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Research Faculty Summit 2012

ADVANCING THE STATE OF THE ART



The Evolution of ChronoZoom

Motivation, Achievements, and Problems

Walter Alvarez and Roland Saekow
University of California, Berkeley

Developing the ChronoZoom Service

Sergey Berezin
Moscow State University

Next Steps and Beyond

Rane Johnson
Microsoft Research Connections

July 17, 2012



ChronoZoom Overview



12 October 1492



12 October 1492



Iberian Peninsula about 1050 AD



Iberian Peninsula about 1050 AD



Iberian Peninsula
about 1490 AD



Columbus reaches the New World...

Voyage history: Columbus' voyage: **37 days** (6 Sept-12 Oct 1492)

Personal history: Columbus' age in 1492: about **40 years** (1451?-1492)

Human History: Rise of Castile: about **500 years** (1000-1500 AD)

Unfamiliar people



Unfamiliar animals

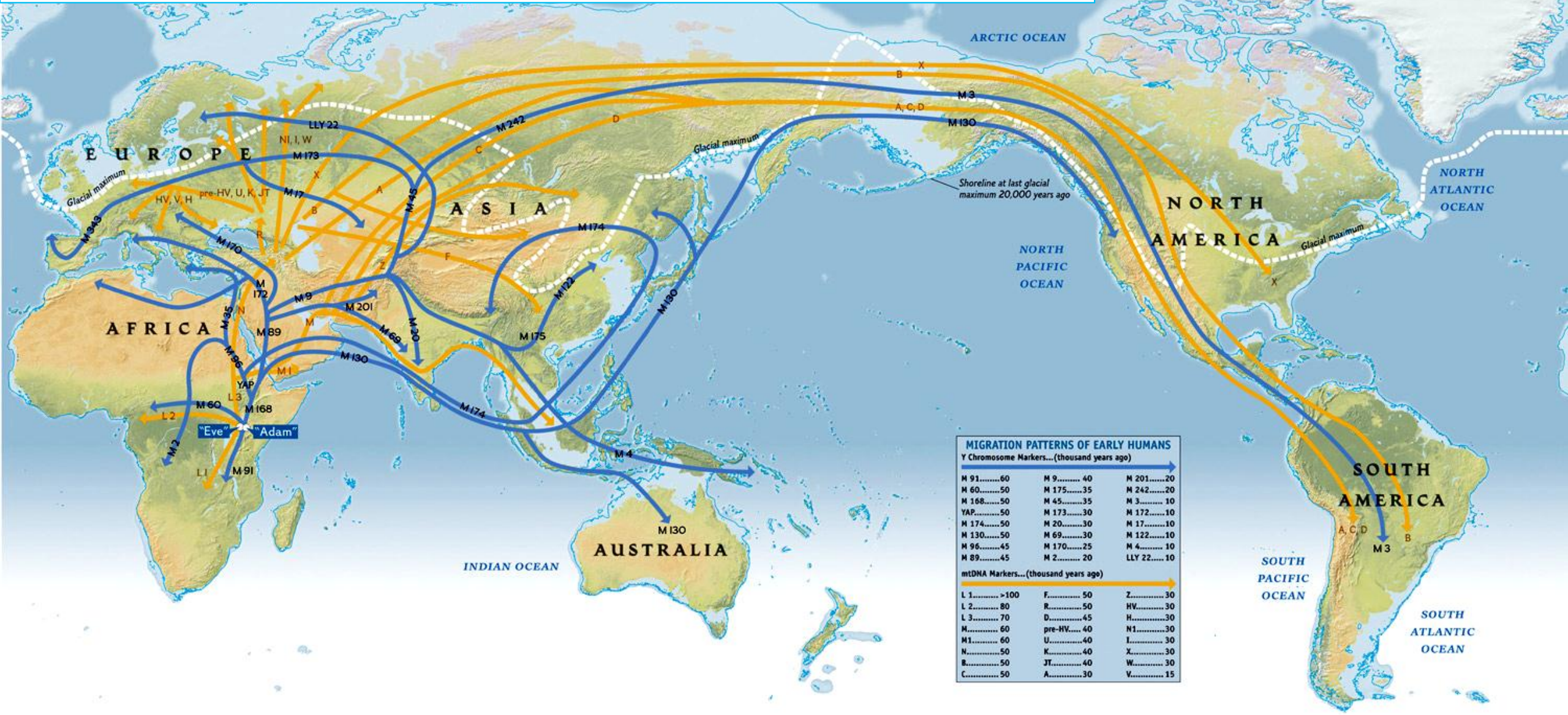


Hispaniolan solenodon

Unfamiliar plants



Journey of humanity over 60 kyr, based on DNA



MIGRATION PATTERNS OF EARLY HUMANS		
Y Chromosome Markers... (thousand years ago)		
M 91.....60	M 9.....40	M 201.....20
M 60.....50	M 175.....35	M 242.....20
M 168.....50	M 45.....35	M 3.....10
YAP.....50	M 173.....30	M 172.....10
M 174.....50	M 20.....30	M 17.....10
M 130.....50	M 69.....30	M 122.....10
M 96.....45	M 170.....25	M 4.....10
M 89.....45	M 2.....20	LLY 22.....10
mtDNA Markers... (thousand years ago)		
L 1.....>100	F.....50	Z.....30
L 2.....80	R.....50	HV.....30
L 3.....70	D.....45	H.....30
M.....60	pre-HV.....40	N1.....30
M1.....60	U.....40	L.....30
N.....50	K.....40	X.....30
B.....50	JT.....40	W.....30
C.....50	A.....30	V.....15

Pangaea, 180 million years ago





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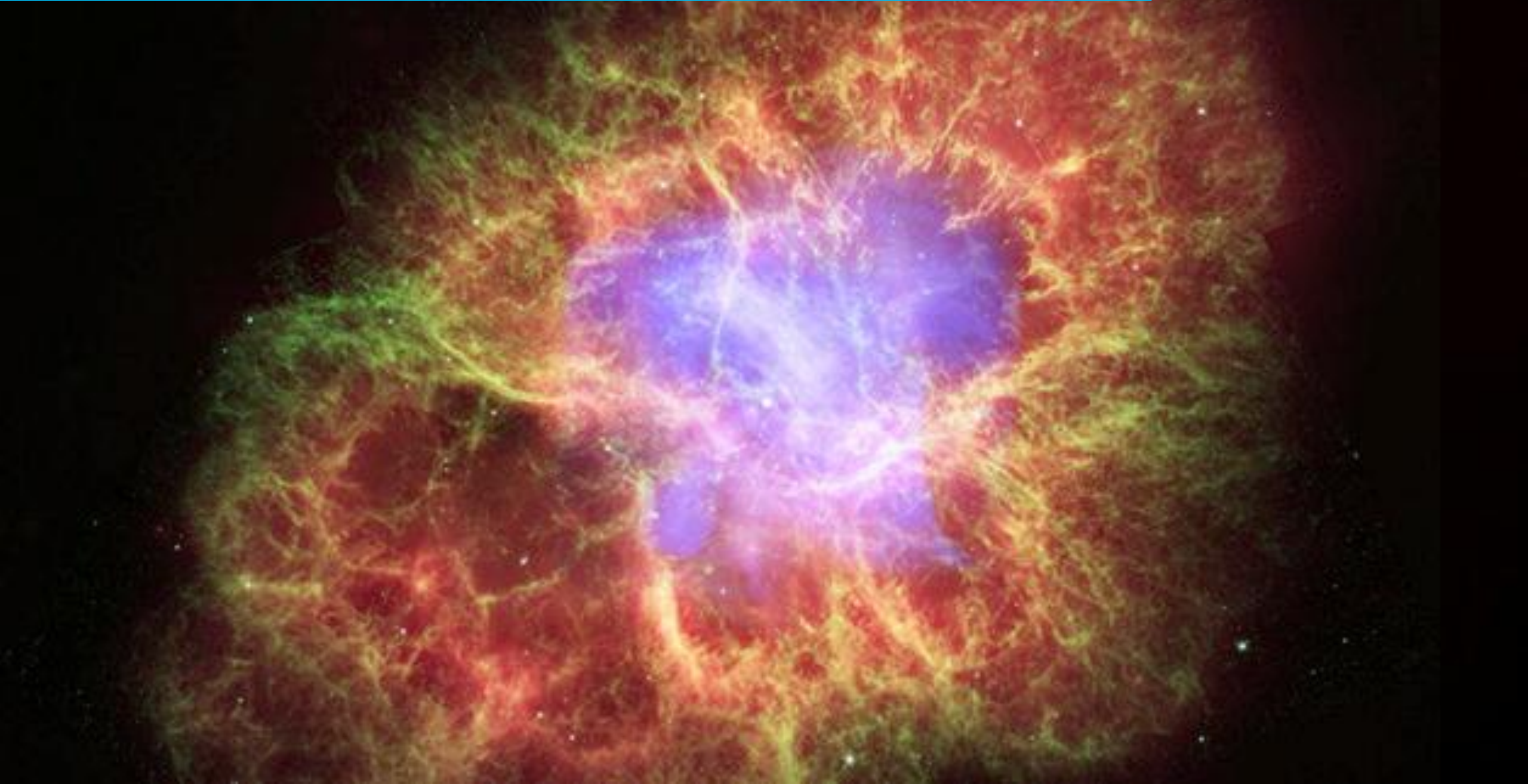
Human Prehistory: New cultures during migrations over **60 kyr**

Life and Earth history: New continents, plants, animals in **180 Myr**

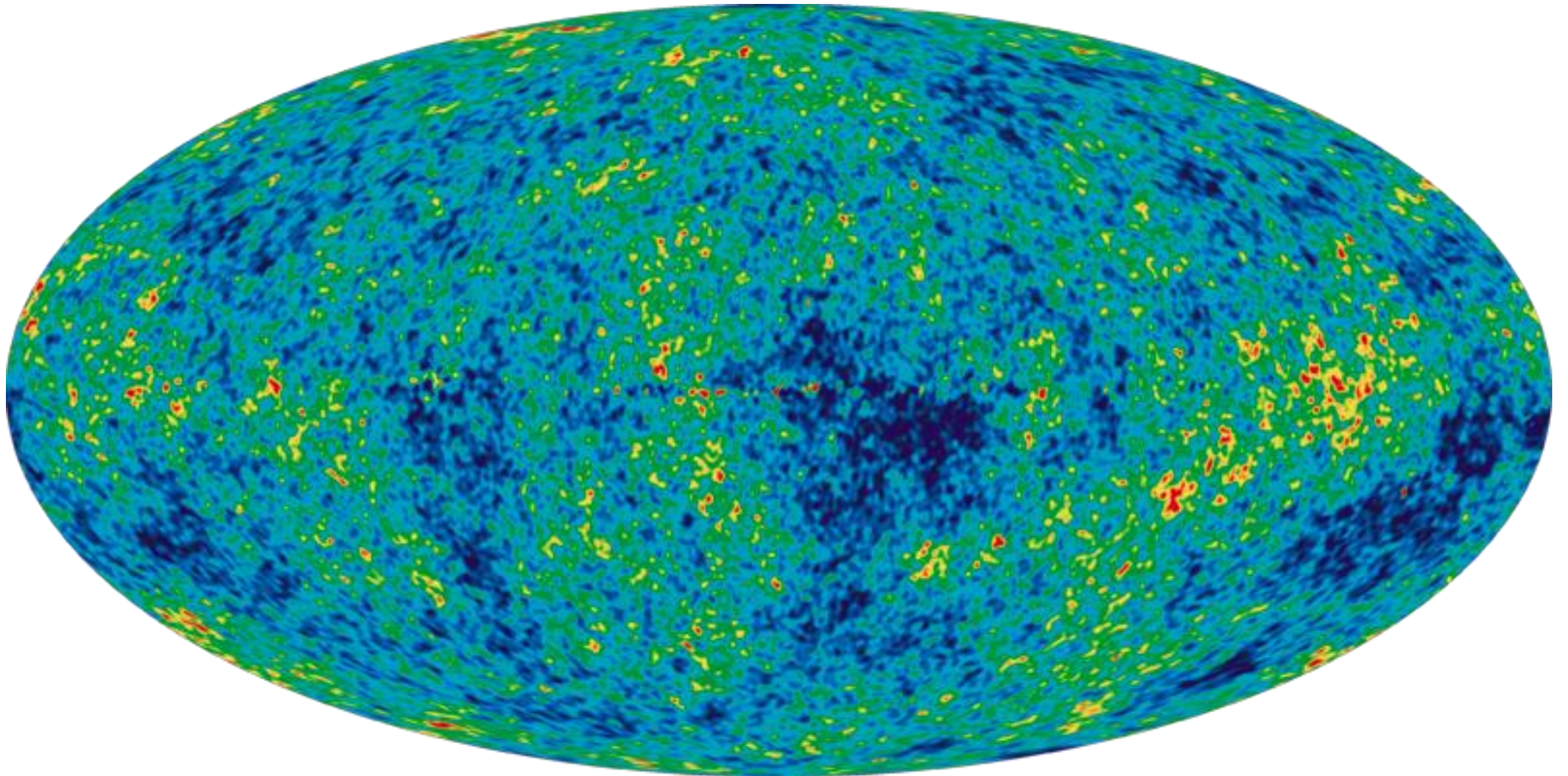
Las Médulas: Roman gold mines in Spain



Supernova explosion — the Crab Nebula (1054 AD)



Cosmic background radiation,
produced in the Big Bang, 13.7 Ga





Columbus reaches the New World...

