Cultural Evolution

Next Factor in Drake Equation: f_c

- f_c: fraction of planets with intelligent life that develop a technological phase, during which there is a capability for and interest in interstellar communication
- No significant biological evolution in last 40,000 to 200,000 years (maybe 6000 yr)
- Evolutionary Takeover
 - Cultural evolution instead of biological
 - Much shorter timescale

What is Cultural Evolution?

- No longer changes in genes (biological)
- Extra-somatic information
 - Information stored outside the body
- Changes in knowledge of group
 - Passed on by learning from others
- Parallels to sexual reproduction in bio evol
 - Allows combination of "lessons learned" from many individuals
 - And correction of mistaken ideas

Example

- Culture in primates other than humans?
 - Differences in behavior of groups
- Example: Orangutans in Kluet swamp in Sumatra
 - Make and use tools (bark-stripped twigs) to get honey and seeds from fruit
 - Genetically similar group across Alas river do not
 - River too wide to cross
 - Key feature is high density: observe each other's behavior and learn

Van Schaik, Sci. Am. April 2006

Concepts

- 1. Timescales
- 2. Origin of agriculture
- 3. Extra-somatic information storage
- 4. Tools, technology
- 5. Interactions: written language, cities, taxes, classes, technology
- 6. Interest in communication
- 7. World view evolution
- 8. Coupling between technology and world view

Timescales

- On next slide (which we will look at in more detail later) notice the timescales
- MUCH shorter than the previous kinds of evolution
- And accelerating!

Time	Information	Technology	World View
2 Myr ago		Stone tools	
??	Oral Language	Collective hunting	
10000 BCE	Oran Language	Agriculture	
6500 BCE	Clay tokens	Cities	
6500 BCE	City tokens	Wheel	
4000 BCE			
3000 BCE	Clay tablets	Copper tools	Oyster World
3000 BCE	Syllabic alphabet		Oyster World
	Synable alphabet	Dranga to als	
2800 BCE 1500 BCE	I attan almbahat	Bronze tools Iron tools	
	Letter alphabet	Holi tools	Natural Dhilosophy
500 BCE			Natural Philosophy
200	D 1 1 D		Ptolemaic Model
1456	Printing Press		
1540			Copernican Model
1610		Telescope	Kepler, Galileo
1665			Newton
1700s		Industrial Revolution	
1859			Darwin
1895	Radio		
1924			Other galaxies
1936	First TV Broadcast		
1950s	Computers	Transistors, microchips	Miller-Urey
1960			First Search for Signals
1990s	Internet		

Importance of farming

- The rise of civilizations all based on farming
- Understand origins of agriculture
- How likely to arise?
- Did it arise independently more than once?

Agriculture

- Arose independently in different regions
 - Perhaps 10 different origins
 - First in Sumeria
 - Corn (maize) in Mesoamerica most remarkable
 - Major modifications from wild ancestor
 - Provided settled lifestyles, surpluses, specialization, central states

Agriculture leads to higher level political organization

		Band	Tribe	Chiefdom	State
	Religion Justifies klepto- cracy?	no	no	yes	yes→no
	Economy				
*	Food production Division of labor Exchanges	no no reciprocal	no → yes no reciprocal	yes→intensive no→yes redistributive ("tribute")	intensive yes redistribu- tive ("taxes")
	Control of land	band	clan	chief	various
	Society				
	Stratified	no	no	yes, by kin	yes, not by kin
	Slavery	no	по	small-scale	large-scale
	Luxury goods for elite	no	no	yes	yes
	Public architec- ture	no	no	no → yes	yes
	Indigenous lit- eracy	no	no	no	often

A horizontal arrow indicates that the attribute varies between less and more complex societies of that type.

TABLE 14.1 Types of Societies				
	Band	Tribe	Chiefdom	State
Membership				
Number of people	dozens	hundreds	thousands	over 50,000
Settlement pattern	nomadic	fixed: 1 village	fixed: 1 or more villages	fixed: many villages and cities
Basis of relation- ships	kin	kin-based clans	class and resi- dence	class and residence
Ethnicities and languages	1	1	1	1 or more
Government				
Decision making, leadership	"egalitarian"	"egalitarian" or big-man	centralized, hereditary	centralized
Bureaucracy	none	none	none, or 1 or 2 levels	many levels
Monopoly of force and information	no	no	yes	yes
Conflict resolu-	informal	informal	centralized	laws, judges
Hierarchy of settlement	no	no	no→para- mount village	capital

Information

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Genes \longrightarrow 10<sup>10</sup> bits (or less)

Brains \longrightarrow 10<sup>14</sup> bits

\longrightarrow 1400 cm<sup>3</sup> in humans
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Extra-somatic information

leads to communication: information passed between individuals.

