THE ADAGE GALLERY TOUR
I: HIGHLIGHTS

J. ALEX STARK

Contents

For further information email `info@mdag.org`.

1. Introduction

This document is a work in progress.

The aim of the Adage project is to develop a powerful, flexible and extensible drawing engine. This document is a pictorial survey of drawing genres; it sets out the vision for the project by example.

The survey is designed to be representative of the forms of drawing to be supported. The drawings are composed entirely of lines, points, filled areas, and text. They are grouped into categories, as follows.

Basic drawings: These drawings are simple and illustrate the basic operation of the Adage system.

Connected nodes: Many drawings are composed of nodes that are connected together. Nodes sometimes represent objects (nouns), and others processes or actions (verbs) with inputs and outputs. Connections indicate relationships, dependencies, sequences and transfers (such as outputs to inputs).

Representing reality: Typically the most sophisticated type, these drawings are a literal representation of something real. This category inclues engineering drawing and architecture.

Plotting and charting: A major category of drawing is the representation of data. Often the aim is illustration with impact, rather than precise detail.

Note that many of these drawings would not be produced by Adage on its own, but rather in combination with another program. For example, the plots of data would be produced by data analysis programs with Adage as the output generator.

2. Basic drawings

This section is devoted to a loose category of drawing: those that use the fundamental facilities of Adage. Some features of these include:

- The drawings are moderately simple compositions of lines, points and text, and of simple filled areas. Lines are either straight or basic curves, such as circle arcs.
- Straightforward geometric construction is used. Examples are points of intersection of two lines, mid-points of lines, and perpendiculars.
- Angle-preserving transformations (scale, rotate, and translate) are employed.
- Reasonable sophistication is required in text placement. In particular, text can be placed with good controlled spacing next to a line or in a corner.

2.1. **Basics: Geometrical elements.** This sample is composition of straight lines, circles, circular arcs, and text. The layout of the entire (main) figure is defined by the three points of the triangle ABC. The position of the inset figure would also need to be defined. The line styles, and drawn annotations would be specified. Ideally the locations of the text elements would be defined in term of the lines and corners to which they are adjacent. For instance, the label 'C′ might be placed in the corner of the lines C″ to C and C to A.

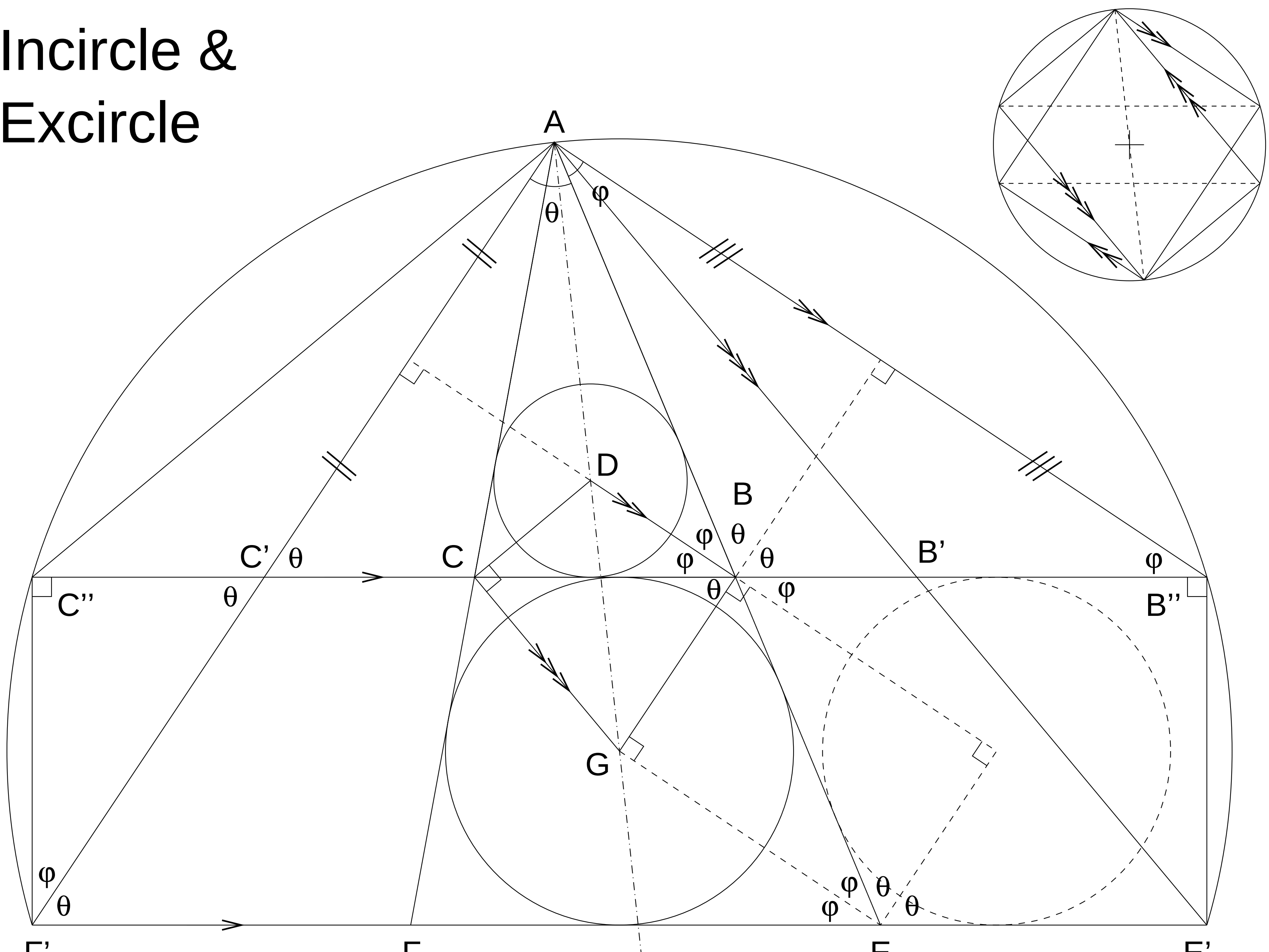
The construction of the figure from the triangle ABC is quite simple. The line BC is extended so that the length A to B′ equals A to C, and B to B″ equals A to B. The points C′ and C″ are similarly located. The incircles and excircles are constructed, and the line through E and F is tangential to the excircle and parallel to BC. The points E, F, E′ and F′ are found from intersections. The angle CBD is φ, and θ is its complementary angle. All other angles (and parallel-line relationships) follow by geometrical principles. Proving that the lines C″ to B″ and B″ to E′ are perpendicular is the most difficult step. One means is to use the inset figure. This is the quadrilateral BDCG with a circle constructed on diameter DG. A copy is made of the quadrilateral, rotated through 180 degrees.

Drawing this figure in XFig required painstaking effort. The whole design is based on Pythagorean triples, in order that every labelled point except for F be on a grid point. The line to F and some of the inset elements are constructed using scaling and rotation. Once Adage is developed, it will be fun to redraw the figure and experiment by moving point A around relative to B and C.

Full-page figure on next page

FIGURE 1. *The relative sizes of the incircle and excircle.* Starting with the triangle ABC construct the incircle and an excircle. The rest of the drawing illustrates interrelationships between lines and points of intersection. *Creation method: XFig, ps output. Category: .*

Incircle & Excircle



2.2. **Basics: Drawing construction.** This figure illustrates some features of the Adage system for drawing. It complements the geometric construction shown in the preceding section. In this case we consider a drawing element that might be used as a node in a connected drawing: a NAND gate for electronic schematics. NAND gates can be used in slightly different ways (A in the figure), depending on the number of inputs. The underlying macro (B) is the same, and we have chosen a typical set of defining parameters, namely the output point, the orientation angle and the gate-size length. These values (rounded rectangles) are inputs to the *create NAND gate* action (ordinary rectangle).

