Demos

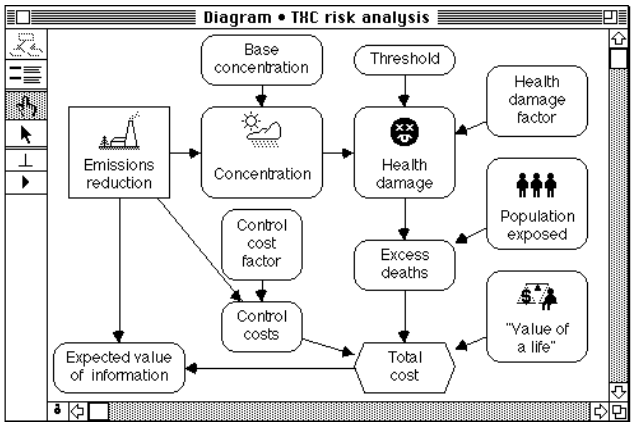
Decision Modeling System

Modeling for insight

Why do you use quantitative models? To generate numbers, of course – but the real goal is to generate insights:

- ❑ Which options are the real contenders?
- ❑ How uncertain are we about the outcomes?
- ❑ Which uncertainties are critical? And which can we ignore?
- ❑ Do disagreements among the experts make a difference?
- ❑ How much would assumptions have to change to influence the recommended decision?
- ❑ What new information would be most valuable?
- ❑ How can we simplify the model? Where would more detail help most?

Demos is a Macintosh-based, graphical environment for creating, analyzing, and communicating probabilistic models for risk and policy analysis. **Demos** is designed specifically to provide these kinds of insights, as quickly and effectively as possible. It represents a new paradigm in modeling software, recognizing that the goal of modeling is to generate clarity as a basis for effective action. Modeling is almost always a group activity, involving analysts, experts, reviewers, and decision makers. **Demos** is designed to support communication among the group, to help people to develop a shared understanding of the problem.



"*The purpose of computing is insight, not numbers*"
Richard Hamming

Problems with conventional tools

Standard modeling tools, such as spreadsheets and simulation languages, often hinder insight generation and communication. Typical complaints include:

- ❑ Model organization is obscure
- ❑ Debugging and verification is time consuming
- ❑ Sensitivity analysis is awkward
- ❑ Explicit treatment of uncertainty is difficult or impossible
- ❑ Model scope and dimensions are restricted
- ❑ Model documentation is confusing and inconsistent
- ❑ Models are difficult to update and extend
- ❑ Models are not trusted; despite vast resources invested, they have little influence on decision making.

If you find these problems depressingly familiar, **Demos** may be the tool you need.

Sample applications of Demos

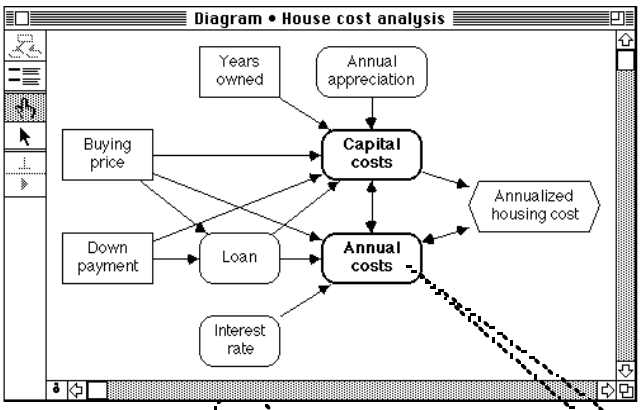
Demos has been used for risk analysis, decision analysis, technology assessment, economic analysis, and strategic planning. It has been used in industry, consulting companies, government agencies and research laboratories, and universities. There are Demos users on four continents. Application domains have included energy, environment, health, business, medicine, aerospace, and telecommunications; examples are:

