

Exploratory Statistical Graphics for an Initial Motion Control Experiment

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Presented by

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Our Questions

- How does the Central Nervous System control movement?
- What are the interactions between visual and proprioceptive information?
- How do we best study the motor system?

Purpose of Experiments

- Rehabilitation of people after accidents
- Knowledge of adaptation of humans to perform mechanical tasks, e.g., arm movement
- Perfection of movements
 - Dancers
 - Ski jumpers
 - Piano players

General Approach

- Flexible platform for experimentation
 - Allows measurement of many variables
 - Isolation of visual and proprioceptive systems
 - Introduction of perturbations.
- Robust **visualization** and analytical protocols

Data Acquisition

- Flock of Birds
- Cyber Glove
- IR Eye Position Sensors
- Electromyelogram
- Ferromagnetic Contact Lenses

Experiments

- Movements in Reality
- Movements in Virtual Reality

Statistical Analysis

- Small to Medium Data Size:
 - 60 to 100 Hz
 - 30 to 120 sec
 - 16 Cyber Glove sensors + 6 x #FOB sensors
 - Here: 25,000 to 40,000 Measurements

Visualization during Experiments

- Complicated setup - impossible to redo once finished
- Data plausible?
- Data correctly recorded?

Possible Problems

- Radio frequency reflections
- Changing fields
- Displacement of hardware attached to human body

Inspiration of Arm Movement



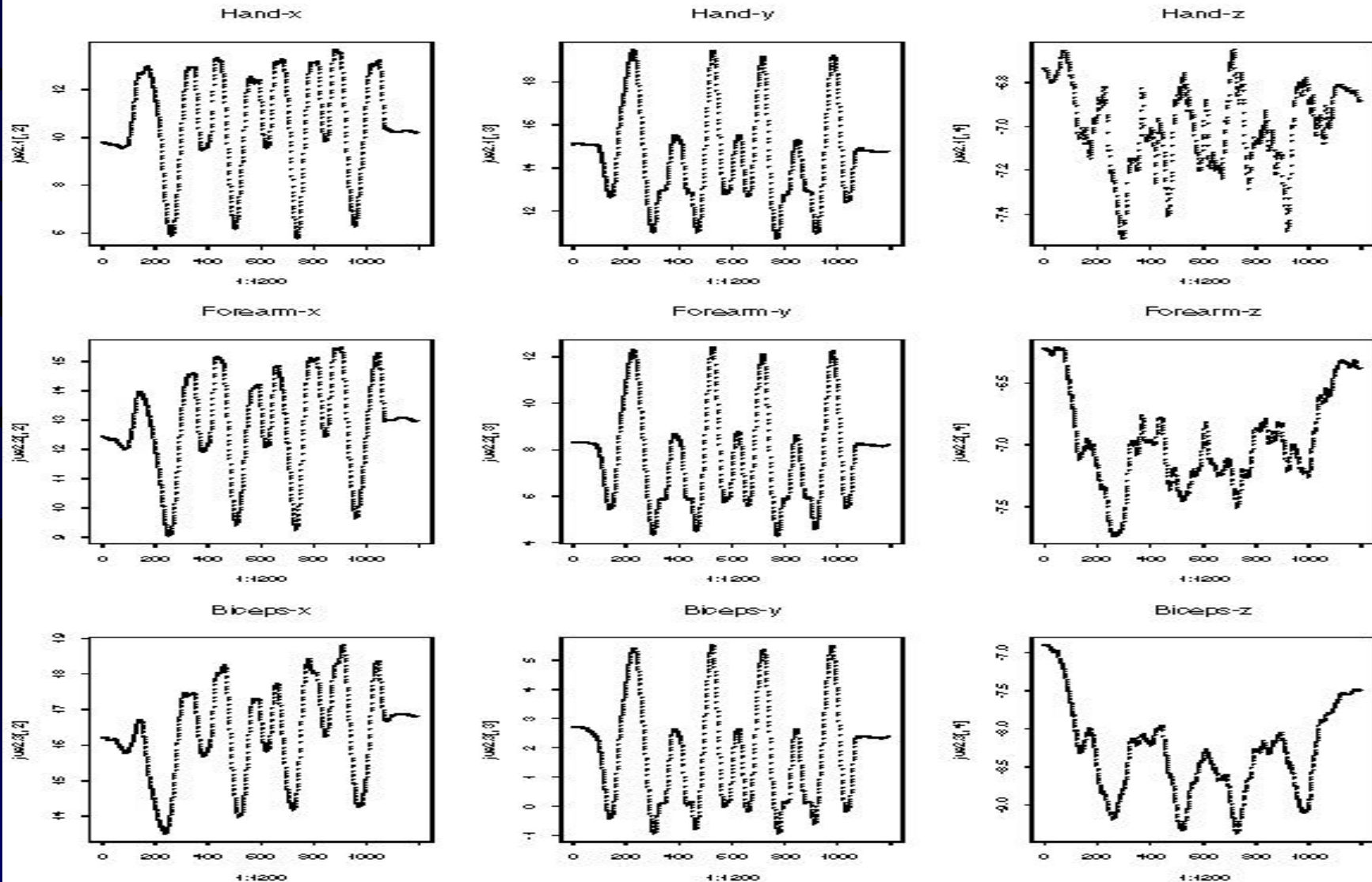
<http://www.christusrex.org/www1/sistine/4-Genesis.html>

