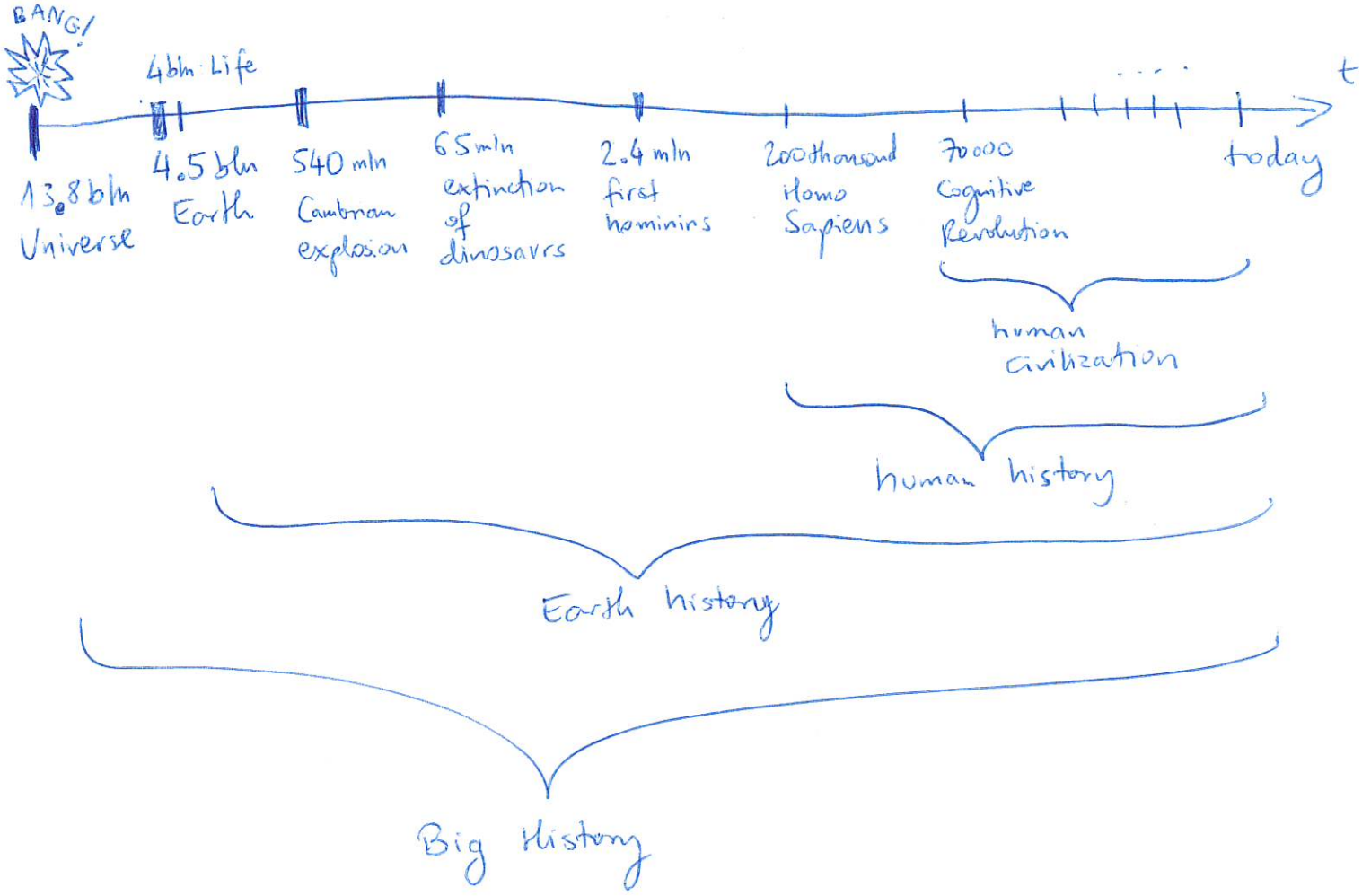
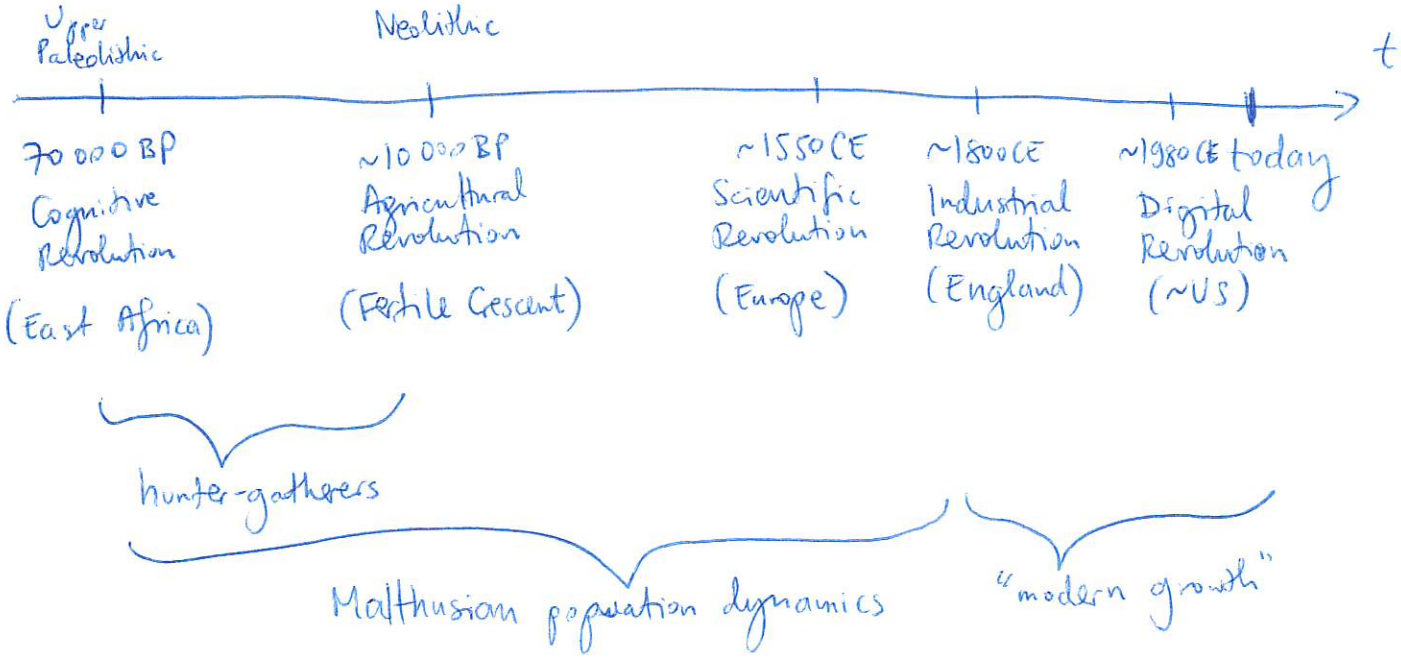
