Class 16:
Decoding Ourselves

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logistics

Final pitch sessions tomorrow

Contact your TA if no pitch scheduled yet

Problem set 5 due Friday at 11:59pm

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outline

1. the longevity project
2. life, luck and death
3. CS and biology
4. examples
5. perspectives

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a life or death question

life expectancies

Life expectancy at birth, 2009 / **Years gained, 1960-2009**

| Country	Life expectancy	Years gained
Japan	83.0	15.2
Switzerland	82.3	10.9
Italy	81.8	12.0
Spain	81.8	12.0
Australia	81.6	10.7
Israel	81.6	9.9
Iceland	81.5	8.6
Sweden	81.4	8.3
France	81.0	10.7
Norway	81.0	7.2
New Zealand	80.8	9.7
Canada	80.7	9.4
Luxembourg	80.7	11.3
Netherlands	80.6	7.1
Austria	80.4	11.7
United Kingdom	80.4	9.6
Germany	80.3	11.2
Greece	80.3	10.4
Korea	80.3	27.9
Belgium	80.0	10.2
Finland	80.0	11.0
Ireland	80.0	10.0
Portugal	79.5	15.6
OECD	**79.5**	**11.2**
Denmark	79.0	6.6
Slovenia	79.0	10.5
Chile	78.4	21.4
United States	78.2	8.3
Czech Republic	77.3	6.7
Poland	75.8	8.0
Mexico	75.3	17.8
Estonia	75.0	6.5
Slovak Republic	75.0	4.4
Hungary	74.0	6.0
Turkey	73.8	25.5
China	73.3	26.7
Brazil	72.6	18.1
Indonesia	71.2	
Russian Federation	68.7	0.0
India	64.1	21.7
South Africa	51.7	2.6

OECD average:
+11.2 years over 49-year period
Average of 2.3 years gained per decade

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the moving horizon

At birth
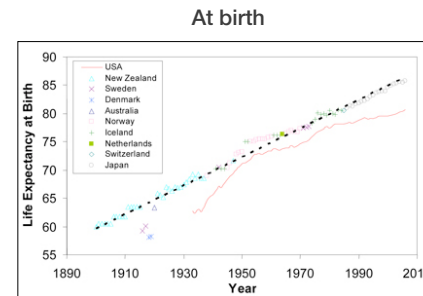
Top countries: 2.5 years/decade

At age 65
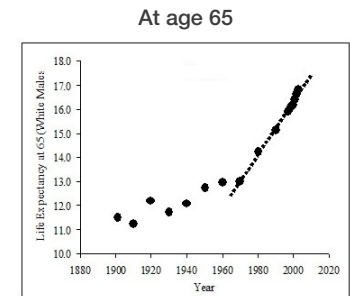
US: 40 days/year

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moving fast enough?
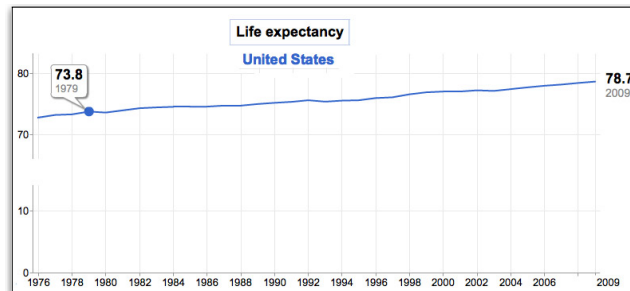
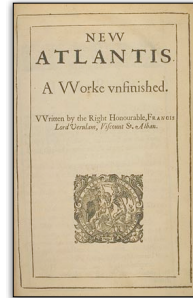**Life expectancy**
United States

73.8 (1979)   78.7 (2009)

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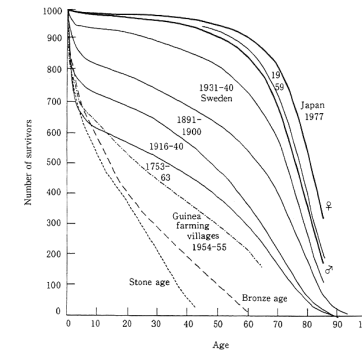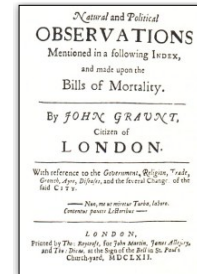
overcoming accidents

the rise of the actuaries

living forever

$$p_x = \text{probability of dying in year x}$$

$$(1 - p_x) = \text{probability of not dying in year x}$$

$$\prod_{x=1}^{n} (1 - p_x) = \text{probability of still being alive at end of year n}$$

$$\prod_{x=1}^{\infty} (1 - p_x) = \text{probability of living forever}$$

The solution to mortality:

$$\prod_{x=1}^{\infty} (1 - p_x) > 0$$

death as accident

the scale of accidents

genetic mutation	car crash	asteroid strike
microscopic	macroscopic	cosmic

If you eliminated all microscopic accidents, you would live to 600-1000

seven types of microscopic accidents

nuclear mutations

mitochondrial mutations

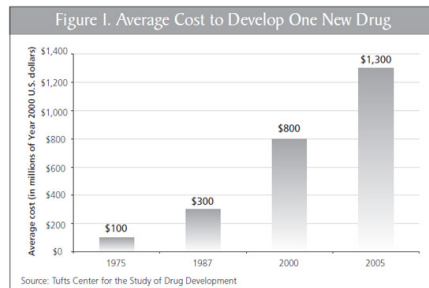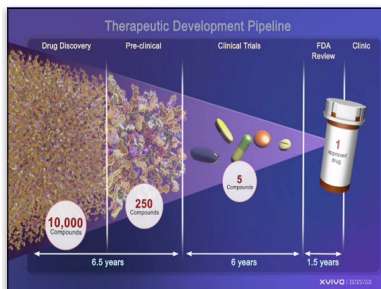intracellular aggregates

