Computer-Based Training in Tree Damage Assessment

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ABSTRACT. DESTIMAS (for Tree Damage Estimation Training System) uses hypermedia technology as a user interface to access not only text and images, but also external object-oriented programs. These external programs dynamically create the desired graphics objects and carry out performance evaluation. The mode of drawing is context-sensitive, through inheritance of an argument list based on the student's browse path through the hypermedia training material. This argument list is passed to the graphics program. The browse history maintained by the hypermedia environment can be used to construct student models. Description of a range of rating systems is facilitated by the ability to construct interactive tables in hypermedia.

Computer-based training in tree damage assessment permits standardization of visual ratings. The system uses a "drill-and-practice" format in which an object-oriented tree graphics program (TREES++) generates known levels of damage in the "drill" or demonstration mode, and test patterns in the "practice" mode. Indicators of student performance are related to' features of the user interface.

Assessment of the extent of foliage loss or foliage discoloration suffered by a tree is highly subjective. It requires an observer to evaluate the observed branching pattern of the tree and estimate how much foliage the tree should have had, then estimate how much has been lost or otherwise affected. Alternatively, a highly laborious sampling approach can be used, requiring removing branches and counting damaged leaves or needles and the scars left from their removal. There can be a high degree of variability among observers' ratings if these are not calibrated. Accurate defoliation estimates are required to predict the impact of the defoliation on tree growth (Alfaro et al. 1982, Thomson and Van Sickle 1980).

Graphical standards have long been used in plant damage assessment studies. Trumbower (1934) published a photographic chart of different patterns for classifying diseased leaves. Horsfall and Barratt (1945) studied the ability of observers to detect differences in damage to individual leaves and found that below 50% damage, the eye sees the amount of diseased tissue; above 50%, the eye sees the amount of disease-free tissue. The ability to distinguish small differences in percentage is best near 0 or 100%, and poorest near 50%.

In the above examples, the scales and standards refer to damage on individual leaves or stems, and are based on proportions of an area affected by damage. However, with tree damage estimation, the reference is the three-dimensional crown, which is not a solid volume, but rather made up of leaves and branches.

Damage assessment in trees can be aided by the development of photographic guides showing different ratings (Innes 1990). When the ratings are assigned to classes such as poor, fair, or good, the appearance of a fair-crowned tree, for example, varies with species, crown class, and site (Gottschalk and MacFarlane 1992). Lee et al. (1983) applied digital image analysis techniques to photographs to estimate defoliation. Results varied with illumination and required that the tree be silhouetted against the sky.

BELOW 50% DAMAGE, THE EYE SEES THE AMOUNT OF DISEASED LEAF TISSUE; ABOVE 50%, THE EYE SEES THE AMOUNT OF DISEASE-FREE TISSUE.

McLaughlin et al. (1992) suggested that the greatest shortcoming in existing forest health surveys is lack of standardization of rating systems, and they developed a rating system based on use of pictorial templates. However, their illustrations suggest loss of foliage is an all-or-nothing event from specific branches. It was indicated that 10 field staff were trained in assessing tree decline symptoms, but the training method was not described. They also indicated that their system could be used in evaluating the effect of legislated emission controls.

Large (1966) reviewed and discussed the development of standard diagrams and selection of the scales and appropriate intervals for examples. James (1971), who developed a pictorial key to damage to achieve standardization in disease assessment, indicated that the degree of desired accuracy of assessment depends on research objectives. It is evident, therefore, that development of standards and training in their use are two separate activities.

Nash et al. (1992) described a computer system which included damage estimation training modules. They found benefits of computer-based training to include provision of standardized training and "instant" expert feedback. This feedback was not limited for example images by weather and time of year, or by quality control within and among estimators. They discussed the benefits of object-oriented simulation, on which their system is based. Object-oriented simulations were used for training in crown injury assessment; however, the foliage in their system was represented by abstract circular patterns superimposed on a tree branching image.

In this paper, a computer-based training (CBT) system for tree damage estimation is described. The system was developed using hypermedia technology, with object-oriented graphics for generating much of the material included. As a number of different technologies are involved in the system, computer-based training, hypermedia, and object-oriented graphics will be discussed prior to describing the Tree Damage Estimation Training System (DESTIMAS).

Computer-Based Training

Computer systems for training form a spectrum based on the degree of intelligence built into the system, and the role (if any) of a human teacher in the training program. System types include computer-based training (CBT), computer-assisted instruction (CAI), computer-managed instruction (CMI) and intelligent tutoring systems (ITS). Some studies differentiate between CBT and CAI, with CBT having all instruction by the computer with no active human teacher, and CAI being the computer-based part of the curriculum, with a human teacher also being involved. Other studies appear to use the terms CBT and CAI interchangeably to refer to the computer-based section of a curriculum which may or may not involve a human teacher. "Computer-assisted instruction (CAI) refers to the use of computers to present drills, practice exercises, and tutorial sequences to the student, and perhaps to engage the student in a dialogue about the substance of the instruction" (Ralston and Reilly 1993).

All systems include an expert's or teacher's views on how best to communicate the concepts of the system domain. Goodyear (1991) elaborates on the incorporation of teacher's knowledge in ITS. Artificial Intelligence (AI) and education share concerns about how to communicate expertise (Lieberman 1987). Learning by example is the most effective learning strategy. Examples help people visualize. Teaching by example has advantages similar to learning by example. In this regard, the "drill and practice" format accounts for nearly 80% of CAI in special education (Male 1988).

The U.S. Congress, Office of Technology Assessment (1988) indicates that there are two fundamental principles behind CAI: 1) Students progress through the instructional material in small steps, without the need for a teacher, and 2) basic instructional decisions are transferred from the teacher to the curriculum developer, who designs the nature and sequence of instructional events, the responses required from the students, and the extent and timing of feedback.

