CPSC 583
temporal data

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1D visualization

Point data
A single data point that changes over time

Examples?
  Speed
  Temperature
  Time
1D visualization

Time – one time divided into hours and minutes
Full circle for hours
Full circle for minutes

1D visualization

altitude when flying
1D visualization

altitude when flying

Linear stream data

- Speech
- Music
- Time variate data

- Complex patterns
- In a sequence of symbols
Repeating subsequences

• One type of structure
• Arc Diagrams
• Visualizing matching substrings

A **maximal matching pair** is a pair of substrings of \( S, X \) and \( Y \), which are:

• **Identical.** \( X \) and \( Y \) consist of the same sequence of symbols.
• **Non-overlapping.** \( X \) and \( Y \) do not intersect.
• **Consecutive.** \( X \) occurs before \( Y \), and there is no substring \( Z \), identical to \( X \) and \( Y \), whose beginning falls between the beginning of \( X \) and the beginning of \( Y \).
• **Maximal.** There do not exist longer identical non-overlapping subsequences \( X' \) and \( Y' \) with \( X' \) containing \( X \) and \( Y' \) containing \( Y' \).

• In 123a123 what is the maximal matching?
  • 123
  • Not 12 or 23
Repeating subsequences

A maximal matching pair does not always work ideally
• 10101010?

A repetition region $R$ is a substring $R$ of $S$ such that $R$ is made up of a string $P$ repeated two or more times in immediate succession. Each repetition of $P$ is called a fundamental substring for $R$.

ABC010101
“010101” repetition region
“01” fundamental substring

Repeating subsequences

An essential matching pair is a pair of substrings of $S$, $X$ and $Y$, which are:
• A maximal matching pair not contained in any repetition region,
• Or, a maximal matching pair contained in the same fundamental substring of any repetition region that contains it,
• Or, two consecutive fundamental substrings for a repetition region.
Repeating subsequences

Connecting an essential matching pair

Repeating subsequences

A substring repeated three times

Immediate repetition
Repeating subsequences

Macro and micro patterns

Translucency give both readings

Repeating subsequences

Too much detail

Small and large sequences obscure each other
Beethoven's *Für Elise*

- Matches based on pitch
- And with chords on the top note

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Beethoven's *Für Elise*

- Top based on pitch
- Bottom based on intervals
Thread Arcs: an email thread visualization
B. Kerr. Thread Arcs: an email thread visualization

Threads are useful in that they
• provide context for message
• show conversations in progress
• show discussion state
• a type of filter (reduce clutter)
• email editing as a group

1. Chronology: arrival sequence -> evolution, order, initiator and most recent.
2. Relationships: all “reply to” relationships visible at a glance. trace back through the chain and see which messages subsequently respond to a particular message.
3. Stability: messages should appear in the same location -> finding the thread (or message) in the future, to see additions.
5. Attribute Highlighting: by a particular person, unread messages, date, time, etc..
6. Scale: small threads and large threads. Since usual length between 2 and 20 does not have to scale to hundreds or thousands of messages.
Thread Arcs: an email thread visualization

**Chronology**
- Important -> position

**Relationships:**
- 
- "reply to" arcs

- to alleviate confusion

- "reply to" arcs

A
B

Thread Arcs: an email thread visualization

Bushy
- many people replying to one sender

Back and forth between two people (narrow)
Thread Arcs: an email thread visualization

Combinatoric space

Distinct message structure for two to five messages

<table>
<thead>
<tr>
<th>n</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>t1</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>24</td>
</tr>
</tbody>
</table>

Thread Arcs: an email thread visualization

Stability

A Thread Arc

B tree diagram

C tree table
Thread Arcs: an email thread visualization

Tree Diagram (A) and Tree Table (B) oversimplify the conversational structure of a thread. The 8 Thread Arcs (C) reveal different ways the conversation may have evolved.
Thread Arcs: an email thread visualization

Different types of sorting
Shows different structure
Stacked graphs

- the twin goals are to show many individual time series, while also conveying their sum.

Common 2D infovis

- Comparing numerical value of a data attribute across data entities
Common 2D infovis

• Comparing several numerical values of a data attribute across data entities
ThemeRiver: Visualizing Theme Changes over Time

Susan Havre, Beth Hetzler, and Lucy Nowell
Battelle Pacific Northwest Division
ThemeRiver: Visualizing Theme Changes over Time


2. Earthquake in Peru buries

3. Earthquake in Iran kills 40,000

4. OPEC agrees to raise oil price
Histogram shows that news is light on Sundays - not a theme shift.

Parallel rivers let users compare AP data from Washington, D.C. and New York from the same time period.
The Ebb and Flow of Movies:
Box Office Receipts 1986 - 2007

The Ebb and Flow of Movies: Box Office Receipts 1986 - 2007


Common 2D infovis

- Relationship between 2 data attributes
• http://www.babynamewizard.com/voyager#


References

