Lesson 2 - Exponentiation

This presentation should help you understand:
Googology 1 – concept 1.2

Presentation made by Mr. A, for a googology canvas course.

What is Exponentiation?

- Exponentiation is just repeated multiplication.

$$x^n = \overbrace{x \times x \times x \cdots \times x \times x}^{n}$$

- It is a useful place to start when making googological numbers.

Properties of Exponentiation:

- When repeated multiplication occurs patterns show up in the final digit.

2^x for $0 < x < 8$ is: **2**, **4**, **8**, 1**6**, 3**2**, 6**4**, 12**8**, 25**6**

3^x for $0 < x < 8$ is: **3**, **9**, 2**7**, 8**1**, 24**3**, 72**9**, 218**7**, 656**1**

- In fact, when handling extremely large repeated exponentiation, we can use modular arithmetic to calculate the last few digits.

Properties of Exponentiation (cont.):

- You can also compare sizes of numbers by using logarithms

  Remember: $log(n^x) = x \cdot log(n)$
- So: $\log_{10}(2^{1024}) = 1024 \cdot \log_{10}(2) = 308.224 \therefore 2^{1024} > 10^{300}$
- Don’t forget, order and parenthesis matter:

  $c^x > x^c$

  $a^{(b^c)} > (a^b)^c$
- For googological purposes, we will most often try to use the parenthesis/order that will create the larger numbers.

What googologisms can we make?

- The number of atoms in the universe is $\approx 10^{80}$.
- A googol is 10^{100}.
- The number of chess games is $\approx 10^{120}$.
- A centillion is 10^{303}.
- The largest known Mersenne prime is $2^{82589933} - 1$.
- A googolplex is $10^{10^{100}}$.
- Complete heat death of the universe is in $\approx 10^{10^{105}}$.
- Skewe's number is $10^{10^{10^{34}}}$.
- Poincare recurrence time is $10^{10^{10^{10^{2.08}}}}$.