Intelligent tutoring systems (ITS), or intelligent computer-assisted instruction (ICAI) systems, combine issues from both AI and education (Frasson and Gauthier 1990). Features of ITS include (Derry and Hawkes 1991):

- An intelligent problem-solving expert that recognizes all feasible plans and strategies for any given problem.
- A sophisticated problem-generation system that can create whatever type of problem the system needs to tutor the student and that matches the student on characteristics such as age, world knowledge, gender, and interests.
- A multipurpose interface that provides concept-enhancing problem-solving tools for the student to use in solving problems and that also helps make explicit the student's strategies, plans, and misunderstandings.
- A coaching expert that can recognize and respond not only to correct moves, but also to errors and indicators of motivational breakdown.
- A lesson planner that selects problems and instructional routines and assembles them into lessons designed to accomplish instructional goals.
- A sophisticated student record system for developing and storing student knowledge models and for establishing instructional goals for students.

No existing system has achieved all these.

ITS can construct models of the student during the interaction by the student with the system. The model can then be used to select the most appropriate material for presentation and to formulate user-specific test sets. There are varying views regarding the role and importance of student modeling in ITS. Spohrer (1992) and Self (1990) emphasize the value of student modeling in adapting educational environments to the needs of individual students, while Sandberg (1987) suggests that "... detailed user models do not necessarily enhance the capability of an intelligent tutoring system...."

DEVELOPMENT OF STANDARDS AND TRAINING IN THEIR USE ARE TWO SEPARATE ACTIVITIES.

CMI helps the teacher with administrative chores and can create and administer individual education plans (Robinson 1991). This type of system is more an administrative assistant than an educational product.

Parsaye et al. (1989), Robinson (1991) and Floyd (1991) discussed the use of hypermedia/multimedia in CAI/CBT. Parsaye et al. (1989) suggest that hypermedia technology, defined below, is particularly useful in training, with hypermedia on-line help systems having a training function. Benefits of multimedia-based systems (Floyd 1991) include ease and low cost of distribution, consistency of message, flexibility of training scheduling, and tracking of performance.

With the introduction of images in hypermedia, the dialogue between the student and the computer may become non-verbal, i.e., presenting a screen of information on which the student clicks on screen objects to enter his information or request, with the computer responding with a new, specially-constructed image. Object-oriented graphics offer a powerful approach to construction of such images.

Hypermedia

Hypertext is based on the traditional method of storing information on 3x5-inch cards, and is defined as the creation and representation of links between discrete pieces of data, with the data being in text form. When the data include graphics or sound, the resulting structure is referred to as hypermedia (Parsaye et al. 1989, Rauscher and Host 1990). In hypermedia systems, a screen-full of information is the analogue of the card. Formation and activation of connections (links) between cards is described by Rauscher and Host (1990) and Rauscher et al. (1993b). When a link to text is activated, the text segment which is displayed is referred to as a node or chunk of text. Hypermedia is a powerful tool for managing scientific knowledge (Rauscher et al. 1993a), and is especially powerful when combined with AI (Thomson et al. 1993).

The system described here was developed using the hypermedia authoring system HyperWriter! (NTERGAID Inc., Fairfield, Connecticut), with some additional programs in C (Borland International, Inc., Scotts Valley, California). See Rauscher and Johnson (1991) for a brief introduction to the HyperWriter! program.

Object-Oriented Tree Graphics

Object-oriented programming is based on the concept of personifying real-world physical or conceptual objects in the program domain (LaLonde and Pugh 1990). The objects encapsulate both state and operations, and can inherit properties from other objects at a higher position in an object class hierarchy. Nash et al. (1992) developed an object-oriented graphics model of tree crowns in which the foliage objects were abstract circular patterns superimposed on a branching structure. Saarenmaa et al. (1994) developed an object-oriented system that included tree parts, but did not display the parts graphically. Object-oriented graphics of tree crowns will be discussed further in relation to particular aspects of DESTIMAS.

There are three other graphics paradigms used to generate images of trees: fractals, L-systems, and simulation, each approach having a different utility. Fractals (Batty 1985, Strand 1990, Zeide 1991, Zeide and Gresham 1991, Zeide and Pfeifer 1991) permit calculation of fractal dimensions which can be used to draw entire healthy crowns. However, they do not permit a flexible format for interacting with the crown to depict damage.

De Leon (1990) describes a topology-based (fractal-like) object modeling system with environmental effects on object properties, including probability effects on orientation. Although objects are used, it is not an object-oriented programming approach.

Prusinkiewicz and Lindenmayer (1990) describe graphical plant modeling using L-systems, which are based on the concept of rewriting, in which parts of a simple initial object are successively replaced using a set of rewriting rules to produce a complex object. This approach has been applied most successfully to herbaceous plants, and stunning graphical images have been produced by rendering three-dimensional graphical models. However, these images require specialized graphics platforms and processing and drawing times incompatible with a training system, where fast display is essential. The graphical display is an essential feature of L-systems, whereas object-oriented models can serve a valuable function, without graphical display, in a purely computational role. Object-oriented modeling permits interrogation of an image. In addition, the L-systems approach is not as powerful as object-oriented graphics in providing an ability to attach a drawing model to each object.

Renshaw (1985) and Kellomaki and Kurttio (1991) describe simulation-based graphical models of branching in conifers. Object-oriented graphics capture all the features of simulation models and provide considerably greater flexibility and power.

An issue that all graphics programs must address is that of scale. A 29-m tall Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) had over 100,000 branch internodes and almost 8 million needles (Jensen 1976). With a screen size of approximately 500 x 500 pixels, each pixel represents 6 x 6 cm for that tree, while individual needles may be only 1 mm wide and 2 cm long. The issue of scale will be addressed specifically in relation to DESTIMAS.