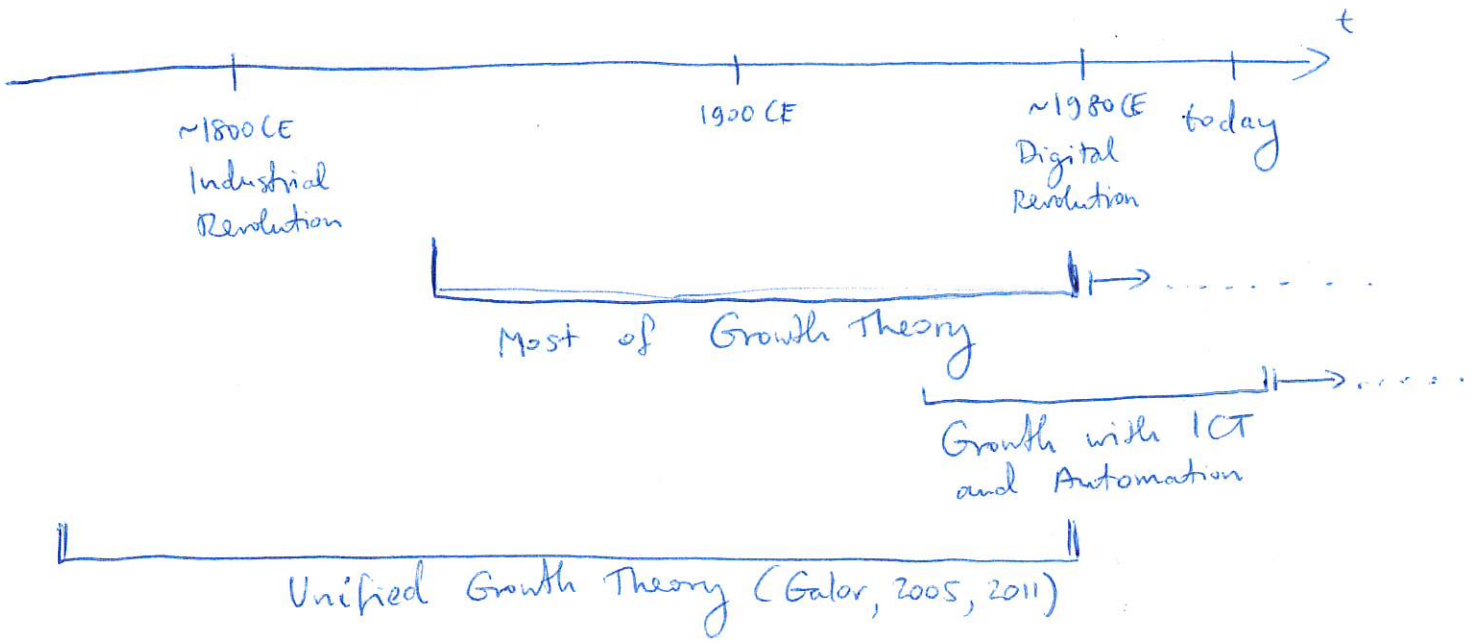
Timeline (not to scale!)



