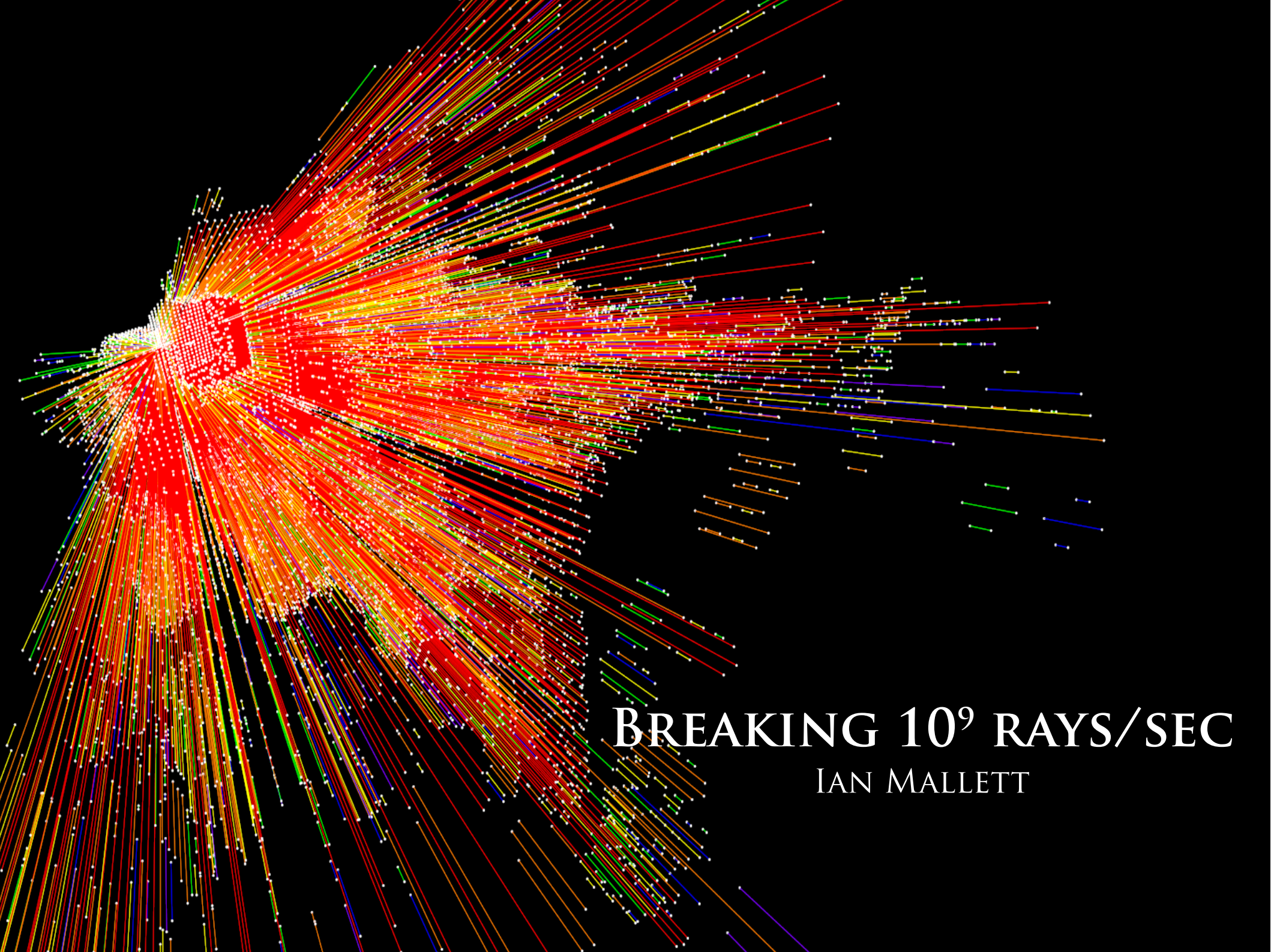
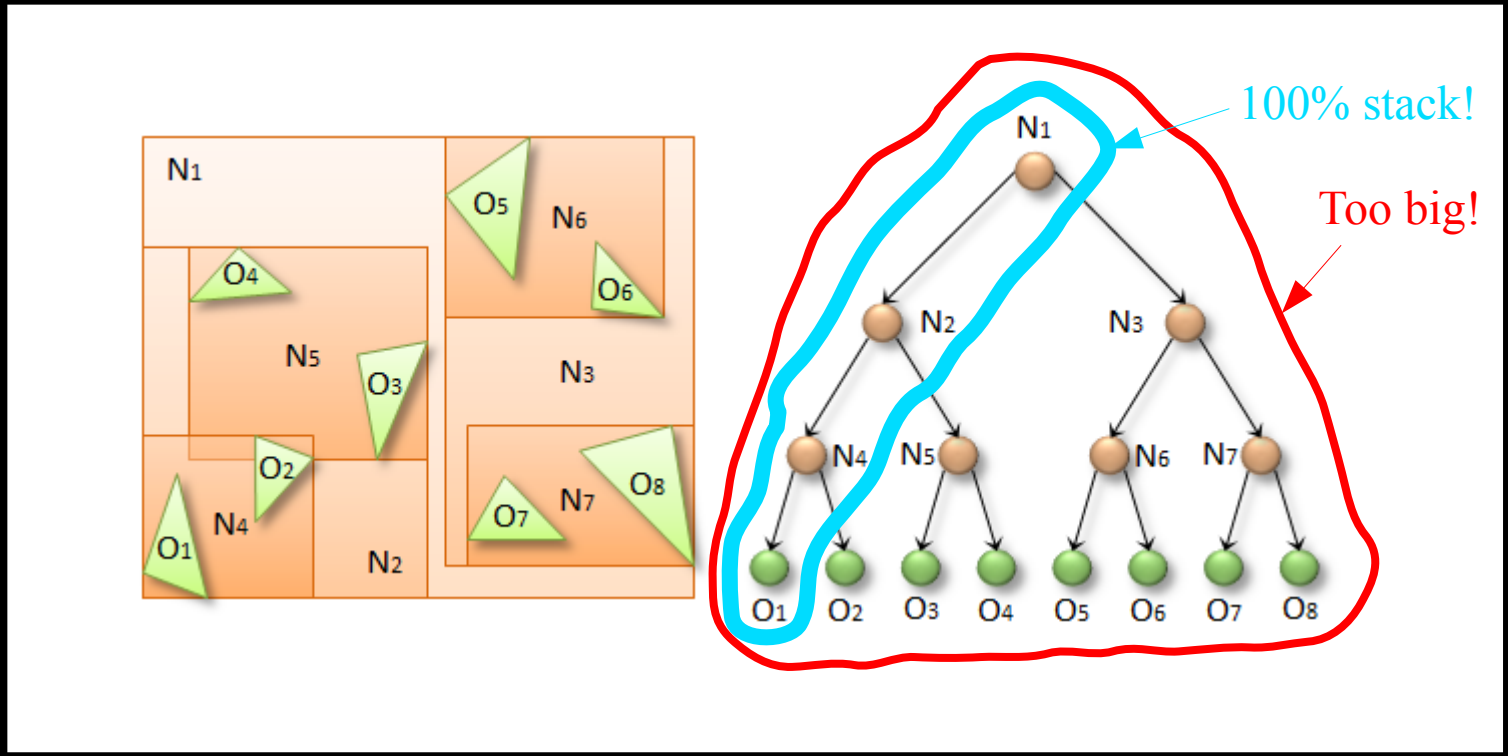
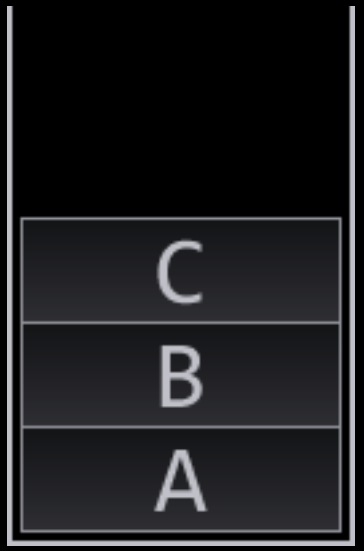

