Curve Fitting and Editing via Interactive Graphics

ARTHUR S. PRIVER and BARRY W. BOEHM

The RAND Corporation, Santa Monica, California

The system described here allows a user to enter a curve into an IBM 360/40 computer via a RAND tablet [1], and interactively to specify various ways of fitting, editing and displaying the curve on an IBM 2250 scope (see Fig. 1). It was developed primarily as a tool to extend the analysis of multivariate function representation (described by Boehm [2]) from tabular methods to polynomial methods. We decided to use an interactive graphics approach for three main reasons:

1.   Experience has shown that much time is spent visually editing curves for input errors; this used to be done on an SC-4020 with one-day turn-around.

2.   We wanted to experiment rapidly with choice of form, as multivariate functions are hard to classify in terms of representability.

3.   The facility was available, along with a basic software support package.

The system consists of a number of interconnected "pages" on the IBM 2250 (see Fig. 2), by which the user can:

1.   enter curves by tracing them onto the tablet,
2.   least-squares smooth the data points in various ways;
3.   consider various subsets of the data points;
4.   add, move, or delete individual data points via the tablet stylus;
5.   fit data points by splines or least-squares polynomials of specified degree (space curves are currently handled as parameterized pairs), and
6.   comparatively display spline and least-squares fits; and
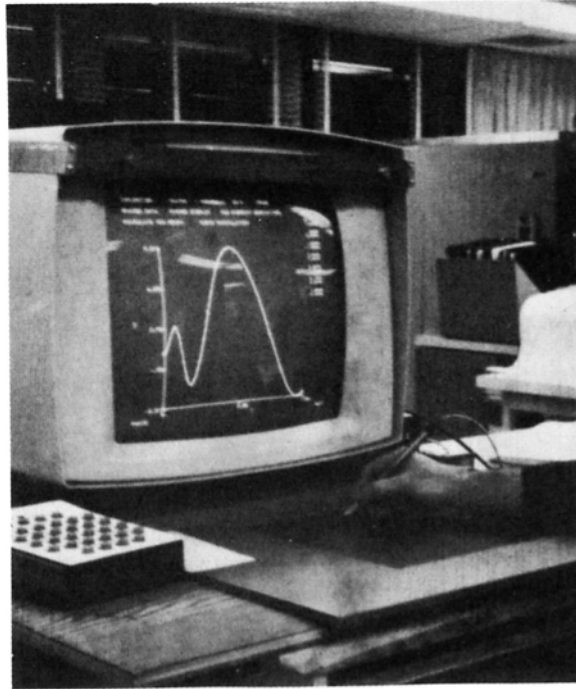7.   punch cards with data points or coefficients.
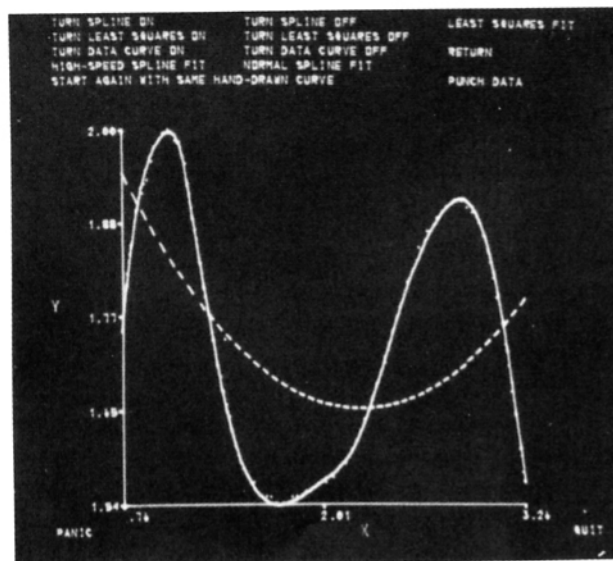
FIG. 1. User with RAND tablet and display.

FIG. 2. Sample curve-fitting page on CRT scope.

Control is exclusively via Tablet stylus, using software-sensitized areas for pointing, and Groner's character recognition program [3] for alphanumeric inputs.

Development experience confirms the need for higher-level graphic tool-building tools, particularly an ability to compose control displays at the scope[1] and an interpretive mode for incremental compiling and higher-level debugging. User experience, indicates the need for more built-in self-extension capability (e.g., letting the user compose a piecewise least-squares technique or a different data subset specification). However, given enough options, an ingenious user can often approximate desired options (e.g., performing weighted or constrained least-squares fits by adding extra points) well enough to satisfy his exploratory needs.

[1] With Vivian R. Lamb, Robert L. Mobley, and John E. Rieber, we have now developed such a capability within a higher-level graphics package called POGO (Programmer-Oriented Graphics Operation).

REFERENCES

1. DAVIS, M. R., and ELLIS, T. O., The RAND Tablet: A Man-Machine Graphical Communication Device, The RAND Corporation, RM-4122-ARPA, August 1964.
2. BOEHM, B. W., Tabular Representations of Multivariate Functions—With Applications to Topographic Modeling, The RAND Corporation, RM-4636-PR, February 1967. (Also in Proc. ACM Natl. Conf., 1967, Washington, D.C., pp. 404–415. Thompson Books, Washington, D.C., 1968.)
3. GRONER, G. F., Real-Time Recognition of Handprinted Text, The RAND Corporation, RM-5016-ARPA, October 1966. (Also in Proc. Fall Joint Comput. Conf. 29, 599–602 (1966). Spartan Books, Washington, D.C., 1966.)