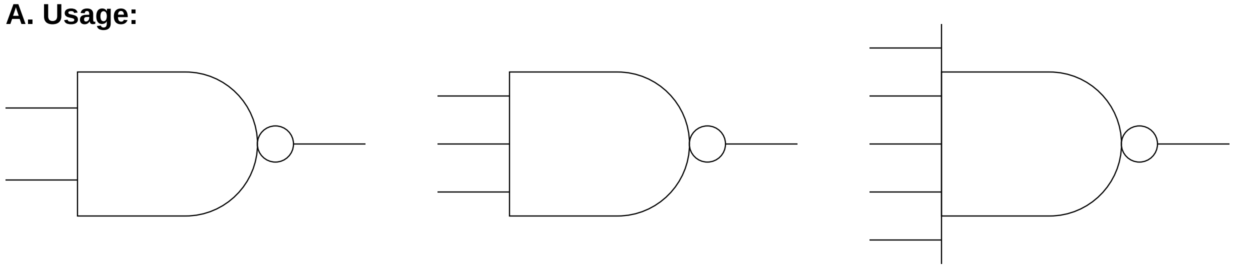
The process of creating such a macro might be elaborate, but Adage is designed so that this can be done in the interactive program. We create a standardized form of the gate (C). This might be done using a 4-point polyline, a 3-pt circular arc, and a circle. These would then be grouped as a set. In order to convert this into a drawing-element macro, we would specify that the six points and the six numerical values are constants built in to the macro rather than inputs. The general NAND gate is then (D) created from the standardized NAND (an object) by applying resizing, rotation and translation transformations.

This framework of a standardized constant object transformed by parameters is very common. Therefore templates are provided along with an inheritance mechanism to make this straightforward.

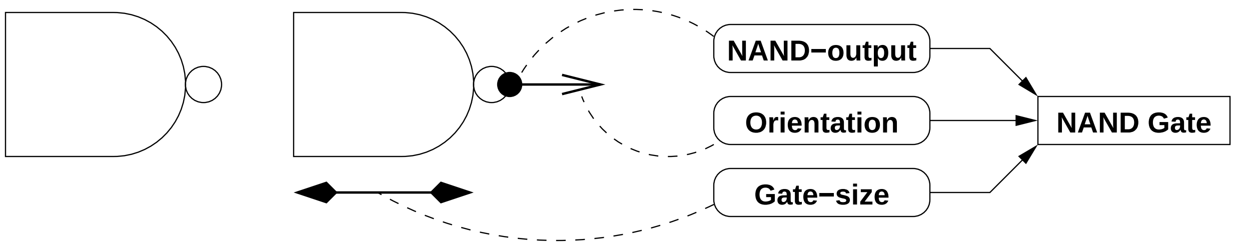
Full-page figure on next page

FIGURE 2. *A NAND Gate.* The electronic schematic NAND gate element (A), and a possible parameterisation (B), and implementation (C and D). *Creation method: XFig, ps output. Category: .*

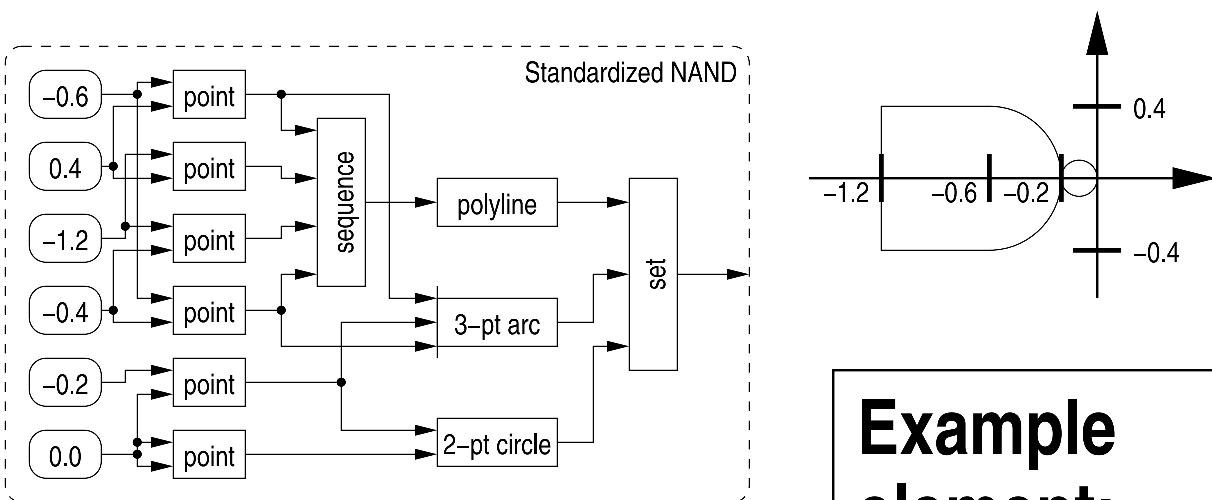
A. Usage:



B. Macro:

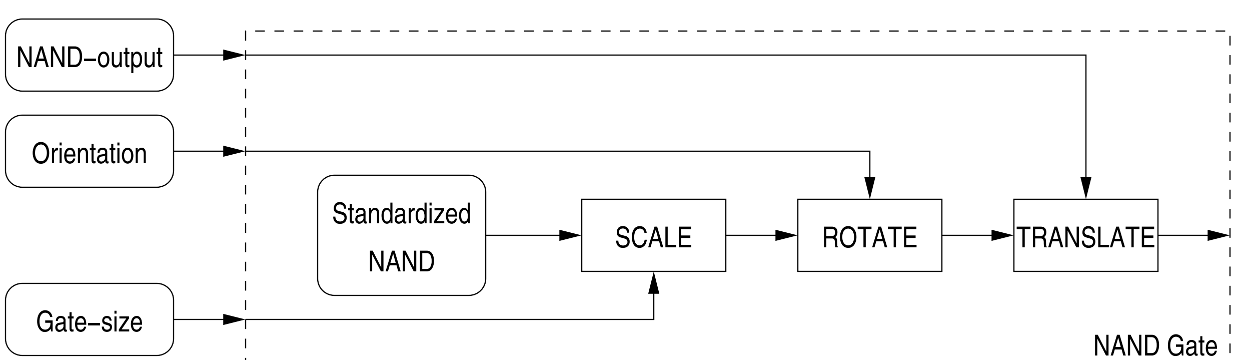


C. Standardized:



Example element: NAND Gate

D. SRT Transformation:



3. Connected nodes

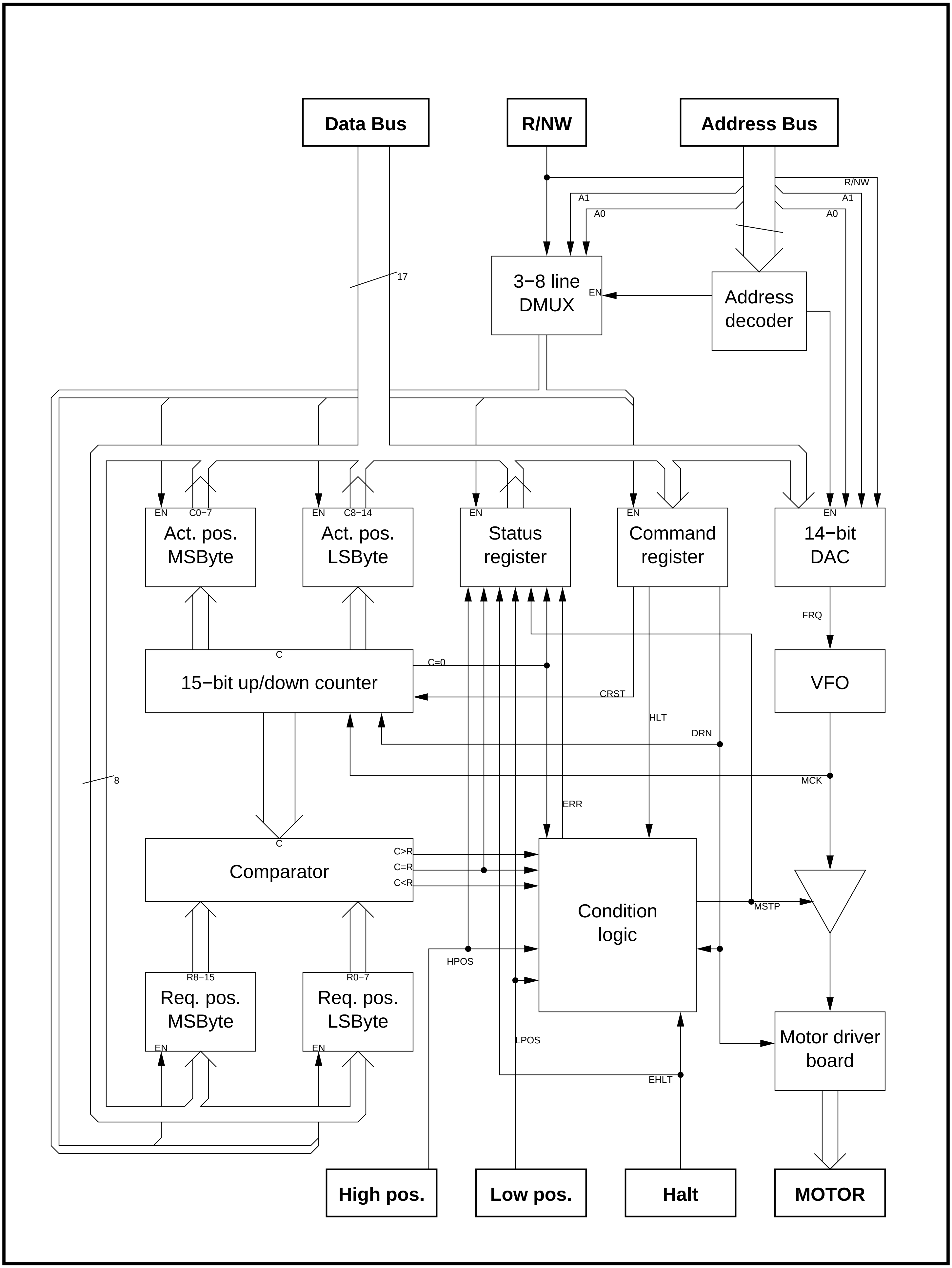
A wide variety of drawings are in structure a set of nodes and connections. Some examples are:

- Family trees, or genealogies; phylogenetic trees;
- Software flow diagrams;
- Software call graphs;
- State diagrams;
- Dependency graphs;
- Hierarchies, reporting structures and organisation charts;
- Electrical and electronic schematics;
- Pneumatic and hydraulic schematics;
- Communication network diagrams.

3.1. **Connected nodes: Flow charts.** This is an example of a system diagram with internal function blocks, connections that carry signals, and links to external signals and devices. It is slightly more elaborate than a software flow chart in which the flow is typically sequential.

Full-page figure on next page

FIGURE 3. *Controller System.* Diagram of the controller of a robotic positioning system. *Creation method: XFig, ps output. Category: .*



Data Bus
R/NW
Address Bus
R/NW
A1
A0
A1
A0
17
3−8 line DMUX
EN
Address decoder
EN
C0−7
Act. pos. MSByte
EN
C8−14
Act. pos. LSByte
EN
Status register
EN
Command register
EN
14−bit DAC
FRQ
VFO
C
C=0
15−bit up/down counter
CRST
HLT
DRN
8
MCK
ERR
C
Comparator
C>R
C=R
C<R
Condition logic
MSTP
HPOS
R8−15
Req. pos. MSByte
EN
R0−7
Req. pos. LSByte
EN
LPOS
EHLT
Motor driver board
High pos.
Low pos.
Halt
MOTOR

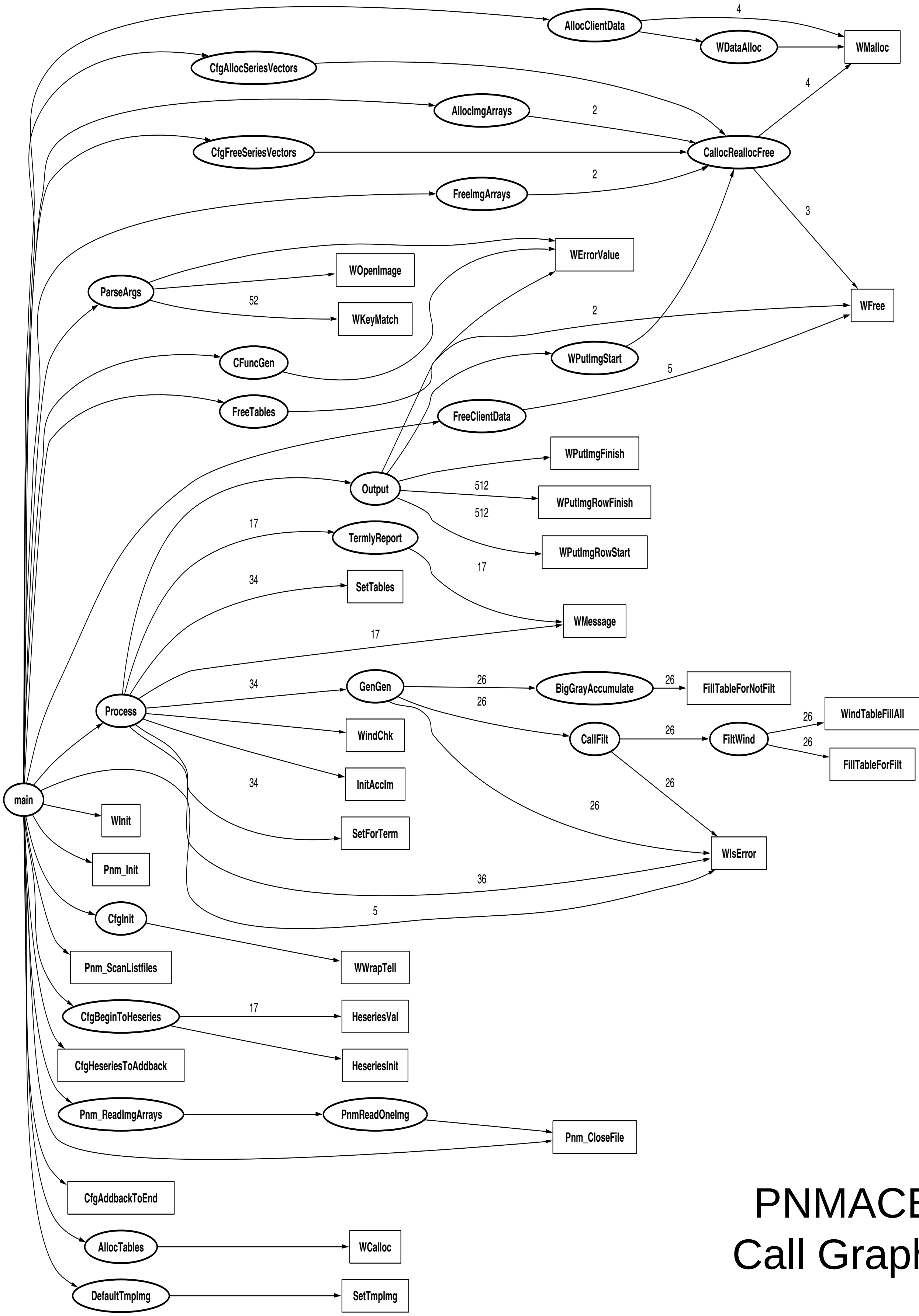
3.2. **Connected nodes: Nodal graphs.** This is a detailed call graph. In contrast with the controller example, which was edited in an interactive drawing package, this was automatically generated by running a profiler on a program, and then processing the results in a package for visualising graphs.