Simple 3-D Movements (C-Programs)

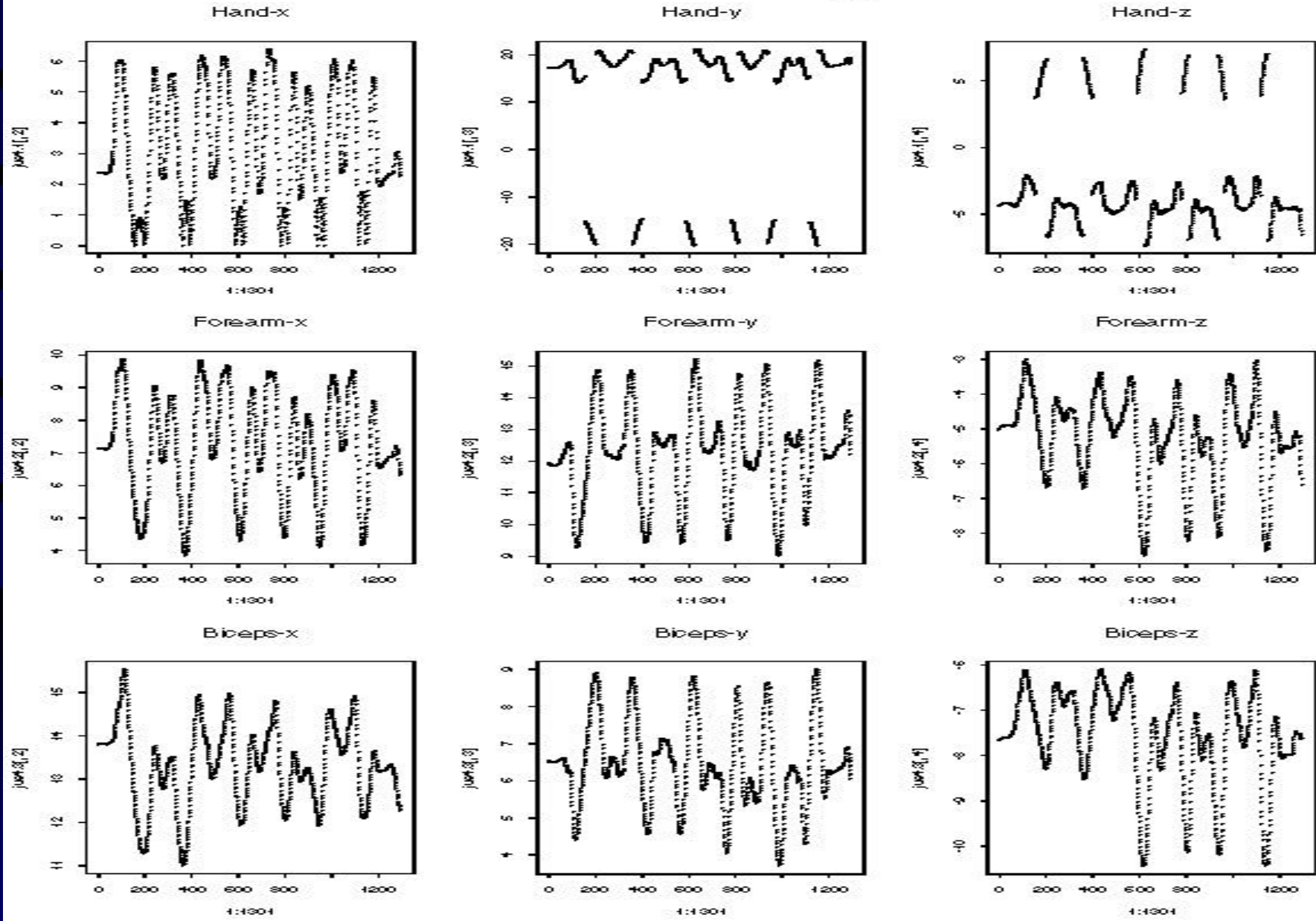


Timeseries Plots (S-Plus)