In addition to the graphical displays of tree crowns, there are many mathematical and statistical treatments of foliage distribution (Massman 1982, Gary 1976, Wang et al. 1990, Myneni and Ross 1991) that can assist in parameterization of the graphical models, and against which the graphical approaches can be compared. Many such studies are in relation to light penetration and radiative transfer models (Norman and Jarvis 1975, Oker-Blom and Kellomaki 1983, Carter and Smith 1985, Oker-Blom and Smolander 1988, Gower and Norman 1991, Smith et al. 1993, Webb and Ungs 1993).

DESTIMAS

The main screen of the system permits access to the three major sections: a system overview, the training itself, and an examples section. The system overview provides a description of the underlying philosophy and the material covered by the two main areas of training. Training is provided in the basics of visual pattern estimation, as well as in estimation of the extent of defoliation or foliage discoloration in conifer and deciduous branches and trees. The examples section shows digitized photographs of trees from British Columbia, Ontario, and the maritime provinces, illustrating and discussing a variety of damage assessment codes. In addition, the main screen provides access to online tutorials and help information (through the **Help** button), as well as to some general information on the system, its developers, and funding sources (through the **Read Me First** button, which also includes discussion of potential enhancements of the system).

Basic Pattern Estimation

The **Training** button permits selection of training in either basic pattern estimation or tree damage estimation. Basic pattern estimation focuses on two-dimensional patterns, although three-dimensional pattern estimation concepts are discussed. Both random and non-random patterns can be studied. Non-random patterns may be distributed towards either the top or the bottom of the background figure, and either low or high degrees of nonrandomness can be selected. Training follows the "drill and practice" format discussed above. Text materials discussing the underlying concepts and describing the use of the programs are available. Programs can be run in either Demonstration (Drill) or Practice Mode (Fig. 1).

The ability to estimate patterns may depend on the pixel size used to construct the patterns, as well as on the contrast of the pattern with its background. In demonstration mode, both the pixel size (using high contrast) and contrast (using medium-sized pixels) can be varied, while the practice mode also tests using patterns where the size and contrast are varied randomly (Fig. 1).

Selecting the **Vary Pixel Size** button in practice mode permits the choice of Small, Medium, or Large pixels on a rectangular, triangular, elliptical or circular background shape (Fig. 2). The rectangular shape might be used to represent patches of damage from an aerial survey, the triangle could represent either a conifer crown or an individual elongated deciduous leaf, the ellipse could represent a deciduous tree crown or a deciduous leaf, and the circle could represent a fish-eye lens view of the forest canopy. This discussion of background shape is available through a hypertext link to the **Background Shape** button in the table. This ability to make parts of a table into hypermedia links is a powerful feature.

The practice session for a particular combination of pixel size and background shape is initiated using the appropriate button. Each button is linked to a separate graphics program, written in C++, that actually draws the required figures and interacts with the system user. A single program includes all features of the basic pattern estimation training, handling demonstration and practice modes, different background shapes, pixel sizes and contrasts, random and nonrandom patterns, and direction and degree of nonrandomness. Each button is linked to the program, to which an argument list is passed

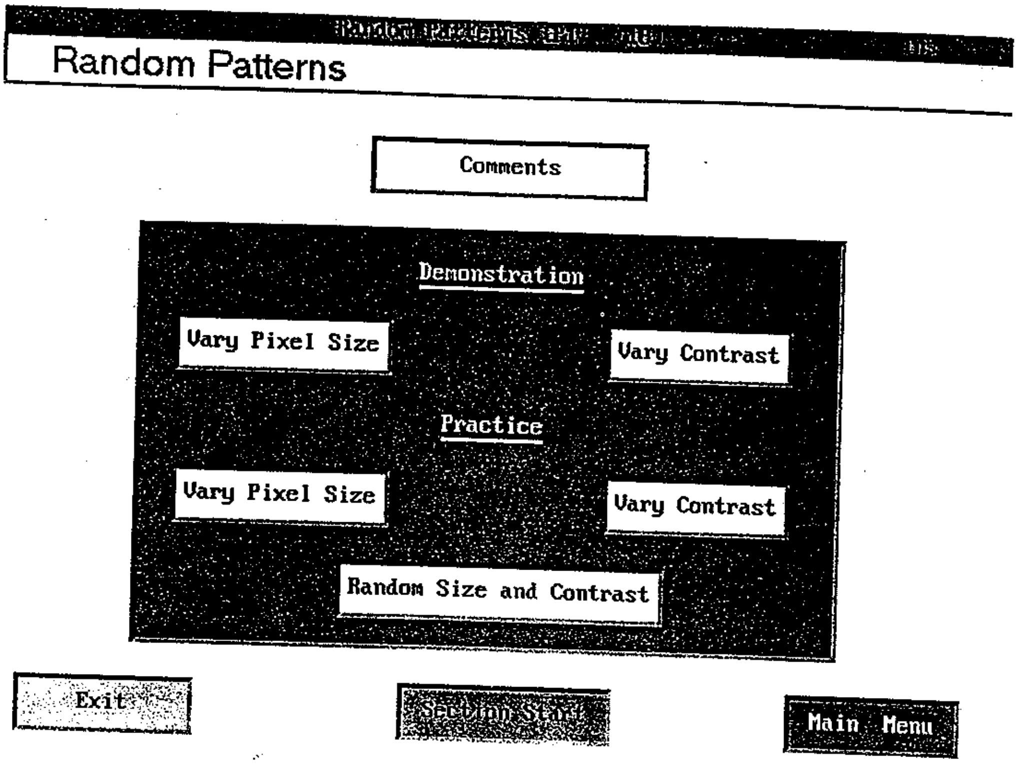


Figure 1. *Selection of demonstration or practice mode for random patterns in the Basic Pattern Estimation training section.*