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Cosmic history: New elements in about **9 Gyr**

Big Bang history: New universe, laws in **a few minutes**



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Life and Earth history: New continents, plants, animals in **180 Myr**

Cosmic history: New elements in about **9 Gyr**

Big Bang history: New universe, laws in **a few minutes**

This is why we need ChronoZoom!

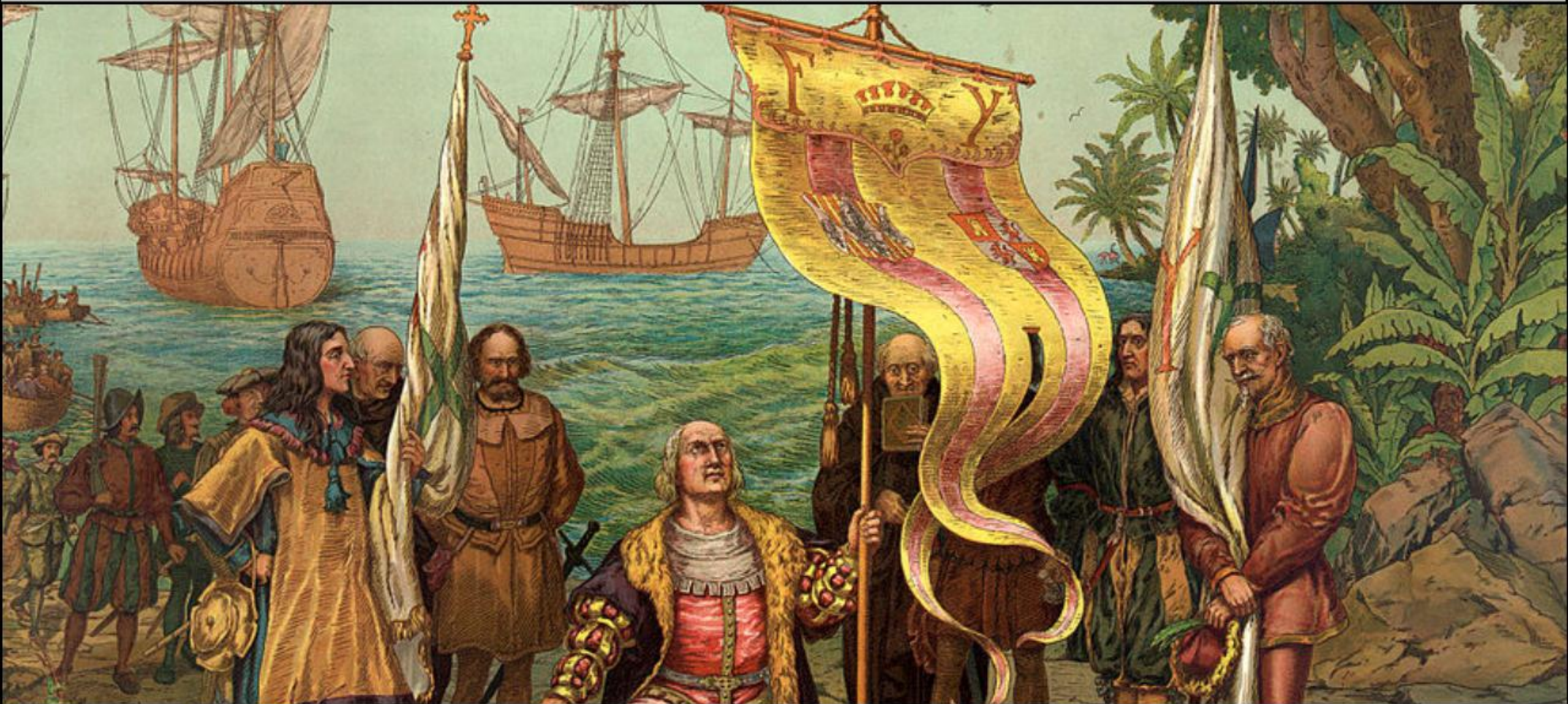


Date
October, 1492 CE

Date
October, 1492 CE

11

11



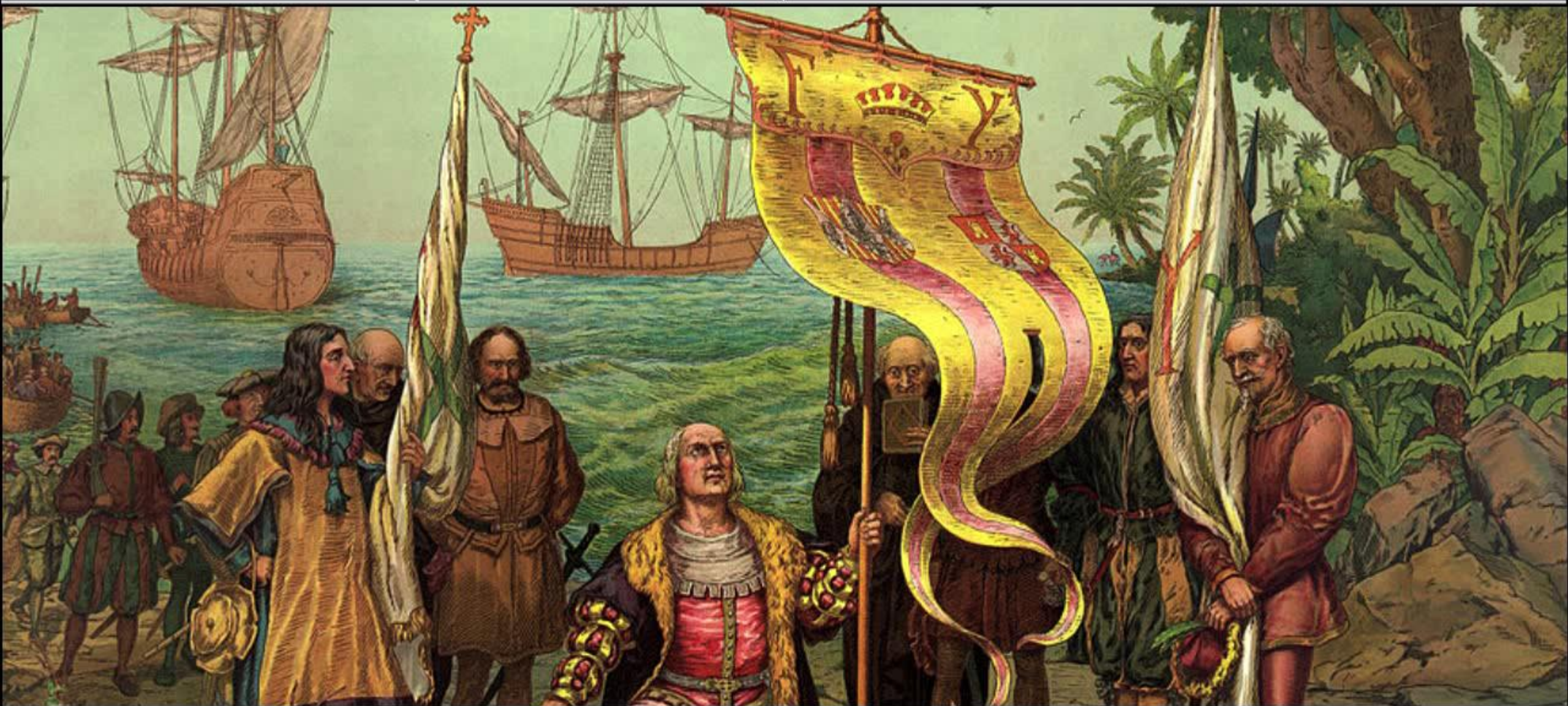


Date
October, 1492 CE

Date
October, 1492 CE

11

11





Landing of Columbus
(1492)



Christopher Columbus arrives in America

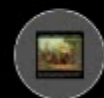
Christopher Columbus was an explorer, colonizer, and navigator, born in the Republic of Genoa, in what is today northwestern Italy. Under the auspices of the Catholic Monarchs of Spain, he completed four voyages across the Atlantic Ocean that led to general European awareness of the American continents.

Bibliography



September

October



The First Voyage - 1492

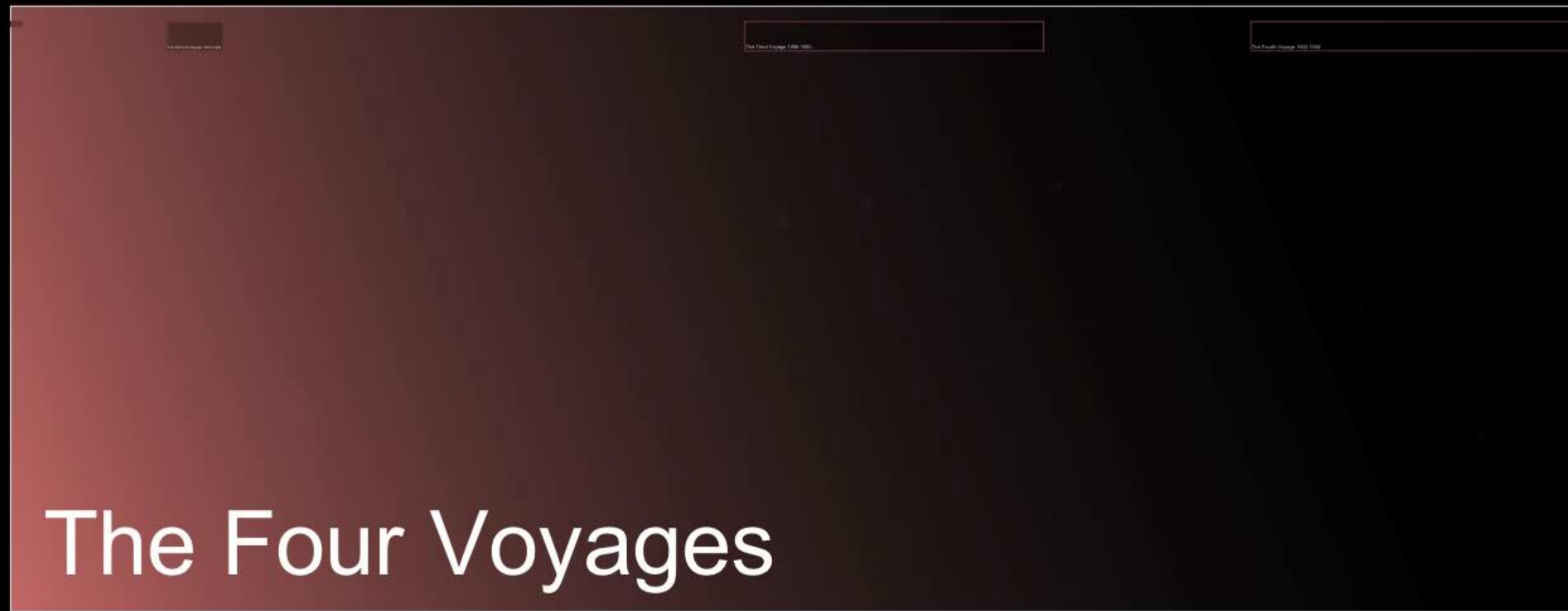


First Second

Third

Fourth

The Four Voyages



The First Voyage 1492-1493

The Third Voyage 1498-1499

The Fourth Voyage 1502-1504

The Four Voyages



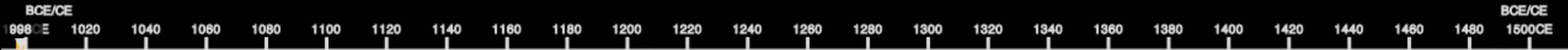
... > Hominine Phylogeny > Genus Homo > Homo sapiens > Humanity > Iberia (Spain + Portugal)