Note that in this case 'graph' has the specific meaning of nodes connected by edges.

This example also makes a distinction between interactive drawings and the use of the Adage system as a library for generating output. It is important to remember that it is not an aim of the project to create such a drawing from scratch. The Adage system would render the drawing, but the task of laying out the elements is separate.

Full-page figure on next page

FIGURE 4. *Call Graph.* The procedural call graph of the *pnmace* program. Numbered edges indicate calls that were made more than once. *Creation method: gprof and Graphviz dot programs, ps output. Category: .*



PNMACE
Call Graph

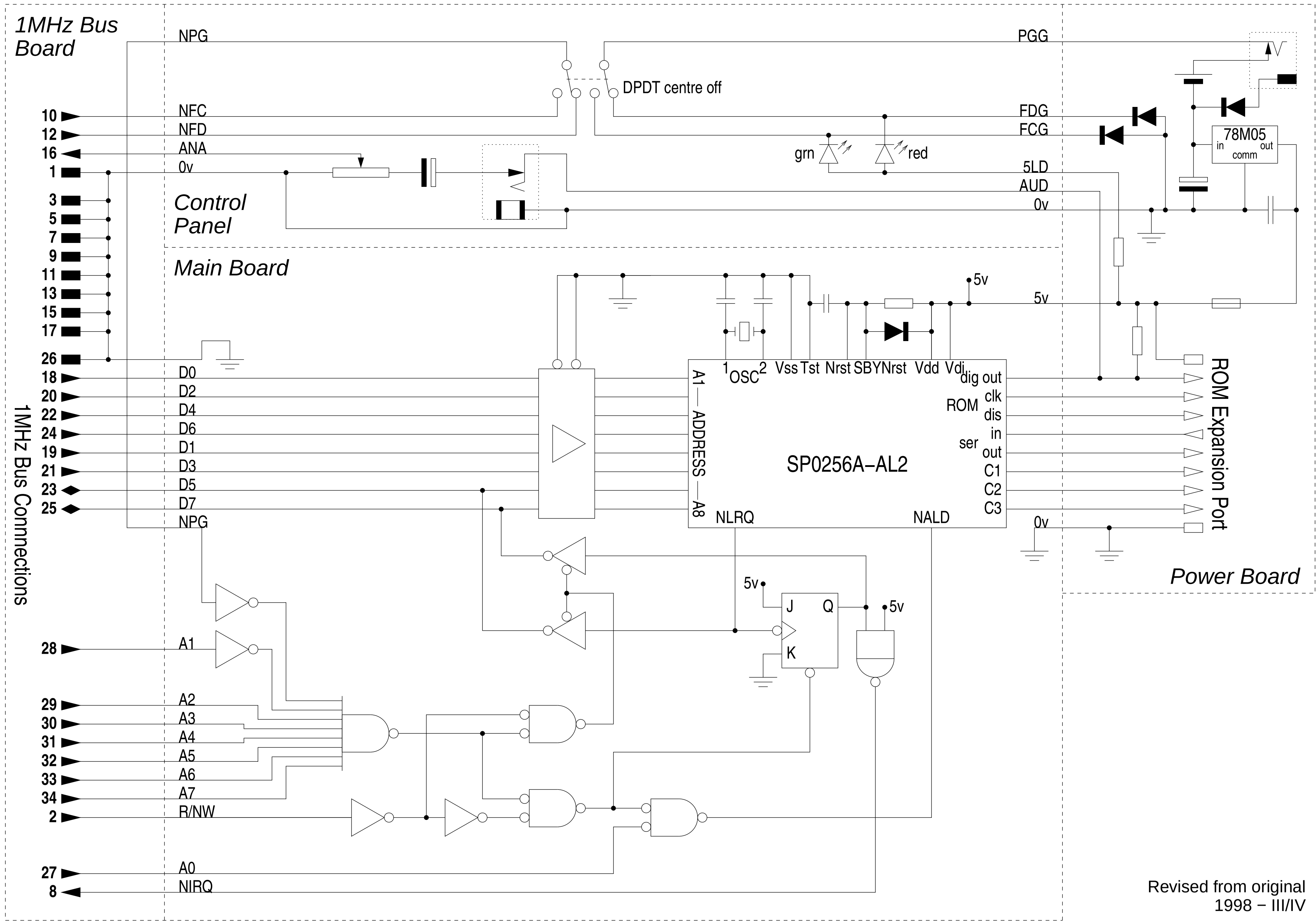
3.3. **Connected nodes: Schematic diagrams.** Circuit diagrams and schematics have a richer variety of node types than other drawing of connected nodes. This example includes a representative range of digital and analogue components, both integrated and discrete.

The circuit comes from a system that the author designed and built in high school. (Desktop computers were only just beginning to be able to handle the computational requirements of speech synthesis at that time.) The original was drawn by hand. Drawing in XFig was not much easier, adding the flexibility of rearranging elements, but making text placement tedious.

Full-page figure on next page

FIGURE 5. *Speech Synthesis System.* Circuit diagram of a speech system. This comprised a speech synthesis IC, an interface to the 1MHz bus of a BBC Microcomputer, power regulation and audio analogue output. *Creation method: XFig, ps output. Category: .*

