PROF & DEV

Lessons learned while collaborating in developing instructional-support software

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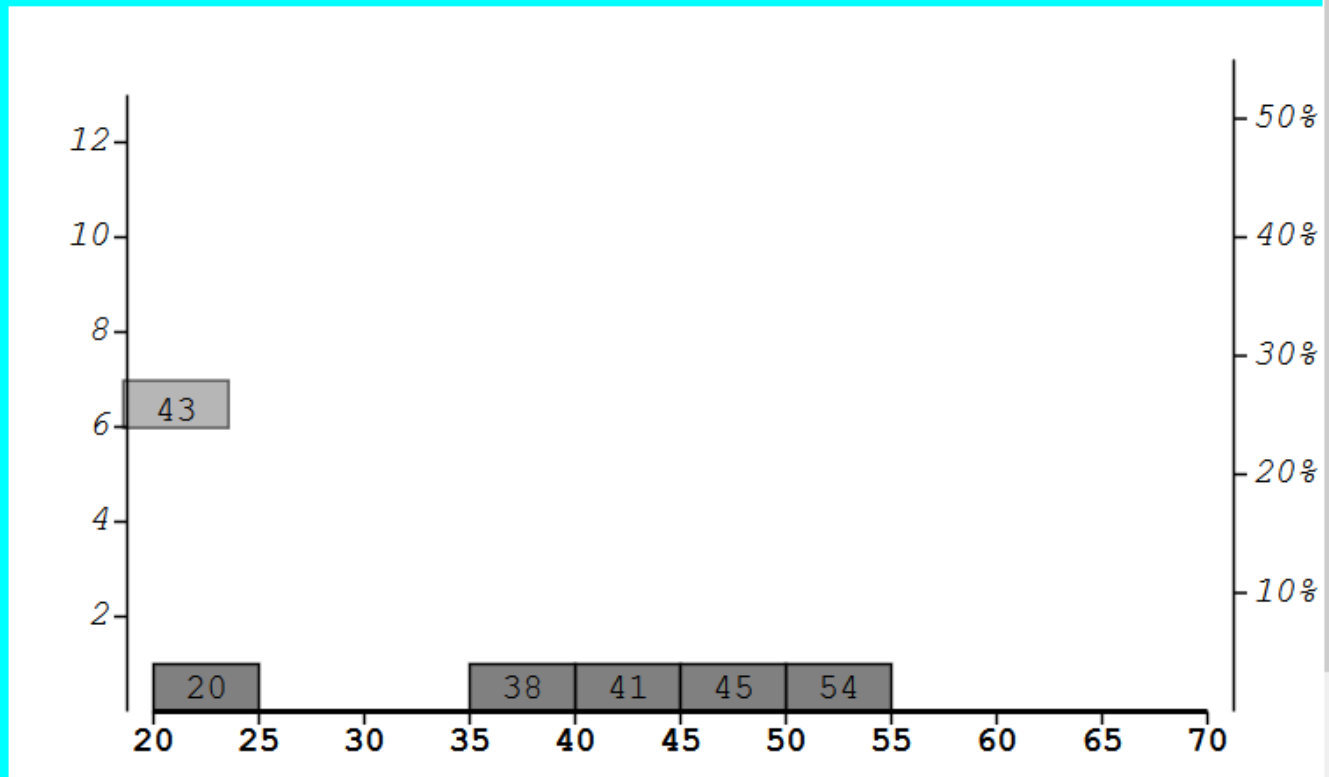
Types of Software for Math Students

- General-use tools (e.g., Excel)
- Professional-level tools (e.g., MATLAB)
- Stand-alone instructional systems (e.g., ALEKS)
- Software systems integrated with textbooks
- Topic-focused web pages
    - *Pages to demonstrate advanced topics*
    - ***Pages to introduce foundational topics***

