Energetic Emus
(name subject to change)

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This is a Busy Beaver.

“No, he’s not busy... in fact, that whole thing is just a myth.”
This is an energetic emu.
Overview

- Turing Machine Productivity

- Busy Beaver: $BB(n) = \text{maximum for machine with } n \text{ states}$

- Energetic Emu: $EE(n) = \text{maximum for machine with } n \text{ transitions}$
Why?

- **BB** is interesting, but what is a state in our physical representations?
- **EE** looks at defined transitions, which is where the work gets done!
- It’s interesting, and appears to be untouched!
Busy Beaver is defined for different types of machines (quintuple, quadruple, implicit, explicit halt)

Energetic Emu domain is that of deterministic quadruple machines with a binary alphabet, implicit halting
Structure of Output

- I examine only how many 1’s are left on the tape. They need not be consecutive nor starting at any particular place with regard to the read/write head.
My Approach

- Exhaustive approach, but with considerations for efficiencies
- Some upper bounds can be determined from existing BB(n) information
- Lower bounds based on observation
Machine Generation

- (I’m indebted to the RPI BB team for the information on their site about efficient machine enumeration)

- Machines are recursively grown from the single state machines, and all possible growths are expanded
For small values of $n$...

<table>
<thead>
<tr>
<th>$n$</th>
<th>$EE(n)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
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<tr>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>?</td>
</tr>
</tbody>
</table>

Problem in machine generation algorithm makes earlier numbers uncertain.

Even in the small numbers, BB changes with $n$. Here there is a brief plateau...
Some machines

EE(1) = 1

EE(2) = 1

EE(3) = 2

EE(4) = 3