The Four Voyages

Life of Christopher Columbus 1451-1506

... > Hominine Phylogeny > Genus Homo > Homo sapiens > Humanity > Iberia (Spain + Portugal)

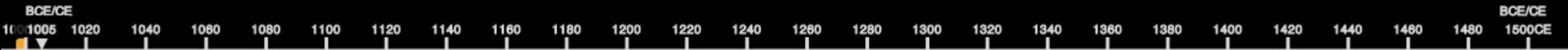


Rise of Castile



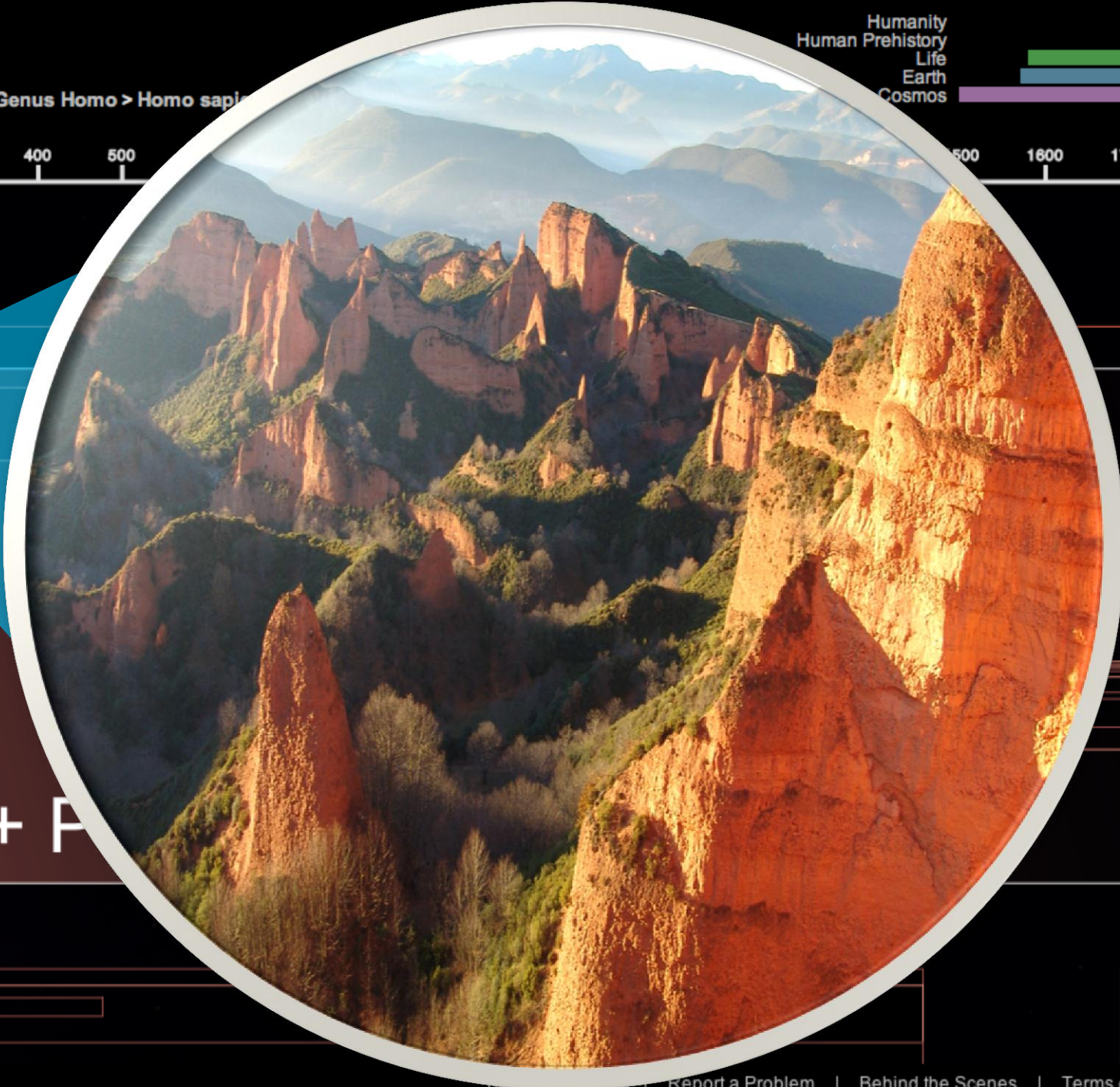
1451-1506

... > Hominine Phylogeny > Genus Homo > Homo sapiens > Humanity > Iberia (Spain + Portugal)



Rise of Castile

Life of Christopher Columbus 1451-1506



Roman Iberia

Iberia (Spain + Portugal)

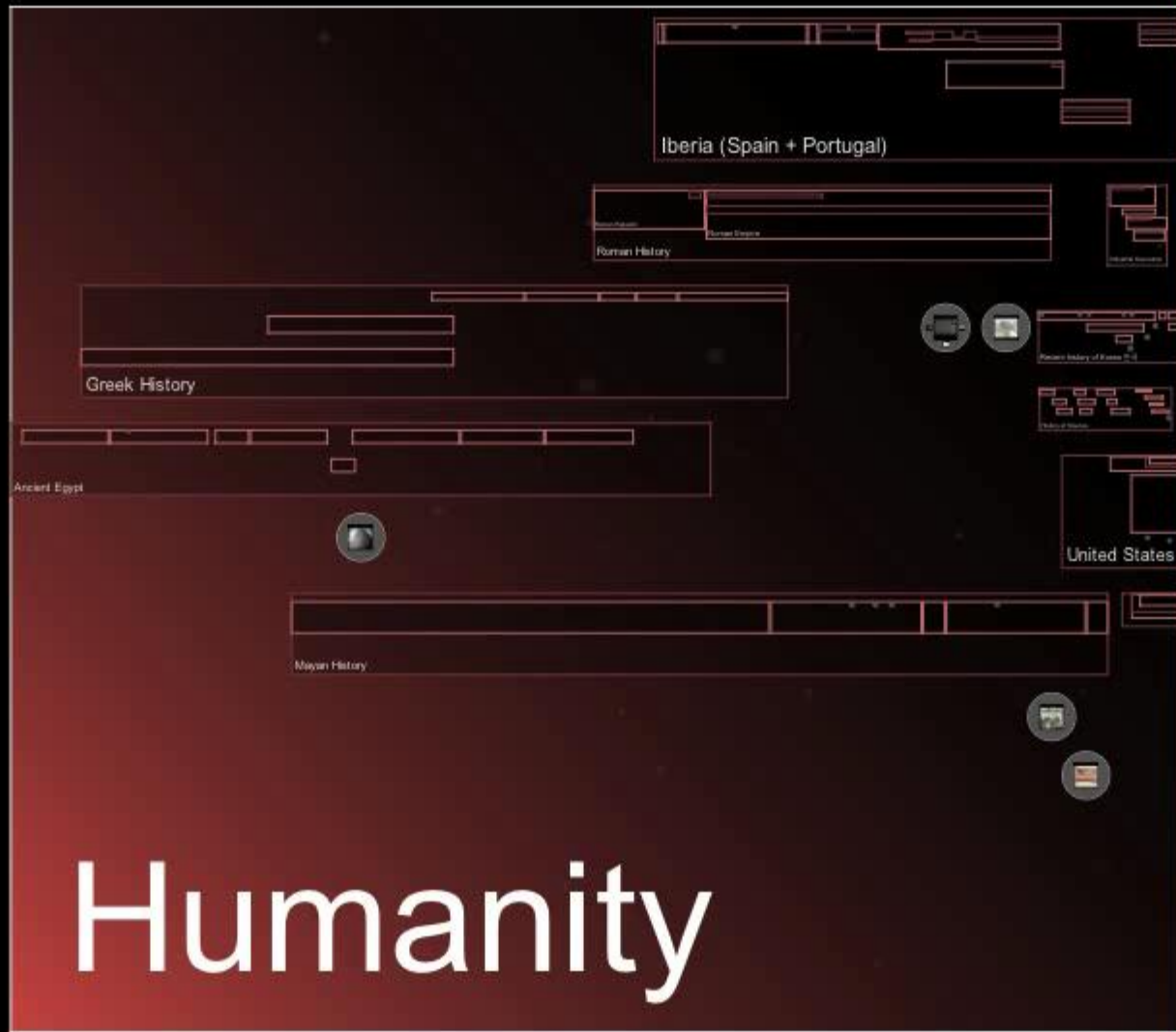
Modern Iberia







... > Life > Human Prehistory > Hominine Phylogeny > Genus Homo > Homo sapiens





Thousands of Years Ago



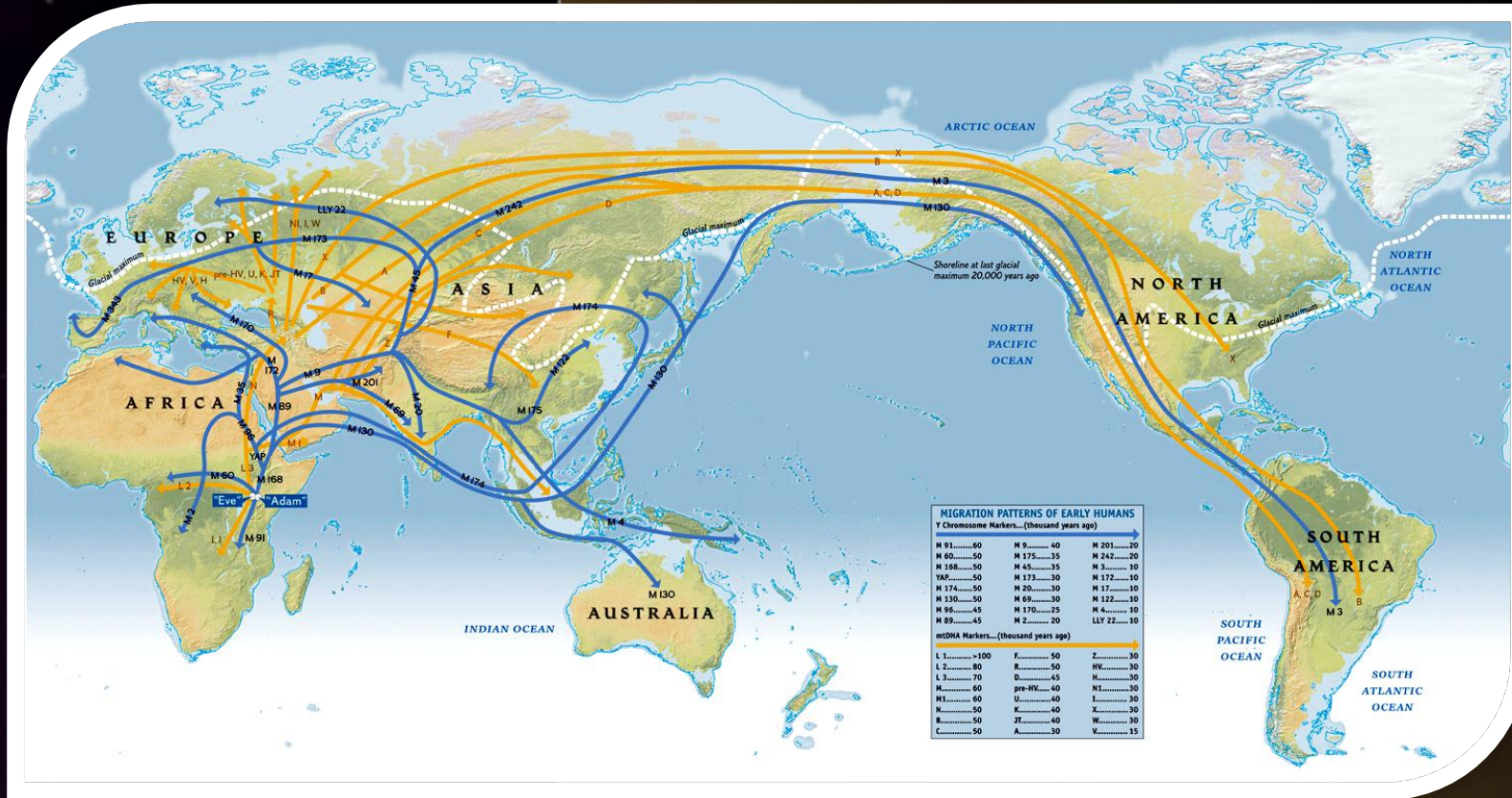
Today

Early Stone Age/Paleolithic Era

Homo sapiens

Thousands of Years Ago

3600ka 3400 3200 3000 2800 2672.700 2400 2200 2000 1800 1600 1400 1200 1000 800 600 400 200 0ka Today

