Working with Temporal Data in ArcGIS

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This Workshop

- Time in ArcGIS
  - Temporal mapping
  - Sharing Temporal Data
- Managing Temporal Information
- Temporal Data Visualization in ArcGIS
Time in ArcGIS
Time and GIS

• Concepts:
  - Different ways to measure and model time
  - Common patterns used with temporal GIS

• ArcGIS 10
Calendar Measurement – Gregorian Calendar

- **Is not metric or base 10 – difficult to compute**
  - A Year is 365, or sometimes 366 days (leap year)
  - A Month can be 31, 30, or 28 days, *or 29!*
  - Weeks and Months are not aligned
  - A Day is 24 hrs
    - but hours are 60 minutes
    - minutes are 60 seconds
Non-Calendar Measurement – Indexed Time

- Represented as a numeric attribute
- Can be arbitrarily assigned
- Features are sequenced by numeric order
- Events occur on a “number line”
- Use with Interval setting
  - Cannot vary time difference between indexes
Non-Calendar Based Measurement - Epochs

- Index of units elapsed since an epoch (epic?) event

  - Unix / Java / Oracle – “Count of seconds since 1/1/1970”
    right NOW would be: **1310676000** (July 14 2011 20:40:00 GMT)

  - Windows / .Net “DateTime” – Count of 100 nanosecond units (ticks)
    - 12:00:00 A.M January 1, 0001 through 11:59:59 P.M December 31, 9999 A.D.
    - Example: 12:00:00 midnight, Jan 01, 0100 = **3124137600000000** ticks.

- Epoch units are internal to a system – convert to Calendar units!

  - *Store your temporal data as DATE type – not an epoch unit*
  - *Always use the Operating System or Platform API’s for conversion*
Additional properties of Time

- **Time is Linear**
  - Wednesday always follows Tuesday

- **Uni-directional**
  - Events which happen today don’t affect yesterday

- **Time can be Cyclical**
  - June 20th happens every year
Why visualize data through time?

Oil Spill: 15 June, 2010
Temporal GIS Patterns

**Dynamic**
- something that moves
- Planes
- Vehicles
- Animals
- Satellites
- Storms

**Discrete**
- something that "just happens"
- Crimes
- Lightning
- Accidents

**Stationary**
- stands still but records changes
- Weather Stations
- Traffic Sensors

**Change**
- change or growth
- Population
- Distribution
- Fire Perimeter
GIS Integration of Time

Temporal Visualization

Multi Dimensional Data (netCDF)

Real Time Sensor Network

Stationary

Mobile

Simulation & Modeling

Files

DBMS

New Ways to Manage, Visualize & Analyze Geography
Time is Built-In to ArcGIS

• Simple Temporal Mapping

• Unified experience for Time
  - Configure time properties on the layer
  - Use Time Slider to visualize temporal data

• Share temporal visualization
  - Time-enabled Map Services
  - Export videos or images
  - Generate temporal map books using ArcPy scripting
  - Layer and map packages
Temporal Mapping in ArcGIS 10

- The map is now time aware
- Create, interact, and serve temporal maps
- Unified experience for Time
  - Works the same in ArcMap, ArcGlobe and ArcScene
  - Part of Desktop, Engine and Server products
Sharing Temporal Maps & Data with ArcGIS 10

- Publish time-aware maps
- Export videos or images, layer and map packages
- Visualize data
  - Access via REST API
  - Web API
    - FLEX
    - JavaScript
    - Silverlight
  - Time Slider web control
  - ArcGIS Online
Time in ArcGIS
Demonstration
Managing Temporal Information in ArcGIS
Ways to model temporal data for use in ArcGIS

- **Time Instant**
  - “Point” in time of a specific feature
  - A sample from continuous data
  - “Observation”, “Event”, etc…

- **Time Extent**
  - A time span, an interval or duration
  - Describes characteristics over a period (start date – end date)

- **Time As Attribute Value**
  - Additional attribute when more than one are used
  - Legal representation such as “valid time”

- **Transactional Time**
  - System generated, auditing (in the database)
  - Provides revision or history management
  - Time Window can be created in SQL view or Query Layer definition
Store Temporal Data – *DATE* field type

- **DATE** is a special field type specific to time

- GeoDatabase provides **DATE** – maps to RDBMS SQL ‘DATE’
  - Not all databases support the same type and operators

- If at all possible – use **DATE** type
  - It’s better, faster, easier
  - Only use String or Number if importing old data
  - Learn to convert

- **DATE** field should be indexed for faster query performance
Other supported formats - Numeric and String

- **Numeric**
  - YYYY
  - YYYYMM
  - YYYYMMDD
  - YYYYMMDDhhmmss

- **String**
  - YYYY
  - YYYYMM
  - YYYYMMDD YYYY/MM/DD YYYY-MM-DD
  - YYYYMMDDhhmmss YYYY/MM/DD hh:mm:ss YYYY-MM-DD hh:mm:ss

- **Only ‘sortable’ formats are supported**
  - Numeric: (YYYYMMDD) 20090630 > 20080830 = TRUE
    (MMDDYYYY) 06302009 > 08302008 = FALSE

  - *Named Month* strings sorted alphabetically!
    - April, August, December, February, etc…
    - Which is first, “DEC-10-2009” or “FEB-10-2009” ?
What if your time is not one of those formats?