New values or **Repeat values**

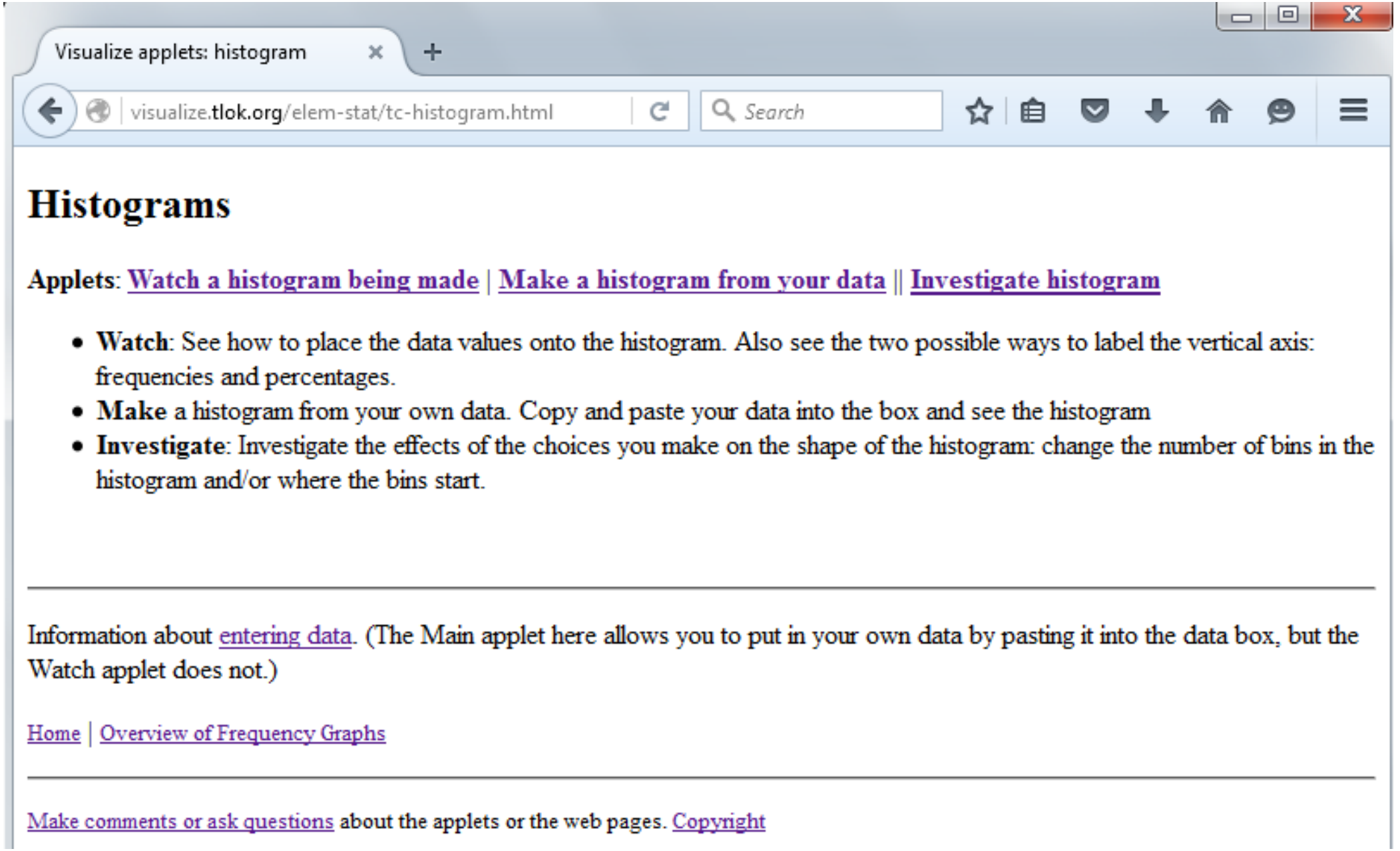
Column mode: ◉ *outline only* ○ *retain boxes* ○ *retain values*