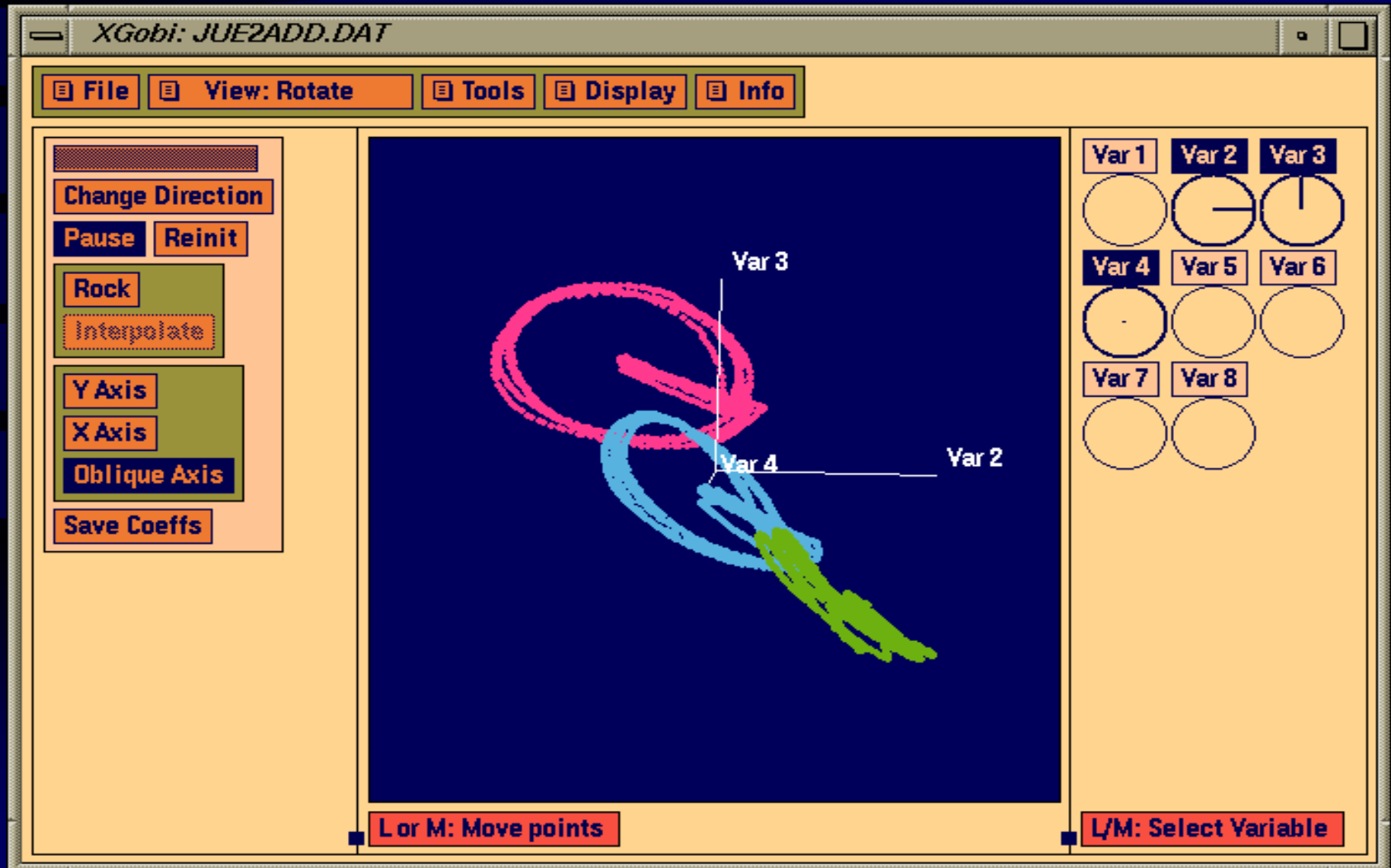
Circle Test - Horizontal



Circle Test - Angular



Scatterplots and Rotation (XGobi)



