A question by @jamestanton Oct 9, 2018

N has 1 digit in base N+1 and more digits in base 2. Let A(N) be the average number of digits of N when represented in bases 2,3,...,N+1.

Graph? Bounds? Limits?

In [1]:

```
? digits
```

```
search: digits digits! ndigits isdigit isxdigit disable_sigint
```

Out[1]:

```
  digits([T<:Integer], n::Integer; base::T = 10, pad::Integer = 1)

  Return an array with element type T (default Int) of the digits of n
 in the
  given base, optionally padded with zeros to a specified size. More
  significant digits are at higher indices, such that n ==
  sum([digits[k]*base^(k-1) for k=1:length(digits)]).

  Examples
  ==========

  julia> digits(10, base = 10)
  2-element Array{Int64,1}:
   0
   1

  julia> digits(10, base = 2)
  4-element Array{Int64,1}:
   0
   1
   0
   1

  julia> digits(10, base = 2, pad = 6)
  6-element Array{Int64,1}:
   0
   1
   0
   1
   0
   0
```

In [2]:

```
digits(209)
```

Out[2]:

```
3-element Array{Int64,1}:
 9
 0
 2
```

In [3]:

```
digits(9,base = 2)
```

Out[3]:

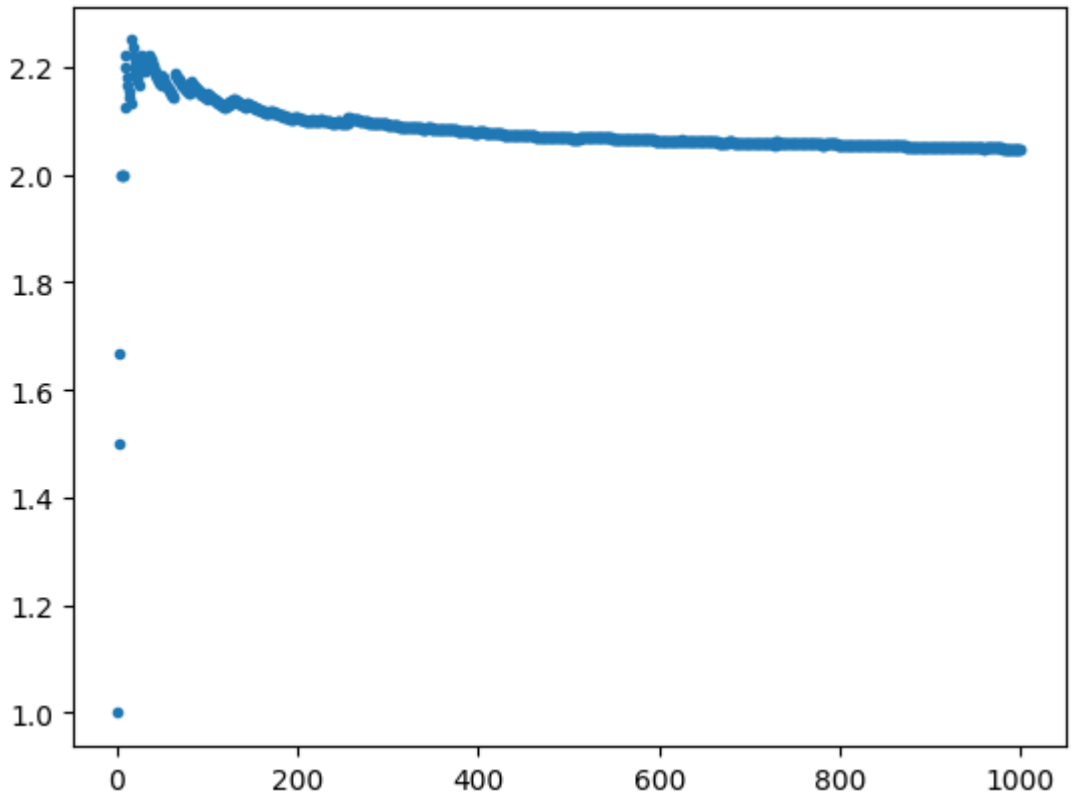
```
4-element Array{Int64,1}:
 1
 0
 0
 1
```

9 in base 2 is 1001

221 in base 4 is 26 in base 10? 2*1 + 2*4 + 1*16

In [16]:

```
using Statistics, PyPlot
A(N) = mean([ length(digits(N,base = b)) for b in 2:N+1])
Nmax = 1000
plot(1:Nmax,A.(1:Nmax),".")
```