Speech Synthesis System



Revised from original
1998 – III/IV

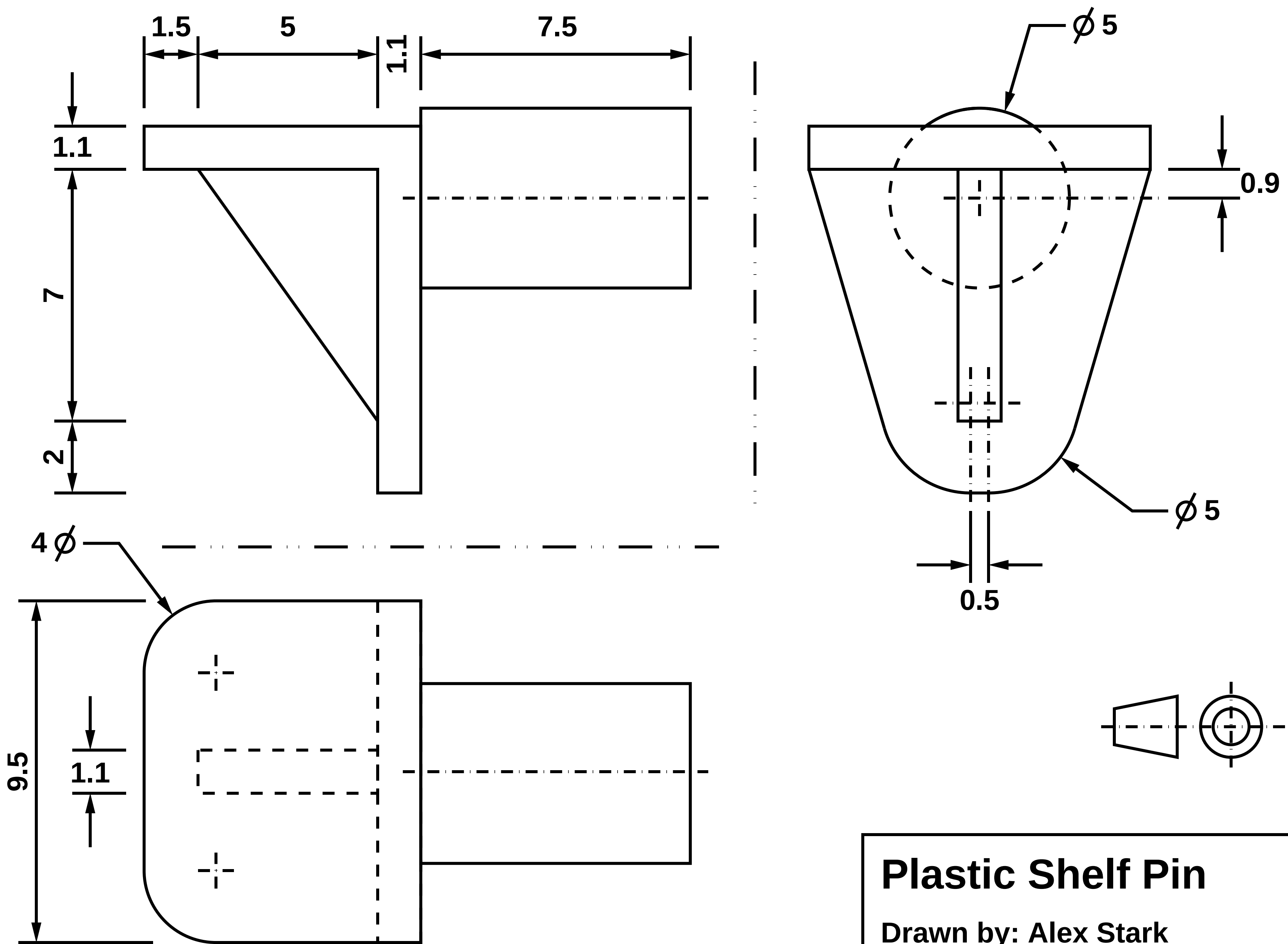
4. Representing reality

Whereas drawings of connected nodes depict logical and functional relationships, and plots illustrate features of data and functions, the drawings in this category are a literal representation of reality. Reality gets complicated, and so these drawings can be very intricate. We consider two subdivisions. First there are representations of objects that are manufactured for functional or aesthetic purposes. Second, there are larger-scale drawings of buildings and land, urban plans, and maps.

4.1. **Representing reality: Drafting.** This is a simple engineering drawing in first angle projection of a plastic shelf pin. These are a version of pins used in adjustable bookshelves. It is not fantastic professional example. The near-term aims of Adage do not include creating a full-blown CAD system. However, provision for the level of complexity of this figure is a near-term aim.

Full-page figure on next page

FIGURE 6. *Plastic shelf pin.* First-angle orthographic projection of a (mythical but realistic) pin for adjustable shelving. *Creation method: Gnuplot & XFig, ps output. Category: .*



DO NOT SCALE. Dimensions in mm.

Plastic Shelf Pin

Drawn by: Alex Stark

Date: 2002/11/15

4.2. **Representing reality: Architectural.** The drawing for this section is not yet complete. The intention is to have a hybrid drawing showing some aspects of three types of plan: (a) a house plan; (b) the site plan; and (c) the arrangement of furniture and appliances. Although these would not normally be shown together, this is a means of illustrating a variety of features together.

Full-page figure on next page

FIGURE 7. *House and site plan.* A hybrid drawing of a the ground floor of a house, its site, and some household appliances and contents. *Creation method: XFig, ps output. Category: .*

5. Plotting and Charting

This is perhaps the most obvious classification of drawing: illustrations of data and functions. We divide this group loosely into two. One subgroup comprises plots of data that are sequential or homogeneous, the other of categorical data.

5.1. **Plotting and charting: 2-D function plotting.** This example shows a pair of associated function plots. These illustrate the second-order response of a harmonic or control system. The response equation is

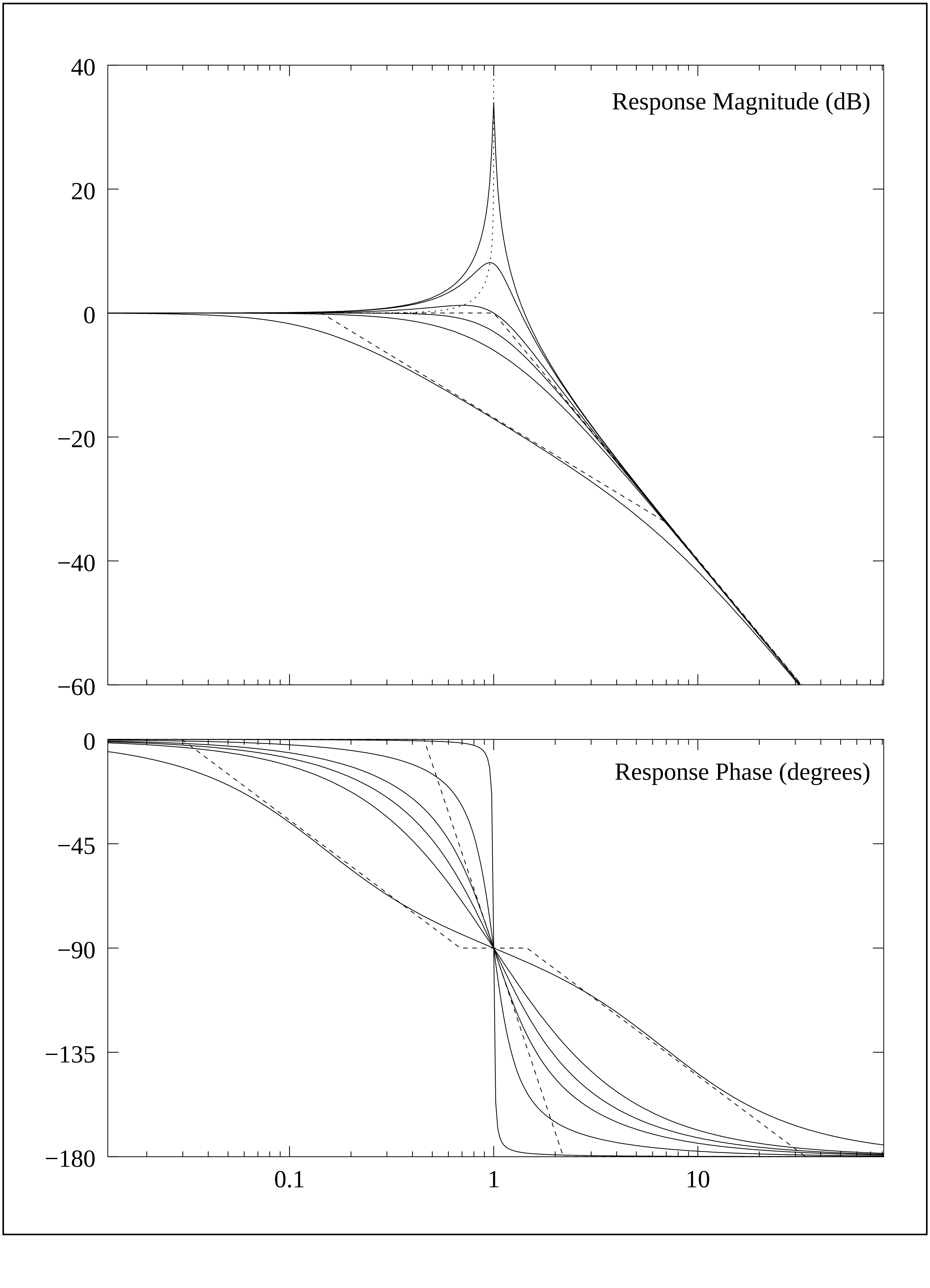
$$F_c(s) = \frac{\omega_n^2}{s^2 + 2c\omega_n s + \omega_n^2} \tag{1}$$

The plots are the magnitude and phase of this function against ω where $s = j\omega$ and the function is normalised with $\omega_n = 1$.