- Use the **Convert Time Field** GP tool
  - Converts numeric & string formats to a date field
    - “20100321” → 03/21/2010
  - Converts custom string formats to a date field
    - “March 21, 2010” → 03/21/2010
Supported data

• Feature Layers
• Data tables
• Mosaic Datasets & Raster Catalogs
• NetCDF (Raster, Feature, Table)
• Tracking Layers
• Network Layers
• … much more
Supported data - Feature Layers

• With one table, features repeat for each time stamp
• Each time stamp has an attribute value
• This model is commonly used for capture or playback of moving objects. (Tracking)
Supported data - Feature Layers (continued)

- With two tables, if your table relationship is:
  - One to one
  - One to many
- Create a join between the layer and the time-series table
  - Add Join GP tool
  - Join on the Layer Properties (Join & Relates tab)
  - Optionally, use the Make Query Table GP tool to create an in-memory layer

- This model is commonly used with fixed position samples, such as weather stations and other sensor networks
Representing Time Span with Two Fields

- Sometimes there is a need to imply that a duration existed between each instant in time feature.
- Populate the End time field with the next successive records Start time.

The last instance will not have a duration as the End time and Start time will be the same.
Supported data - Mosaic Datasets Raster Catalogs

- Use a date/time field
- Use an index field (i.e. ObjectId)

<table>
<thead>
<tr>
<th>OBJECTID</th>
<th>NAME</th>
<th>Shape</th>
<th>Raster</th>
<th>Date_Time</th>
<th>SHAPE_Length</th>
<th>SHAPE_Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Image1.gif</td>
<td>Polygon</td>
<td>Raster</td>
<td>1998-10-14 12:00:00</td>
<td>3068</td>
<td>522753</td>
</tr>
<tr>
<td>2</td>
<td>Image2.gif</td>
<td>Polygon</td>
<td>Raster</td>
<td>1998-10-15</td>
<td>3068</td>
<td>522753</td>
</tr>
<tr>
<td>3</td>
<td>Image3.gif</td>
<td>Polygon</td>
<td>Raster</td>
<td>1998-10-15 12:00:00</td>
<td>3068</td>
<td>522753</td>
</tr>
<tr>
<td>4</td>
<td>Image4.gif</td>
<td>Polygon</td>
<td>Raster</td>
<td>1998-10-16</td>
<td>3068</td>
<td>522753</td>
</tr>
<tr>
<td>5</td>
<td>Image5.gif</td>
<td>Polygon</td>
<td>Raster</td>
<td>1998-10-16 12:00:00</td>
<td>3068</td>
<td>522753</td>
</tr>
<tr>
<td>6</td>
<td>Image6.gif</td>
<td>Polygon</td>
<td>Raster</td>
<td>1998-10-17</td>
<td>3068</td>
<td>522753</td>
</tr>
<tr>
<td>7</td>
<td>Image7.gif</td>
<td>Polygon</td>
<td>Raster</td>
<td>1998-10-17 12:00:00</td>
<td>3068</td>
<td>522753</td>
</tr>
</tbody>
</table>

- Note: The layer will initially draw as a wire frame if more than 9 rasters.
What if time is stored in columns?

- ArcGIS works with time stored in records, not columns
  - Need to transpose data in columns into records
  - Reformat table with Transpose Fields GP tool
Supported Data - NetCDF data

- An array based data structure for storing multidimensional data.
- **N-dimensional coordinates systems**
  - X coordinate (e.g. longitude)
  - Y coordinate (e.g. latitude)
  - Z coordinate (e.g. altitude)
  - Time dimension
  - … other dimensions
- **Variables – support for multiple variables**
  - Temperature, humidity, pressure, salinity, etc
NetCDF Layers and Table

- Make a layer or table from the NetCDF file
- Choose the dimension to visualize through ????
- Multidimension GP Tools
Time Zones

Source: wikipedia.org
Time Zones

- ArcGIS integrates data across different time zones
- If possible, standardize on UTC (or GMT)
- What if your data is across different time zones?
  - GP tool – Convert Time Zone
Daylight Savings Time

- Problems with DST
  - Regional differences – political disagreement on DST
  - Some DST zones adjust less than an hour
    - 30 minute and 45 minute DST offsets
    - Evolving definitions (US DST rules changed in 2007)

- Store timestamps as Standard Time (not DST)
Managing Temporal Information in ArcGIS - Demonstration
Temporal Data Visualization
Time Animations

• Use Time Animation for creating dynamic visual effects
  - Visualize temporal data while flying over an area
  - Fading in/out layers while visualizing temporal data
  - Visualizing time enabled layers at different time steps

• Existing ArcGIS 9 Time Layer Animations
  - Should work automatically in ArcGIS 10
  - Time properties on layers are set automatically

• Note - If you just want to visualize data over time, use the Time Slider
Animation – “Fly Over” plus Time Progression
Animating data in graphs

