

# Mind Uploading

## Becoming a Virtual Being

By Deuce of FurryMUCK =^.^=

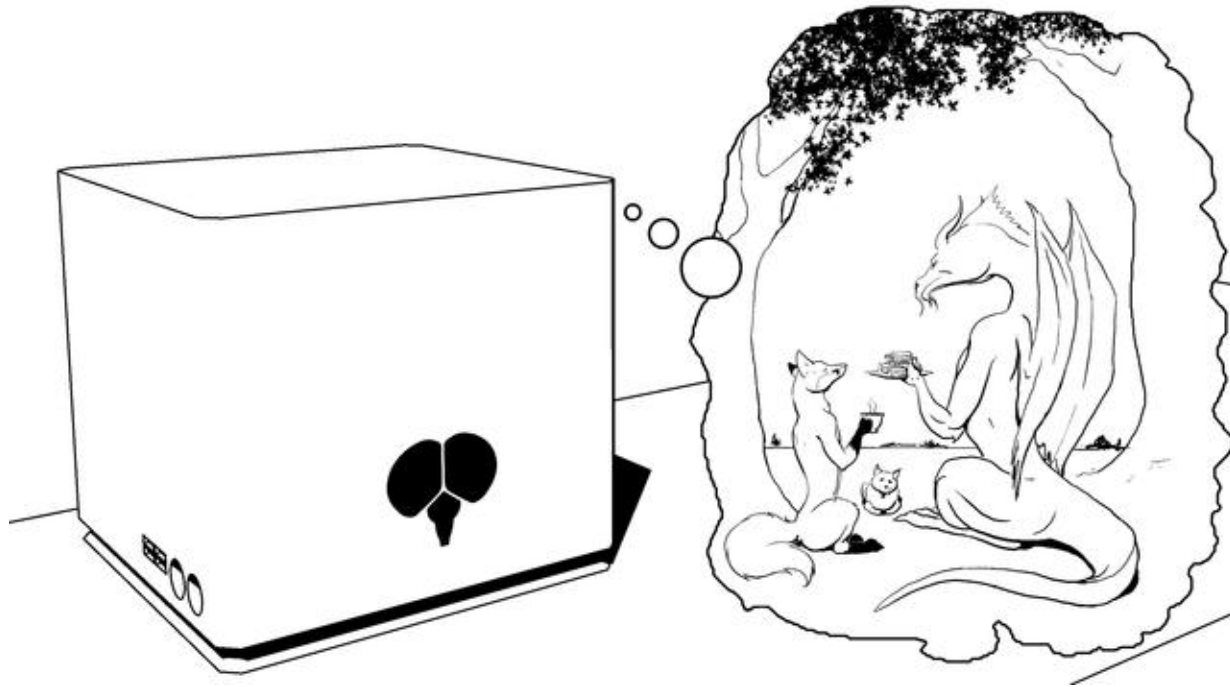
Additional art by Richard Bartrop  
(<http://rjbartrop.deviantart.com>)

# Why Upload?

- Vastly improved standard of living
  - Simulating a beautiful world is much easier than simulating a mind!
- Immortality
  - Backups, synchronized group-minds

# Why Upload?

- Be whatever you want, in any world you want!



# Computing and Storage Capacity

- Estimate based on neural structure:
  - $1e+15$  synapses
  - Neurons perform weighted sum and threshold
  - Update rate about 10 Hz (trains of 1 ms pulses)
- Storage: 1 PB ( $1e+15$  bytes)
- Processing:  $1e+16$  multiply-accumulates/sec.

# Computing and Storage Capacity

- Estimate based on content and searching:
  - Sensory data is about 1 MB/frame at 10 Hz
  - Assume 30 years worth of recall ( $1e+9$  seconds)
  - Assume a full query takes 1 second
- Storage: 10 PB ( $1e+16$  bytes)
- Processing:  $1e+16$  bytes/sec throughput

# Building Suitable Hardware

- With current hardware:
  - 1,000 one-terabyte drives (archive.org “petabox”)
  - 1,000,000 ten-gigaflops processors (huge cluster)
- Bottleneck is communications and disk I/O!
  - 1 GB per processor lets you cache it.
- Costs \$1 billion, consumes 100 MW.
  - Alternate: 1000 processors, underclocked 1000x.

# Building Suitable Hardware

- Limits to power: 0.1 eV per logic node/cycle
  - With padding, gives  $1e-18$  J per node per cycle
  - 8-bit MAC uses about 1000 nodes
  - Result: 10 W for full speed mind simulation
- Limits to space: 100 nm cube per bit now, 10 nm cube later
  - If mostly memory, 1 cubic inch now, 10x shrink later (seed or thin film).

# Hardware in Fiction

- Near future tech in fiction:
  - Permutation City (Greg Egan, 1994)
  - Freejack (1992 film)
- Far future tech in fiction:
  - Accelerando (Charlie Stross, 2005)
  - Culture novels (Iain M. Banks, 1987-ongoing)

# Scanning Minds

- Information needed:
  - Connection topology (what links to what)
  - Synapse weights
  - Other chemical factors (learning feedback state, hormone feedback system)
- Usual assumptions:
  - Mind is wholly represented by body/brain
  - Brain encoding is purely classical (safe bet)

# Scanning Minds

- Easy way: Freeze and Strip
  - Freeze brain, shave in micron-thick slices
  - Full spectrum imaging gives physical and chemical state.
  - Could be done today, with effort!
- Hedging for humans: Cryonics
- Likely early application: Resurrecting pets

# Scanning Minds

- Hard way: Monitor While Alive
  - “Smart dust” nano-motes or other sensors throughout living brain
  - Build correlation map of nerve activity
- Problems:
  - Hard to get power in and data out
  - Heating problems
  - Health problems (sand in your head will kill you)

# How Would This Change Things?

- Economics would change.
  - Economic value is given by scarcity.
  - Storage space, processing power, bandwidth have value.
  - Personal effort has value (expert use of processing power).
  - Virtual objects don't have value!
  - Artificial scarcity possible but difficult.

# How Would This Change Things?

- Social values and rights would change.
  - Rights are a function of what we value.
  - Wrongs are things we think cause harm.
  - Both of these may change drastically!
  - Other rights may vanish (death is only inconvenient, not permanent).
- Far future: Most of the population virtual!
  - Most infrastructure supporting computation.

# Looking Forwards

- Could upload a human mind-state now, expensively.
  - Limit is knowledge of what to scan and to simulate.
- Virtual humans (and furies) on horizon and approaching fast.