Zoom in:



(to scale)



How many Industrial Revolutions ??

ENERGY

1. ~1800 CE, steam engine, Railroads, Loom
2. ~1870 CE, Electricity, Internal combustion engine, Telephone

DATA PROCESSING

3. ~1960 CE (?) (Gordon, 2016), ICT [computers, cell phones, Internet]
4. ~2000 CE (??) (Schwab, 2016), Cyber-physical systems, Internet of things, 5G, 3D printing, ...

Growth Theory vs Development Economics

Growth Theory

- SOURCES OF GROWTH IN RICH COUNTRIES
- FOCUS ON THE WORLD TECHNOLOGY FRONTIER
- R&D TECHNOLOGICAL PROGRESS
- INSTITUTIONS AS A SOURCE OF GROWTH?

Development Economics

- GROWTH AND CATCH-UP IN POORER COUNTRIES
- FOCUS ON DISTANCE TO FRONTIER
- TECHNOLOGY DIFFUSION, ADOPTION
  FOREIGN DIRECT INVESTMENT, SPILLOVERS
- INSTITUTIONAL FAILURES ('Why Nations Fail?')

CROSS-COUNTRY PERSPECTIVE

- Wealth of Nations (Adam Smith)
- 'Why Do Some Countries Produce So Much More Output Per Worker than Others?' (Hall & Jones, 1999)

(1) Some region takes off, others stay behind ⇒ DIVERGENCE

(2) Forces of catch-up, tech diffusion ⇒ CONVERGENCE

(3) New tech breakthrough, acceleration at WTF ⇒ DIVERGENCE

(4) .....

Possibility of LEAPFROGGING!