Allows societies to evolve.

Oral language	400,000?	Cooperative hunting?
Oral historians	30,000?	Traditions and Lore
Clay tokens	~ 6500 BCE	Sumeria (record keeping)
Clay tablets	~ 3000 BCE	Business, Taxes
Paper	~ 100	China
Printing press	1456	Europe
Radio	1895	Italy
Television	~ 1936	First "strong" broadcast
Computers	~ 1950's	
World-wide-web	~ 1990's	

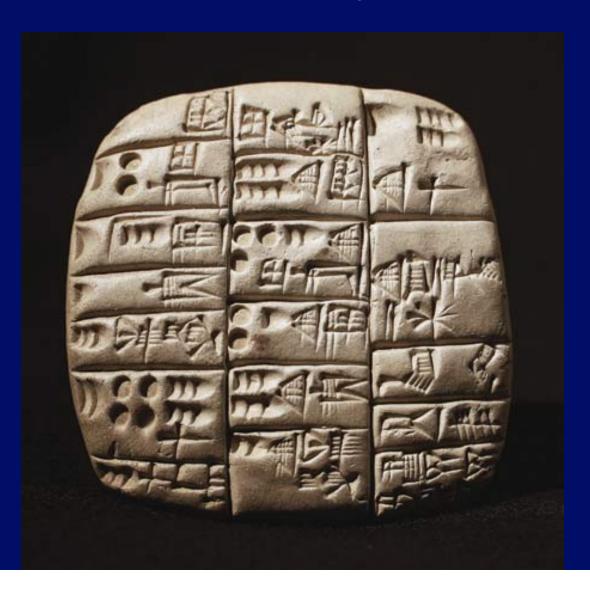
Written Language

- Played key role in expanding knowledge
- Could be stored outside any person's body
- Developed first in Sumeria
 - Clay tokens to keep accounting
 - Clay tablets

Clay Tokens and "Vase" to hold them



Evolved into Clay Tablets



To Printing Press to Computer screen

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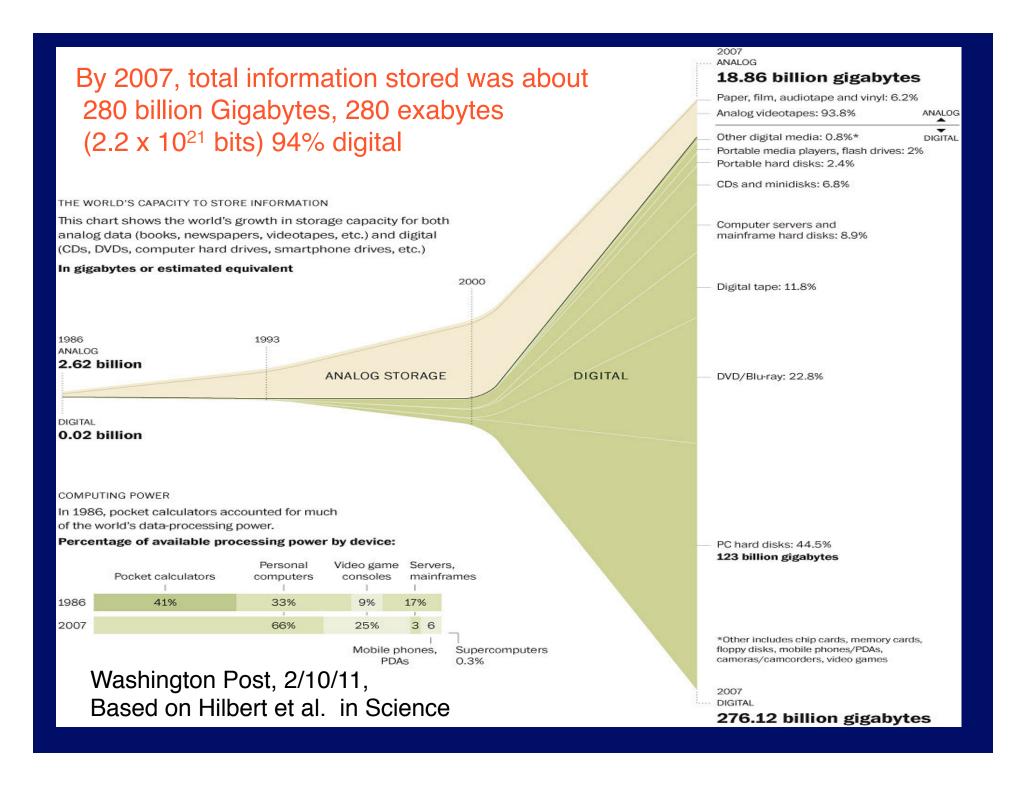
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Information and Intelligence

