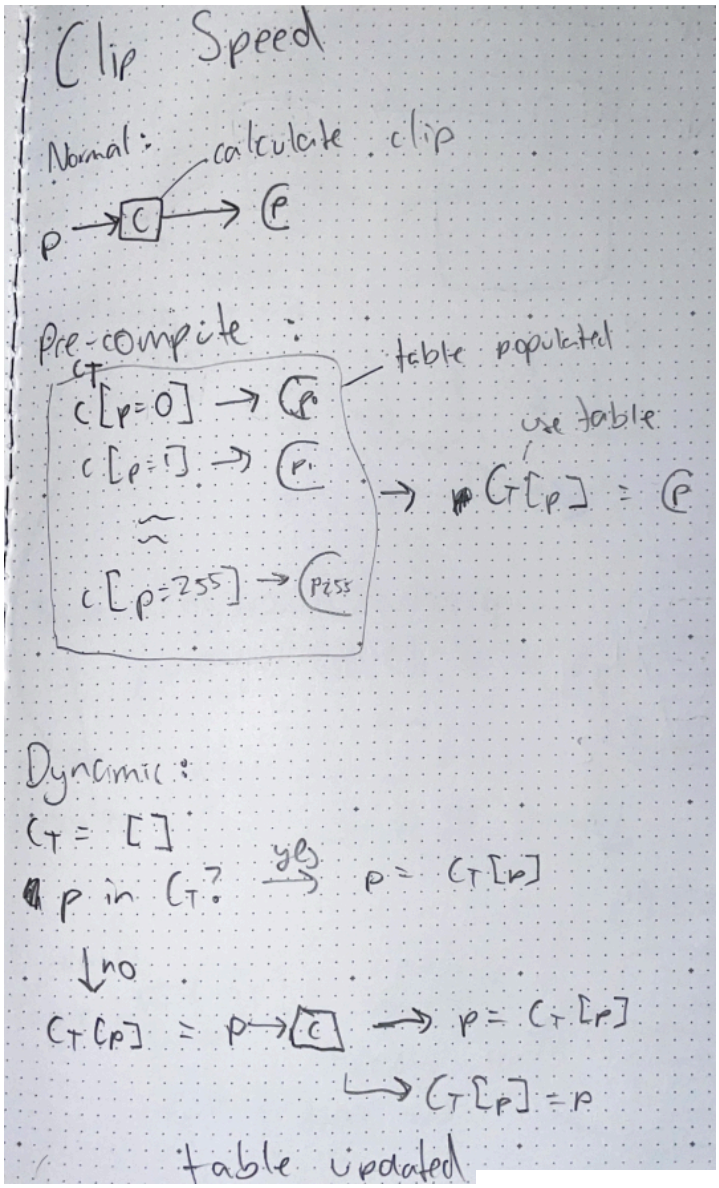
My initial design for reverse is to read the whole file into memory, and use pointers and fseek to read frames from the back of the file and then write them to the output file. I then used omp parallelisation but I found that it actually made the program run slower. This could be because of the overheads involved. I then looked into memory mapping as I read it reduces runtime for accessing memory non-sequentially - as done when reversing. I faced challenges doing so as it did not run on my Windows mounted WSL ubuntu remote window but I persevered and made it work by moving the folders from local to virtual. I also discovered it was more efficient to only memory-map the input file, as the output file was being written to sequentially. The result was a

superior runtime to normal and also a greatly reduced use of memory, which is particularly useful for larger files.