~~41~~	~~54~~	~~45~~	~~20~~	~~38~~
~~43~~	50	58	32	26
27	25	61	49	37
41	35	60	31	25
59	65	34	28	66



Topic-focused web pages

- Teachers choose when/where/whether to use
- Each page focuses on a single concept
- Not connected to grading systems
- In most cases, each student will visit only briefly
- Fill in gaps in student background
- Develop student mathematical visualization



Histograms

Applets: **Watch a histogram being made** | **Make a histogram from your data** || **Investigate histogram**

- **Watch**: See how to place the data values onto the histogram. Also see the two possible ways to label the vertical axis: frequencies and percentages.
- **Make** a histogram from your own data. Copy and paste your data into the box and see the histogram
- **Investigate**: Investigate the effects of the choices you make on the shape of the histogram: change the number of bins in the histogram and/or where the bins start.

Information about entering data. (The Main applet here allows you to put in your own data by pasting it into the data box, but the Watch applet does not.)

Home | Overview of Frequency Graphs

Adjustment Of Histogram Bin Settings

Colorize

Paste data values below and **Display**

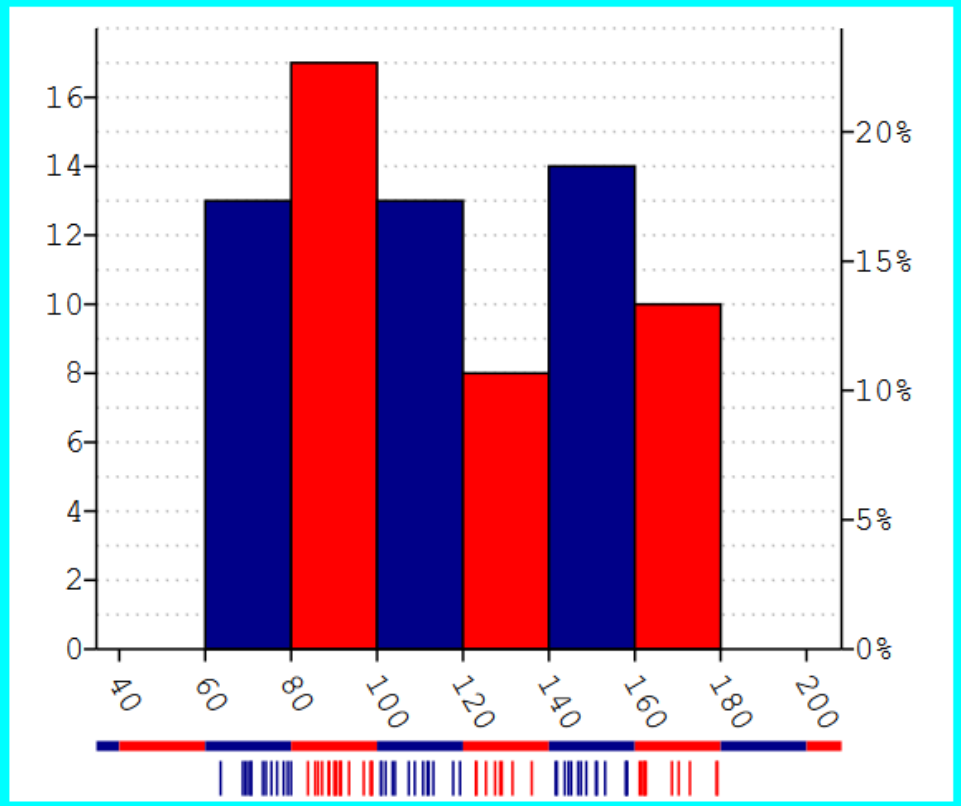
```
70.69 68.75 123 158.21 161.51
170.24 131.53 83.92 69.94 150.96
162.04 117.73 90.52 157.89 98.74
87.21 172.83 91.62 136.02 158.09
145.21 148.71 102.01 113.12 88.9
153.09 85.6 74.14 93.48 112.01
```