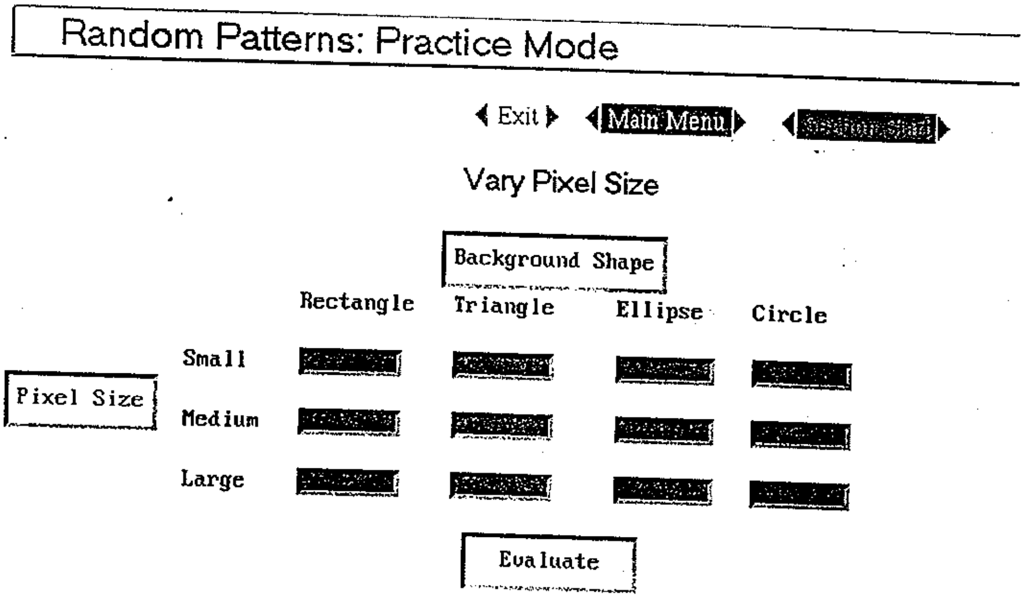


Figure 2. *Selection of pixel size and background shape for random patterns in practice mode of Basic Pattern Estimation.*

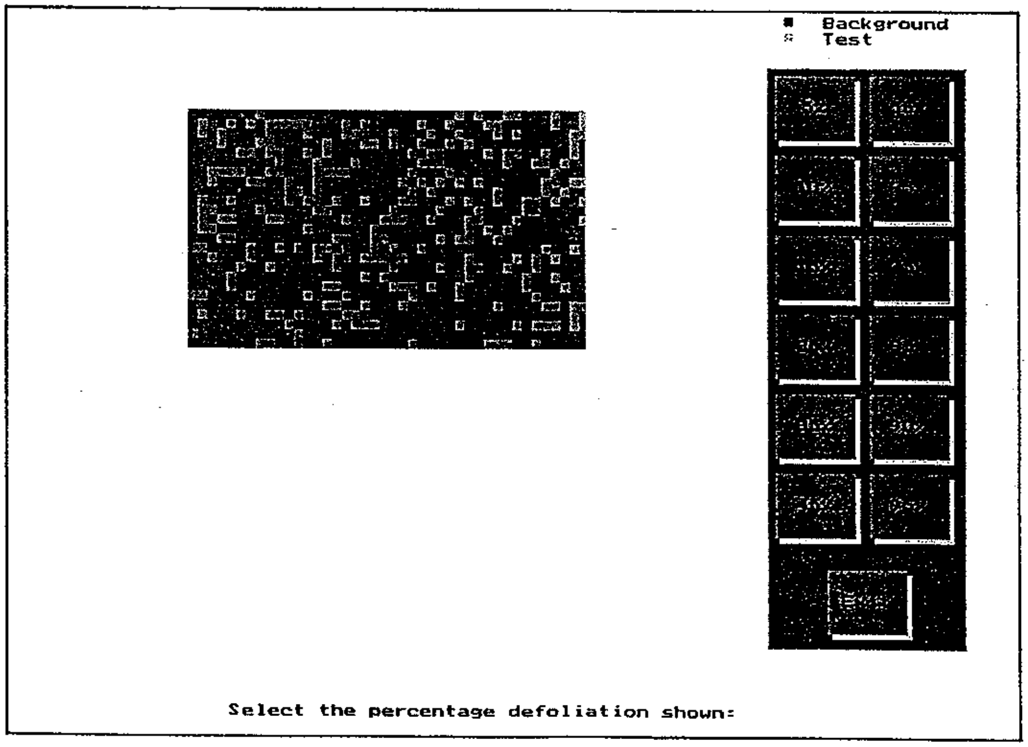
specifying the mode of action. As the student navigates through the hypermedia environment, the elements of the argument list are inherited until the final list is passed to the drawing program. After completing the practice session, the results can be displayed through the **Evaluate** button. The Demonstration Mode screen for random patterns is similar to the screen in Figure 2, but without the **Evaluate** button.

Note the difference in format between the navigational aids (**Exit, Main Menu** and **Section Start**) in the screens illustrated in Figures 1 and 2. The choice of buttons (Fig. 1) or word links (Fig. 2) and their placement was determined based on visual considerations as well as on a system design policy of maintaining a consistent format within related screens. The functionality is identical in both formats.

Selecting medium pixels and a rectangular background shape in practice mode, using random patterns, activates the graphics program (Fig. 3). The student selects the button corresponding to his/her estimate of the percentage of pixels of the test color (referred to as defoliation in the figure). A practice session consists of 10 test patterns, but the session can be terminated at any time using the **Exit** button. In demonstration mode, the sequence is reversed, with the student selecting a percentage button and the program drawing an example.

Performance Evaluation

The performance summary displayed by the **Evaluate** button is similar for both the Tree Damage Training and the Basic Pattern Estimation (Table 1). Performance indicators are based on a button-numbering system. There are 12 possible buttons (Fig. 3), internally numbered 1 to 12 in increasing order. Defining d_i as the difference between the correct button number and the selected button number for the ith test,



Select the percentage defoliation shown:

Figure 3.
An example of a test pattern of medium pixels on a rectangular background, presented by the practice mode of Basic Pattern Estimation.

