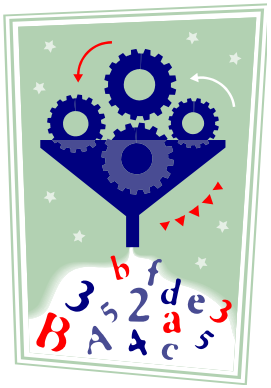
Complexity



Moore's Law

- The number of transistors per square inch doubles every 18 to 24 months.
- Corollaries:
  - Number of bytes of memory per dollar
  - Number of bytes of disk space per dollar
  - Number of bits per second of network bandwidth
  - Personal computer RAM size

PC RAM

Year	RAM size (kb)	2^m
1984	512	9
1988	2,048	11
1992	8,192	13
1996	32,768	15
2000	131,072	17
2004	524,288	19
2008	2,097,152	21
2012	8,388,608	23
2016	33,554,432	25

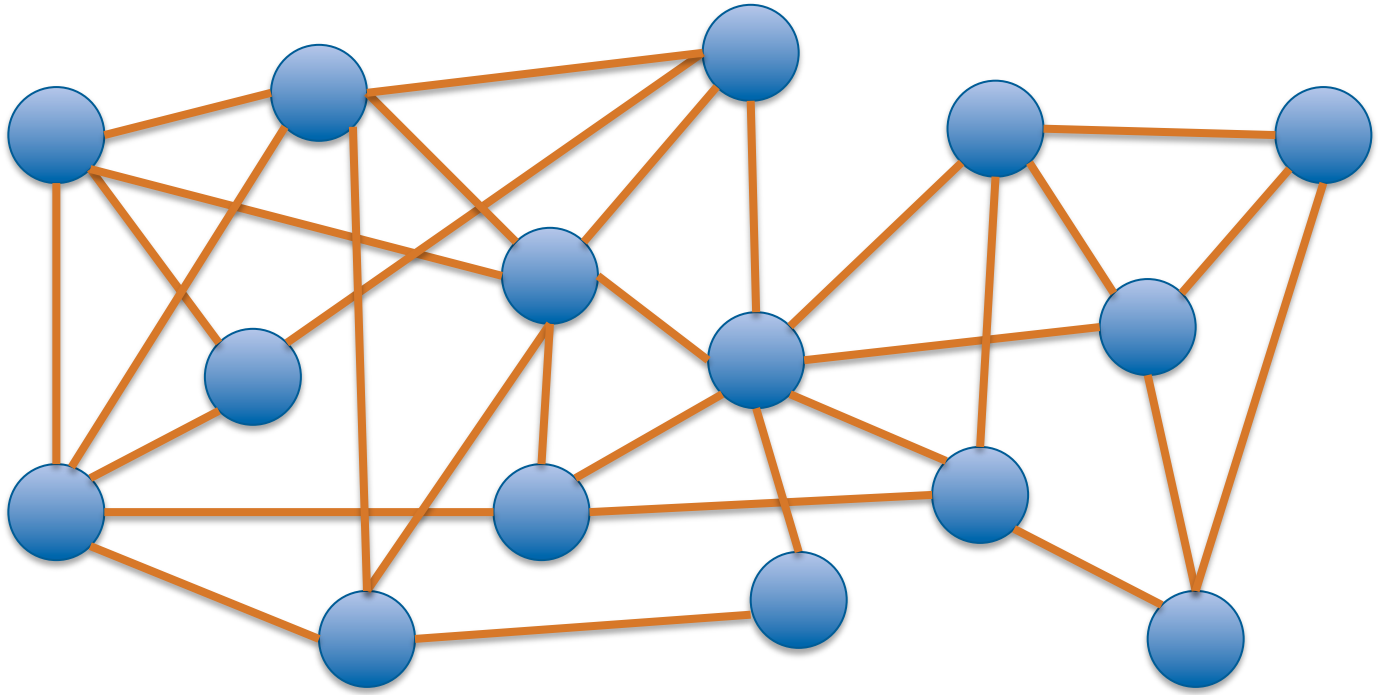
Software Size

- Measured in Lines of Code (LOC)