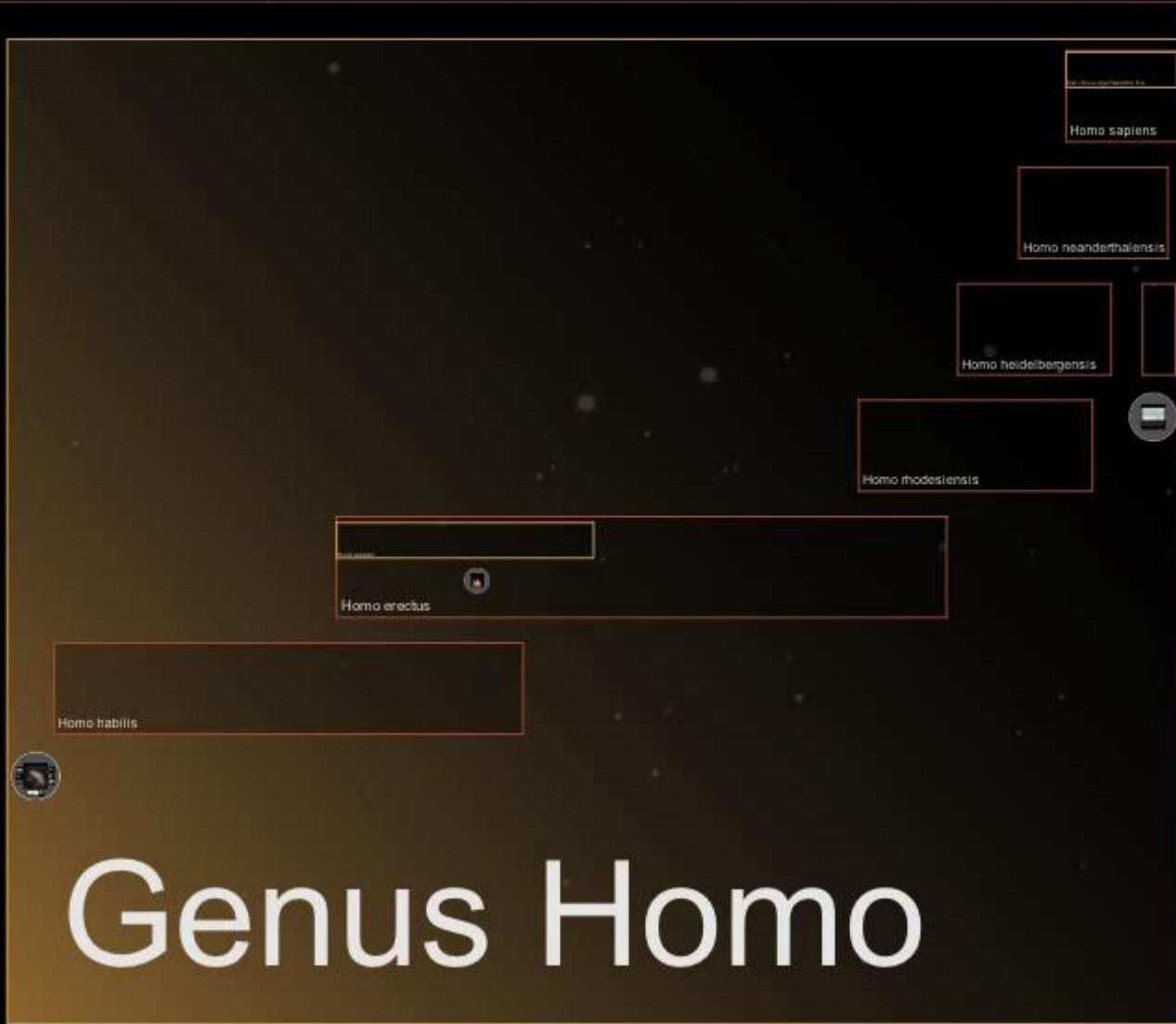


Genus Homo

Thousands of Years Ago

3600ka 3400 3200 3000 2800 2600 2400 2200 2000 1800 1600 1400 1200 1000 800 600 400 200 0ka

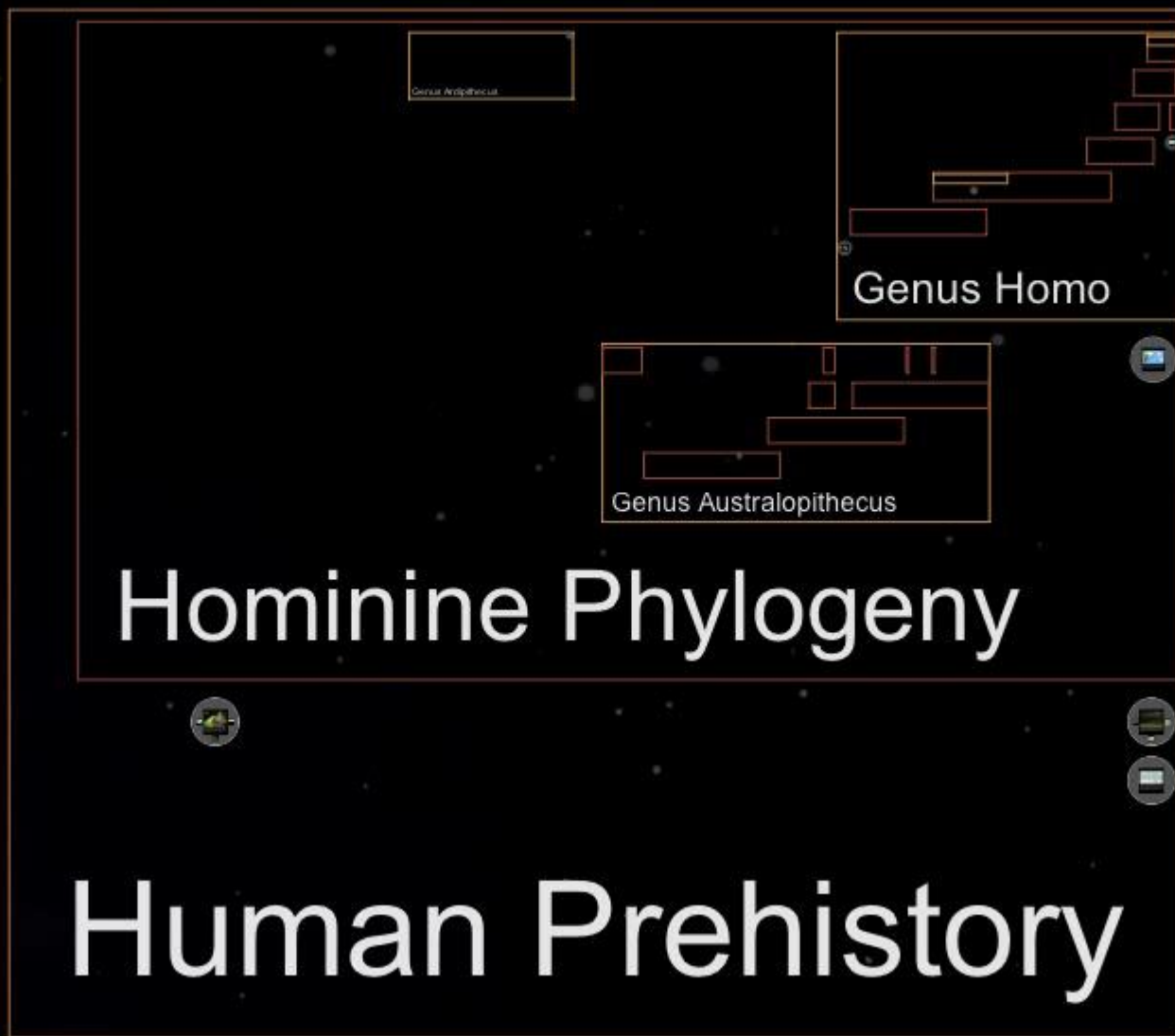
Today



Genus Homo



Millions of Years Ago



Human Prehistory



Cosmos

Millions of Years Ago



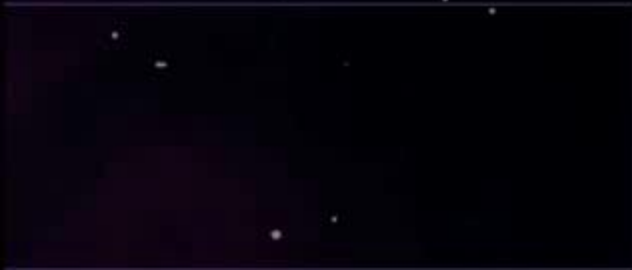
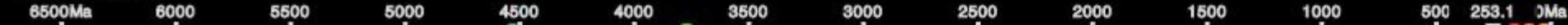
Earth & Solar System