Table 1. *Example of the evaluation screen following testing on tree damage estimation. In this case, the test has been terminated after seven examples, rather than completing the default 10. The evaluation screen from the testing on basic pattern estimation is essentially identical, apart from the header.*

*** TREE TESTING EVALUATION ***

Pattern Number	Correct Answer	Your Answer	# of buttons off
1	45	65	2
2	5	5	0
3	95	90	-1
4	25	35	1
5	25	15	-1
6	85	75	-1
7	90	90	0

Number of estimates correct : 2
Number of estimates with one button off : 4
More than one off : 1

The average of your estimates is close to the average of the actual estimates, but your accuracy is poor. You should examine more patterns in the demonstration mode to refine your approach to the estimation.

Table 2. *The four statements analyzing performance, presented when the Evaluation button is selected.*

1. Your estimates are generally close to the actual values. Congratulations on good performance.
2. The average of your estimates is close to the average of the actual estimates, but your accuracy is poor. You should examine more patterns in the demonstration mode to refine your approach to the estimation.
3. You consistently overestimate the percent damage. Retake the test, reducing your estimates consistently, and see if your scores improve.
4. You consistently underestimate the percent damage. Retake the test, increasing your estimates consistently, and see if your scores improve.

Table 3. *Selection of analysis statement based on indicators of performance. The performance indices discussed in the text are cross-referenced to determine the appropriate statement number from Table 2.*

Indicator 2	**Indicator 1** < -0.5	 -0.5 <= x <= 0.5	 > 0.5
<= 1	4	1	3
> 1	4	2	3

indicators 1 and 2 are calculated as

$$\text{Indicator } 1 = \Sigma\, d_i/N$$
$$\text{Indicator } 2 = \Sigma\, |d_i|/N$$

where N = number of tests.

There are four possible performance analysis statements (Table 2), selected based on the values of the two indicators (Table 3). The use of the button-oriented performance statements was related to the anticipated audience, which may include field workers with limited appreciation of statistics, to whom terms such as mean and standard deviation might be less meaningful.

This section is the only AI in the system at present. A human examiner would look at accuracy, bias, and consistency of ratings. The indices above permit a computer program to evaluate these features in a non-statistical manner.

Tree Damage Training

Training in tree damage estimation can be in relation either to defoliation, where needles or leaves are absent, or to discoloration, where the leaves and needles change color (in this case to red) due to disease or environmental effects. As with the Basic Pattern Estimation, both demonstration and practice modes of operation are possible. Damage can be studied on fir-type or pine-type conifers or on deciduous trees (oak) (Fig. 4). Branch-level damage (Fig. 5) or tree level damage can be studied, with trees being viewed from above, below (Fig. 6a,b), or laterally (Fig. 7). Because of the drawing time for some views, we recommend that an IBM PC-compatible 486 or at least a faster 386 computer be used.

Figures 5-7 illustrate some features of the object-oriented tree graphics system (TREES++) on which the training is based. Needle objects can be built into shoot objects; these can be combined into branch objects (Fig. 5). Branches form whorl objects in the coniferous trees and are built into tree objects (Fig. 6). The boles of conifers are whorls with no branches, whereas a separate bole object is used in deciduous trees. The leaf objects of deciduous trees are bitmaps (Fig.

7), which can be used to display within-leaf damage patterns by selecting from an array of bitmaps using an appropriate set of probabilities. Characteristics of leaves, shoots, branches, etc. are inherited from the species of the tree object.

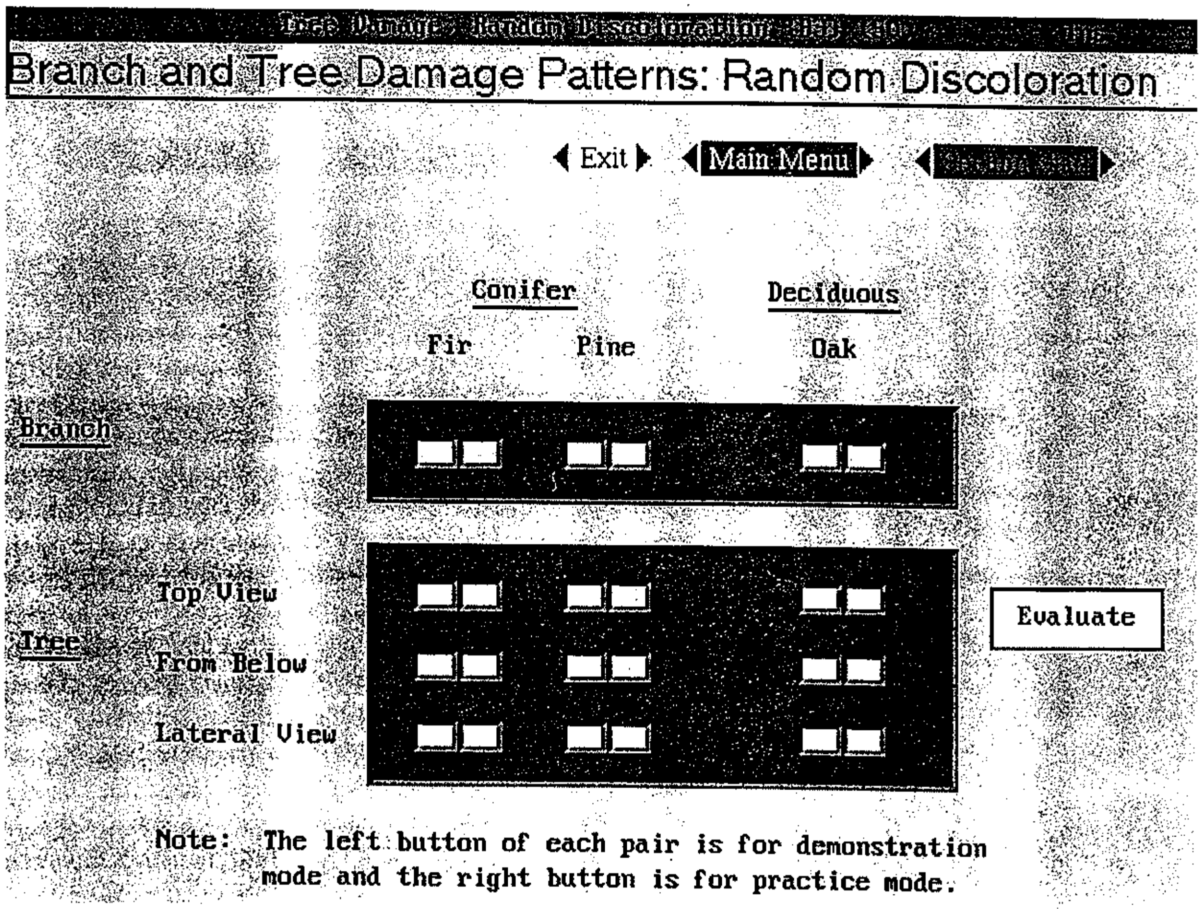
Although non-random patterns are included in the basic pattern estimation training, only random patterns of tree damage are included at present, for the following reason. It is easy in the object-oriented graphics model to make damage a probability function of foliage age and position in the crown. However, to display a specified percentage damage for a given mode of non-randomness, we would require the ability to predict the appropriate probability model given the current branching and foliage dynamics. The algorithm for this is known, but its implementation was not possible given the time and budgetary constraints of the project.