Out[16]:

```
1-element Array{PyCall.PyObject,1}:
```

```
PyObject <matplotlib.lines.Line2D object at 0x7f3dff9eb990>
```

In [19]:

```
A(3*10^4)
```

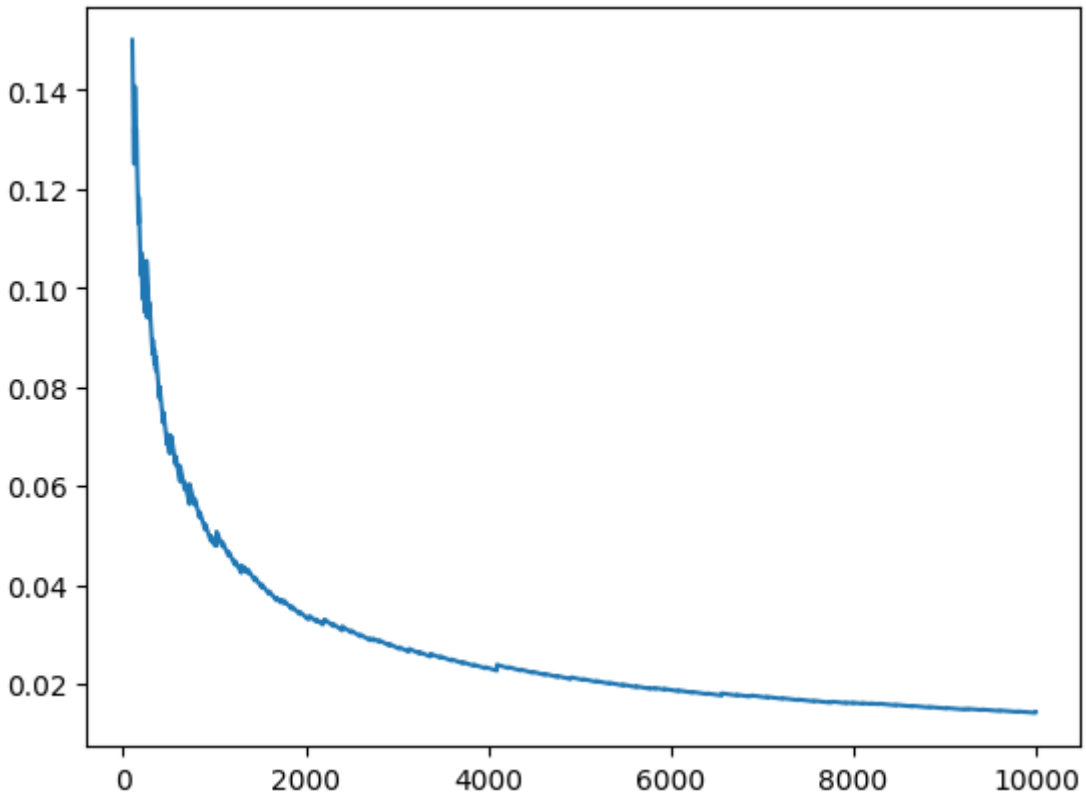
Out[19]:

```
2.007833333333333
```

Conjecture:
$\lim_{N\to\infty} A(N) = 2$

In [20]:

```
errs = [A(N) - 2 for N in 100:10000]
plot(100:10000,errs)
```



Out[20]:

```
1-element Array{PyCall.PyObject,1}:
 PyObject <matplotlib.lines.Line2D object at 0x7f3dff95ed90>
```

number = $\sum_{k=1}^{n} d_k b^{k-1}$

In [44]:

```
N = 34234
b = 8
dig = digits(N,base = b)
println(dig)
sum([dig[k]*b^(k-1)  for k in 1:length(dig)])
```

```
[2, 7, 6, 2, 0, 1]
```

Out[44]:

```
34234
```

In [45]:

```
parse(Int,"102672", base = 8)
```

Out[45]:

```
34234
```

0,1,2,3,...,9,A,B,C,D,E,F Hex

In [29]:

```
0xFF + 1
```

Out[29]:

```
256
```

In [35]:

```
0xFEB4 - 1 + 1
```

Out[35]:

```
65204
```

In [34]:

```
N = 18
b = 16
digits(N,base = b)
```

Out[34]:

```
2-element Array{Int64,1}:
 2
 1
```

In [43]:

```
? parse
```

search: **parse** try**parse** **par**tial**s**ort**p**erm **par**tial**s**ort**p**erm! **pa**i**rs** ski**p**char
s