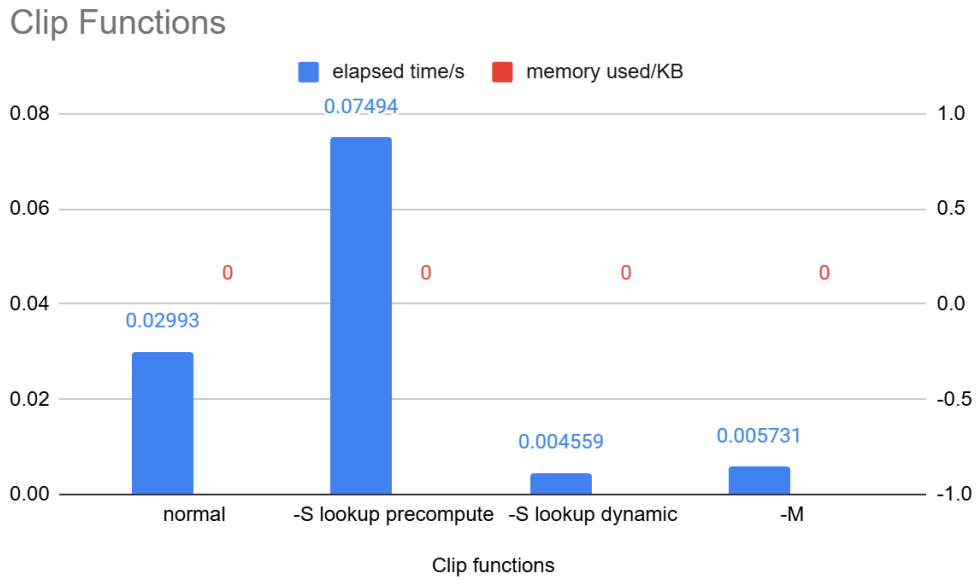




clip_channel

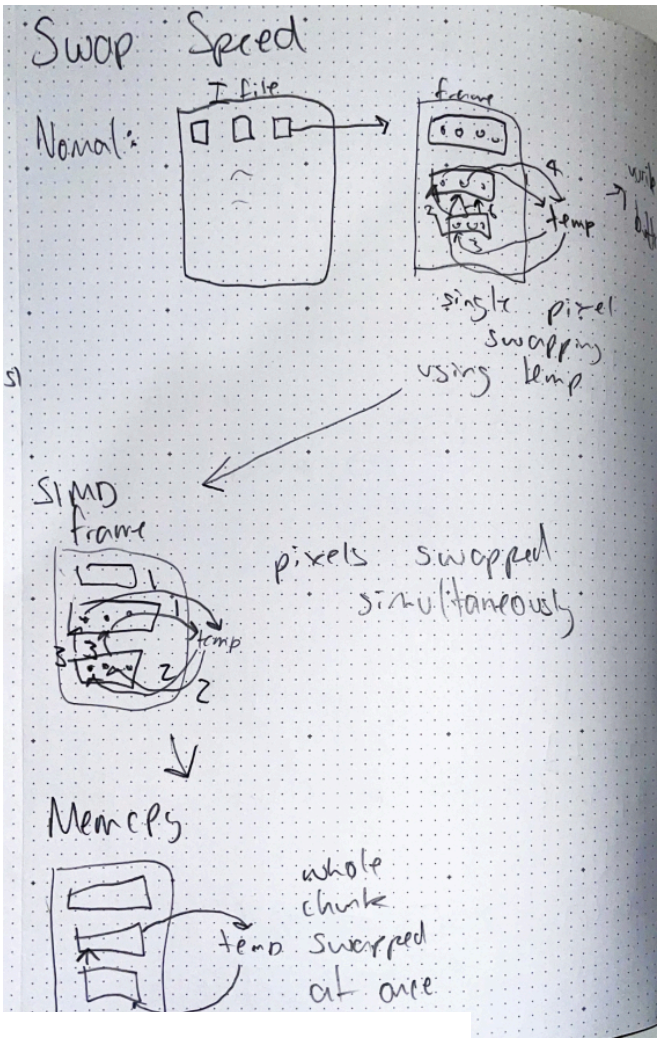


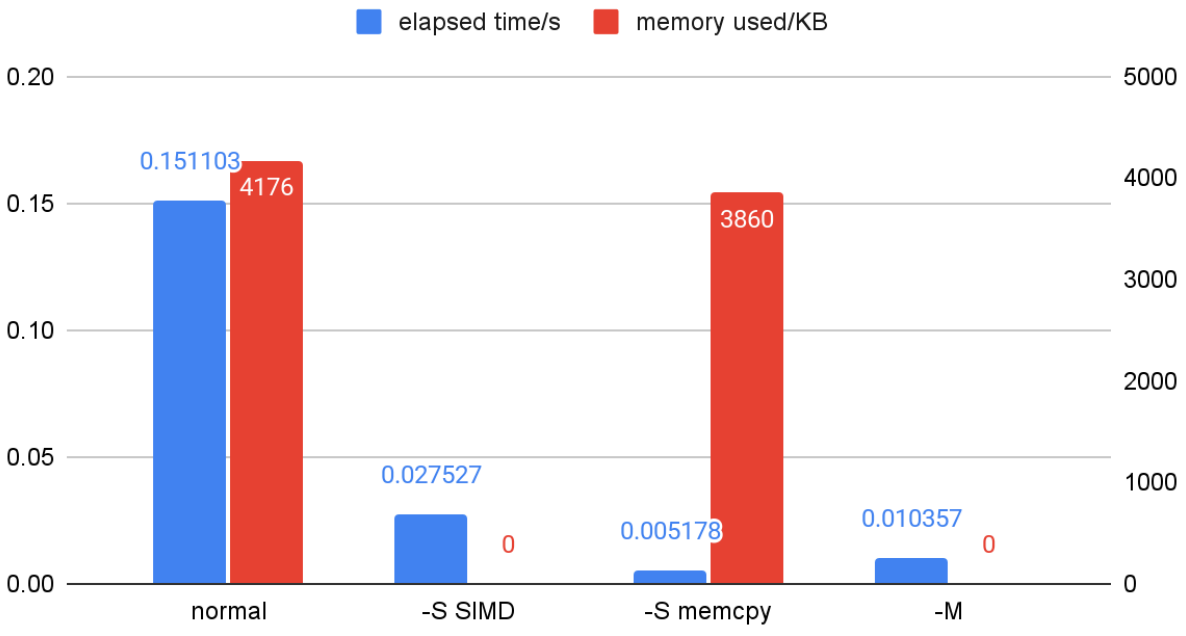
For *clip_channel*, my initial approach involved reading the file frame by frame, using a buffer to index channel sections, and clipping each pixel individually. However, I later optimized this by precomputing the clipping values once and storing them in a hash map, which eliminated redundant computations. To further enhance efficiency, I initialized the hash map as empty and dynamically added new pixel values during processing. This significantly improved runtime for *test.bin*, though it's worth noting this approach might be less effective for files with a broader range of color values.