Examples Section

The examples section of the system includes discussion of rating systems and examples of digitized images of trees rated by different systems. Some systems divide the tree crown into thirds; others provide separate ratings for old and new foliage. Some rating systems are branch-oriented and others tree-oriented. Some systems are specific to conifers, and others can also be used with deciduous trees.

The facility of hypermedia to provide interactive tables has already been described, and this feature was used extensively in this section. Tables could have a similar structure regardless of rating system, with details of the specific features accessible through hypertext links.

The graphic illustrations were linked directly to table entries. The graphic format was limited to those supported by the HyperWriter! tool. A



Note: The left button of each pair is for demonstration mode and the right button is for practice mode.

Figure 4. *Selection of tree species and view in the Tree Damage Estimation part of the system.*

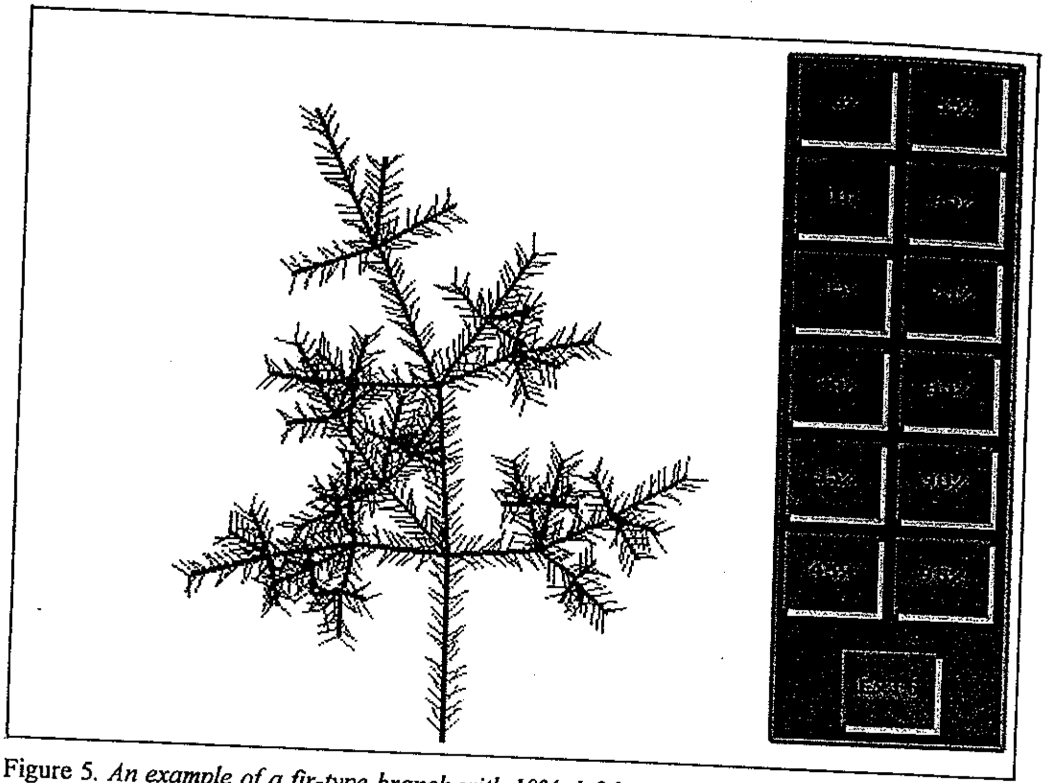


Figure 5. *An example of a fir-type branch with 10% defoliation, displayed by selecting the 10% button when the system in demonstration mode.*

higher resolution PCX image was used than in the system described by Thomson et al. (1993), but due to the issue of pixel scale compared to needle scale discussed earlier, the digitized images were not as satisfactory as photographs for displaying details of damage. Use of a separate hard-copy photographic series may be appropriate in such cases to accompany the computer-based training system.

Discussion

Many interacting issues must be resolved in developing computer-based training products. The interaction of button design and performance indicators, taking account of the background of potential users of the system, has already been discussed. The depth to which performance should be analyzed and discussed also must be considered in relation to the performance indicators; those used here deal with overall performance—there is no attempt to determine if the student is having difficulty at one part of the damage range more than others, and there is no carry-over of performance indicators from one practice session to the next. While all these are possible, their inclusion in a system depends on resources available for their implementation, as well as on the intended use of the system.

