



LEARNING BY VISUALIZING

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“Now you see it, now you know it”

- *“Approximately 65% of the population are visual learners”*
- *“The brain processes visual information 60,000 times faster than text”*
- *“Visual aids in the classroom improve learning by up to 400%”*

<http://www.visualteachingalliance.com/>

Challenges

- Most students struggle with understanding the concepts of limits, surface areas, volumes, analyzing big data...
- Most students do not fully comprehend the OO development environments, they face difficulties when designing databases, they struggle to understand the concept of networking just from text...

Visualization in Computer Science

- We look at the application of Visualization in 3 pillars of Computer Science:
 - Programming
 - Databases
 - Data Mining
- Over the last 2 decades, researchers have developed and used several visualization tools such as LOGO, ALICE, Tableau, TOONTALK, etc.

Programming



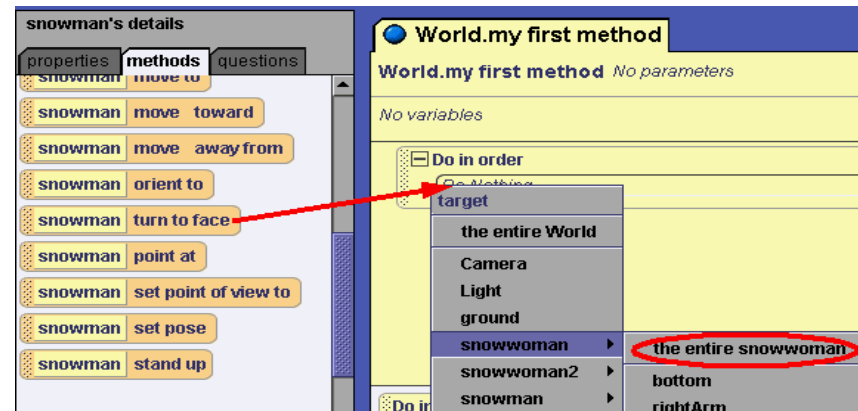
- Instructors of introductory programming classes are faced with the challenge of helping novice programmers learn to design, build, and debug computer programs.
- One of the major shortcomings of programming environments is the lack of visualization mechanisms.
- Using 3D animations for program visualization offers computer science instructors an approach to introduce fundamental concepts to novice programmers.

The Alice Software

- A **3D interactive animation environment**
- A tool for teaching **fundamental programming** concepts
 - object oriented
- System developed at Carnegie Mellon

The Alice Approach

- Uses **3D graphics** to engage students
- Has a “**smart**” **drag-and-drop editor** that prevents syntax errors



- Appeals to **wide audience**
 - Storytelling
 - (young women, minority students)
 - Interactive computer games
 - (young men)
 - Not threatening; Alice builds students' confidence

Key Alice Features

- Makes **objects** something students can see and relate to



- Has a **java syntax mode** to ease the transition to C++/Java/VB.net

Textbook Features

- Emphasizes **design** using storyboards
- Supports varying instructional approaches
 - “**objects-early**”
 - “**objects-first**”
- Allows an (optional) early introduction to **events**
- **Color** screen captures illustrate step-by-step construction of programs

Schools using Alice

- Bucknell University
- California Lutheran University
- California State University at Humboldt
- Camden County College
- Carnegie Mellon University
- Clemson University
- Colorado School of Mines
- Community College of Philadelphia
- Cornell University
- Duke University
- Georgetown College
- Haverford College
- Ithaca College
- Manor College
- Mississippi Valley State University
- Plymouth State University
- Saint Edward's University
- Saint Joseph's University
- Saint Lawrence College
- San Diego State University
- Sierra Nevada College
- Southwestern University
- Tompkins Cortland Community College
- University of Colorado
- University of Illinois
- University of Mississippi
- Virginia Tech
- New York City College of Technology
- And several high schools

Results of NSF-supported study

- As used towards retention of CS majors

- **GPA improved**



- Grades went from C to B

- at-risk students (students with little to no prior programming experience and/or weak mathematics background)



- Increased retention from **47% to 58%**

- **Improved attitudes** towards computing

URLs

- The software: www.alice.org
 - Includes forums for discussion/help
- Supplementary instructional materials and solutions to exercises in the text:
www.aliceprogramming.net
 - lectures
 - labs
 - assignments
 - sample chapter of the text
 - sample virtual worlds (programs)