- Create a graph using a layer or table
- Create an animation in the usual way, attaching the layer or table to a time layer track
- When the animation is played, the graph will animate
ArcGIS Tracking Analyst and Tracking Server

- Collect and Monitor real-time data
- Visually organize point data into track lines
- Analyze change over time - Aging of color, size, shape
- Per-feature analysis
  - GeoFencing
  - Filtering

Enabling Real-Time Temporal GIS Solutions
Temporal Data Visualization Demonstration
Summary & Closing
Summary of Best Practice Recommendations

- Use DATE field type whenever possible
- Database Index on the DATE field
- UTC (or GMT) for time zone
- Use Standard Time – avoid Daylight Savings (DST)
- Use Data Conversion tools to convert to supported field types and storage formats
- Know when to model with single vs. join tables
What’s coming in ArcGIS 10.1?

• Live mode on the Time Slider
  - Allows you to visualize the most recent updates to time-enabled data

• Space time clustering using Spatial Statistics GP tools

• Time text displayed in the map view
  - For embedding time in the exported videos or sequential images

• Time window improvements
  - Data being displayed twice in consecutive time windows
  - Options to exclude or include data at the start and end time of a specified time window
Questions?

• Contact Us:
  - David Kaiser  dkaiser@esri.com
  - Hardeep Bajwa  hbajwa@esri.com

• Please complete an online session evaluation: www.esri.com/sessionevals
Sample Screenshots Layout *(preferred)*
Grids for Images/Screenshots (may ask designer for assistance)

- Environmental conservation
- Disaster response
- Demographic analysis
Diagrams/Icons
Arrows for Connecting Items

Arrows for Connecting Large Concepts
Shapes for Diagrams

Quick Style: Subtle Effect
ArcGIS
ArcGIS
ArcGIS
ArcGIS
ArcGIS
ArcGIS

Quick Style: Moderate Effect
ArcGIS
ArcGIS
ArcGIS
ArcGIS
ArcGIS
ArcGIS

DON'T APPLY EFFECTS from the Design tab
Shapes for Diagrams (continued)

- Cloud optimized for use behind diagrams
- Cloud for general diagram
- Circle behind a group of objects
- Content box for each tier (see sample diagrams)
- Optional: Use as a frame around showcased screenshots
Sample Diagrams
ArcGIS Implementations

**Desktop**
- Individuals
  - Ad Hoc Projects
  - Analysis/Modeling
  - Mapping

**Server**
- Workgroups
  - Shared Database
  - Fixed Applications
  - Transactions

**Enterprise**
- Organizations
  - Shared Services
  - Integration
  - Collaboration

**Web GIS**
- Cloud
- Enterprise
- Local

**New**
ArcGIS 10 — A Complete System

Easier
More Powerful
and Everywhere

- Discover
- Create
- Manage
- Visualize
- Analyze
- Collaborate

Cloud
Enterprise
Local

Web
Mobile
Desktop
Esri is Publishing Our REST Interface as an Open Standard

Open REST API

Any Application

Open Data Access

Quick Style — Moderate Effect
Access the Entire Icon Library

Over 160 items added in 2010

- 430 total icons available for Esri use
- Browse and search from any Microsoft Office application
- Accessible when you’re connected to the Esri Network
- Also available offline as directories of PNG files
- See the presenter notes below for details
A Selection of Frequently Used Icons

ArcGIS Desktop
ArcGIS Online
Web Blog
Web Blog
Mashups
Mashups
Browser
Open Standards
ArcGIS Desktop Authors
Web Map
Web Map
Map
Web Map
Web Map
Map
Web Map
Web Map
Web Map
Map
Web Map
Web Map
Explorer
Web Map
Designing & Planning
Situational Awareness
Professional Services
Professional Services
Education
Education
Mobile GIS User
GIS User
Business Partner
This area is the **title safe area** (10% in from each slide edge). All text and graphics should be contained within this area to prevent loss during transmission and reproduction.

Any information outside the title safe area runs the risk of being cropped off when captured to video.

*Please note the adjusted title and body template styles adhering to the title safe area. Presenters will need to adjust their slides accordingly as needed to reposition text and graphics.*

Right-click and select Grid and Guides
Check "Display drawing guides on screen"
Successful Presentation Guidelines

• Know your target audience
• Use slides to lead not read
  - Use a key phrase or a few words
  - Avoid more than two levels of bullet points
• Use title slides for each section
  - Make it clear where you are going
• Avoid too much animation—Keep it simple!

Additional ESRI presentation resources available on ArcZone
http://arczone/resources/presentations.cfm
Migrating to the New Template

This template was rebuilt from scratch and fixes problems found in previous versions.

- Download the instructions and support files from http://arczone/resources/presentations.cfm
**Color Guidelines**

**Color Swatches**
Use **Esri 2011** as theme colors (see presenter’s notes for the instruction of how to add the Esri theme and theme colors)

**Projector Color Guidelines**
Use the **sRGB** video mode on the projector. Most projectors have this setting.

Additional ESRI presentation resources available on ArcZone
http://arczone/resources/presentations.cfm