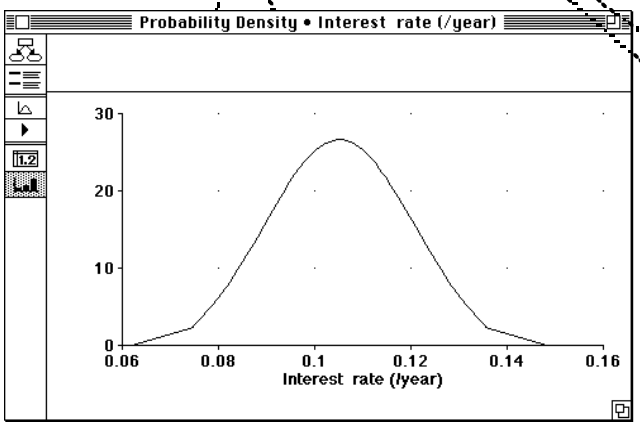
- ❑ Analysis of energy efficiency of office automation and the paperless office.
- ❑ Studies of automobile safety: comparison of seat belts and air bags
- ❑ The Atmospheric Deposition Analysis Model (ADAM) to examine effects and costs of acid rain and mitigation strategies
- ❑ A tool for power utilities to analyze the cost-effectiveness of pollution-control technologies for fossil-fuel power plants
- ❑ Economic analysis of fiber-optics telecommunications links to homes and offices
- ❑ Reliability and lifecycle cost analysis for the National Aerospace Plane (NASP)
- ❑ Design and cost analysis for the NASA Space Station
- ❑ Exploring the effects of global climate change due to emissions of radiatively important trace substances (RITS), such as CO2 and other “greenhouse” gases.

Demos

Influence diagrams

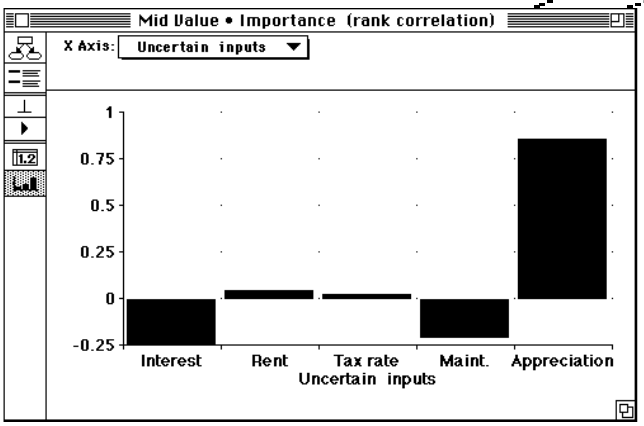
This representation provides a natural perspicu
view of the model structure. An influence diagr
indicates the types of quantities by node shape -
decisions, uncertain variables, objectives, and s
and their dependencies by arrows. The essential
qualitative structure is unobscured by mathema
details.





Uncertainty

You can express uncertainty about any value as
probability distribution. You can use either a
standard distribution – such as uniform, normal,
lognormal – or you can specify a tailored, discre
continuous distribution. Uncertainties are
propagated automatically through the model
whenever needed to generate the correspondin
uncertainties on the outputs.



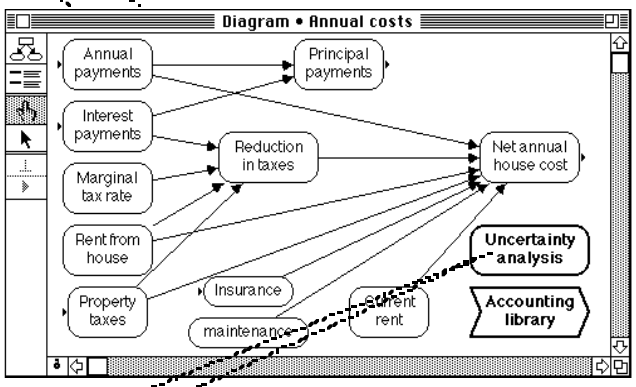
Hierarchical models

Unlike other influence diagram softwa**Demos**lets
you create a hierarchy of models. You can orgar
large model into many manageable submodels,
with its own influence diagram. Just click on a s
model node to see its detailed structure.