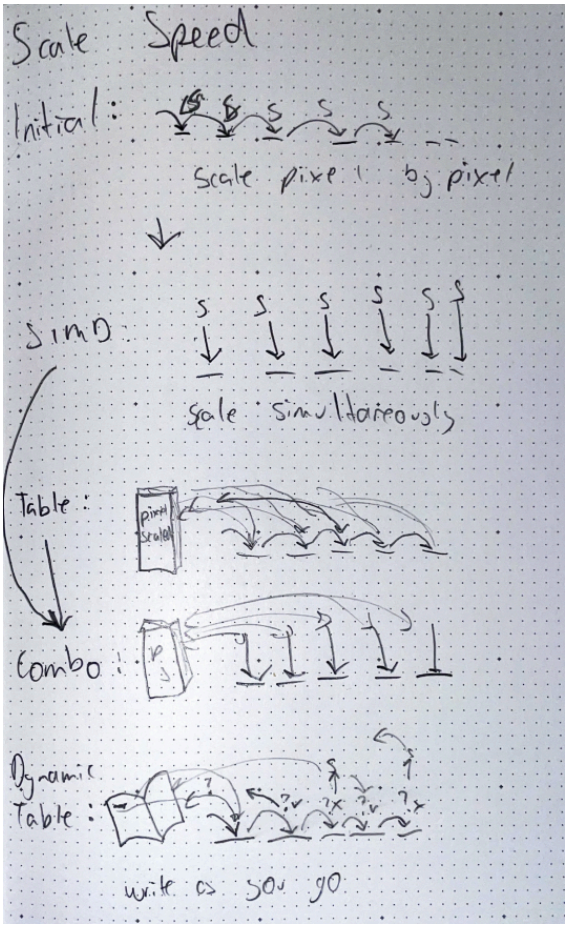
swap_channel

My initial implementation used a basic loop to iterate over each pixel, swapping channel values directly. While functional, it lacked efficiency. I next explored SIMD instructions to process multiple pixels simultaneously. This approach significantly improved performance by reducing the number of iterations. However, alignment issues and setup overhead limited its effectiveness for smaller frames. Finally, I tested *memcpy* for swapping channel sections. By copying and swapping blocks of memory at once, this method proved to be the fastest for larger test files, leveraging optimized memory operations. However, its benefit diminishes for smaller resolutions or fewer channels.

