The Evolution of ChronoZoom

Motivation, Achievements, and Problems
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Developing the ChronoZoom Service
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Next Steps and Beyond
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Microsoft Research Connections

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Iberian Peninsula about 1050 AD
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
Journey of humanity over 60 kyr, based on DNA
Pangaea, 180 million years ago
Voyage history:  Columbus’ voyage: 37 days (6 Sept-12 Oct 1492)

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

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

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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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This is why we need ChronoZoom!
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 northeastern 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.
The First Voyage - 1492
The Four Voyages
The Four Voyages
Life of Christopher Columbus 1451-1506
Rise of Castile
Rise of Castile
Iberia (Spain + Portugal)
Iberia (Spain + Portugal)
Humanity
Early Stone Age/Paleolithic Era

Homo sapiens
Genus Homo
Hominine Phylogeny

Human Prehistory
Earth & Solar System
Earth & Solar System
Threshold 1: The Big Bang
(13.7 Ga)

Cosmic background radiation

Cosmic background radiation is well explained as radiation leftover from an early stage in the development of the universe, with its discovery considered a seminal test of the Big Bang model of the universe. When the universe was young, before the formation of stars and planets, it was essentially a hot, plasma-filled universe glowing from the residual light of hydrogen plasma. As the universe expanded, both the plasma and this radiation began to cool. When the universe cooled enough, protons and electrons could form neutral atoms.

Bibliography
Nucleosynthesis of elements heavier than hydrogen that were incorporated into the Solar System.
The Future

• Content: Crowd sourced? Or curated by experts?

• Y-axis: How should we organize it?

• Map view: A 3rd dimension?
Organizing the Y-axis
The problem of timelines across geography
The map face of the 3-D cube
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?
ChronoZoom architecture

More at http://chronozoom.codeplex.com/documentation
ChronoZoom client

[Image of a virtual canvas with labeled components: Time scales, Input events, Gestures generator, Gestures stream, UI commands, Virtual canvas, and UI controller.]

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

Abstract set of gestures
Pan/Zoom/Pin
Resolution independent
Rx operations to convert device-dependent events to abstract ones

Navigation w/mouse
Mouse events ➔ Mouse gestures generator ➔ Gestures stream

Navigation w/touch
Touch/pointer events ➔ Touch gestures generator ➔ Gestures stream
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://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**

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

**Embedding PDF**

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

**Programming tricks**

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

1. Open http://www.chronozoomproject.org
2. Locate canvas element by ID
3. Simulate mouse events for panning
4. Get controller state/wait for animation end
5. Get new viewport
6. Check for correct values
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/
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 is Virtual Canvas v2?
Hierarchical vector rendering engine with unlimited number of nested interactive elements
  A flavour of GIS with time as X axis?

What are limitations?
Amount of data loaded from server on startup
Number of objects inside browser
Rendering is not a limitation!

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
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

Average temperature deviation (°C)
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?

**Build your own History**
Curated vs. personal ChronoZoom canvas
How to exchange timelines/exhibits?

**Kinect support**
Swim through the time

**ChronoZoom for researcher**
Visualization tool
What else?

**Categorizing the data**
Filtering and grouping data by topic

**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