extracellular aggregates

cell loss

cell senescence

extracellular crosslinks

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traditional drug discovery

Therapeutic Development Pipeline

Drug Discovery — Pre-clinical — Clinical Trials — FDA Review — Clinic

10,000 Compounds — 250 Compounds — 5 Compounds — 1 Approved drug

6.5 years — 6 years — 1.5 years

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Figure I. Average Cost to Develop One New Drug

Year	Average cost (in millions of Year 2000 U.S. dollars)
1975	$100
1987	$300
2000	$800
2005	$1,300

Source: Tufts Center for the Study of Drug Development

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how big is the search space?
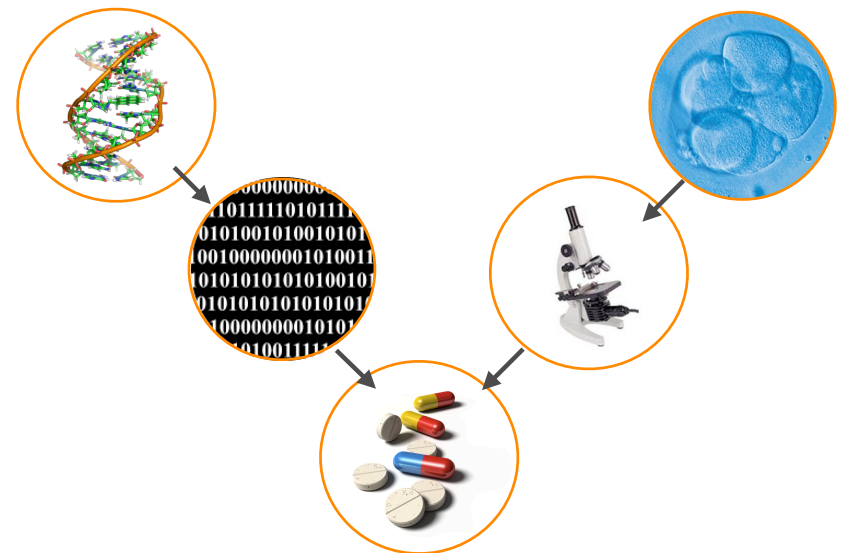
the shift to computation

biological processes	computational processes
luck	agency
irreversible	reversible
degradation	rejuvenation
mortality	immortality
traditional therapeutics →	computational biology

the rise of bioinformatics

hope of the human genome project

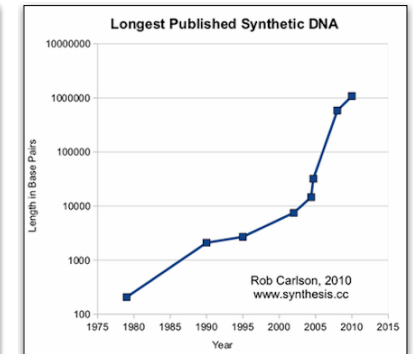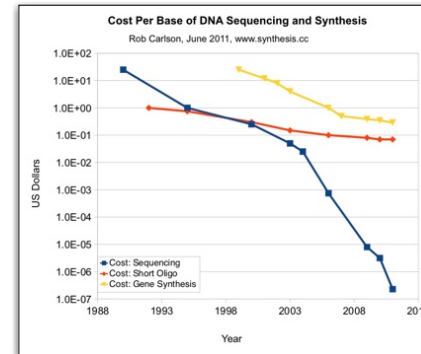"[it will] revolutionize the diagnosis, prevention and treatment of most, if not all, human diseases."
-Bill Clinton, 2000

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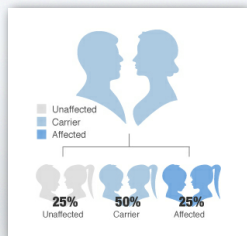5. perspectives

biological

computational

Counsyl

Counsyl

Simple pre-pregnancy test for parents with Mendelian diseases

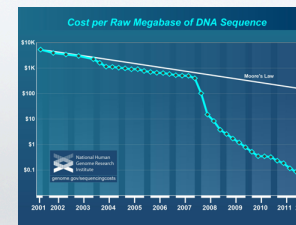Reducing the cost of carrier testing by literally one hundred fold
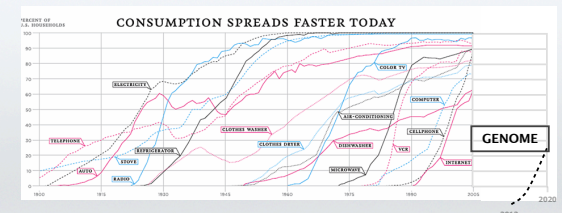
www.counsyl.com

Genomics

To understand genomics requires only two plots
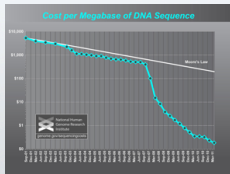

The supra-exponential decline in sequencing costs

The increasingly steep curve of technology adoption

www.counsyl.com

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