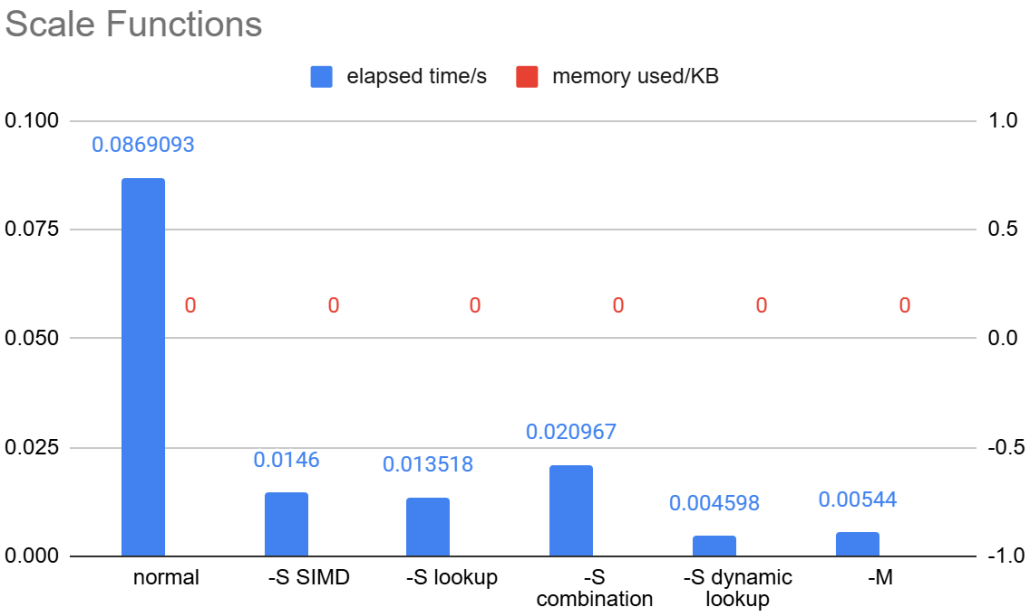




scale_channel



My first implementation for scale_channel used a basic loop, scaling each pixel one at a time. While simple and functional, it was slower due to the repeated multiplication for every pixel. Moving to SIMD improved efficiency by processing multiple pixels in parallel, taking advantage of modern processor capabilities. Introducing a lookup table for precomputed scaled values further reduced runtime by eliminating repeated calculations, though it required additional memory. Combining SIMD with the lookup table proved less effective due to the overhead of managing both. Ultimately, an on-the-fly lookup approach balanced speed and simplicity, avoiding memory overhead while remaining efficient.