Hypertext

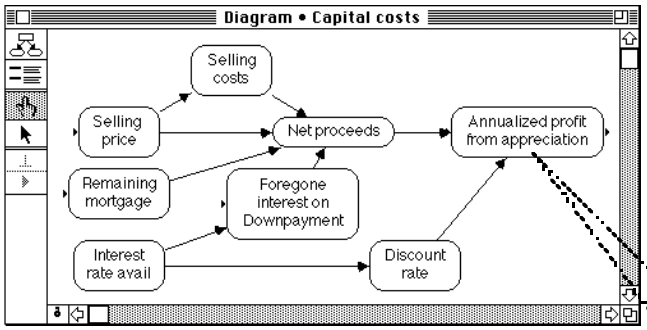
Effective modeling requires lucid communicatio
among analysts, experts, reviewers, and decisio
makers. A**Demos**model is a hypertext and graph
document that you can sc
in

Hierarchical
influence diagrams are an
excellent representation for communi-
cating model stucture. Graphs powerfully conv
the behavior, uncertainties, and sensitivities of a
model.



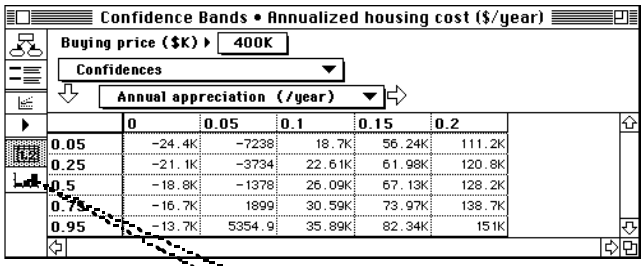
Uncertainty analysis

To help you identify which uncertainties are mo
important,**Demos**provides a variety of powerful
techniques for uncertainty analysis. For examp
rank-order correlation tells you the importance
each uncertain input variable in terms of the
variable's contribution to the uncertainty in the
results. This technique gives reliable results ev
with highly non-linear models with skewed
distributions, where the conventional technique
error analysis or one-at-a-time perturbations ca
misleading. Frequently, just a few uncertainties
this case, the rates of appreciation and interest)
dominate the rest.



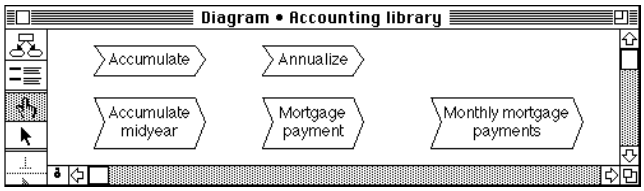
Multidimensional arrays

You may need to model variations over several dimensions – time periods, geographic locations, decision options, future scenarios, budget categ organizational units, or types of people. Whereas spreadsheets restrict you to one or two dimensio **Demos** variables can have as many dimensions as you need.



Smart arrays

The table viewer and grapher let you create and display multidimensional arrays, flexibly selecting the dimensions and projection to give the clearest view. **Demos** lets you specify operations on an array in a singl expression, unlike a spreadsheet, which requires separate expression for every cell in the array. S **Demos**, it's easy to change the size and number o dimensions as you refine the model to find the be level of detail or aggregation. Arrays generalize automatically with minimal effort on your part. power of **Demos** modeling language for handling multiple dimensions is part of what makes it an "industrial strength" modeling environment.

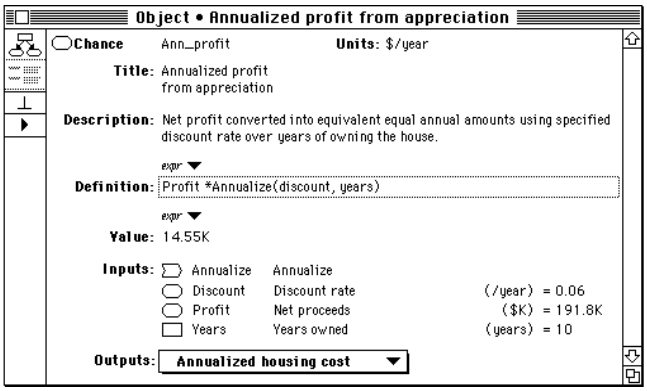


Libraries

You can define new functions and so extend the modeling language to address new classes of problems. This libary contains functions for computing mortgages.