Leaders in population density

1. East Africa (~200 000 BP onwards)

AGR REV

2. Fertile Crescent (Mesopotamia, Indus Valley; Nile Valley) (~10 000 BP onwards)

3. Mediterranean Basin (ACHAEMENID EMPIRE ~480 BCE, 49.4 mln, 44% of world pop)

4. China (1500 CE: 125 mln, 28,5% of world pop)

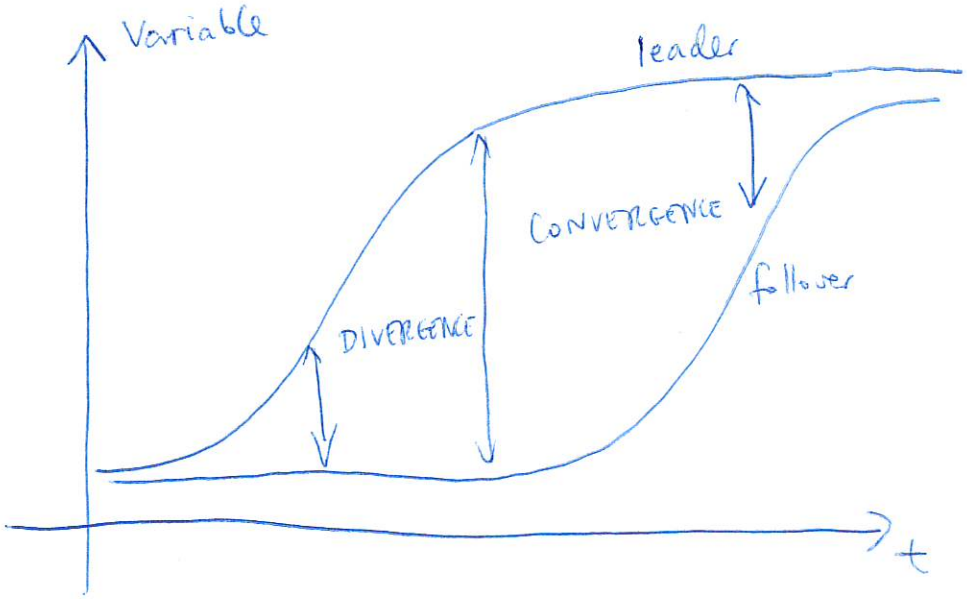
Leaders in GDP per capita (Maddison 2008)

SCI REV

1. Italy, 1500 CE, 1100 $/cap (1990, PPP)
2. Netherlands, 1600 CE, 1400 $
   1700 CE, 2100 $

IND REV

3. UK, 1870 CE, 3200 $
4. USA, 1913 CE, 5300 $
   2008 CE, 31 200 $



Convergence concepts

- **β - convergence**

$$Growth_t = \underbrace{\beta}_{\beta<0} \cdot GDP_{t-1} + \underbrace{\dots}_{2} + \varepsilon_t \quad \left(\approx 2\% \text{ per annum}\right)$$

→ absolute
→ conditional
] convergence

- **σ - convergence**

$Var(GDP_i)$ ↘ with time

→ absolute
→ club convergence (Quah, 1995, ...)

- You may have absolute β-divergence with conditional β-convergence.
- — " — σ-divergence with club convergence

Sources of growth? (GLOBALLY & AT FRONTIER)

(1) Technological progress
- IDEAS ARE NON-RIVALROUS AND THEREFORE A SOURCE OF INCREASING RETURNS TO SCALE (Romer 1990)

(2) Factor accumulation
- K
- Human capital
- Compute software [?]

} KNOWN DECREASING RETURNS

(3) Raw materials [?] Energy [?] Data [?]

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(Mark a Country, Slide the Year)

e.g. → (Income vs. Life Expectancy)
(Income vs. CO_2 Emissions)
(Income vs. Total Fertility Rate)
(Income vs. Child Mortality)
(Income vs. Growth 10 yrs) (UK vs. US)

Global Income Distribution