With different bin settings, these same values can be used to make other histograms

Make each bin width **smaller** or **bigger**

Or move bin boundaries **left** or **right**

75 values are placed into 6 bins
The lowest bin used starts at 0
Each of the bins is 20 units wide



Individual-value plot of this data

Enterprise vis-à-vis Faculty Situations

Start-up Software Enterprise

- Free choice of markets to serve
- Users have choice of products
- Ceiling matters more than threshold (power more important than clarity)
- User knowledge of concepts assumed
- Costs to users secondary to power

Introductory-Mathematics Faculty

- Market defined by educational mission
- Teachers have choice of products
- Threshold matters more than ceiling (clarity more important than power)
- Concept development/reinforcement
- Costs to users very important

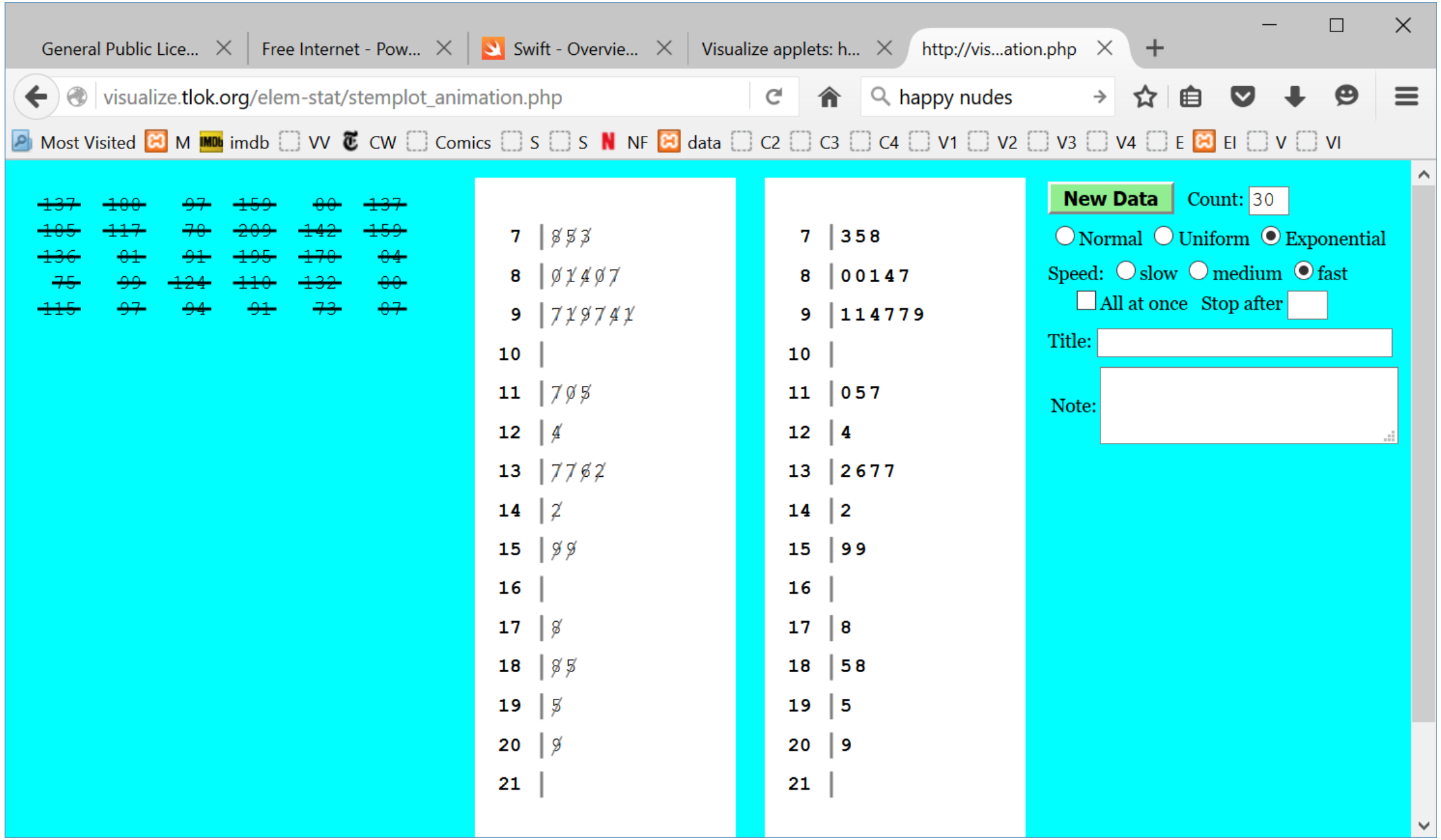
DEV vis-à-vis PROF Principles

Computer-Software Developer

- Don’t Repeat Yourself
- Hide the machinery
- Unify capabilities
- Intuitive interfaces
- Standardized language

Introductory-Math Teacher

- Helical revisiting of topics
- Reveal the machinery
- Separate focus on each step
- Clear instructions
- Language should match that used in rest of course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137 108 97 159 80 137
185 117 78 209 142 159
136 81 91 195 170 84
75 99 124 110 132 80
115 97 94 91 73 87
7 | 8 5 3
8 | 0 1 4 0 7
9 | 7 1 9 7 4 1
10 |
11 | 7 0 5
12 | 4
13 | 7 7 6 2
14 | 2
15 | 9 9
16 |
17 | 8
18 | 8 5
19 | 5
20 | 9
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7 | 3 5 8
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17 | 8
18 | 5 8
19 | 5
20 | 9
21 |
New Data
Count: 30
Normal
Uniform
Exponential
Speed: slow medium fast
All at once
Stop after
Title:
Note:

Mutual Problems

PROF problems with DEVs

- Unaware of the low thresholds needed by weaker students
- “Continuous improvement” can mean random breakages
- Want to put too many options into each page
- Sometimes over-automate, undermining student learning

DEV problems with PROFs

- Need to separate instructional goals from page-design ideas, and to prioritize them
- Need to realize that old-code revision is essential for efficient addition of new features
- Need to take responsibility for beta testing