The six curves are for damping factors, c, of 0.01, 0.2, 0.5, $1/\sqrt{2}$, 1, and 25/7. The asymptotes and tangents are shown for $c = 0.5$ and $c = 25/7$. In the latter overdamped case the magnitude response is close to the asymptotes, the phase response is not close to the tangents. When overdamped, a second-order system is essentially a combination of two separate first-order systems.

Full-page figure on next page

Figure 8. *Second-order response curves.* The magnitude and phase response of a system for the damping factors 0.01, 0.2, 0.5, $1/\sqrt{2}$, 1, and 25/7. *Creation method: Octave, Gnuplot, XFig, ps output. Category: .*



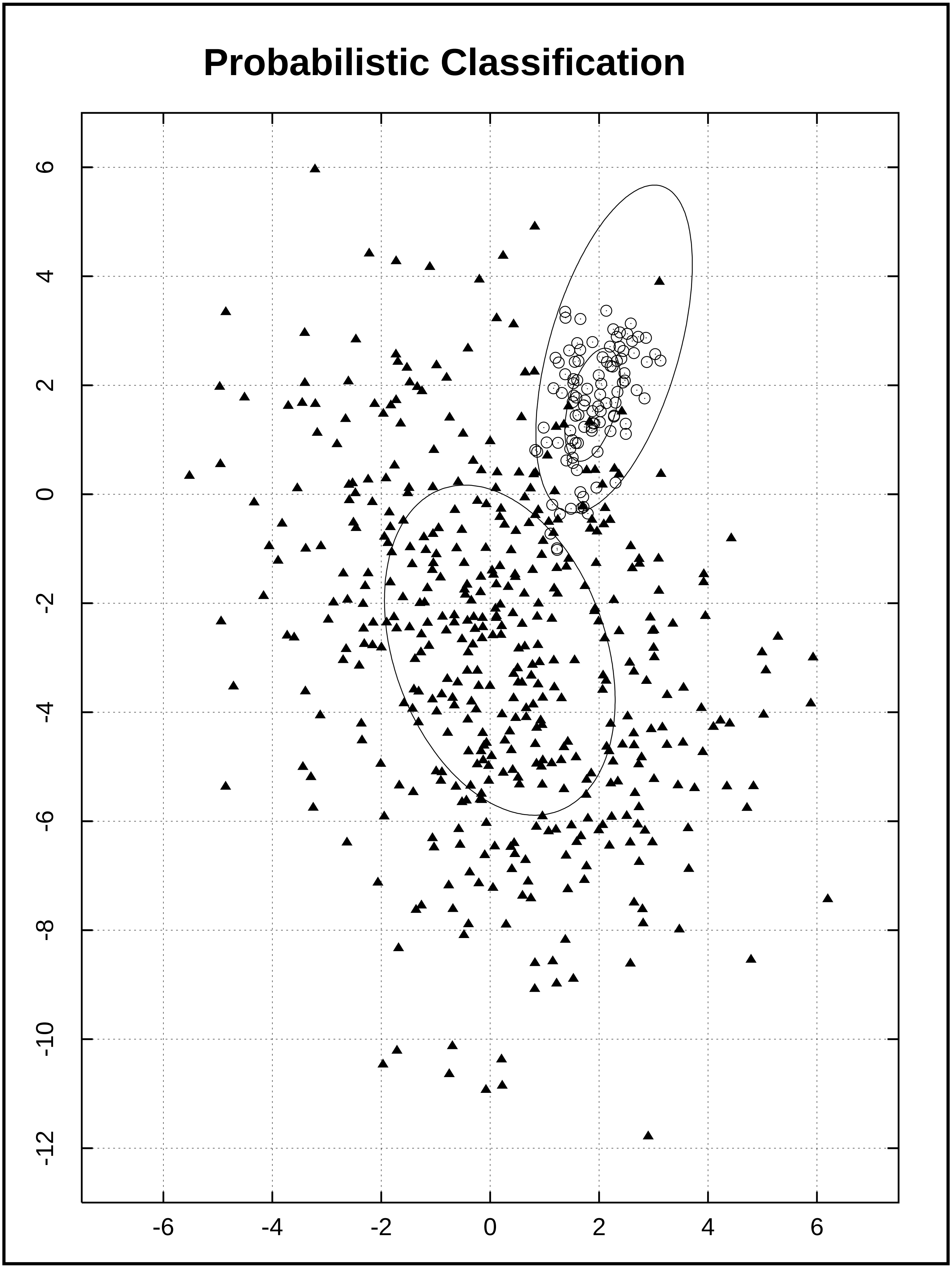
Response Magnitude (dB)
40
20
0
−20
−40
−60
Response Phase (degrees)
0
−45
−90
−135
−180
0.1
1
10

5.2. **Plotting and charting: 2-D statistical plotting.** Statistical plots have a lot of variety. Here we illustrate a fairly simple classification problem.

The idea is that we are given a set of training data in 2 classes and with 2 observed (or feature) variables. We assume that the measurements are bivariate Gaussian (normal) distributions in each case, but that the parameters are different in each case. The plot shows simulated data, and 2 of the ellipses indicate the mean, variance and covariance estimated separately for the 2 classes. Based on this a third ellipse has been drawn that passes between the others. A Bayesian interpretation is most straightforward. Using as prior probabilities the relative frequencies of classes in the training set, measurements on this ellipse have equal posterior probability of being in each of the 2 classes. For all other measurements, one class has a higher probability than the other.

Full-page figure on next page

FIGURE 9. *Bivariate 2-class classification.* Training data points are shown, along with indicators of their distribution. The ellipse passing between the others divides the space of observation values for which each class has a higher posterior probability than the other. *Creation method: Octave, eps output, with title and border added in XFig, ps output. Category: .*


Probabilistic Classification
6
4
2
0
-2
-4
-6
-8
-10
-12
-6
-4
-2
0
2
4
6

5.3. **Plotting and charting: Data charts and plots.** This example is composed of three illustrations of drawing types used to convey business and economic information. The pie chart is standard. Note that under our definition the graph of frequency over time is a *plot* whereas the graph of frequency by price is a *chart*. The first incorporates a histogram. This has two axes, one being the interval scale time. The second is a bar chart which represents categorical data and has distinct bars.

Even though one can draw formal distinctions between these drawings, they are typical of illustrations designed to convey a limited amount of information with clarity and impact.

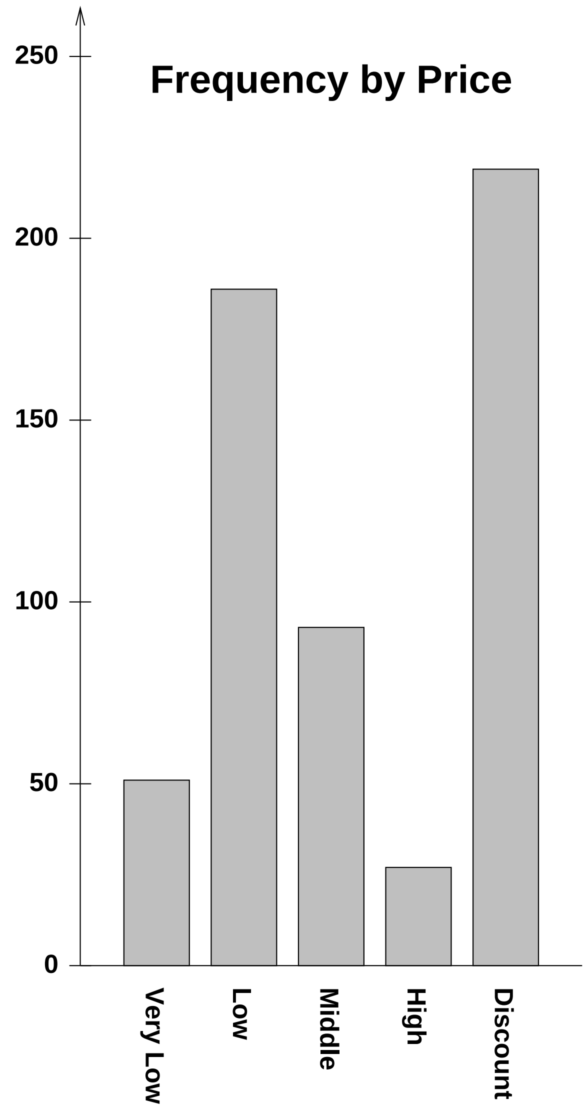
Although fictitious, the author's (JAS's) CD buying habits are reflected somewhat in this data. Naxos continues to expand its range of high-quality classical music at attractive prices, in contrast to most other labels. Most CDs normally at premium prices were only affordable at club ('discount') rates. This is not intended to be a product endorsement, but rather a criticism of other labels.