Breaking $10^9$ rays/sec
Ian Mallett

# Idea 1 of 3


N1
O5
N6
O6
O4
N5
O3
N3
O2
N4
O1
N2
O7
N7
O8
100% stack!
Too big!
N1
N2
N3
N4
N5
N6
N7
O1
O2
O3
O4
O5
O6
O7
O8

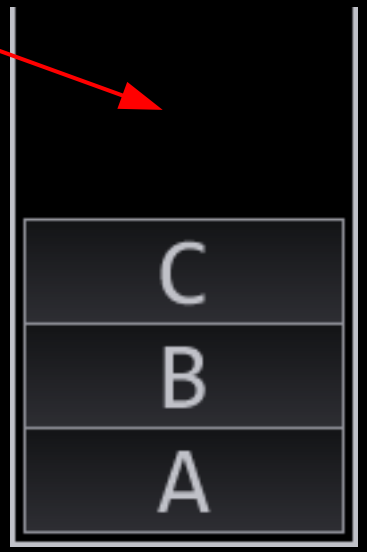
# Data Structures

- Stack?



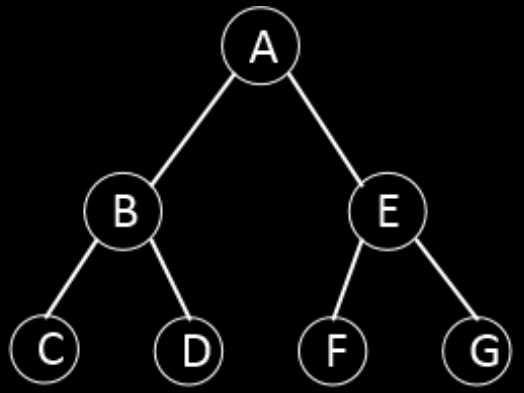
# Data Structures

- Stack?
  - Huge amount of wasted space.
  - No parallel paths stored.



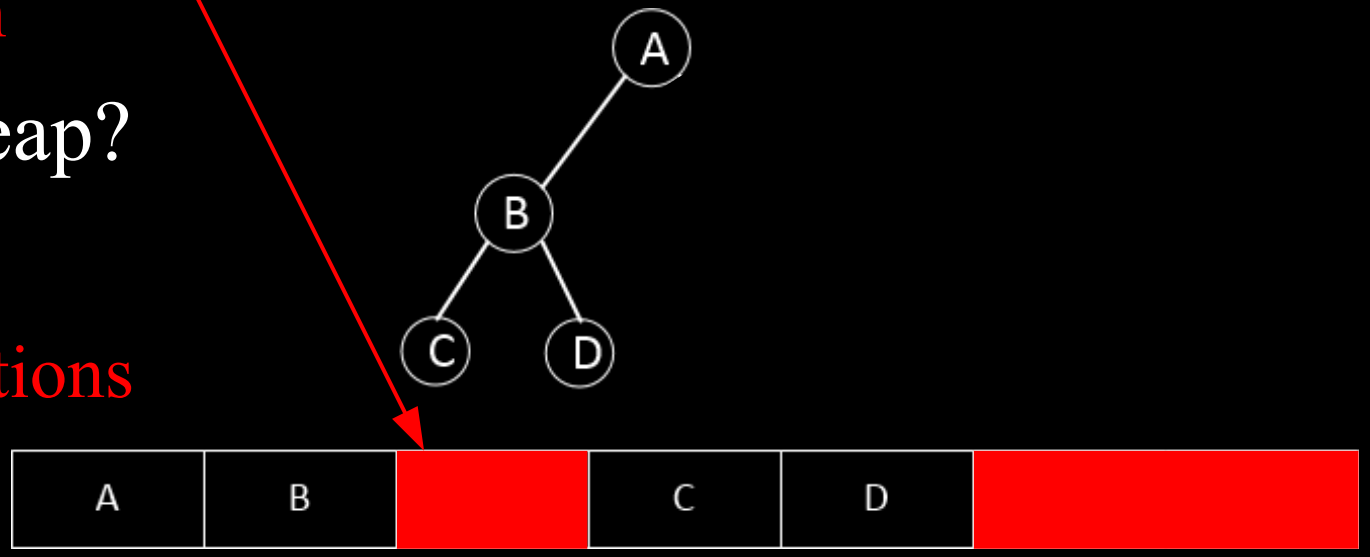
# Data Structures

- Binary Heap?