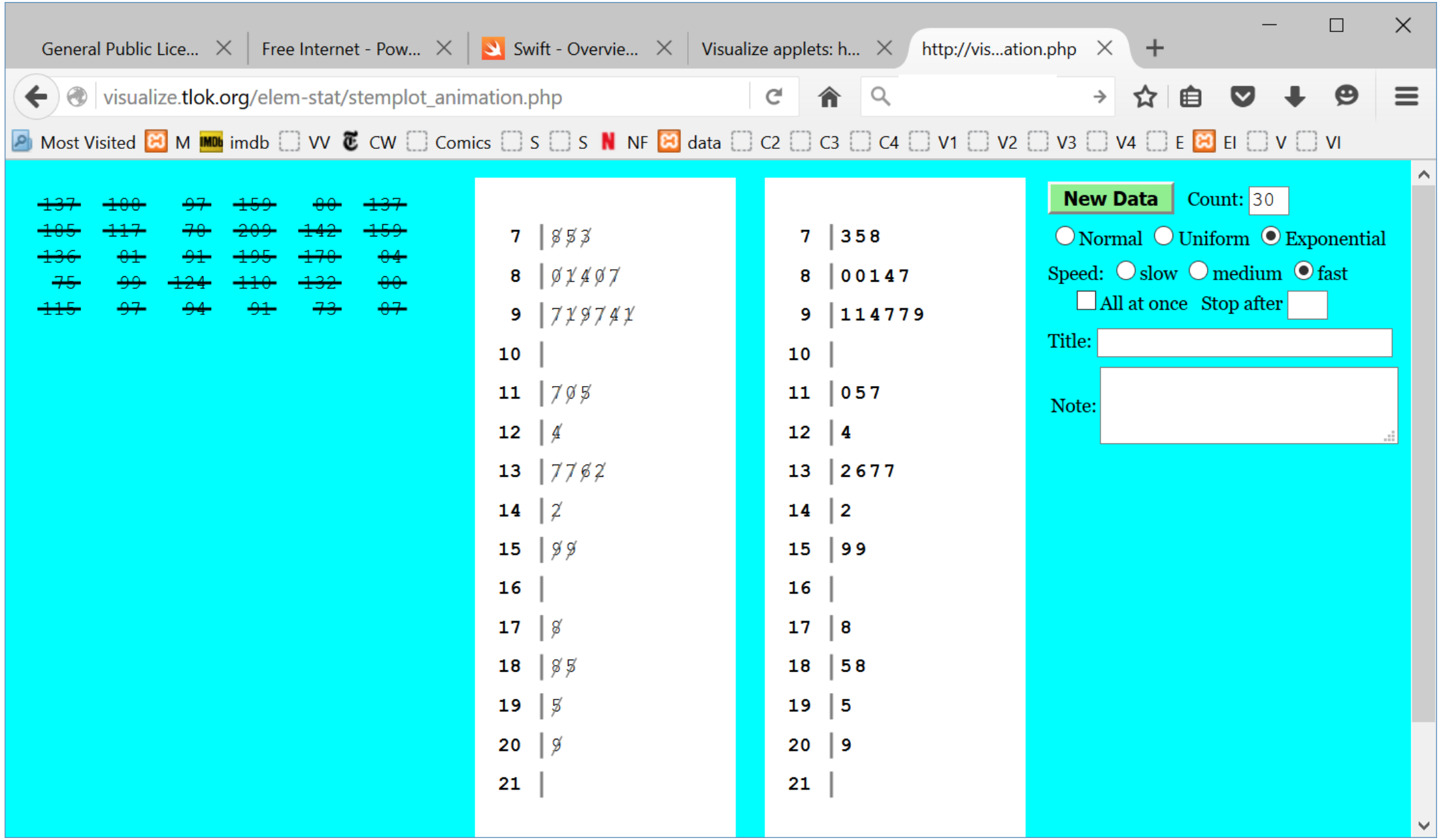
The Most Fundamental Truth About Instructional-Software Development

Neither the teacher nor the developer knows what will work best until they make an initial version and see how students interact with it.

Balancing two sets of trade-offs requires a sustained collaboration, not a “build my idea” one-way message.