XGobi: JUE2ADD.DAT

- File
- View: Rotate
- Tools
- Display
- Info

Change Direction

Pause Reinit

Rock

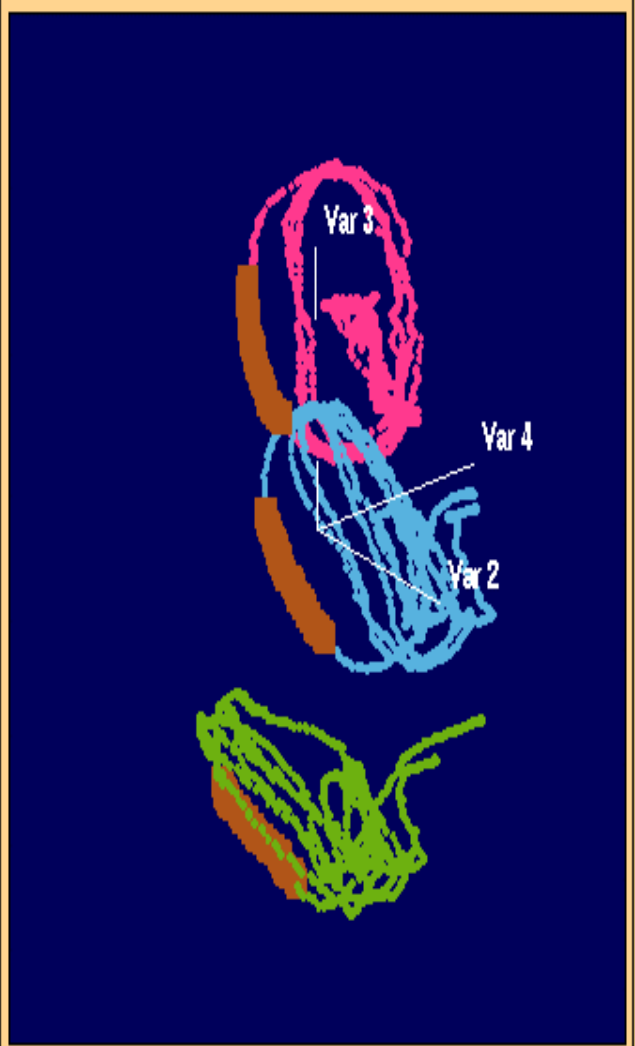
Intepolate

Y Axis

X Axis

Oblique Axis

Save Coeffs



