GPGPU

FROM RUNNING *CRYSIS* TO SOLVING CRISES

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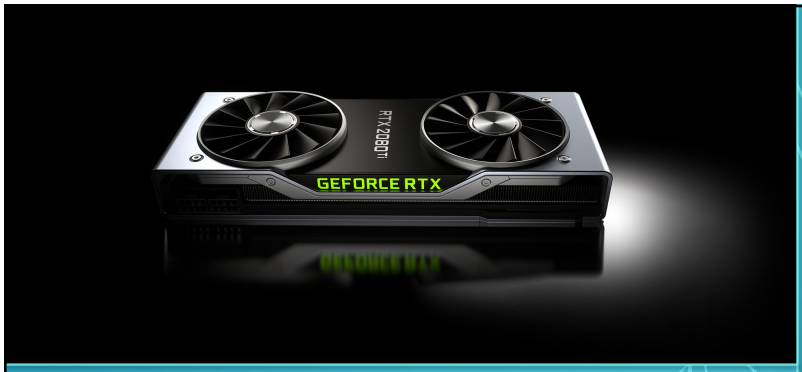
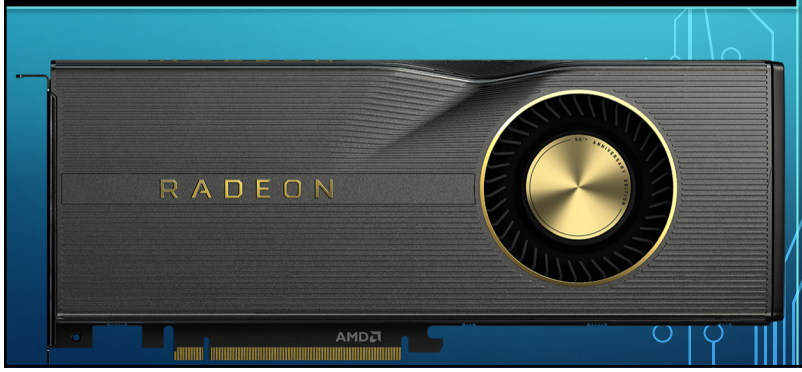
CPTR 380 – FINAL PROJECT PRESENTATION





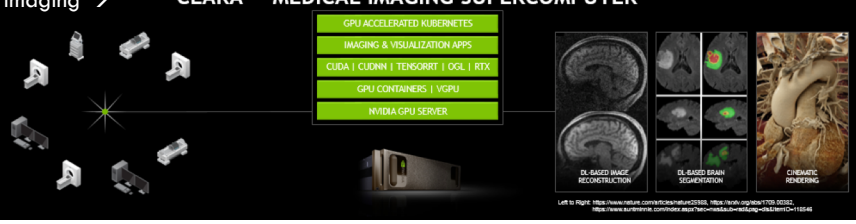
THE GPU

- Very parallelized
- Very fast
- Let's go gamers 😎

GPGPU APPLICATIONS

- Large matrix/vector operations (BLAS)
- Protein Folding/Molecular Dynamics
- Fast Fourier Transform
- Ray Tracing
- Physics Simulation
- Medical imaging →
- Speech Recognition
- Databases
- Sort/Search
- Sequence matching
- And much more.

CLARA – MEDICAL IMAGING SUPERCOMPUTER



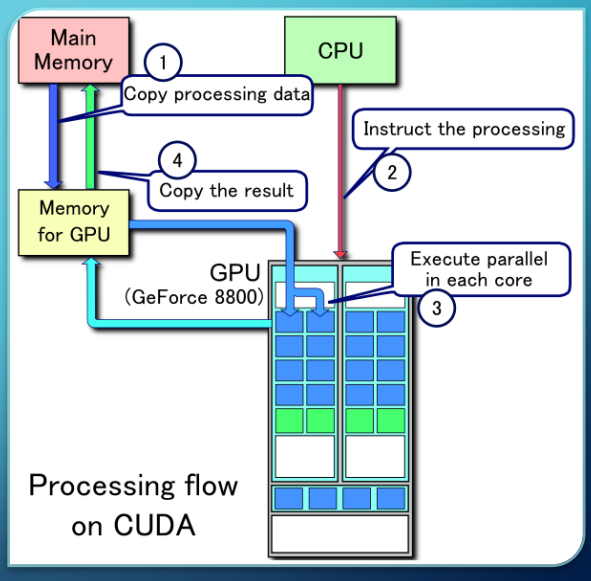
IS IT POSSIBLE TO LEARN THIS POWER?

- Not from AMD.
- The old days – OpenGL and DirectX
  - Had to convert data into graphical terms.
- The new hope – CUDA, OpenCL, MS DirectCompute

OpenGL
Microsoft DirectX
NVIDIA CUDA
OpenCL

CUDA (NOT A SELLOUT BTW)

- Compute Unified Device Architecture – 2007
- Compatible with C, C++, and Fortran.
- Give direct access to the GPU's (if CUDA-enabled) virtual instruction set and parallel computational elements.
- Gone are the days of data conversion to graphics.



MY GPGPU EXPERIENCE - TL;DR

- OBJ: Move a nonlinear MRI data fitting process from the CPU to the GPU.
- Where? Loma Linda University Medical Center
- How? CUDA.
- Why? Because there are many data sets (30-100+), each taking up to 30 hours by CPU.
- Hotel? Trivago.
- Result: It got very fast.

	CPU Time (sec)	GPU Time (sec)	Approximate Acceleration
DCE – Patlak Model	124,645	20.7	6014x
DCE – Two Compartment Exchange Model (2CXM)	112,817	138.3	816x
Dixon – Three Parameter Fitting	417.7	43.5	9.6x

GPU VS CPU

CPU

- Fast caches (optimal data reuse)
- Fine branching granularity
- Lots of different processes/thread
- High performance on a single thread of execution

GPU

- Lots of math units; ALU-heavy
- Fast access to onboard memory
- Run a program on each fragment/vertex
- High throughput on parallel tasks

Conclusion: CPUs are optimal for **task** parallelism
GPUs are optimal for **data** parallelism

SOURCES

- https://blogs.nvidia.com/blog/2018/03/28/ai-healthcare-gtc/
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- https://en.wikipedia.org/wiki/CUDA
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- https://graphics.stanford.edu/~mhouston/public_talks/R520-mhouston.pdf
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- https://submissions2.mirasmart.com/ISMRM2020/ViewSubmissionPublic.aspx?sei=ZluGiDQqO

ANY QUESH'?