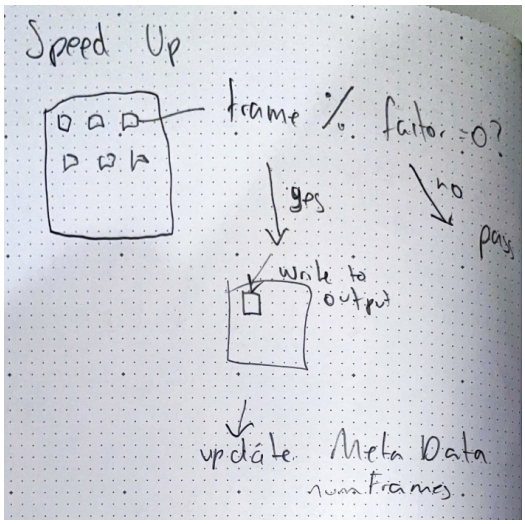


Extra Credit

speed_up

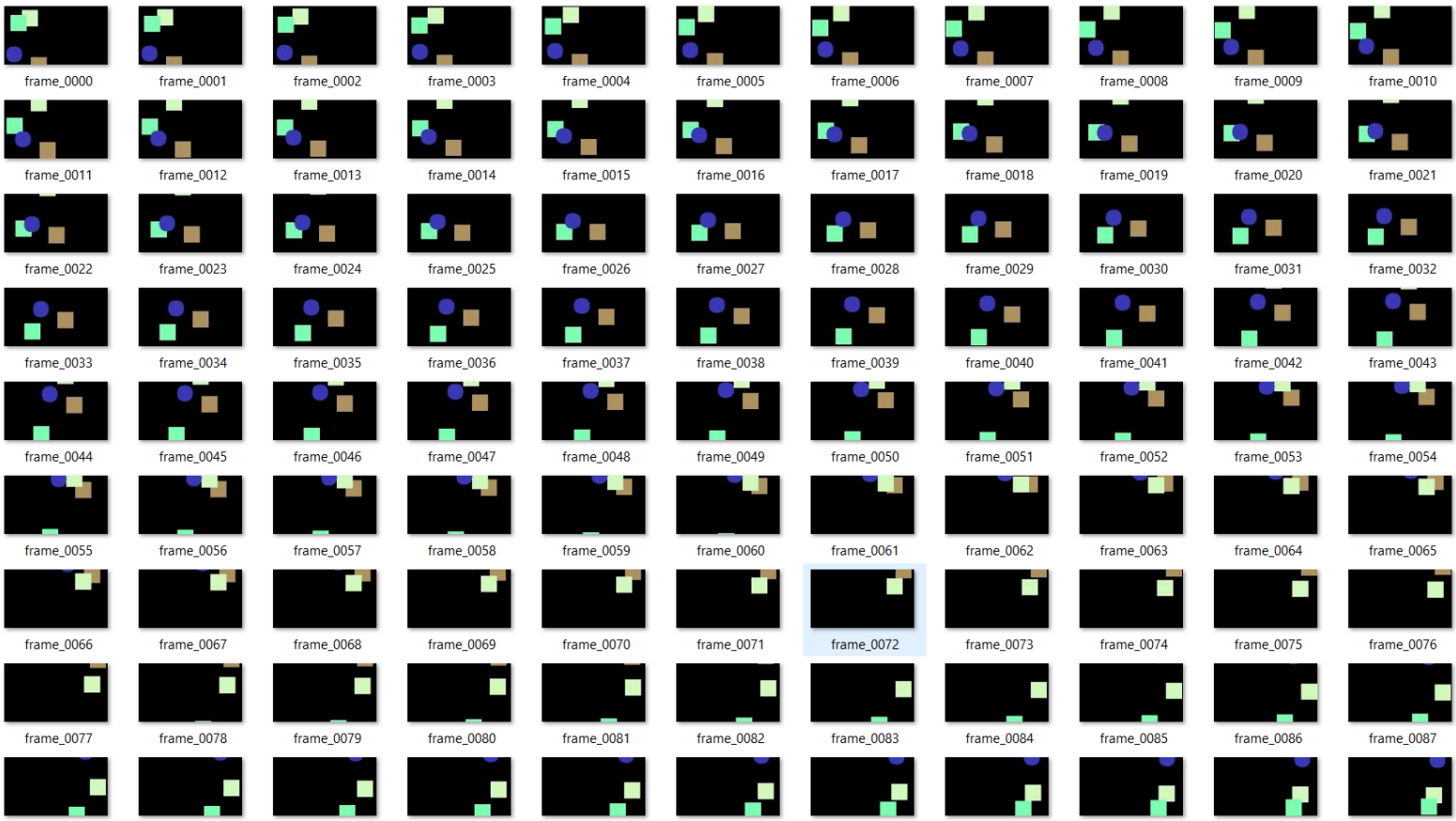
The fist function I wanted to design was a speed up/stop motion function that simply made the video quicker by removing a proportion of frames.

Usage: ./runme data/test.bin rose_s.bin fast_forward 4
Result: 0.002336 seconds 0 KB



crop_aspect

One function I thought might be useful to film-makers is crop to aspect ratio. I chose to crop instead of add black bars because it would look less unsightly for non black backgrounds, but the consequence is some image is lost.
Usage: ./runme data/test.bin rose_s.bin crop_aspect 16:9
Result: 0.007712 seconds 0 KB


frame_0000
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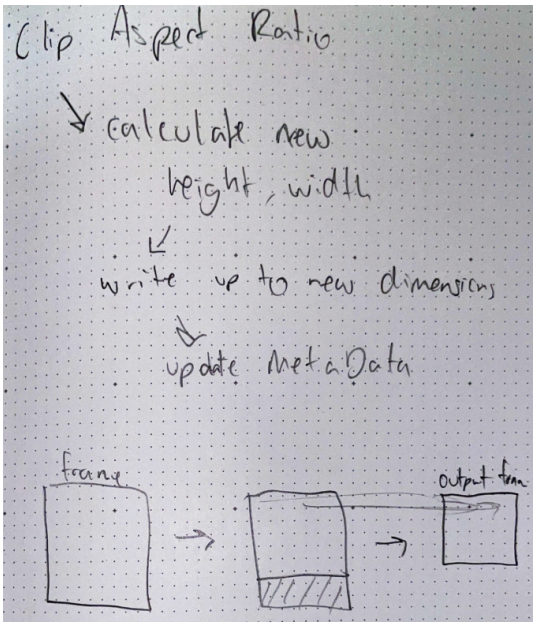
Clip Aspect Ratio
calculate new
height, width
write up to new dimensions
update MetaData
frame
output frame