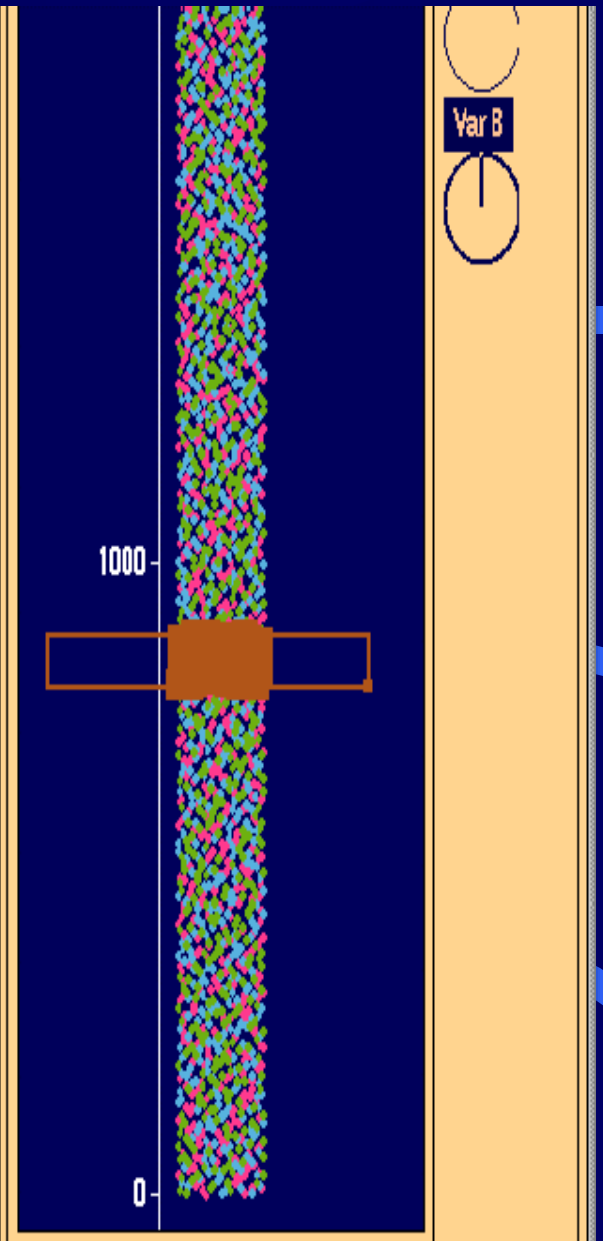
Var 1 Var 2 Var 3

Var 4 Var 5 Var 6

Var 7 Var 8

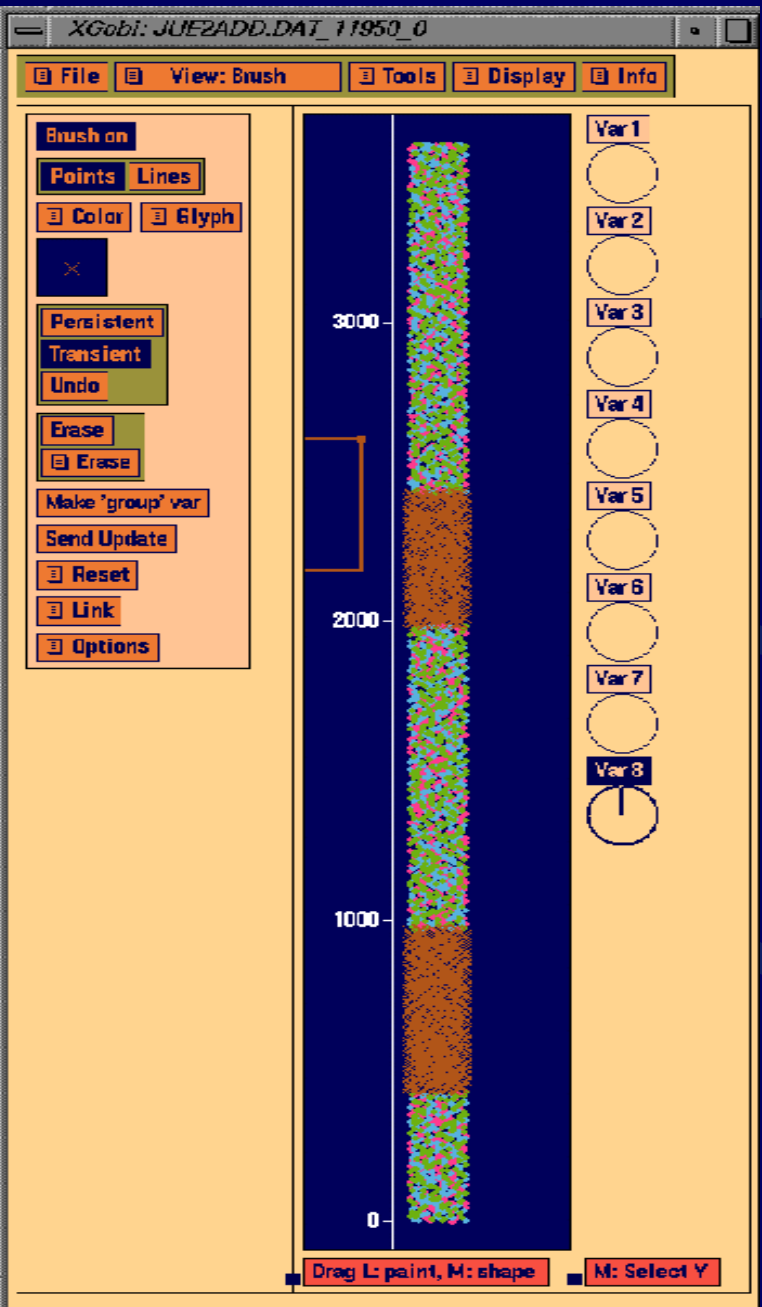
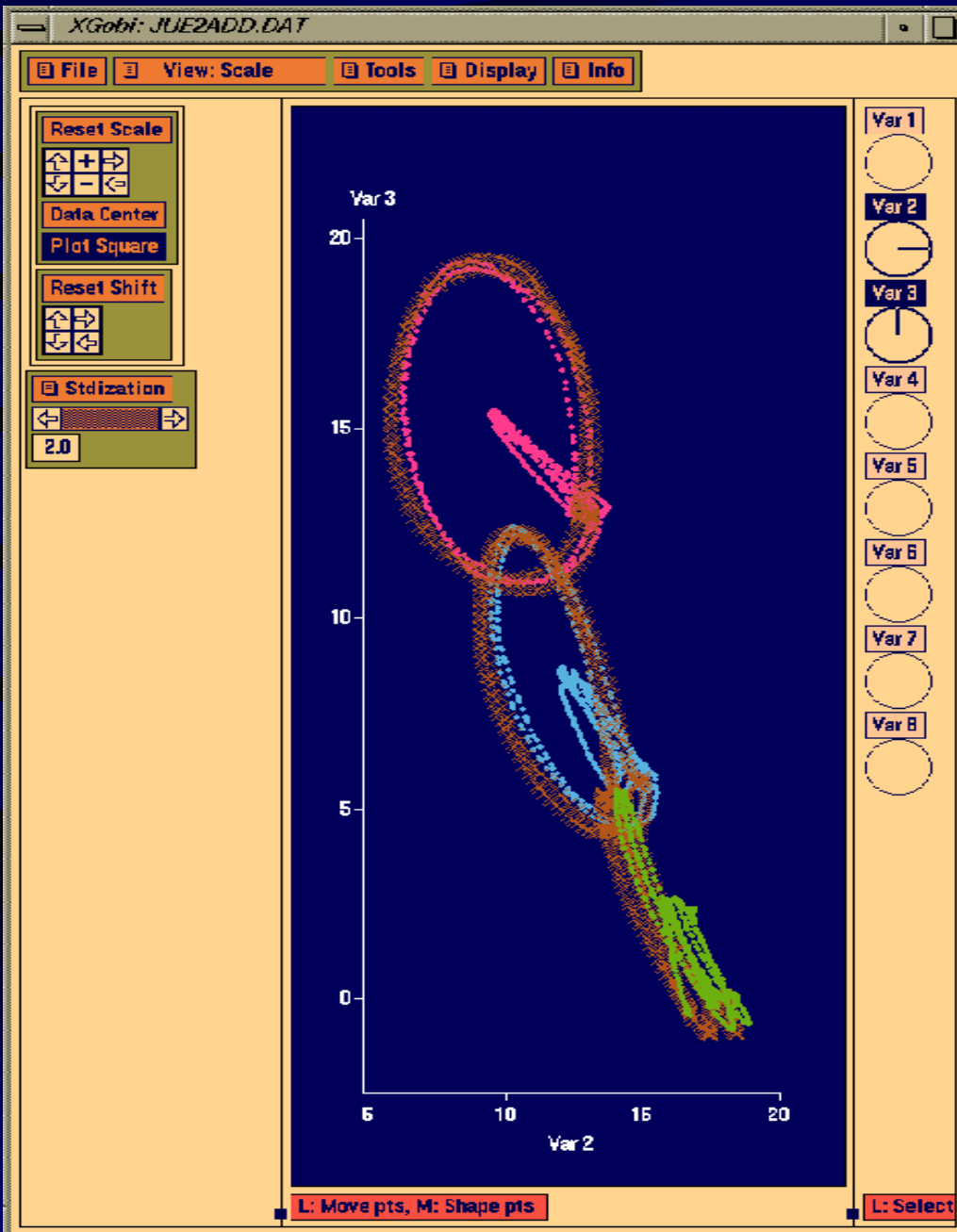
L or M: Move points