stem



Cosmos

Millions of Years Ago



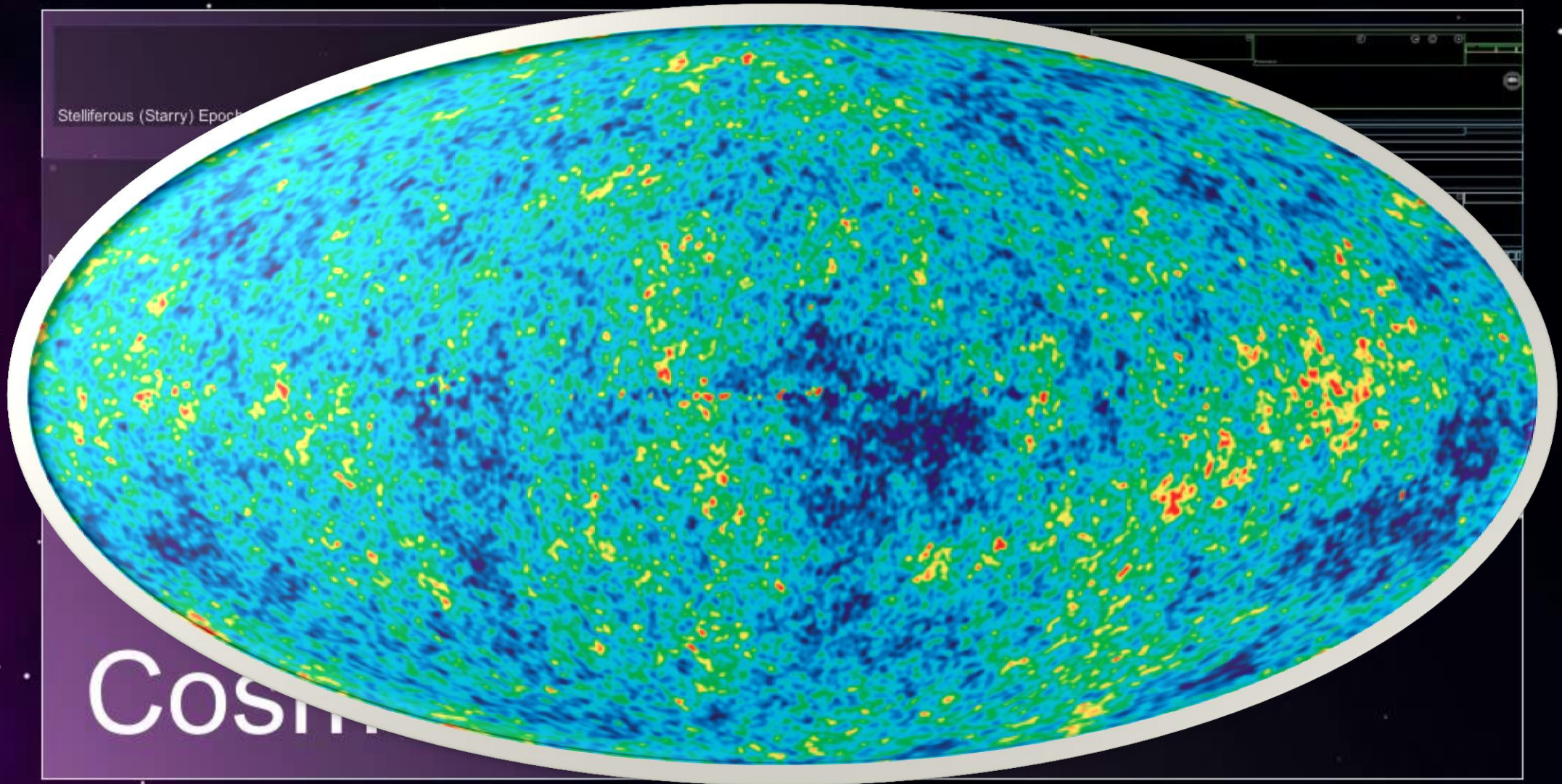
Earth & Solar System



Billions of Years Ago



Stelliferous (Starry) Epoch



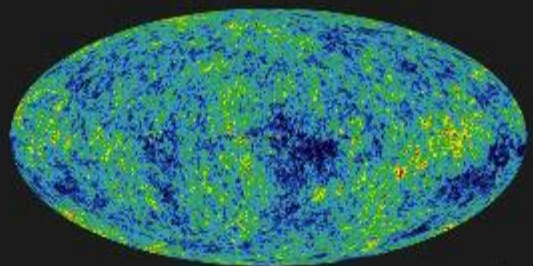
Cosmic



Billions of Years Ago

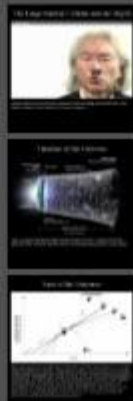


Threshold 1: The Big Bang (13.7 Ga)



Cosmic background radiation

Cosmic background radiation is well explained as radiation left over from an early stage in the development of the universe, and its discovery is considered a landmark test of the Big Bang model of the universe. When the universe was young, before the formation of stars and planets, it was smaller, much hotter, and filled with a uniform glow from its white-hot fog of hydrogen plasma. As the universe expanded, both the plasma and the radiation filling it grew cooler. When the universe cooled enough, protons and electrons could form neutral atoms.



Bibliography



Stelliferous (Starry) Epoch

Nucleosynthesis of elements heavier than hydrogen that were incorporated into the Solar System



Earth & Solar System

Cosmos

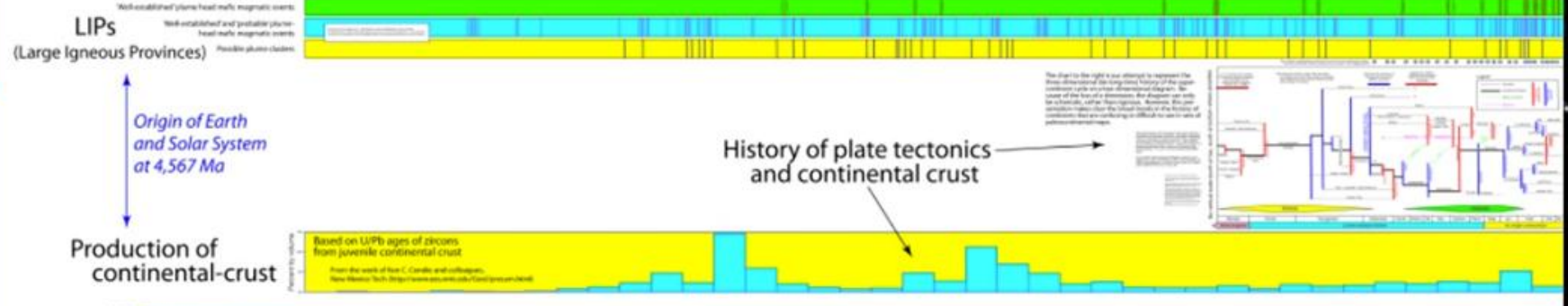
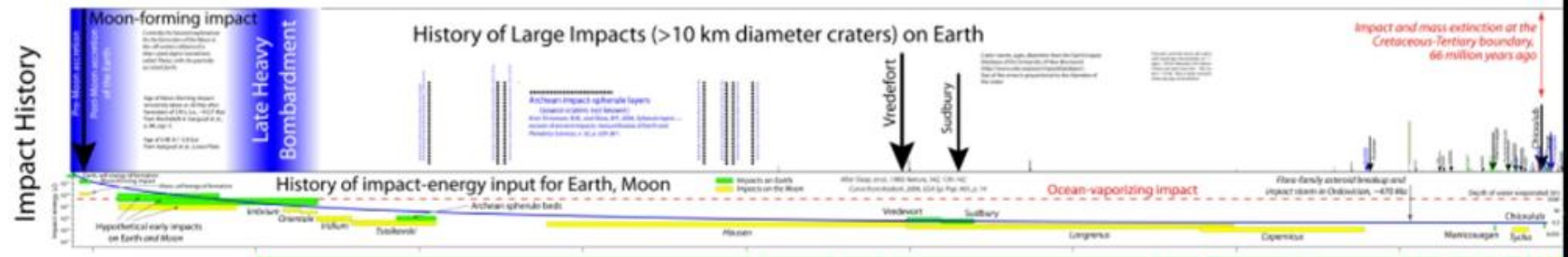
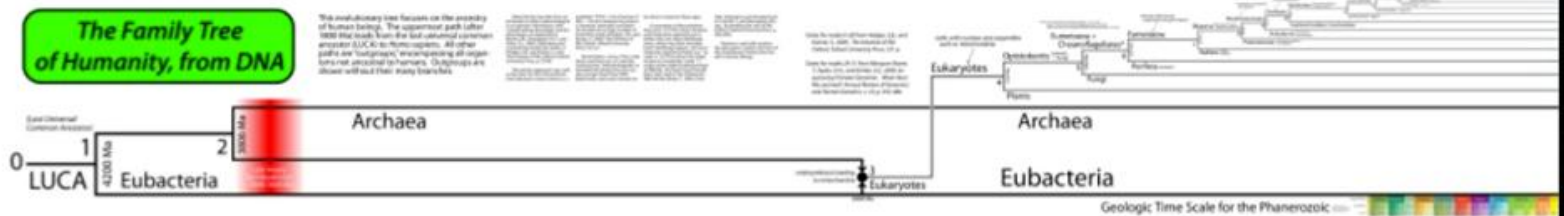
Life

Climate and Atmosphere

Major Impacts on Earth

Geological Time Scale

ChronoZoom v.1 (raster graphics), 2010

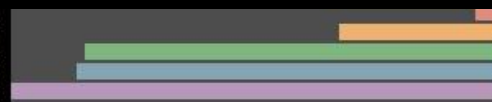


ChronoZoom v.2 beta (vector graphics), 2012

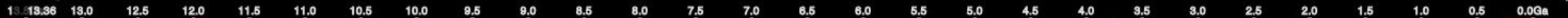
ChronoZoom[®] postbeta



Humanity
Human Prehistory
Life
Earth
Cosmos



Billions of Years Ago



Today

Stelliferous (Starry) Epoch



Threshold 1: The Big Bang



Earth & Solar System





The Future

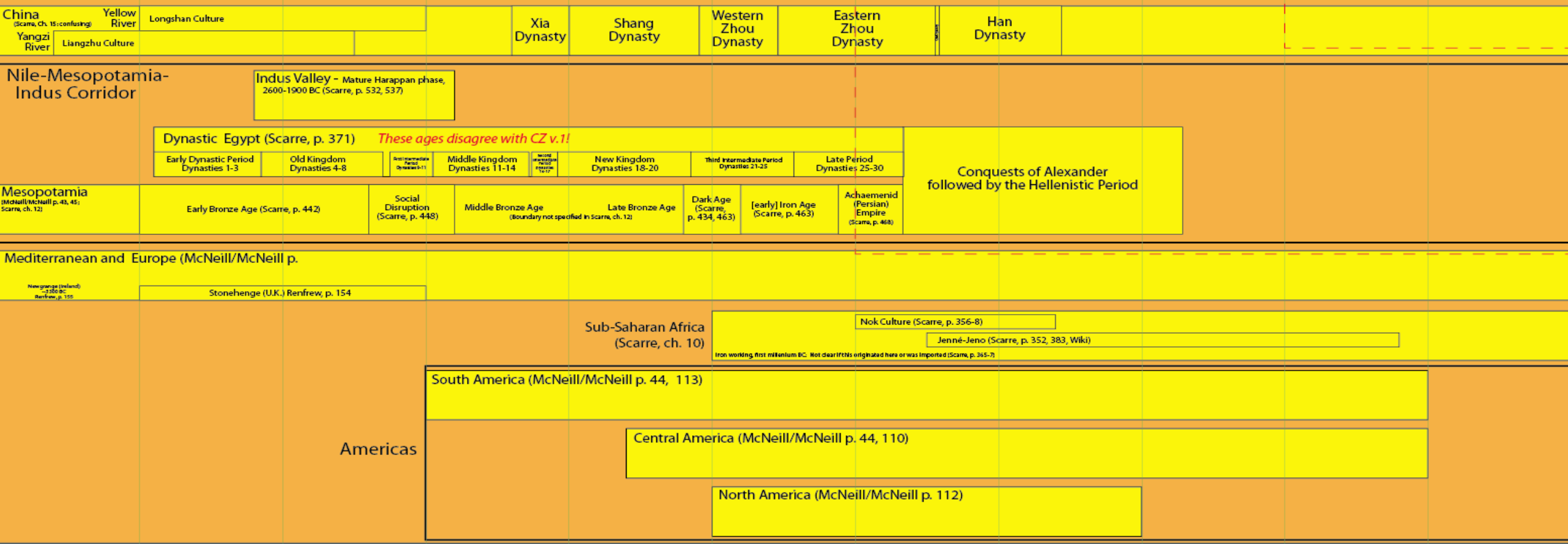
- Content: Crowd sourced? Or curated by experts?
- Y-axis: How should we organize it?
- Map view: A 3rd dimension?