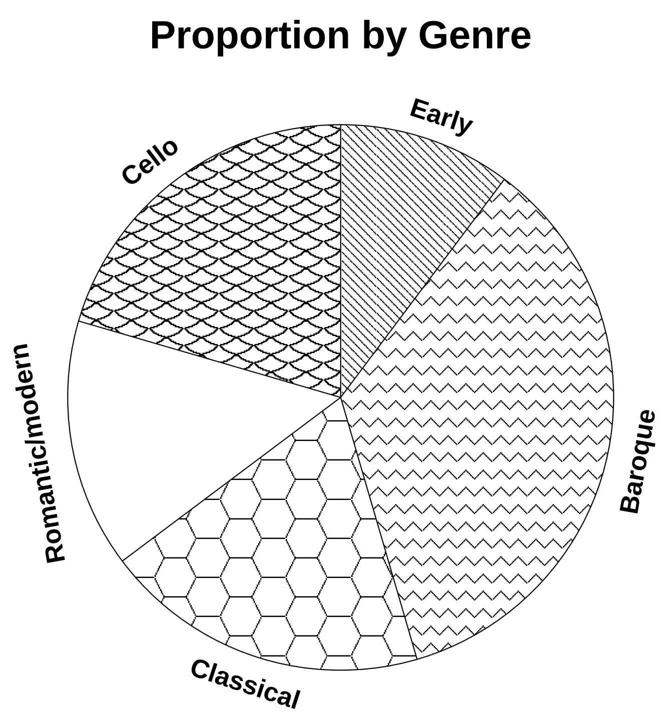
Full-page figure on next page

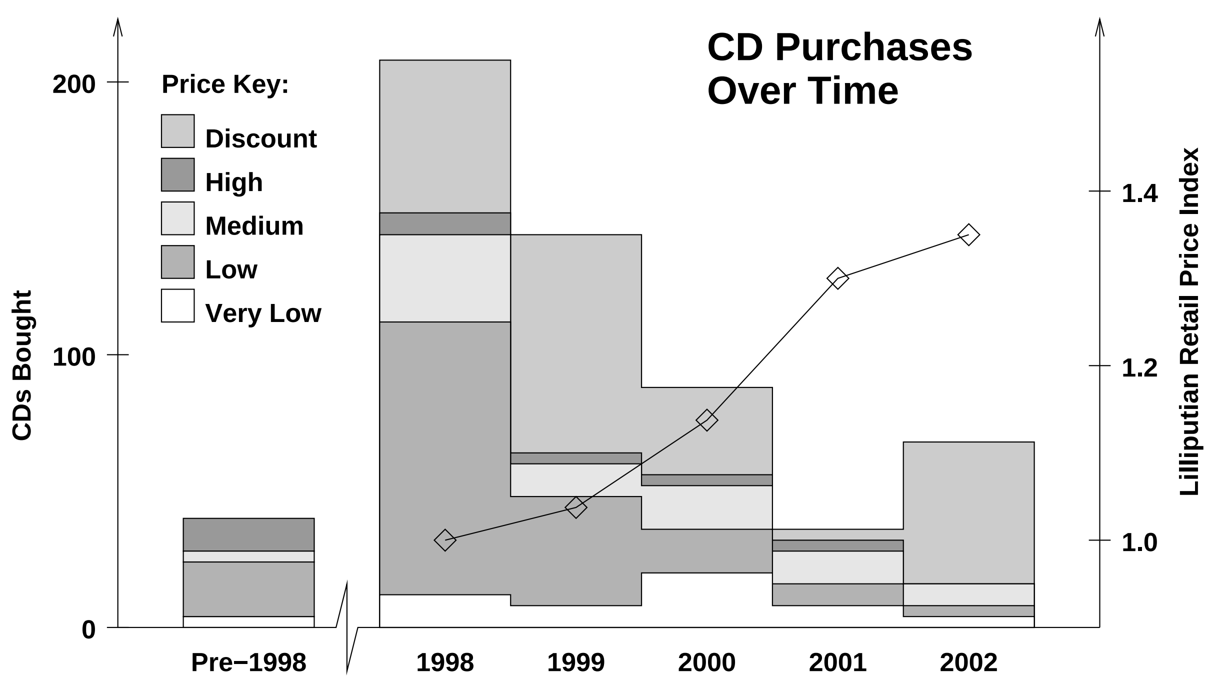
FIGURE 10. *Presentation charts and plots.* Illustrations of fictitious CD buying habits. *Creation method: XFig, ps output. Category: .*

CD Purchasing Habits

Falsified by
J Alex Stark







5.4. **Plotting and charting: The virtual oscilloscope.** To many readers this may seem a rather minor use of a drawing program. However, the author (JAS) has found the tools for signal processing to be lacking. Application areas for signal display include communications, audio and biomedical systems.