L/M: Select Variable



Drag L: paint, M: shape

M: Select Y



XGobi: JUE2ADD.DAT

File View: Rotate Tools Display Info

Change Direction

Pause Reinit

Rock

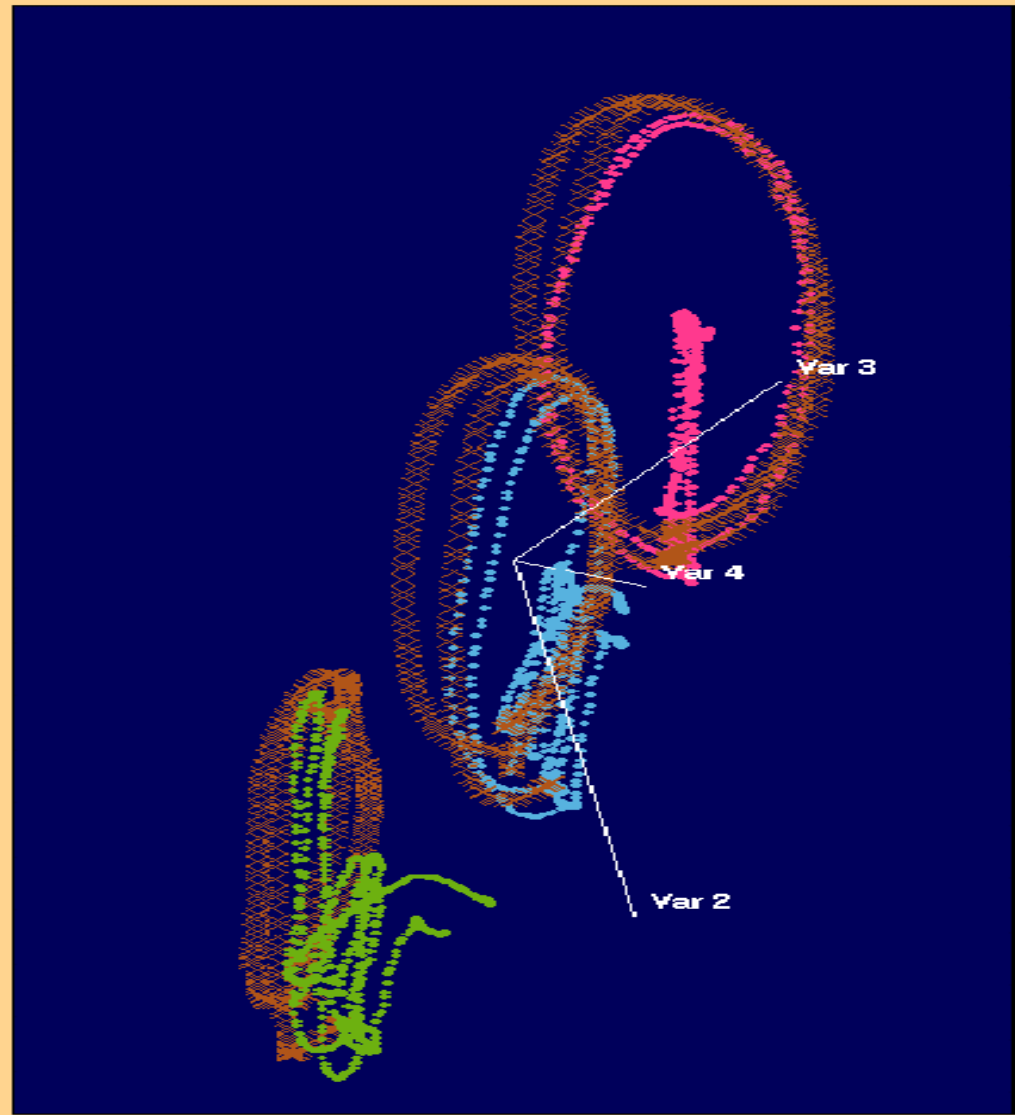