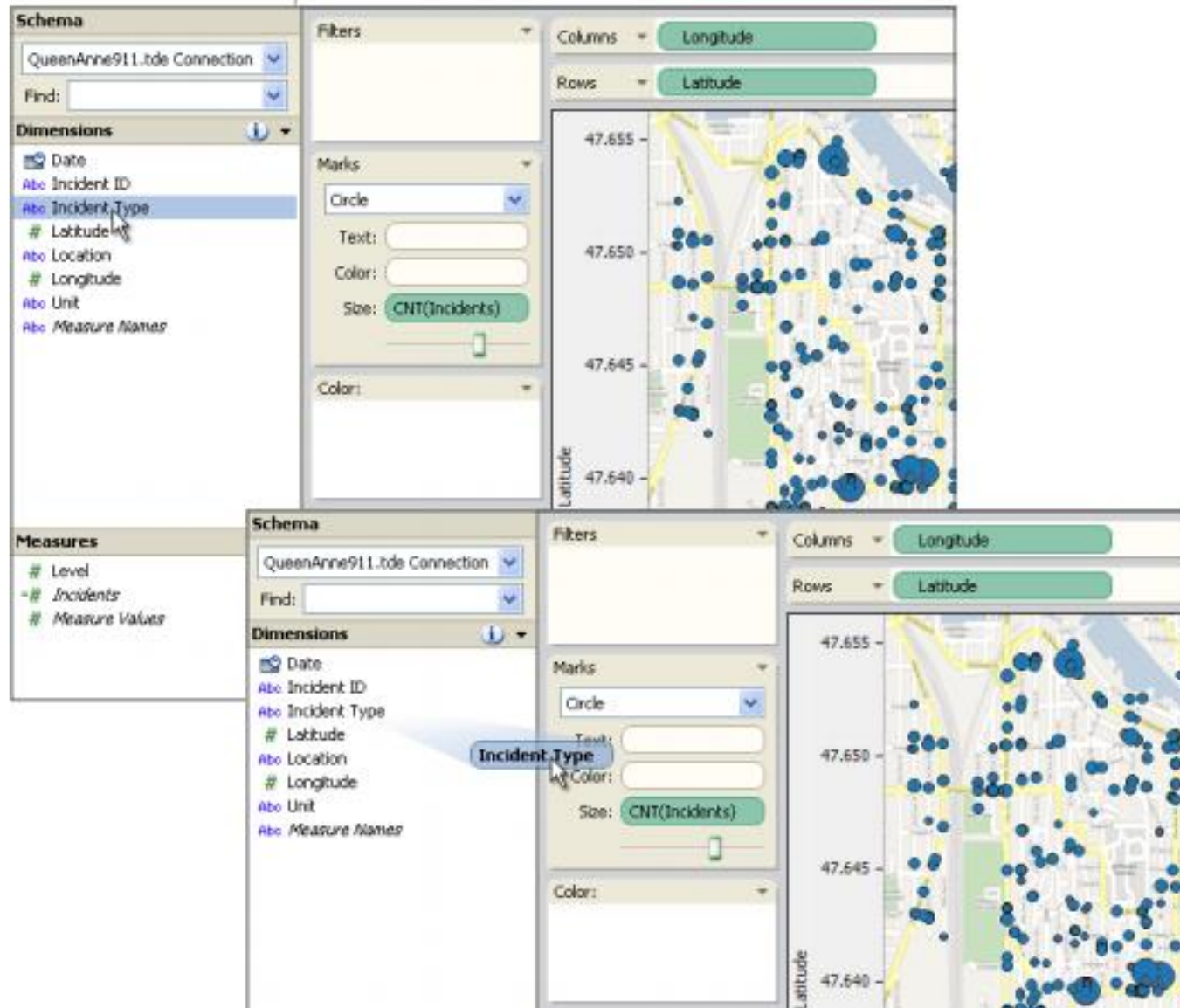
Databases

- A *database* is structured collection of data.
- Almost all computer science undergraduate programs require the students to take database courses.
- We have noticed that students mostly face difficulties when designing databases. We have seen that this problem can be solved when the students are given the opportunity to *visualize* the database that they are going to design.

Tableau

- R&D project of Stanford University
- Tableau's products allow students to plow through large dimensional databases quickly.
- It quickly generates graphs even against large database tables. By giving a student the ability to spot trends and relationships visually, information buried in the data becomes more readily visible.

Tableau's user interface is based on drag and drop analysis. Here, a user examines a database of Seattle 911 calls. She is able to generate an informative visualization of the data in seconds.



Data Mining

Data mining is the exploration and analysis of large quantities of data in order to discover valid, novel, potentially useful, and ultimately understandable patterns in data.

Valid: The patterns hold in general.

Novel: We did not know the pattern beforehand.

Useful: We can devise **actions** from the patterns.

Understandable: We can interpret and comprehend the patterns.

WEKA

- WEKA is the product of the University of Waikato (New Zealand) and was first implemented in its modern form in 1997.
- The software is written in the Java™ language and contains a GUI for interacting with data files and producing visual results (think tables and curves).
- It also has a general API, so you can embed WEKA, like any other library, in your own applications to such things as automated server-side data-mining tasks.

Preprocess

Classify

Cluster

Associate

Select attributes

Visualize

Classifier

Choose J48 -C 0.25 -M 2

Test options

 Use training set Supplied test set

Set...

 Cross-validation Folds 10 Percentage split % 66

More options...

(Nom) class

Start

Stop

Result list (right-click for options)

11:49:05 - trees.j48.J48

Classifier output

=== Run information ===

Scheme: weka.classifiers.trees.j48.J48 -C 0.25 -M 2

Relation: iris

Instances: 150

Attributes: 5
sepalength
sepalwidth
petallength
petalwidth
class

Test mode: split 66% train, remainder test

=== Classifier model (full training set) ===

J48 pruned tree

petalwidth <= 0.6: Iris-setosa (50.0)
petalwidth > 0.6
| petalwidth <= 1.7
| | petallength <= 4.9: Iris-versicolor (48.0/1.0)
| | petallength > 4.9
| | | petalwidth <= 1.5: Iris-virginica (3.0)
| | | petalwidth > 1.5: Iris-versicolor (3.0/1.0)
| petalwidth > 1.7: Iris-virginica (46.0/1.0)

Number of Leaves : 5

Status

OK

Log

 x 0