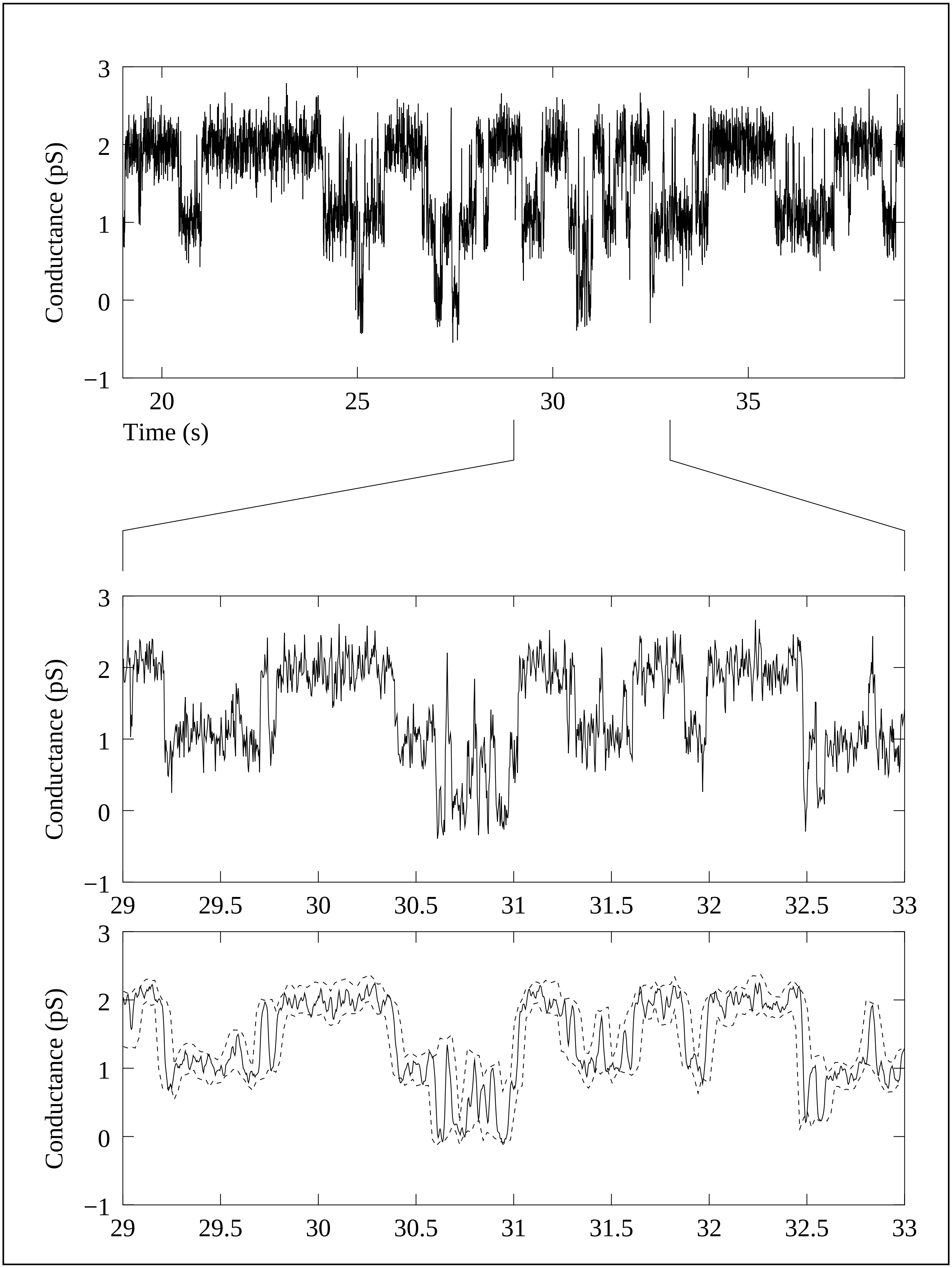
This example illustrates two features that are not generally supported in a signal display:

- The display of two selections together. In this case a zoomed segment is shown below another.
- The display of a processed segment or an analysis of a segment along side the original signal.

In addition to these features, one application of the Adage system might be a dynamic oscilloscope-type signal viewer. This would be able to produce the same kind of display but allow the user to scroll through interactively.

Full-page figure on next page

FIGURE 11. *Patch-clamp record.* A simulated signal with two C-O-C ion channels. The middle plot is a segment of the upper signal, and the lower plot shows a smoothed signal and indication of the envelope. *Creation method: Octave, Gnuplot & XFig, ps output. Category: .*



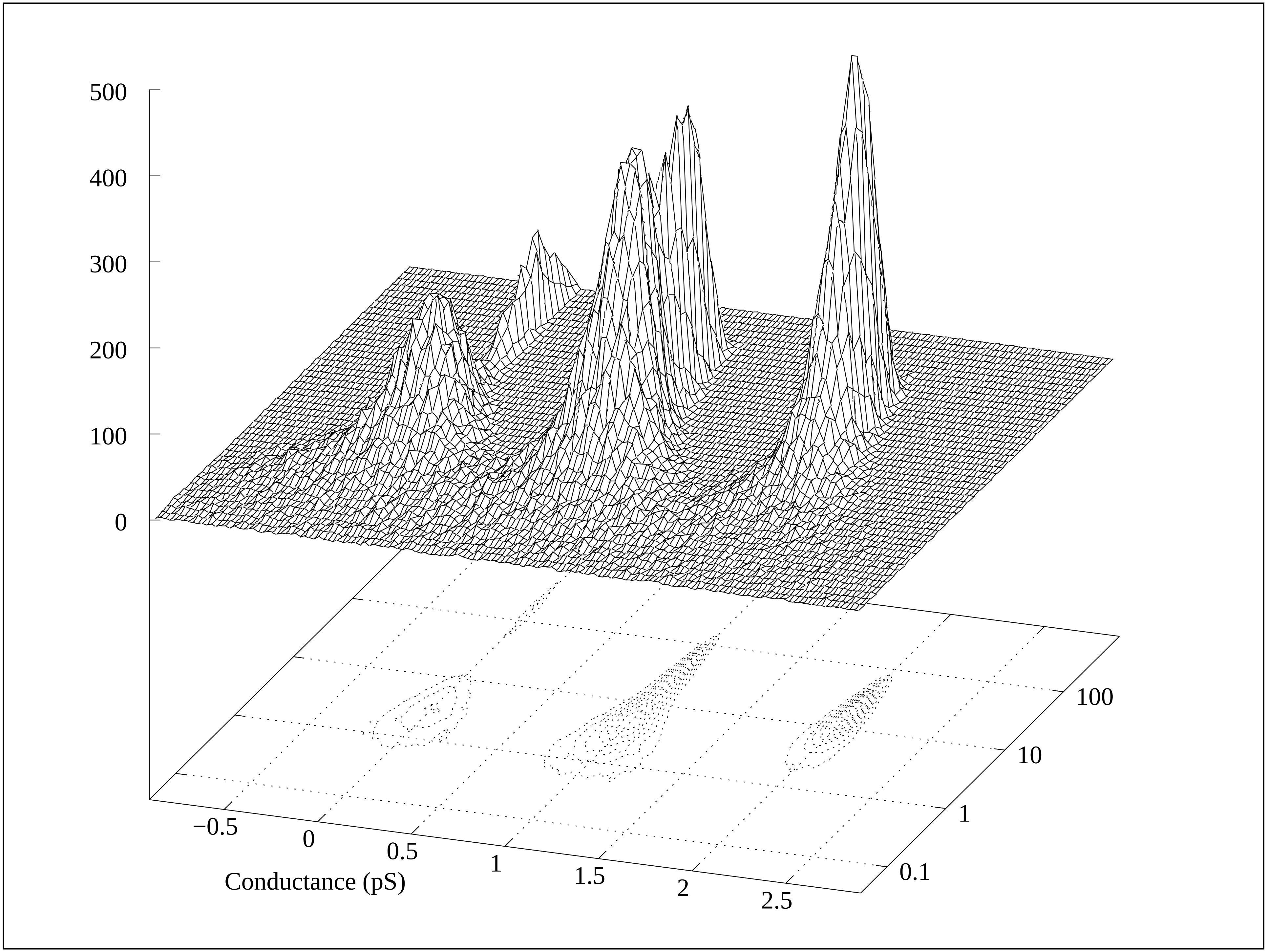
Conductance (pS)
Time (s)
3
2
1
0
−1
20
25
30
35
29
29.5
30
30.5
31
31.5
32
32.5
33

5.5. **Plotting and charting: 3-D plotting.** This plot shows the frequency with which a simulated ion channel signal had segments with different conductances and durations. It is largely self-explanatory. It is not yet an aim of the Adage project to implement all the processes required to generate such a plot. Adage would be used as the rendering engine for a program that can generate the contours from multidimensional data. Nevertheless, this could become part of the project.

The contours are plotted in an inappropriate dotted line because Gnuplot is incapable of producing anything better. A *waterfall* plot might have been preferred, but Gnuplot is also inadequate in this regard. A waterfall plot is like a mesh plot but with connecting lines in only one direction. Instead of looking like a deformed grid, it is like a deformed striped carpet.

Full-page figure on next page

FIGURE 12. *Histogram against durations and conductances.* The plot is of the frequency with which segments of a simulated ion channel signal had specific ranges of conductances and durations. *Creation method: Octave, Gnuplot & XFig, ps output. Category: .*



500
400
300
200
100
0
−0.5
0
0.5
1
1.5
2
2.5
Conductance (pS)
0.1
1
10
100