View 20 (3500 BC-now): Civilizations

View 21 (500 BC-now) Intro: Social complexity

View 22 (1000-now) Intro: 1000-2000 AD: Last millenium

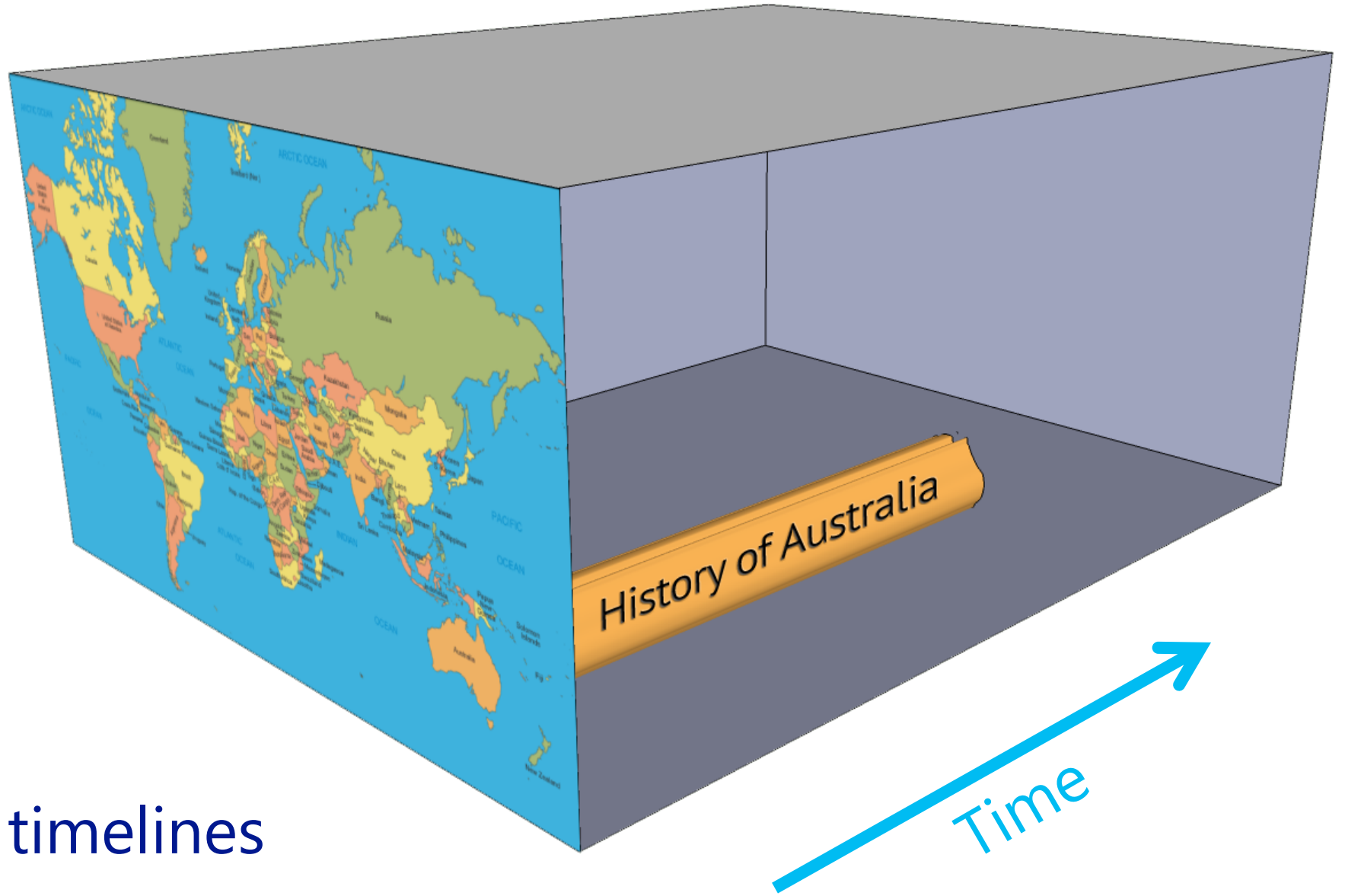
Boulevard 3: Civilizations



Boulevard 2: Sea-level history

Boulevard 1: Oxygen isotope temperature/ice volume proxy

Organizing the Y-axis



The problem of timelines
across geography



The map face of the 3-D cube

View 20 (3500 BC-now): Civilizations

View 21 (500 BC-now) Intro: Social complexity

View 22 (1000-now) Intro: 1000-2000 AD: Last millenium

Boulevard 3: Civilizations

China <small>(Scarre, Ch. 15: confusing)</small> Yellow River Yangzi River	Longshan Culture		Xia Dynasty	Shang Dynasty	Western Zhou Dynasty	Eastern Zhou Dynasty	Han Dynasty		
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Nile-Mesopotamia-Indus Corridor

Indus Valley - Mature Harappan phase, 2600-1900 BC (Scarre, p. 532, 537)

Dynastic Egypt (Scarre, p. 371) *These ages disagree with CZ v.1!*

Early Dynastic Period Dynasties 1-3	Old Kingdom Dynasties 4-8	First Intermediate Period Dynasties 9-11	Middle Kingdom Dynasties 11-14	Second Intermediate Period Dynasties 15-17	New Kingdom Dynasties 18-20	Third Intermediate Period Dynasties 21-25	Late Period Dynasties 25-30
--	------------------------------	---	-----------------------------------	---	--------------------------------	--	--------------------------------

Conquests of Alexander followed by the Hellenistic Period

Mesopotamia

(McNeill/McNeill p. 43, 45; Scarre, ch. 12)

Early Bronze Age (Scarre, p. 442)	Social Disruption (Scarre, p. 448)	Middle Bronze Age (Boundary not specified in Scarre, ch. 12)	Late Bronze Age	Dark Age (Scarre, p. 434, 463)	[early] Iron Age (Scarre, p. 463)	Achaemenid (Persian) Empire (Scarre, p. 468)
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Mediterranean and Europe (McNeill/McNeill p.

Newgrange (Ireland) ~3500 BC (Renfrew, p. 155)

Stonehenge (U.K.) Renfrew, p. 154

Sub-Saharan Africa (Scarre, ch. 10)

Nok Culture (Scarre, p. 356-8)

Jenné-Jeno (Scarre, p. 352, 383, Wiki)

Iron working first millennium BC. Not clear if this originated here or was imported (Scarre, p. 365-7)

Americas (McNeill/McNeill p. 44, 113)

Americas

Central America (McNeill/McNeill p. 44, 110)

North America (McNeill/McNeill p. 112)

Boulevard 2: Sea-level history

Boulevard 1: Oxygen isotope temperature/ice volume proxy

The timeline face of the 3-D cube



The Future

- Content: Crowd sourced? Or curated by experts?
- Y-axis: How should we organize it?
- Map view: A 3rd dimension?

Moscow State University

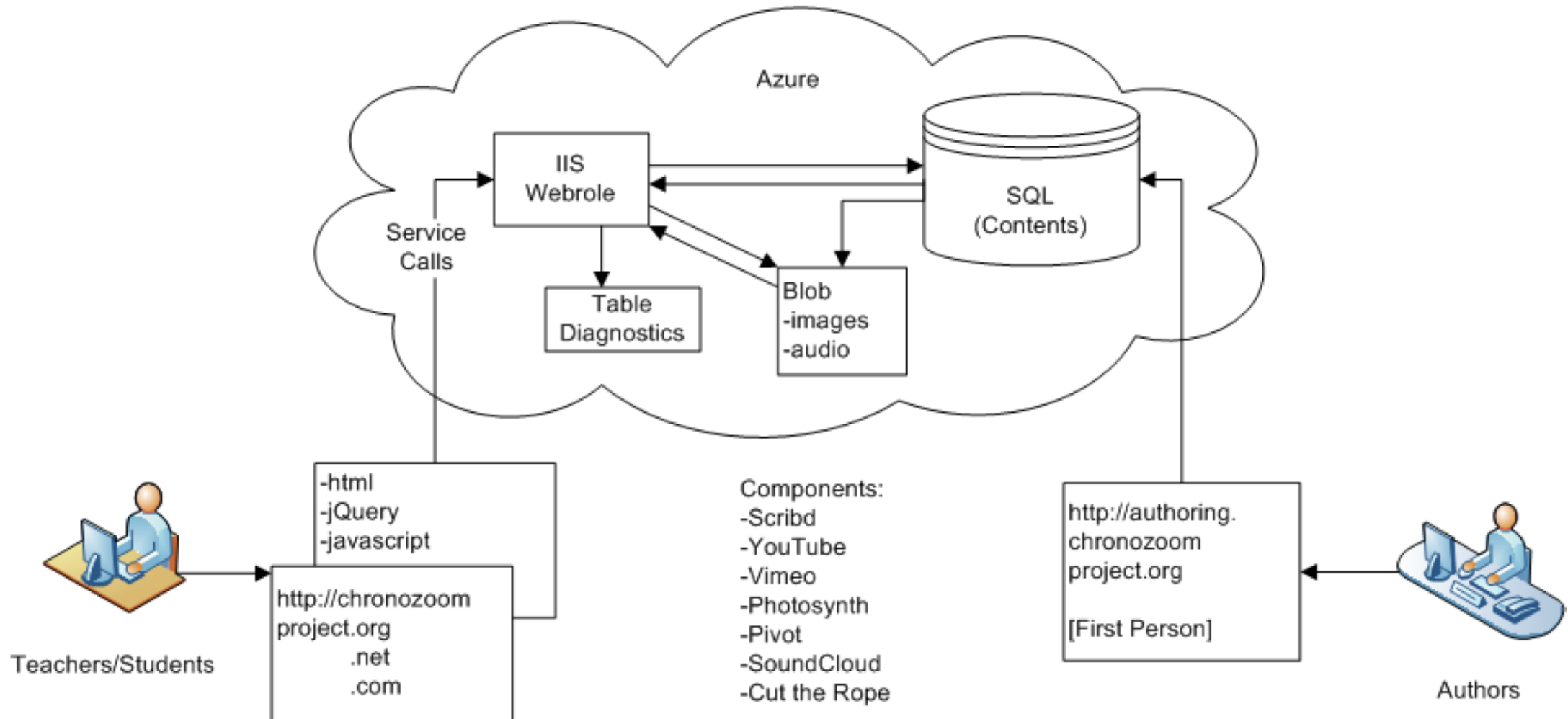




ChronoZoom Project

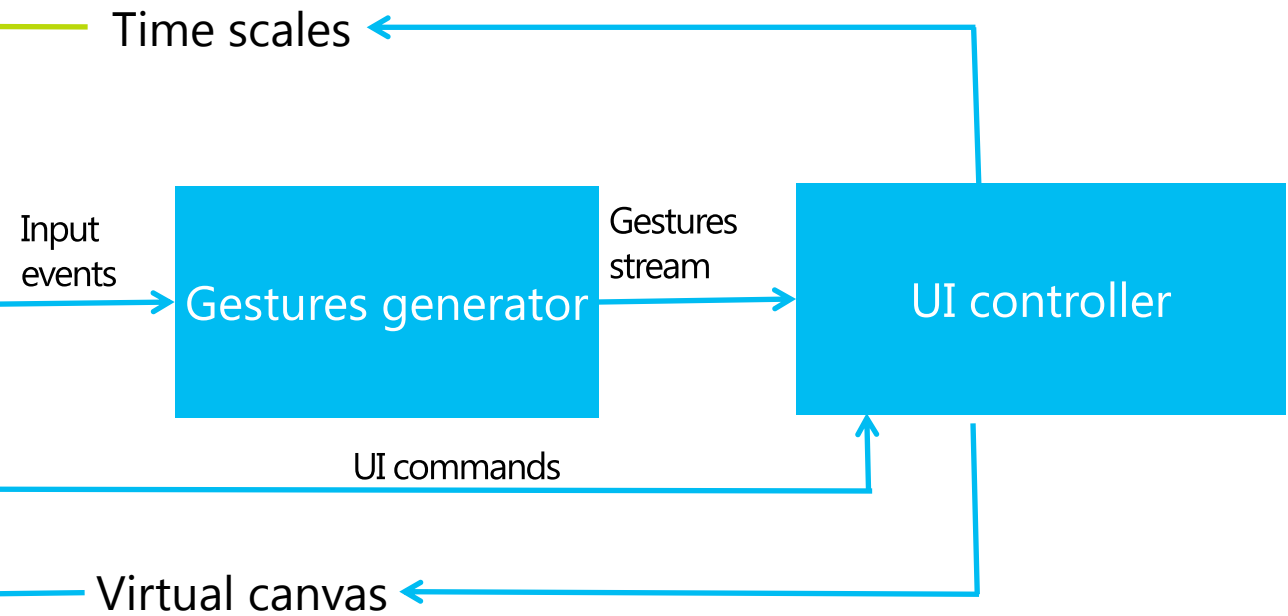
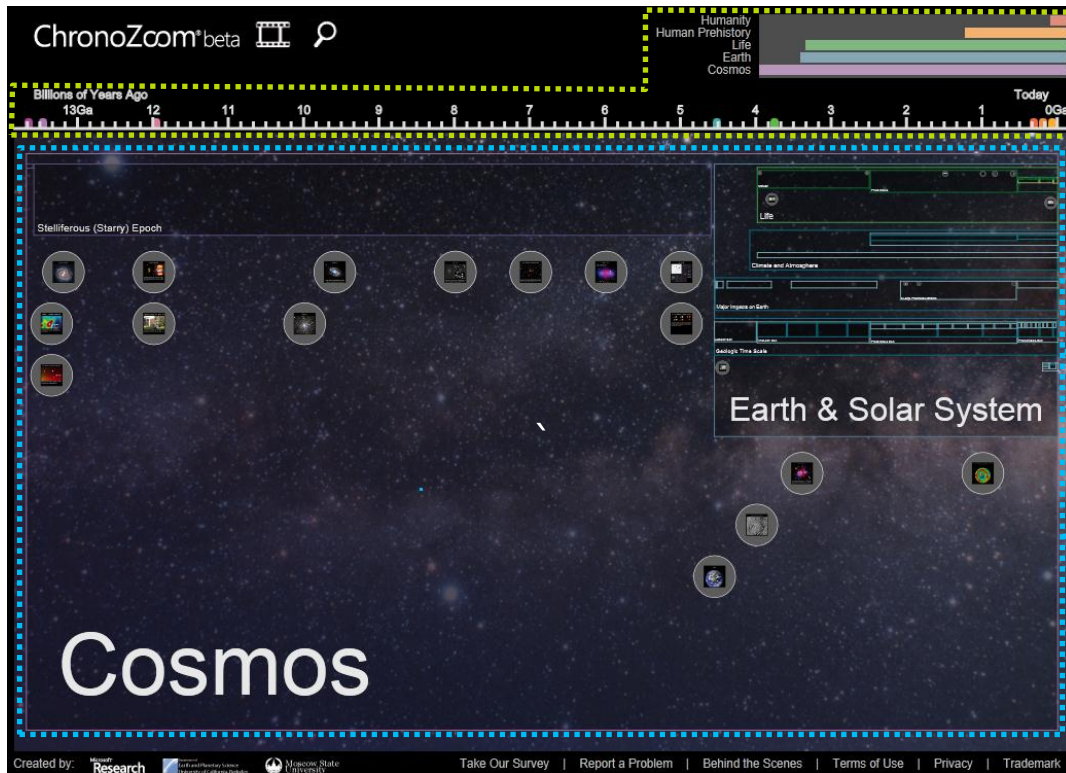
Sergey Berezin
Moscow State University