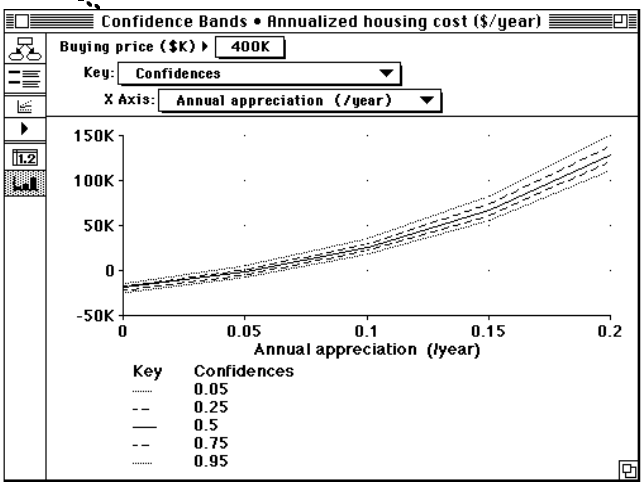
Integrated explanation

Each variable or sub-model includes text that ex what it represents, and on what assumptions it i based. This text is integrated into the computer representation, along with the mathematical definition used to compute each variable. The integration of model and documentation greatly facilitates sharing models with colleagues for collaborative model development and review.



Parametric analysis

To elucidate the model sensitivity to key uncerta inputs you can graph the effect on an outcome c changing one or more inputs over their ranges. can use this technique to discover tradeoffs and switchover points where the best option change Below we examine the effect on net housing cos changing the appreciation rate from 0 to 15%/y given buying price is $400,000. The probabilisti uncertainty is represented by 50% and 90% confidence bands about the median values.



Lumina

Decision Systems

Rapid computation with Demos

To propagate probabilistic values, **Demos** uses Latin hypercube sampling (LHS), an efficient variant of Monte Carlo simulation. The computer time needed for sampling is directly proportional to the model size, making this approach practical for models with thousands of uncertain variables, which standard decision-tree and discrete influence-diagram algorithms cannot handle. **Demos**' technique of *parallel propagation* also makes the system substantially faster than other LHS programs. **Demos** performs *lazy evaluation*, calculating values only when they are needed, and then storing them for reuse. This strategy minimizes computation and maximizes speed for interactive model exploration.

Rapid modeling with Demos

Much as you may appreciate rapid computation, the speed with which you can create models is usually more critical. If you are like most modelers, you spend much more time constructing, debugging, and refining models, and formatting results, than you do waiting for computations. **Demos**' hierarchical influence diagrams, interactive browser, flexible array language, and powerful graphics let you build, debug, and refine models, and generate useful results, far more rapidly than you can with conventional tools.

Creation of end-user applications

You can use **Demos** to build a model for a generic problem of interest to a class of end users. One example is a tool for power utilities to analyze the cost-effectivess of pollution-control technologies for fossil-fuel power plants. Another is a tool for commercial realtors to help their clients evaluate prospective investment property. The end user simply fills in fields to characterize the particular situation, and **Demos** provides customized results. **Demos** has special facilities that let you build graphic interfaces for end users, using Hypercard and other tools. Decision analysts, management consultants, and policy researchers will find this mode of use especially valuable. You can use **Demos** to rapidly construct a modeling tool tailored to the needs and interests of your clients.

"*As far as the laws of mathematics refer to reality, they are not certain;*
as far as they are certain, they do not refer to reality"
Albert Einstein

Demos is easy to learn

The intuitive graphical interface makes **Demos** easy to learn. It uses the standard Macintosh features. You examine and evaluate a model simply by clicking on appropriate buttons. You create a model graphically as an influence diagram, by positioning nodes and drawing arrows between them. Non-programmers have learned to use **Demos** and to develop sizeable models in 2 weeks.

A guide to modeling uncertainty is available with the **Demos** software: *Uncertainty: A Guide to the Treatment of Uncertainty in Quantitative Policy and Risk Analysis*, M. Granger Morgan and Max Henrion, Cambridge University Press, New York, 1990, 332 pp.

Demos is based on 10 years of research and applications

Demos is the culmination of over a decade of research on modeling tools, uncertainty analysis, and user-interface design conducted at Carnegie Mellon University. Earlier versions of **Demos** have been in use for 10 years for research, teaching, and policy analysis in universities, government agencies, consulting firms, and industry.

Requirements

Demos runs on Macintosh computers with a minimum 1.5 Mbyte of RAM and a hard disk. It is fully compatible with System 7.

How to obtain Demos

For more information on **Demos**, including prices and availability, please contact

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