- Can we think of extra-somatic information as intelligence?
- Collective "intelligence" of the species
- But cannot be assimilated by any individual
- The concept of a "meme" as a unit of cultural information (can mutate and evolve...)
- Collective knowledge does lead to ability to engage in interstellar communication

Tools and Technology

Stone

Oldowan 2.6 Myr H. habilis

Acheulian 1.6 Myr H. erectus

Mousterian 200,000 yr Neanderthals

Paleolithic 90,000 yr H. sapiens (Africa)

Paleolithic 40,000 yr H. sapiens (Europe)

Pottery 7,000 BCE

Wheel 6,500 BCE Sumeria

Oldowan Tools (H. habilis)



OLDOWAN TOOLS
 (left to right): end
 chopper, heavy-duty
 scraper, spheroid
 hammer stone
 (Olduvai Gorge); flake
 chopper (Gadeb);
 bone point, horn core
 tool or digger
 (Swartkrans).

From http://www.handprint.com/LS/ANC/stones.html

Acheulian (H. erectus)



ACHEULIAN TOOLS
 (left to right): cleaver
 stone (Bihorei oest,
 France); lanceolate
 hand ax (Briqueterie,
 France); large hand ax
 (Olduvai Gorge).

Mousterian (Neanderthal)



MOUSTERIAN TOOLS
 (left to right): cutter
 or point, Levallois
 core and point,
 Aterian point with
 base tang, double sided scraper (various
 sites in France).

Upper Paleolithic (H. sapiens)



 UPPER PALEOLITHIC TOOLS (left to right): biconical bone point, Perigordian flint blade, prismatic blade core, Soluterean Willow leaf point, double-row barbed harpoon point (various sites in France).

Tools and Technology

Metal

Copper Tools 4,000 BCE

Bronze Tools 2,800 BCE

(bronze is a copper alloy: arsenic, tin, ...)

Iron Tools 1,500 BCE

Industrial Revolution

Mass Production

Silicon

Transistor 1948 U.S.

Microchip 1959

Internet 1990's

Metal Tools



Copper



Bronze



Iron

The Importance of Iron

- Iron played crucial role because of strength
- But late because it requires very high temperatures to 'reduce' to elemental state
 - And addition of carbon to make an alloy
- In 1800 BCE, 40 ounces of silver to buy one ounce of iron!
- By 600 BCE, one ounce of silver bought 2000 ounces of iron

From The Substance of Civilization by Stephen Sass

Uniqueness

1. Agriculture

At least 5 (and maybe 10) independent origins Southwest Asia, China, Mesoamerica, Andes, Eastern U.S.

2. Written language

2-4 independent origins
Sumer, Mesoamerica, China(?), Egypt (??)
Only after farming

From Guns, Germs, and Steel Jared Diamond

HISTORY'S HAVES AND HAVE-NOTS • 9 9

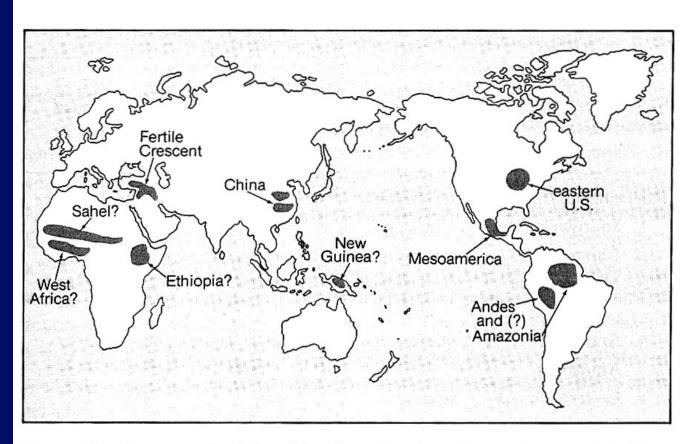


Figure 5.1. Centers of origin of food production. A question mark indicates some uncertainty whether the rise of food production at that center was really uninfluenced by the spread of food production from other centers, or (in the case of New Guinea) what the earliest crops were.