Out[43]:

```
  parse(type, str; base)

  Parse a string as a number. For Integer types, a base can be specifi
ed (the
  default is 10). For floating-point types, the string is parsed as a
 decimal
  floating-point number. Complex types are parsed from decimal strings
 of the
  form "R±Iim" as a Complex(R,I) of the requested type; "i" or "j" can
 also be
  used instead of "im", and "R" or "Iim" are also permitted. If the st
ring
  does not contain a valid number, an error is raised.

  Examples
  ==========

  julia> parse(Int, "1234")
  1234

  julia> parse(Int, "1234", base = 5)
  194

  julia> parse(Int, "afc", base = 16)
  2812

  julia> parse(Float64, "1.2e-3")
  0.0012

  julia> parse(Complex{Float64}, "3.2e-1 + 4.5im")
  0.32 + 4.5im

  ------------------------------------------------------------------------
--------

  parse(Colorant, desc)

  Parse a color description.

  This parses subset of HTML/CSS color specifications. In particular,
  everything is supported but: "currentColor".

  It does support named colors (though it uses X11 named colors, which
 are
  slightly different than W3C named colors in some cases), "rgb()", "h
sl()",
  "#RGB", and "#RRGGBB' syntax.

  Args:
```

```
    • Colorant: literal "Colorant" will parse according to the desc

  string (usually returning an RGB); any more specific choice will ret
urn a
  color of the specified type.

    • desc: A color name or description.

  Returns: An RGB{N0f8} color, unless: - "hsl(h,s,l)" was used, in whi
ch case
  an HSL color; - "rgba(r,g,b,a)" was used, in which case an RGBA colo
r; -
  "hsla(h,s,l,a)" was used, in which case an HSLA color; - a specific
Colorant
  type was specified in the first argument
```

In [46]:

```
bitstring(19)
```

Out[46]:

```
"00000000000000000000000000000000000000000000000000000000000010011"
```

N->1 machine.... 10->1 2-> 1

|||*|**|

In [47]:

```
bitstring(5)
```

Out[47]:

```
"00000000000000000000000000000000000000000000000000000000000000101"
```

In [48]:

```
M = 5
b = 10
#The b->1 machine
function explode(arr)
   newArr = copy(arr)  #creates a copy of the array so we can work on it....
   for k in 1:M-1
      if arr[k] >= b
         #do an explosion... and quit...
         newArr[k] -= b
         newArr[k+1] += 1
         return newArr
      end
   end
   return newArr
end
```

Out[48]:

```
explode (generic function with 1 method)
```

In [51]:

```
explode([12,2,11,0,0])
```

Out[51]:

```
5-element Array{Int64,1}:
  2
  3
 11
  0
  0
```

In [52]:

```
explode(explode([12,2,11,0,0]))
```

Out[52]:

```
5-element Array{Int64,1}:
 2
 3
 1
 1
 0
```

In [54]:

```
explode([213,0,0,0,0])
```

Out[54]:

```
5-element Array{Int64,1}:
 203
   1
   0
   0
   0
```

In [55]:

```
explode(Out[54])
```

Out[55]:

```
5-element Array{Int64,1}:
 193
   2
   0
   0
   0
```

In [56]:

```
explode(Out[55])
```

Out[56]:

```
5-element Array{Int64,1}:
 183
   3
   0
   0
   0
```

In [58]:

```
b = 2
arr = [19,0,0,0,0]
while true
    println(arr)
    newArr = explode(arr)
    if newArr == arr #if no explosion
        break
    end
    arr = newArr
end
```

```
[19, 0, 0, 0, 0]
[17, 1, 0, 0, 0]
[15, 2, 0, 0, 0]
[13, 3, 0, 0, 0]
[11, 4, 0, 0, 0]
[9, 5, 0, 0, 0]
[7, 6, 0, 0, 0]
[5, 7, 0, 0, 0]
[3, 8, 0, 0, 0]
[1, 9, 0, 0, 0]
[1, 7, 1, 0, 0]
[1, 5, 2, 0, 0]
[1, 3, 3, 0, 0]
[1, 1, 4, 0, 0]
[1, 1, 2, 1, 0]
[1, 1, 0, 2, 0]
[1, 1, 0, 0, 1]
```

In [59]:

```
bitstring(19)
```

Out[59]:

```
"00000000000000000000000000000000000000000000000000000000000010011"
```

In [ ]:

```
#try to make a function that takes an array, number1 in b1 (a base) and returns an a
convert(number1,b1,newBase)
```