SequenceJuxtaposer: Fluid Navigation For Large-Scale Sequence Comparison in Context

James Slack*, Kristian Hildebrand*†, Tamara Munzner* and Katherine St.John¥

* University of British Columbia,
† Bauhaus University Weimar,
¥ City University of New York
Overview

1 Introduction
1 Previous Work
1 Interaction Metaphor
1 SequenceJuxtaposer
1 Conclusion and Future Work
Introduction

1. Sequence visualization tool
   1. Exploration and comparison
2. Accordion Drawing
   1. Stretch and shrink rubber sheet
   1. Borders tacked down
Zur Anzeige wird der QuickTime™ Dekompressor „MPEG-4 Video“ benötigt.
Previous Work

1. Accordion Drawing
   1. TreeJuxtaposer [Munzner 03]

1. Sequence Browsers
   1. Ensembl [Hubbard 02], UCSC Genome Browser [Kent 02], NCBI [Wheeler 02]
   1. MacClade [Maddison 92], VISTA [Mayor 02], phylo-VISTA [Shah 03]
   1. Artemis [Rutherford 00], LaiNView [Duret 96], BARD [Spell 03], PipMaker [Schwartz 00]
Accordion Drawing

1. SequenceJuxtaposser guarantees 3 key properties
   1. Context
   1. Visibility
   1. Frame Rate
Guaranteed Context

1. **Focus+Context**
   1. Combine overview and detail into single view
   1. More information visible simultaneously
   1. Avoid getting lost while exploring
   1. Major information visualization research theme

1. **Navigation metaphor**
   1. Rubber sheet with borders tacked down
Guaranteed Visibility

1. Highlight marks always visible
   1. Never fall outside of current view window
   1. Never hidden by something in front
   1. Never vanish, even if smaller than one pixel

2. Requires efficient algorithms
   1. Explicitly checking all items too slow
      1. Linear in number of pixels, not number of items
   1. Details in TreeJuxtaposer paper
      [Munzner et al, Siggraph03]
Guaranteed Frame Rate

1. Need realtime update
   1. Focus+Context interaction must be fluid
   1. 20-30 frames per second

1. Computer graphics challenge
   1. Progressive rendering
SequenceJuxtaposer

1. Fluid comparison of multiple sequences
2. Handles DNA and RNA sequence data
3. Provides searching, difference calculation
Zur Anzeige wird der QuickTime™ Dekompressor „MPEG-4 Video“ benötigt.
Algorithm Complexity

1. Sublinear:
   1. Runtime algorithms

1. Linear:
   1. User-initiated actions

1. Subquadratic:
   1. Preprocessing algorithms
Searching

1. Search for motifs
   1. Protein/Codon search
   1. Regular expressions supported
1. Results marked with guaranteed visibility
Differences

1. Explore differences between aligned pairs
2. Slider controls difference threshold in realtime
3. Results marked with guaranteed visibility
Interaction

1. **Resizing**
   1. Expand or contract rectangular areas
   2. Drag visible rubberband interactively
Interaction

1. Animated transitions
   1. Grow and shrink groups
   1. Allow user to track visual landmarks
Drawing

1. Very high information density
2. Avoid overdrawing in compressed areas
3. Progressive rendering
   1. Draw for fixed time, check for user interaction
   2. Priority queue to draw items in order of current onscreen size
Zur Anzeige wird der QuickTime™ Dekompressor „MPEG-4 Video“ benötigt.
Results and Performance

1. Java prototype using OpenGL, GL4Java
2. Memory for AD data structures
   - significant, but linear
   - paper: 1.7 million base pairs
   - current: 20 Mbp
Conclusion

1. Accordion Drawing for sequences
   1. Powerful new information visualization technique

1. Guarantees
   1. Context for maintaining orientation
   1. Visibility of landmarks: searches, differences
   1. Frame rate for realtime response to interaction

1. Fluid exploration of big datasets
Future Work

1. Performance
   1. Memory, speed
2. Annotation
3. Editing
4. Connecting trees and sequences
5. Other data types
   1. BACs (bacterial artificial chromosomes)
Open Source

1 Freely available from
http://olduvai.sourceforge.net

1 SequenceJuxtaposer
olduvai.sf.net/sj

1 TreeJuxtaposer
olduvai.sf.net/tj
Acknowledgements

1 Collaboration
   1 David Hillis and lab members, UT-Austin

1 Discussions
   1 Wayne Maddison, David Haussler, Nina Amenta

1 Technical writing
   1 Ciáran Llachlan Leavitt

1 Funding
   1 NSF/DEB-0121651/0121682
   1 German Academic Exchange Service