Other issues include number of levels of difficulty in testing, scale, and which features of the object-oriented tree graphics to include. The current system does not have varying difficulty levels, but rather includes all parts of the damage range in the testing. Some issues relating to pixel scale and actual needle and shoot scale have already been described. However, because the training system focuses on visual appearance, the essential visual features of tree damage could be displayed with scales that were quite different from those in nature. This was especially so in the tree graphics; the branch graphics were closer to natural scales.

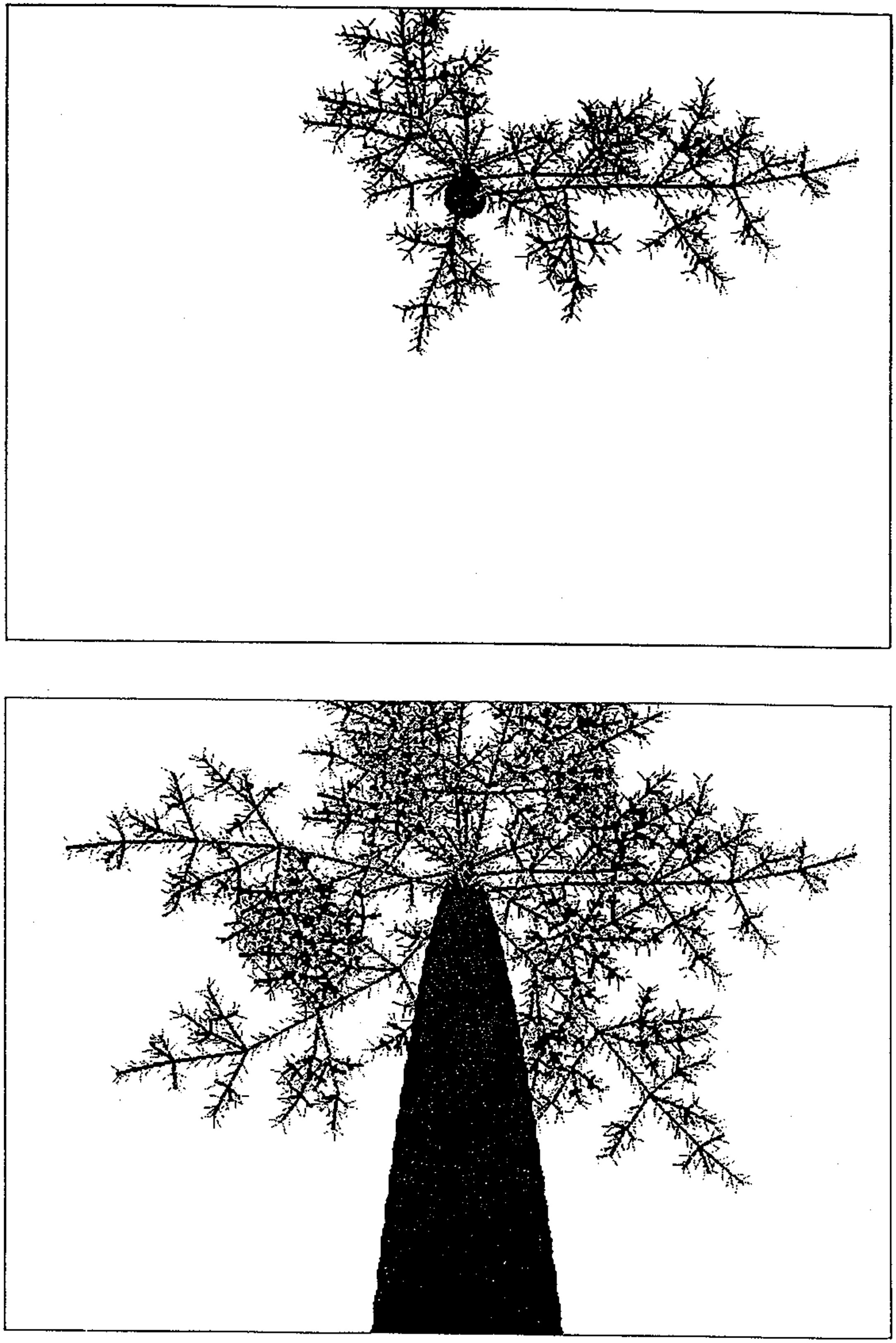


Figure 6. *(a) Intermediate and (b) final stages in the drawing of a defoliated fir-type tree from below.*