From Guns, Germs, and Steel Jared Diamond

IOO GUNS, GERMS, AND STEEL

TABLE 5 - Examples of Species Domesticated in Each Area

Area	Domesti	Earliest Attested	
	Plants	Animals	Date of Domestication
Independent Origins of D	Oomestication		
1. Southwest Asia	wheat, pea, olive	sheep, goat	8500 в.с.
2. China	rice, millet	pig, silkworm	by 7500 в.с.
3. Mesoamerica	corn, beans, squash	turkey	by 3500 в.с.
4. Andes and Amazonia	potato, manioc	llama, guinea pig	by 3500 в.с.
Eastern United States	sunflower, goosefoot	none	2500 в.с.
? 6. Sahel	sorghum, Afri- can rice	guinea fowl	by 5000 в.с.
? 7. Tropical West Africa	African yams, oil palm	none	by 3000 в.с.
? 8. Ethiopia	coffee, teff	none	?
9. New Guinea	sugar cane, banana	none	7000 в.с.?
Local Domestication Fol	lowing Arrival of Fo	under Crops from	Elsewhere
10. Western Europe	poppy, oat	none	6000-3500 в.с
11. Indus Valley	sesame, eggplant	humped cattle	7000 в.с.
12. Egypt	sycamore fig, chufa	donkey, cat	6000 в.с.

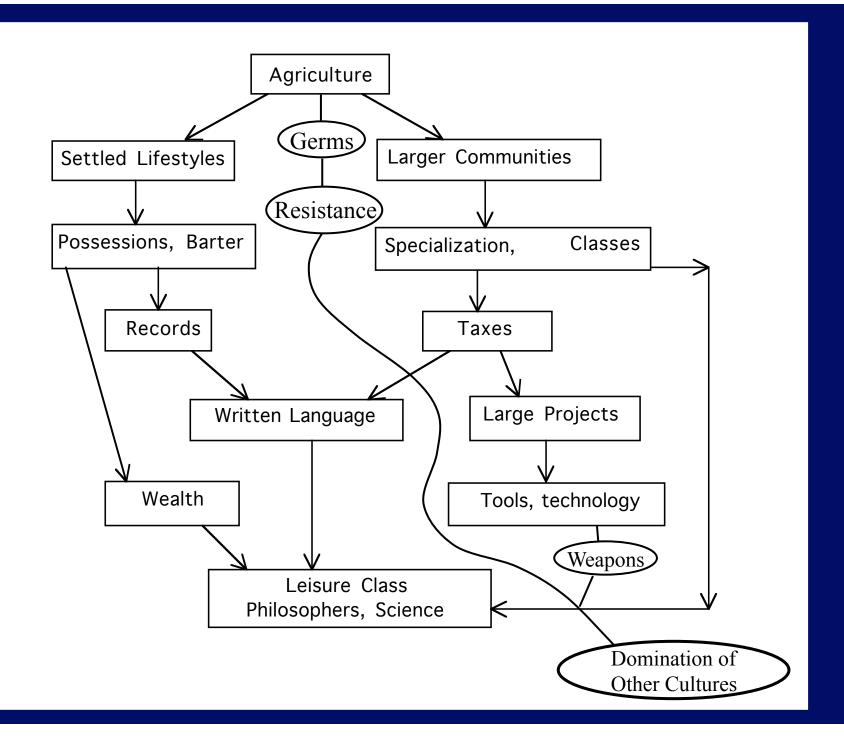
Uniqueness

Centralized states, specialization
 Several independent origins
 Only after farming

4. Metal use

Near East New World (Andes) mostly decorative

5. Industrial Revolution, modern electronics (no test possible - all world in contact)



Questions

How does cultural evolution differ from biological evolution?

Does "natural selection" operate in cultural evolution?

If so, is technology an "advantageous trait"?

Is "cultural evolution" a valid description of "history"?