Reconciling the two perspectives

- PROF-DEV communication to understand each other's constraints
- Enable each participant to make independent use of their expertise
- Open-source licensing to ensure free access and revision options
- Configurability, with source-release controls possible by each college
- Sophisticated reusable core of library routines so that individual pages are short, making variations to shift focus simple and robust
- Support both college-level and individual-teacher customization of language for titles, explanations, and navigation to teacher materials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105 117 78 209 142 159
136 81 91 195 170 84
75 99 124 110 132 80
115 97 94 91 73 87
7 | 8 5 3
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14 | 2
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7 | 3 5 8
8 | 0 0 1 4 7
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11 | 0 5 7
12 | 4
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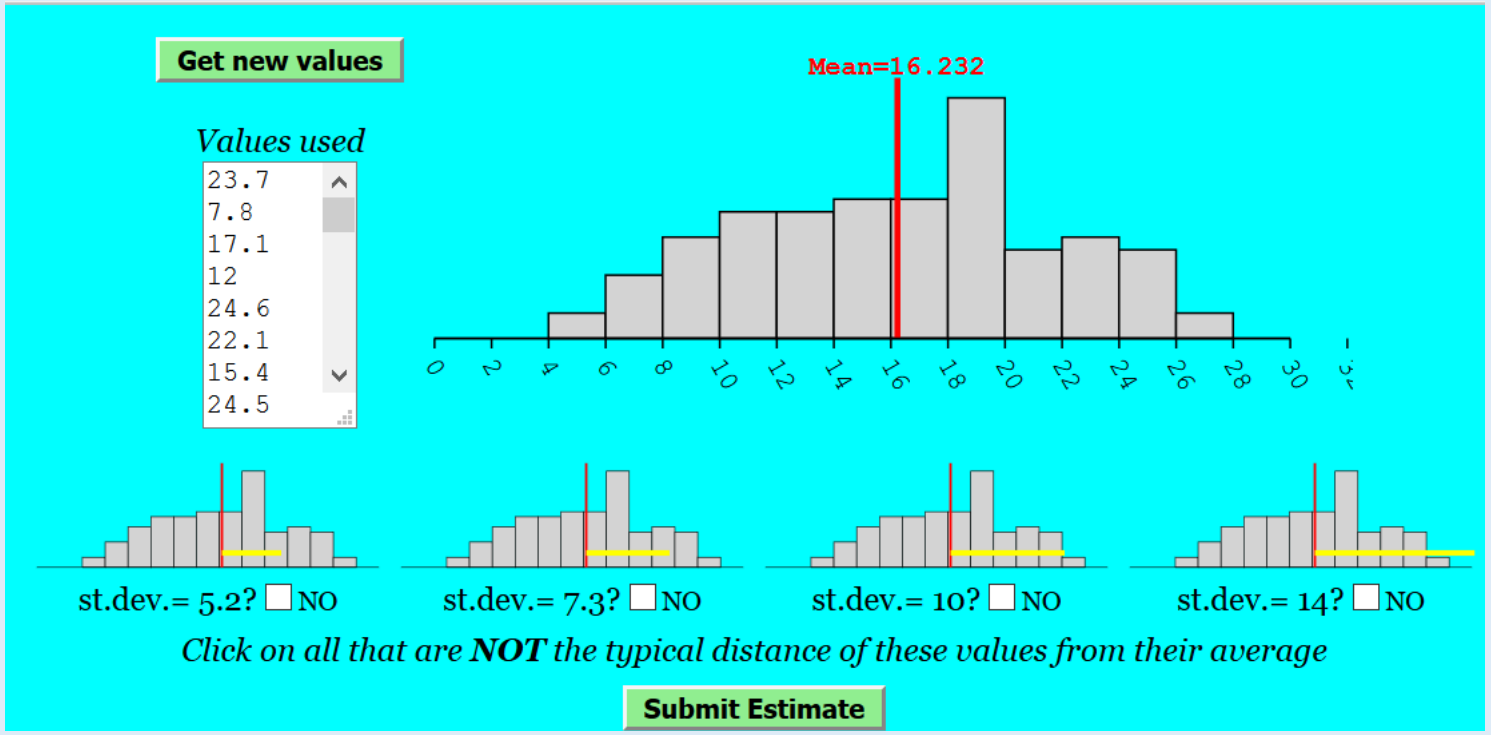
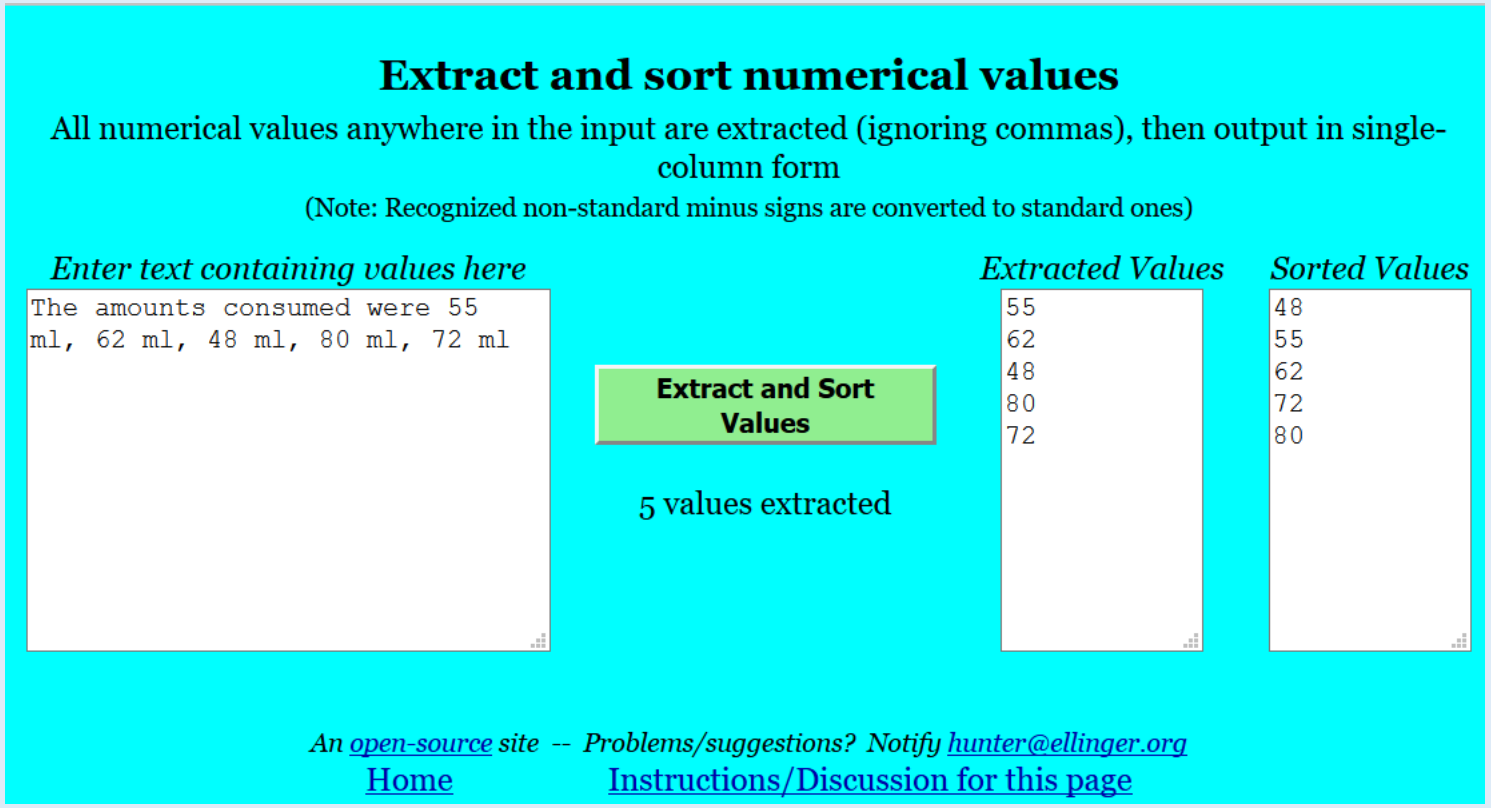
A Lesson Learned

- The threshold issue can be addressed by related pages at different levels of sophistication: training-wheels, standard, and teacher



Another Lesson Learned

Provide flexible tools that quickly convert nonstandard numerical input to a useable form.



Other Lessons Learned

- Loosely-coupled utility routines can provide students with flexibility while still requiring them to decide on and execute a solution plan
- Animation of basic procedures can provide weak-background students a chance to catch up with better-prepared ones
- Provide mechanisms for individual-teacher designation of the default data sets for each page

The most useful advice to teachers about software development

Free modern resources such as HTML5, scripting, and relational databases, combined with the web and fast computers, have made development of user-accessible software much faster and easier.

Most individual software tasks are now either easy or almost impossible; relatively few are hard.

Some useful instructional ideas you have may fall in the easy category.

But **they won't happen unless you talk to a developer** about them**.**