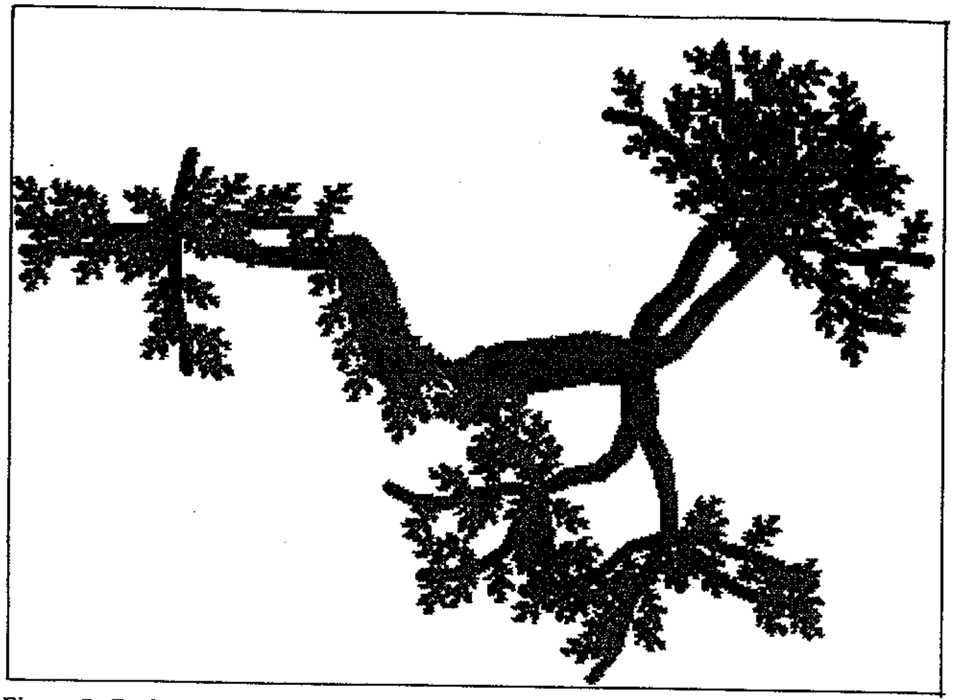


Figure 7. *Early stage in the drawing of a deciduous tree (oak).*

The available features of the object-oriented tree graphics system were used to only a very limited extent in the training system; e.g. only a single set of branching levels, shoot density, and needles per centimeter were used rather than having these modified to reflect variability in site characteristics.

The student currently is left to browse the hypermedia-based training system and select areas of interest based on text descriptions. Expert system guidance could be provided on useful paths (Thomson et al. 1993). This is facilitated by the ability of the hypermedia tool to maintain a history record of the browse path of the student. This history facility would also provide a valuable resource for student modeling studies. The history function also permits guidance on "What haven't I looked at?"

A final issue was whether or not to provide feedback to the student during testing. As one design philosophy of the system was to provide an enjoyable experience, feedback on each test case was provided as the answer was entered.

Many of the issues discussed above point to future directions of possible continuing research, not only in the training system but also in the object-oriented tree graphics program (TREES++) on which the training system is based. Current research is in the following areas.

A higher-level plot object is being developed, using standard forest plot data of tree coordinates, species, age, dbh, and damage codes. This can be used to simulate a remote sensing pixel and linked to radiative transfer models. It can also be used in conjunction with stand models for visualization.

As discussed earlier, at present the tree and branch damage patterns are random. The system can actually use different probability models to make damage a function of foliage age and position in the crown. Implementation of the algorithm for selecting the required probability model to generate a specified overall percent damage, given the particular branching patterns and needle dynamics, has a high priority.

Other tree objects such as dead branches, cones, flowers, fruit, signs and symptoms of damage agents, such as fungal fruiting bodies or dwarf mistletoe infections, can be included. Related to this is refinement of existing objects. For example, in conifers, older shoots could lose needles at a rate depending on foliage age. The innermost branch segments could be bare. The existing tree objects were created within the limits of the time constraints of a specific funding program and could be made more lifelike. In deciduous trees, the basis of damage or discoloration is currently the whole leaf. Bitmapped graphics make it easy to deal with damage to part leaves.

The current graphics used in the object-oriented tree model is low resolution to enable use of the system on a wide range of platforms. In addition, the present drawings are not true three-dimensional renderings, but rather a simulated three-dimensional view to permit rapid drawing. A true three-dimensional rendered model would be more realistic, although drawing time on a PC would make it incompatible with the requirements of a training system. Note that an object-oriented graphics model used in rendering systems with ray tracing, followed by analysis of the resulting image, offers a new alternative to radiative transfer models from the traditional mathematical approaches.

Finally, research is being conducted into computer video applications through which customized videos can be produced under expert system control (Thomson and Sivertson 1994). By linking such systems to the history function of the hypermedia, a new approach to video-oriented computer-based training systems becomes feasible.

The title of this article refers to computer-based training, reflecting the current status of the system. However, the title screen of the DESTIMAS system refers to computer-assisted instruction, in anticipation of future enhancements. At present, the only AI in the system is in the evaluation of the student's performance in rating a single set of examples covering the whole range of damage values from a particular viewpoint. The use of AI in conjunction with student models in a full intelligent tutoring system could determine if a student was having problems with a particular part of the damage range, viewed from a specific direction, and develop a training regime appropriate for that situation.

Validation of the system in an operational setting is currently in progress, and one issue has already arisen. There is concern that use of the system with damage appraisers currently involved in projects may change their approach to rating, resulting in inconsistencies in estimates over the course of the studies. While the appraisers may have bias, it is important for some purposes that this be consistent. Bias can be evaluated after the studies are complete. The role of any training in an operational setting must be evaluated with care.

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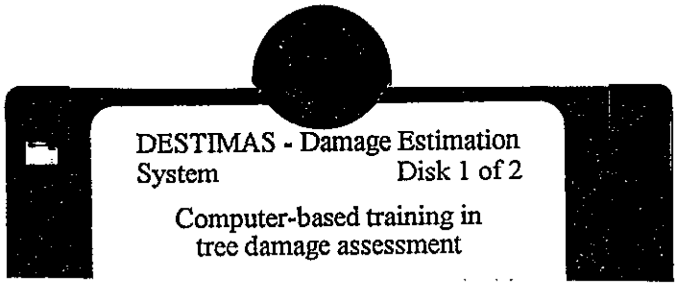

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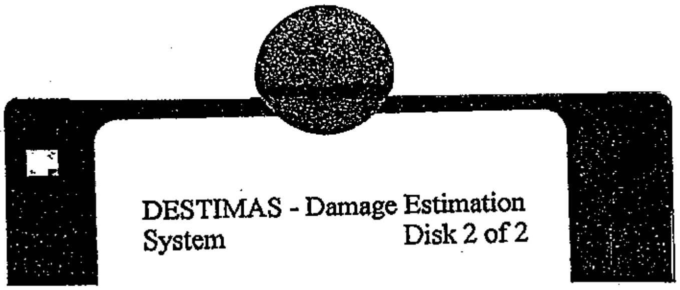

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