ChronoZoom architecture



More at <http://chronozoom.codeplex.com/documentation>

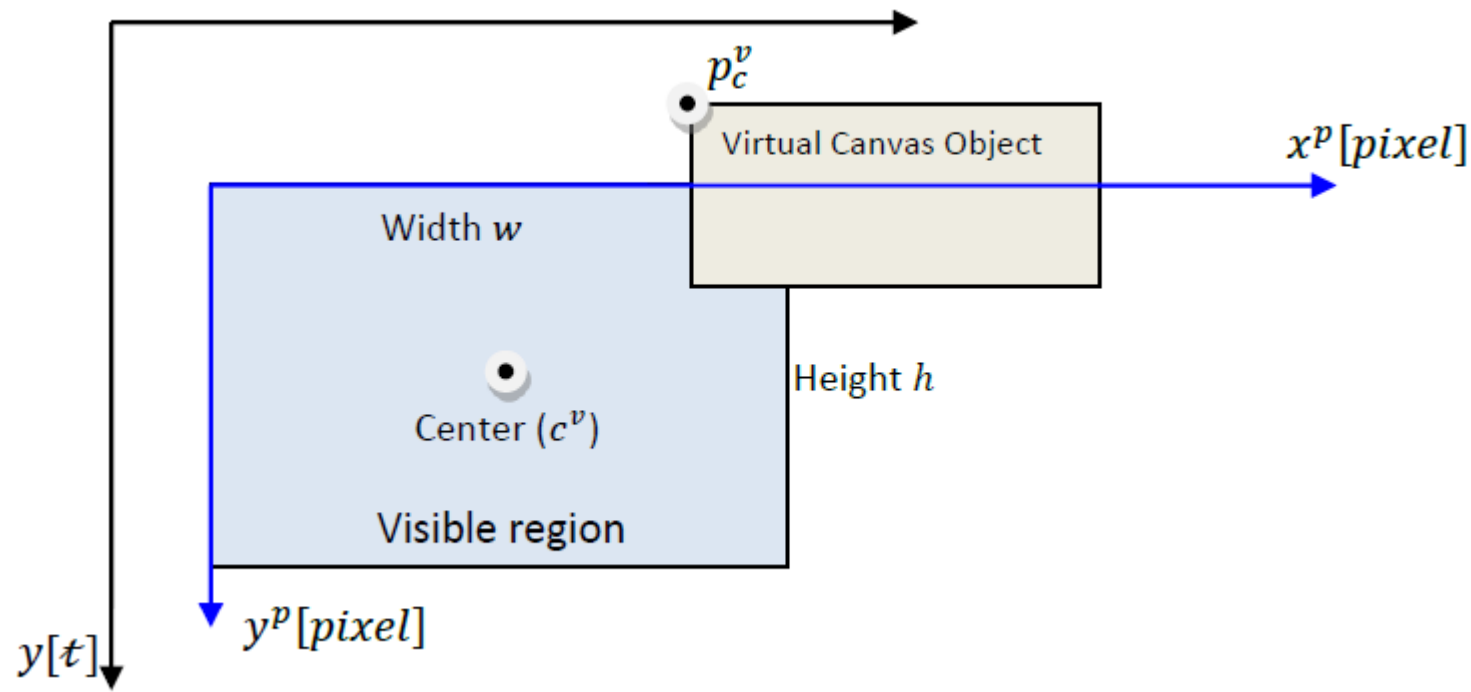
ChronoZoom client



More at <http://chronozoom.codeplex.com/documentation>

Virtual Canvas: core of ChronoZoom client

Virtual canvas projects R^2 space and a hierarchical set of objects placed in that space into screen coordinates



More at <http://chronozoom.codeplex.com/documentation>

Navigation layer architecture

The Reactive Extensions

Available for .NET/JavaScript

Also known as LINQ to events

<http://msdn.microsoft.com/en-us/data/gg577609.aspx>

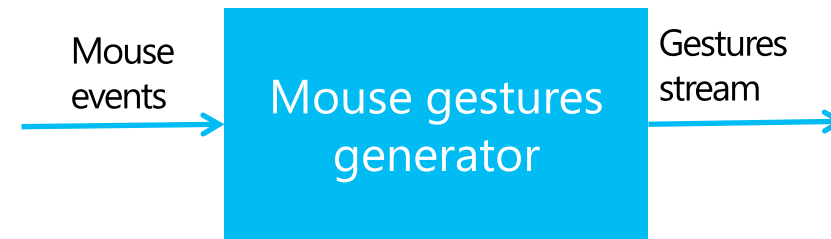
Abstract set of gestures

Pan/Zoom/Pin

Resolution independent

Rx operations to convert device-dependent events to abstract ones

Navigation w/mouse

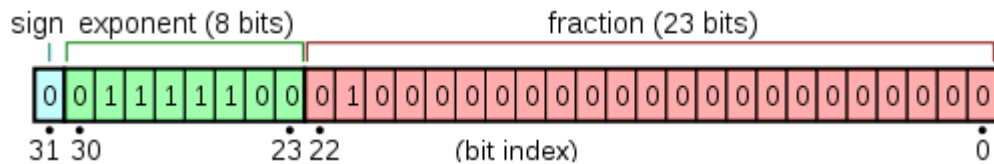


Navigation w/touch

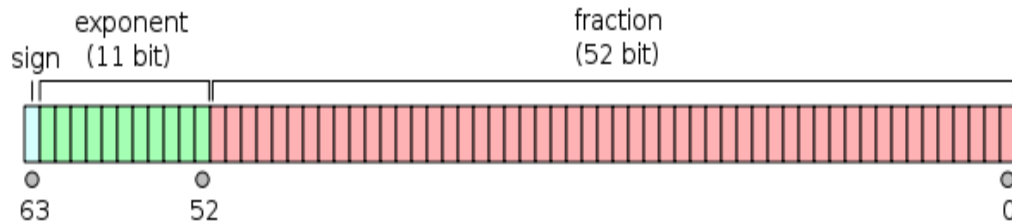


Numeric accuracy at the scales of Universe

Single vs. Double



Single precision ~ 7.225 decimal digits



Double precision ~ 15.995 decimal digits

At scale of ChronoZoom...

13.7G years : 1 day = 1 : 1.999e-13

Single precision is not enough

Some SVG and HTML5 canvas use single precision

Clipping errors and 'geometry' trembling occurs

SVG appeared inappropriate

JavaScript Number type uses double precision

Perform geometry scaling in JavaScript

Sutherland clipping algorithm and so on...



JavaScript performance

Animating the time

At each frame:

- Traversing hierarchical data structures

- Drawing a lot of objects

User experience:

- Low frame rate is not good

- Repeating freezes/glitches is very bad!

On Javascript performance

Recipe books change frequently

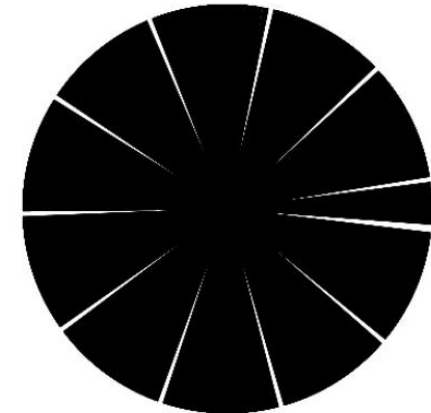
<http://blogs.msdn.com/b/eternalcoding/archive/2012/03/22/unleash-the-power-of-html-5-canvas-for-gaming-part-1.aspx>

<http://www.slideshare.net/nzakas/high-performance-javascript-2011>

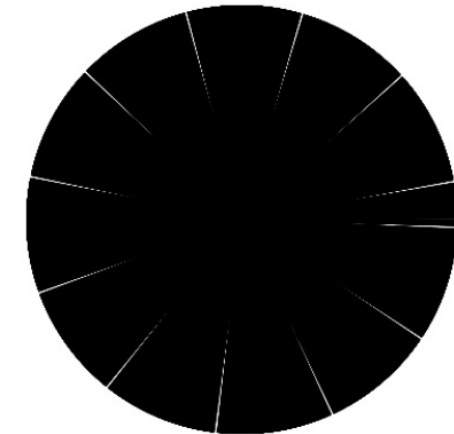
JS garbage collection

Rendering rotating line @ 6 degree per second

2M objects in tree:



4M objects in arrays:



Embedding external objects using <iframe>

Embedding Vimeo

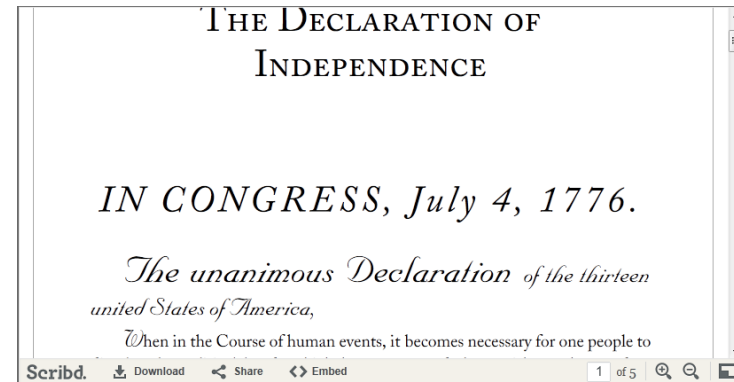


```
<iframe src="http://player.vimeo.com/video/37941738"...></iframe>
```

Programming tricks

Use CSS clipping to pan content around the screen
Use special <div> to intercept mouse over <iframe>

Embedding PDF



```
<iframe src="http://www.scribd.com/embeds/203086/content?start_page=1&view_mode=list"...></iframe>
```

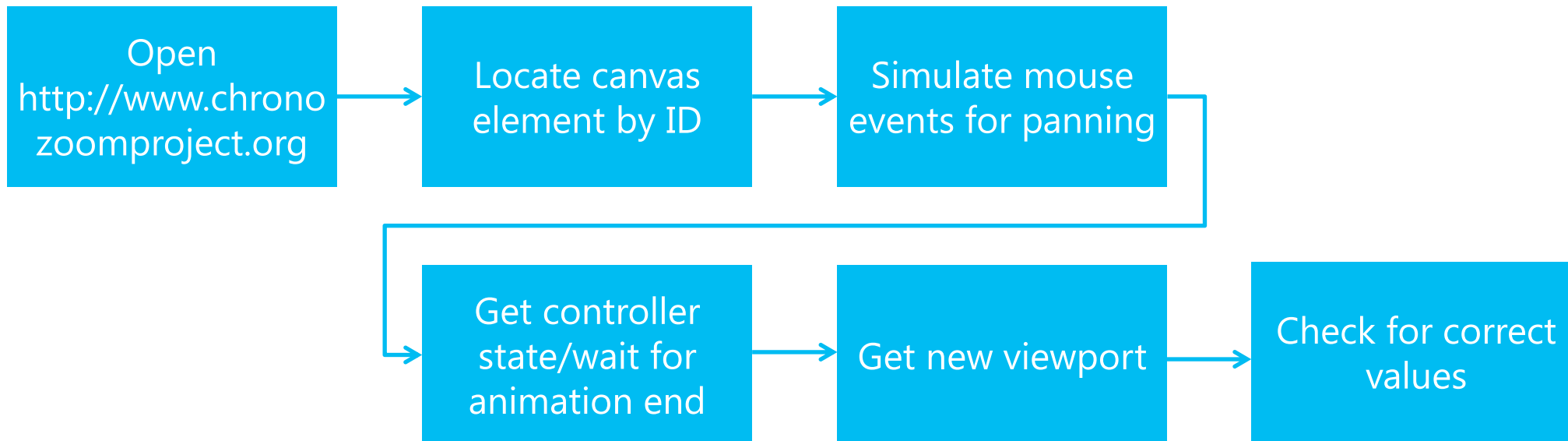
ChronoZoom testing

Extensive set of automated and manual tests

Microsoft Test Manager for manual tests

Selenium (<http://seleniumhq.org>) for automated tests

Automated test workflow





JavaScript in Visual Studio 2010

JScript Editor Extensions

Available from Visual Studio Gallery: <http://visualstudiogallery.msdn.microsoft.com>

