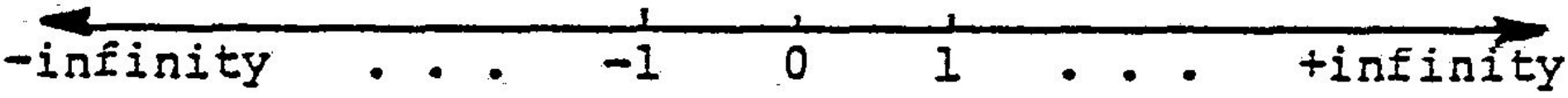
Large Numbers

- Gautam Kotian


-infinity . . . -1 0 1 . . . +infinity

Commonly heard large number terms

1 Billion = 10^9 (1 followed by nine zeroes)

1 Trillion = 10^{12} (1 followed by twelve zeroes)

Not-so-commonly heard large number terms

1 Quadrillion = 10^{15}

1 Quintillion = 10^{18}

1 Sextillion = 10^{21}

1 Septillion = 10^{24}

1 Octillion = 10^{27}

$$10^{80}$$

$$1 \text{ Googol} = 10^{100}$$ (1 followed by a hundred zeroes)

$$1 \text{ Googolplex} = 10^{\text{Googol}}$$ (1 followed by a googol zeroes)

Counting

3, 4, 5, 6, ... 25, 26, 27

Addition (iterated counting)

$$3 + 3 + 3 + \ldots\ldots\ldots + 3 = 27$$

9 steps

Multiplication (iterated addition)

$$3 * 3 * 3 = 27$$

3 steps

Exponentiation (iterated multiplication)

$$3^{3} = 27$$

1 step

Symbol

Knuth’s up-arrow notation

$$2 \uparrow 3 = 2^{3} = 8$$

Tetration (iterated exponentiation)

$$3 \uparrow\uparrow 5 > \text{Googolplex}$$

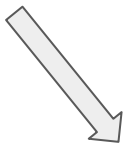
$$3 \uparrow\uparrow 3 = 3 \uparrow (3 \uparrow 3)$$

Pentation (iterated tetration)

$$3 \uparrow\uparrow\uparrow 3 = 3 \uparrow\uparrow (3 \uparrow\uparrow 3)$$

Hexation (iterated pentation)

$$3 \uparrow\uparrow\uparrow\uparrow 3 = 3 \uparrow\uparrow\uparrow (3 \uparrow\uparrow\uparrow 3)$$



g_1

$g_1 = 3 \uparrow\uparrow\uparrow\uparrow 3$

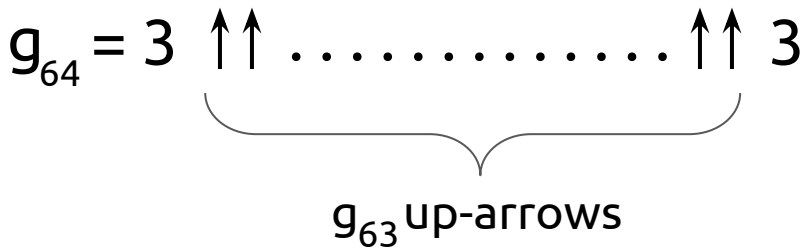
$g_2 = 3 \underbrace{\uparrow\uparrow \cdots\cdots\cdots\cdots \uparrow\uparrow}_{g_1 \text{ up-arrows}} 3$

$g_3 = 3 \underbrace{\uparrow\uparrow \cdots\cdots\cdots\cdots \uparrow\uparrow}_{g_2 \text{ up-arrows}} 3$

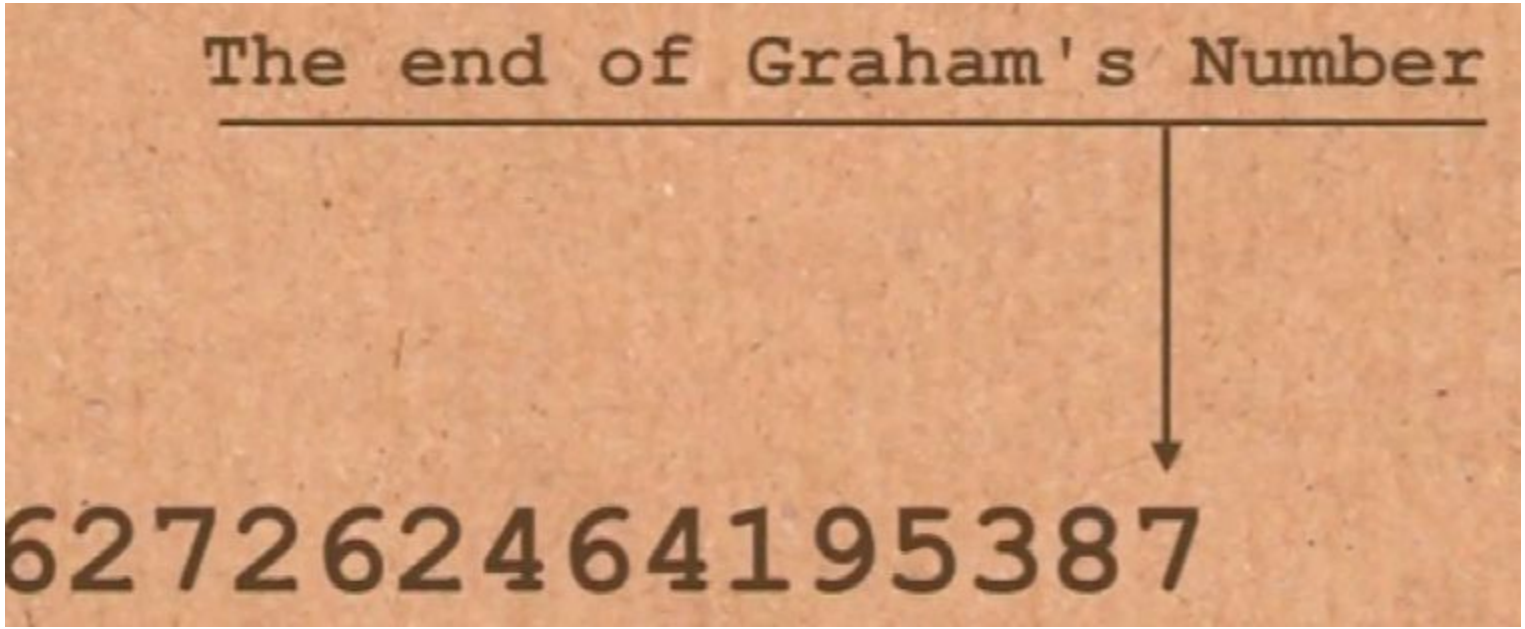
g_4

g_5

g_6



Graham's Number


The end of Graham's Number
6272624641953 87

Key Takeaways

- Tools above exponentiation exist
  (technical term = hyperoperation sequence)
- Mathematicians are weird people

Thank You

Slides in repo “presentations” on GitHub.user : @gkotian

References:

https://www.youtube.com/watch?v=GuigptwlVHo
https://en.wikipedia.org/wiki/Large_numbers
https://en.wikipedia.org/wiki/Graham%27s_number
https://en.wikipedia.org/wiki/Knuth%27s_up-arrow_notation
http://waitbutwhy.com/2014/11/1000000-grahams-number.html