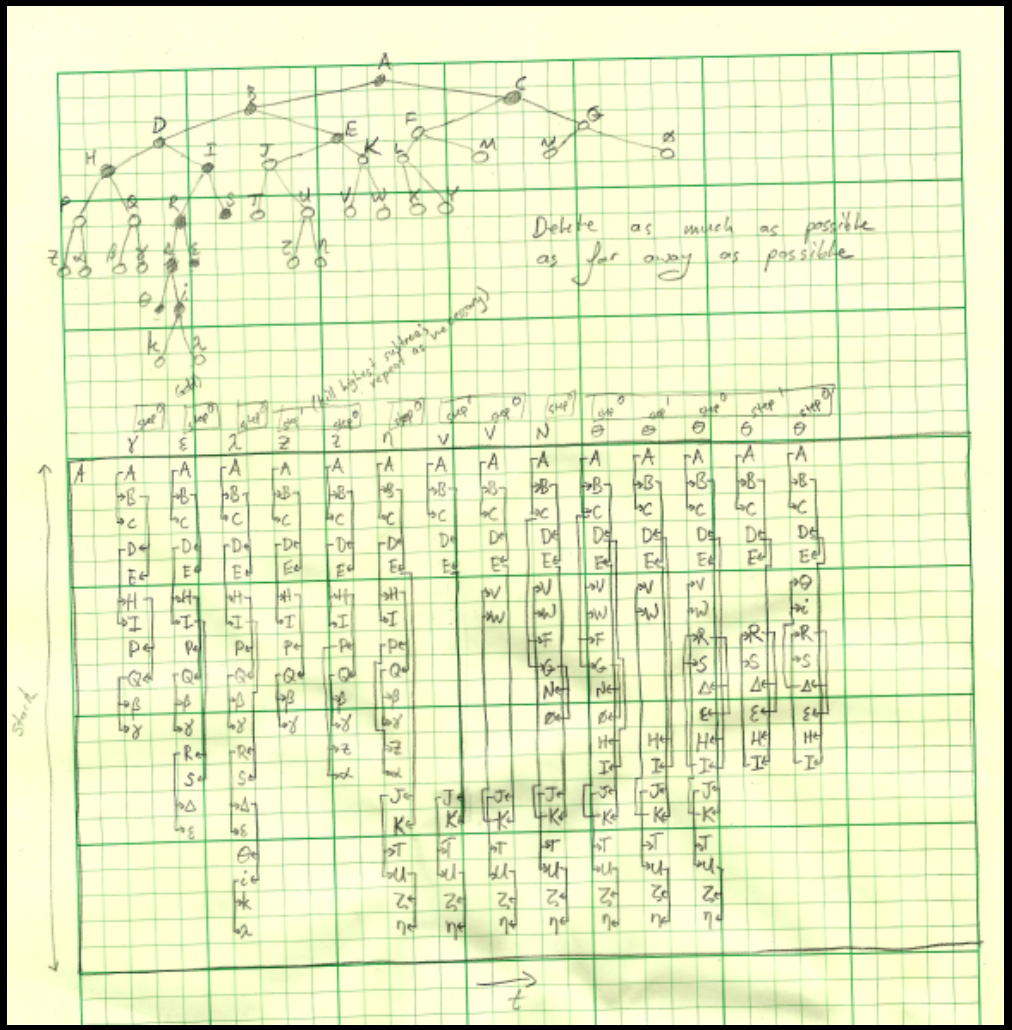

# Data Structures

- Binary Heap?
  - Linear insert/remove operations
  - Balanced → lots of wasted space
  - Fragmentation
- Skew binary heap?
  - Unbalanced
  - Ehhhhh operations still linear



# Data Structure

- My magical heap-like structure



# Data Structure

- My magical heap-like structure
  - Adds in amortized O(1)
  - Deletes O( |*deletion*| )
  - Memory:
    - Fragmentation (but reuses some)
    - Uses all space (except for fragmentation loss)
    - Substantial (~$^{1}/_{6}$th) overhead for bookkeeping
  - Complex

# Data Structure

- My magical heap-like structure
  - Adds in amortized O(1)
  - Deletes O( |*deletion*| )
  - Memory:
    - Fragmentation (but reuses some)
    - Uses all space (except for fragmentation loss)
    - Substantial (~$^{1}/_{6}$th) overhead for bookkeeping
  - Complex

Where's the magic? :-(

# Data Structure

- My magical heap-like structure (ver. 2)
  - Adds in amortized O(1)
  - Deletes O( |*stack*| + |*deletion*| )
  - Memory:
    - No fragmentation!
    - Uses all space!
    - No extra bookkeeping overhead!
  - Simple (ish)!

# Data Structure

- *Heuristic: delete as much as possible as far away as possible.*

# Progress

- Worked out this data structure
- Optimized path tracer as a start
  - ~1.6e8 rays/sec cornell box (no L1, no L2, no BVH)

Questions?

# Image Credits

- http://elasticdog.com/images/2008/11/stack-push.png
- http://bryanwagstaff.com/wp-content/uploads/2013/10/d
- me