Brace matching

Outlining/cold-folding

Intellisense improvements

Web Standards Update for Microsoft Visual Studio 2010 SP1

Available from Visual Studio Gallery: <http://visualstudiogallery.msdn.microsoft.com/>

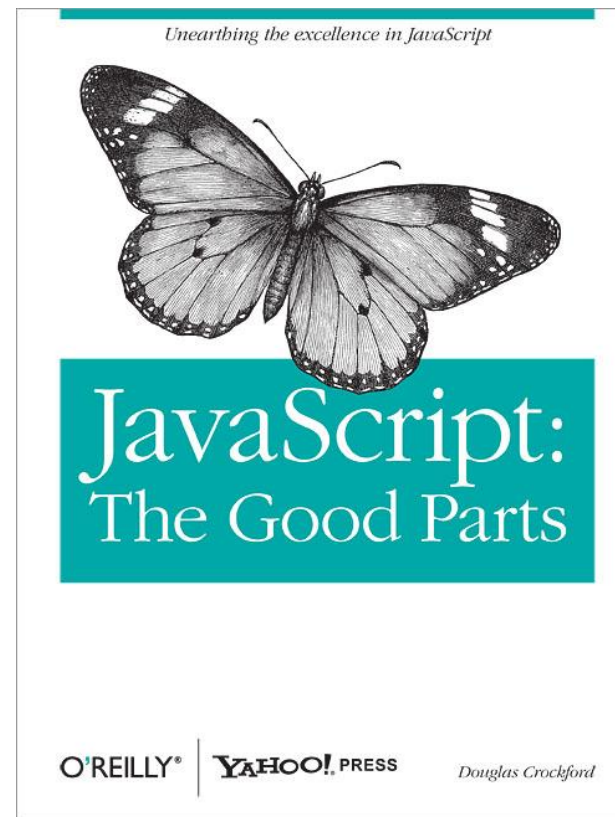
Online JSON viewer

<http://jsonviewer.stack.hu/>

JavaScript: The Good Parts

A must read book on JavaScript

Not yet another language specification
Especially for C++/C# developer





Virtual Canvas: what's next

Virtual Canvas is a tree

Timelines contains timelines and exhibits

- All data is loaded simultaneously

- Layout is performed on client

- Canvas items are rendered when they are big enough

- Canvas items are interactive

What are limitations?

- Amount of data loaded from server on startup

- Number of objects inside browser

- Rendering is not a limitation!

What is Virtual Canvas v2?

Hierarchical vector rendering engine with unlimited number of nested interactive elements

- A flavour of GIS with time as X axis?

Problems to solve

- Fetch data as user zooms in

 - Perform layout on server

- Replace zoomed out timelines with thumbnails

 - Generalization of current approach to small exhibits/content items

Ultra resolution images

Imagine virtual gallery of arts inside ChronoZoom

Pictures ordered by creation time

Each has gigapixel resolution

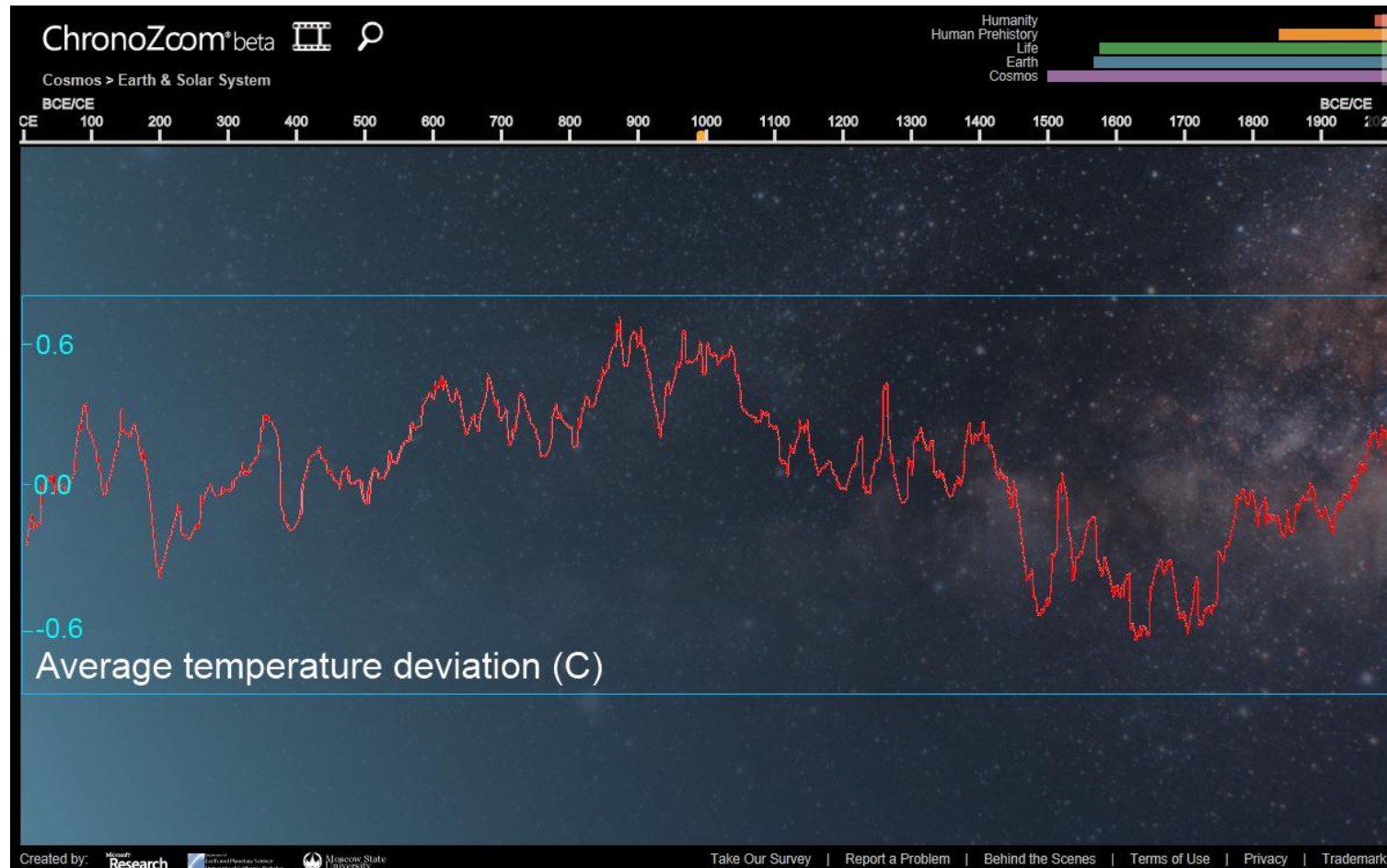


Tiled image approach

Based on Microsoft ZoomIt technology (<http://zoom.it>)

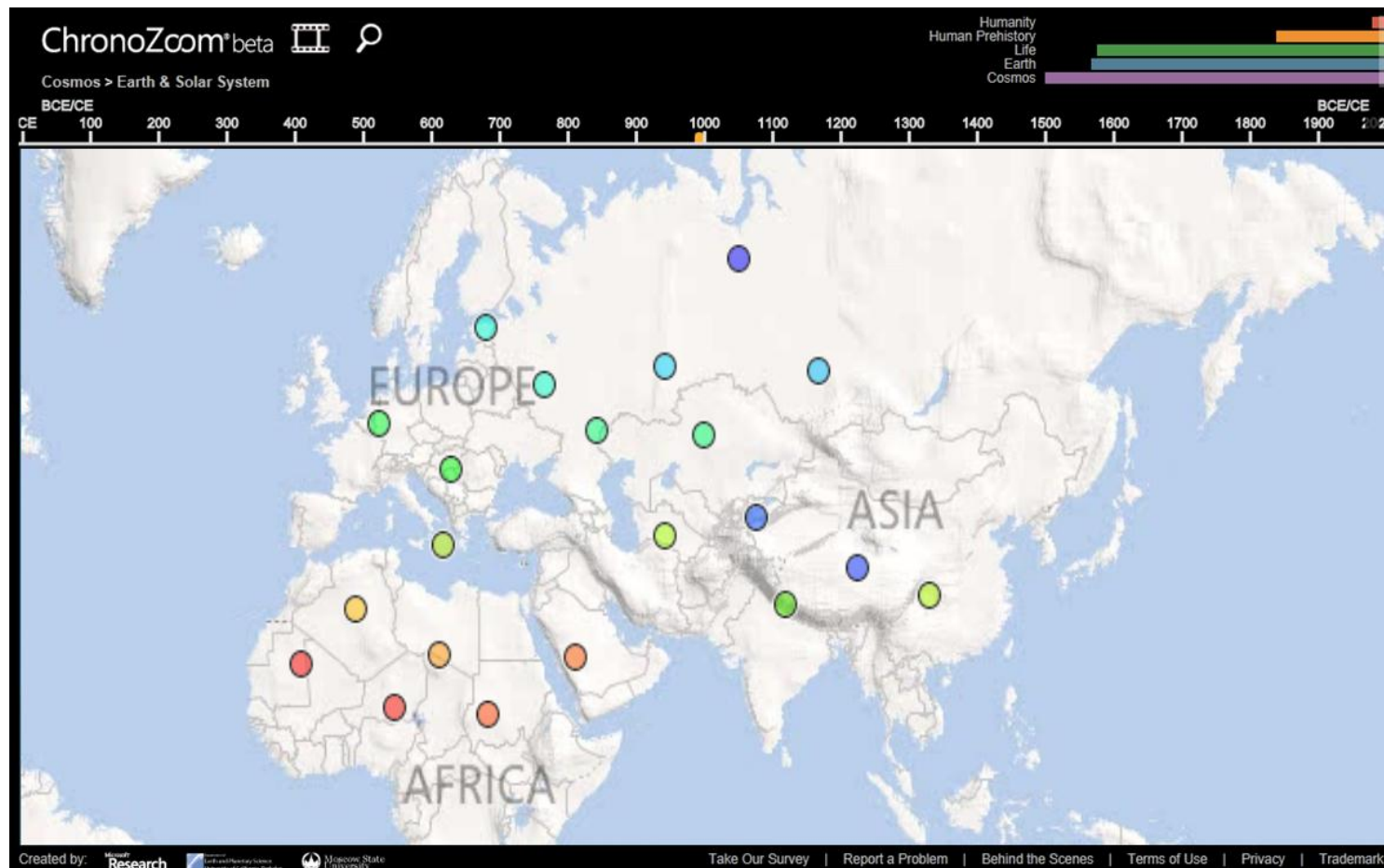
Visualizations in ChronoZoom

Time series inside ChronoZoom: (date,value) series



Visualizations in ChronoZoom

Bing maps inside ChronoZoom: (lat,lon,value) series



Timeline collation

Collate two arbitrary timelines:



What else we can do with Y axis?



More ideas to discuss...

Offline mode

Take a part of history with you: access cached data without Internet connection

Windows 8 app?

Kinect support

Swim through the time

Categorizing the data

Filtering and grouping data by topic

Build your own History

Curated vs. personal ChronoZoom canvas

How to exchange timelines/exhibits?

ChronoZoom for researcher

Visualization tool

What else?

More ideas?



Next Steps and Beyond

- ✓ Engage Computer Science and iSchool Capstone Courses to work on features
- ✓ Work with large archives and collections for automatic generation
- ✓ Engage more CS & Scientific researchers
- ✓ Email chronozoomproject@microsoft.com

Microsoft