Interpolate

Y Axis

X Axis

Oblique Axis

Save Coeffs



Var 1

Var 2

Var 3

Var 4

Var 5

Var 6

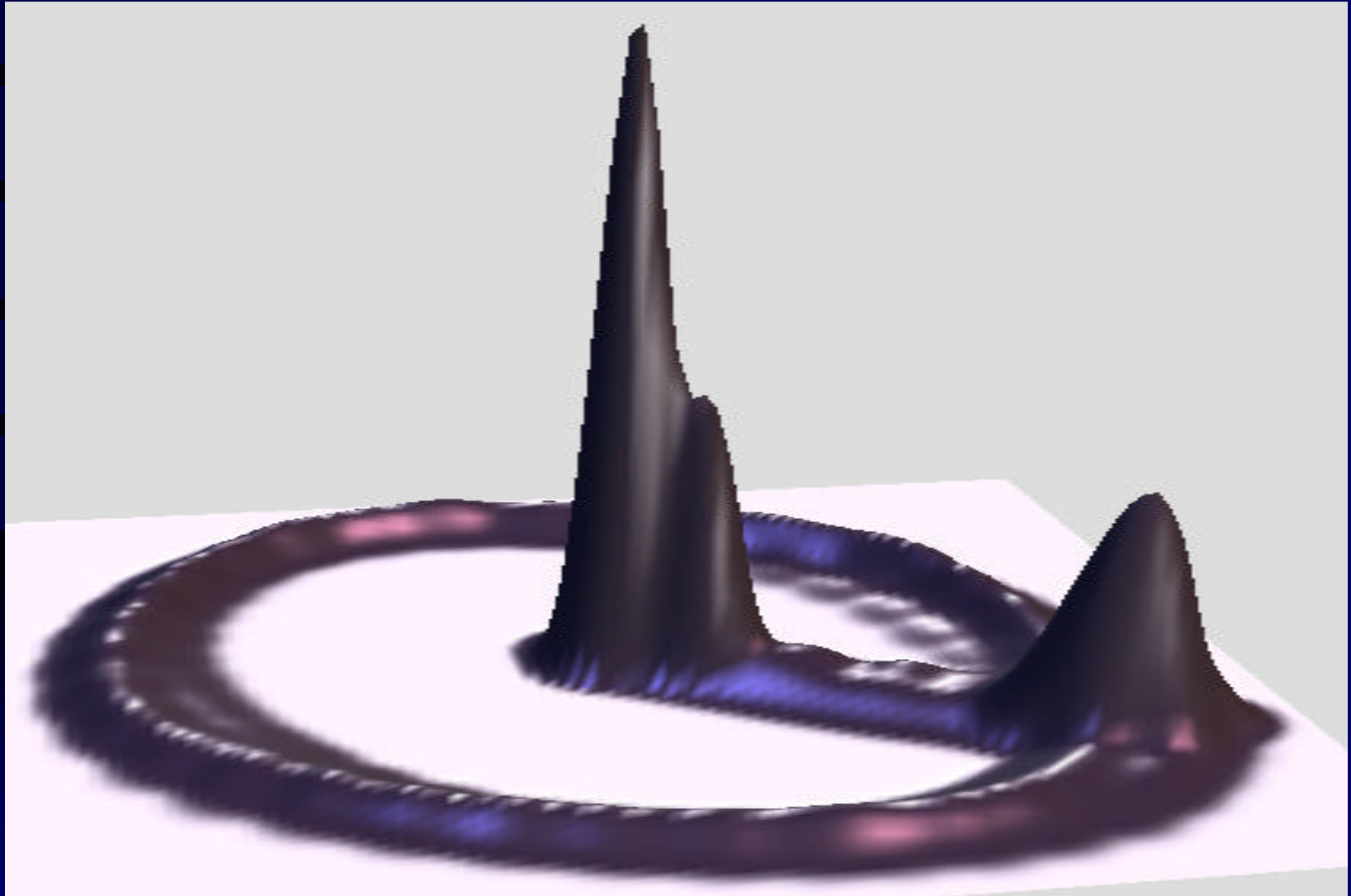
Var 7

Var 8

L or M: Move points

L/M: Sele

Density Plots (ExplorN)