Year	m	LOC = 2^m
1965	19	524,288
1975	21	2,097,152
1985	23	8,388,608
1995	25	33,554,432
2005	27	134,217,728
2015	29	536,870,912

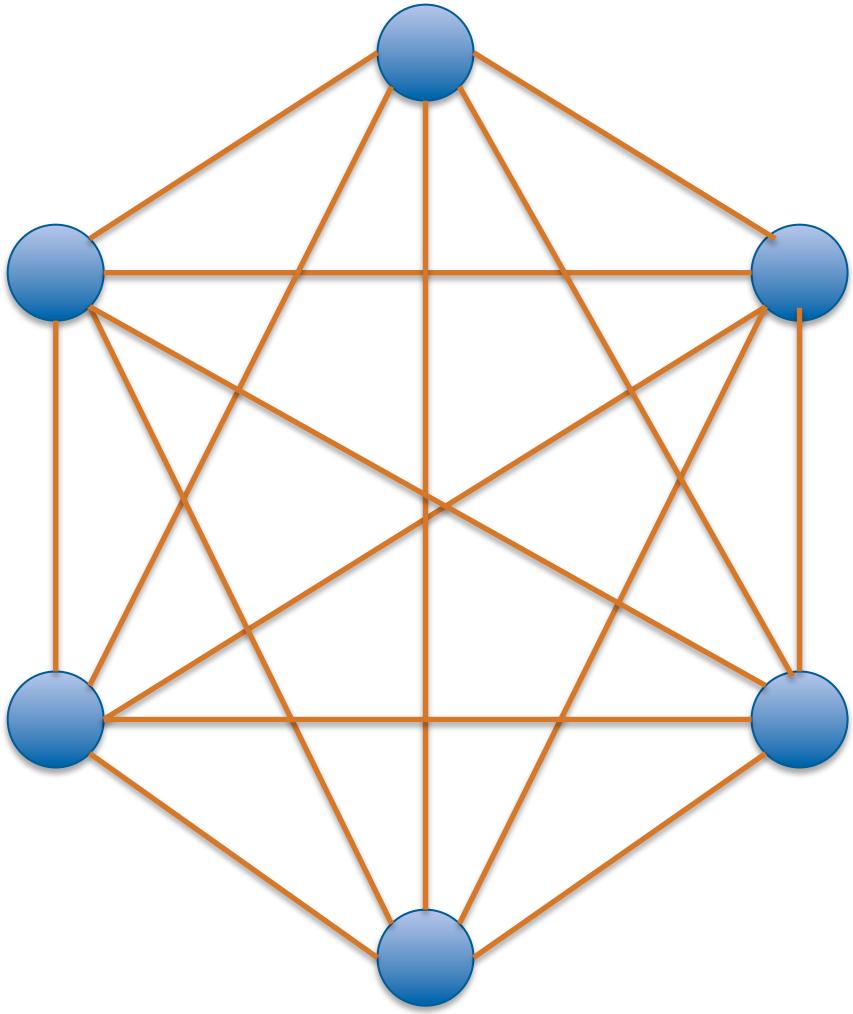
Complexity vs. LOC

- Complexity is related to the number of **interactions** between lines of code.



Some Graph Theory

n	e
1	0
2	1
3	3
4	6
5	10
6	15
n	n(n-1)/2



Complexity Trend

- If there are n lines of code in a program, the complexity is proportional to $n(n-1)/2$
- For large n, this is approximately $n^2/2$
- We previously expressed the number of lines of code in terms of a power of 2
- If the number of lines of code is given by $n = 2^m$, the complexity would be $(2^{2m})/2$, or 2^{2m-1}

Complexity Is Getting Out Of Hand

Year	m	LOC = 2^m	Complexity = $2^{(2m-1)}$
1965	19	524,288	137,438,953,472
1975	21	2,097,152	2,199,023,255,552
1985	23	8,388,608	35,184,372,088,832
1995	25	33,554,432	562,949,953,421,312
2005	27	134,217,728	9,007,199,254,740,992
2015	29	536,870,912	144,115,188,075,855,872

Next

- So, what do we do about it?