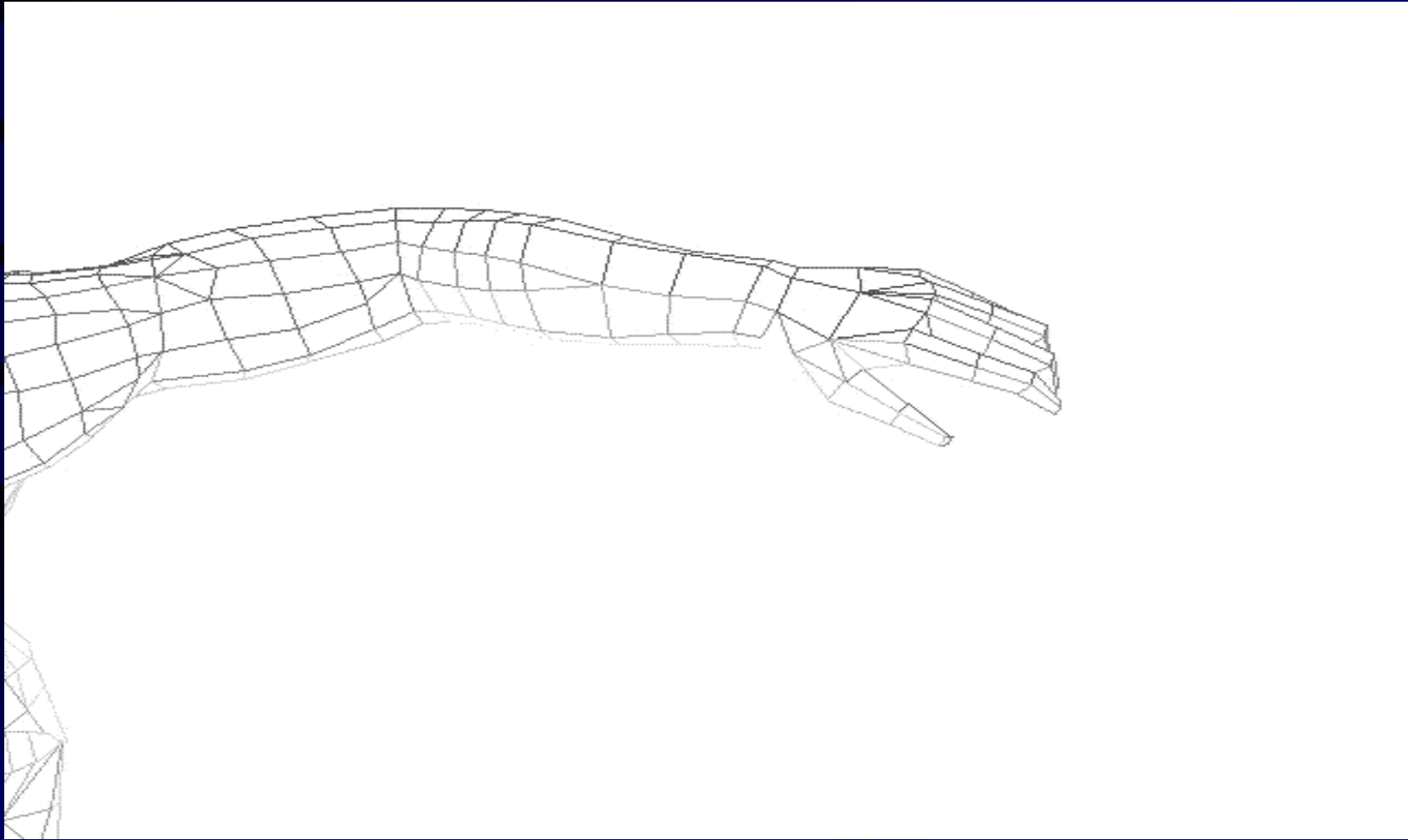
Future Work I: Analysis & Data Compression

- Time Series Analysis
- Wavelets
- Multidimensional Wavelets

Future Work II: Rendering of Virtual Arm

- Realistic Appearance
- Movement about each Joint
- Real Time "Driving" of Arm with FOB

Realistic Arm Rendering



Questions?