Motivation

**CPSC 221, Data Structures and Algorithms** is a high content course split across theory and implementation expectations.

The high learning load makes 221 a traditionally difficult course for many students.

Often students perform only averagely or worse across the various topics within the course.

An in-class, active learning approach can help....
Traditional Course Structure

Class is split into **lectures** and **labs**

**Lectures** deliver the bulk of material in a fairly traditional lecture-based delivery format

**Clickers** are used to assess student progress regularly through the term

**Labs** require practice of high-level theory concepts as well as implementation practice via C++ (a new language to the students)
Lectures were reworked to include scaffolded, interactive, in-class activities.

Content delivery was partially replaced by these activities.

- Basic definitions were often introduced via activities.
- Focus of lectures became application of theory.
  - Labs then became only implementation practice, driven by theory learned in class.
The Activities

Two general types:

**Hands-On Content Delivery**
- Some or all of the material is new to the students
- Content delivered through step-by-step, exploratory-style questions

**Hands-On Content Practice**
- Given after the material is delivered in lecture
**IMPORTANT FIRST STEPS:**
1. Close your laptops and put them away (if necessary, you may refer to your course notes).
2. Form a group of 2-3 students.
3. Clearly put your names and IDs on 1 copy of this worksheet.
4. Be sure to turn this exercise in at the end of class.

**Hashing**

Today's exercises are all about hash tables and the notion of a mapping between keys and elements. Recall that a hash table is just a particular type of mapping where the key is passed through a hash algorithm that results in an index value into an array.

Let's get hashing!

Let's choose we have the following hash function: \( h(x) = \lfloor x / 10 \rfloor \)

And we use the following compression mapping: \( h(x) = x \mod 10 \)

**Advice for working in a group:**

First start by discussing the problem and making sure everyone in your group understands it. For this particular problem, if you have something you can stack (such as coins, or pieces of paper) it may be helpful, otherwise you can draw it out using pencil and paper.

Keep in mind that everyone learns/works a little differently--it may be helpful to give everyone a few minutes to work on the problem on their own, and then get back together to discuss it. Resist the urge to do it all on your own, though. Learning to discuss these sorts of problems at a high level will go a long way in helping you do well not only in this course, but in future courses, job interviews, and the jobs themselves!

Try to keep everyone involved, and don't be afraid to challenge the group with “what if” questions!

**What happened?**

This is what we call a collision. Apply the pigeonhole principle to describe a collision (What are the pigeons, what are the pigeonholes?):

**Procedure:**

```plaintext
procedure func_A(A: list)
do
  swapped := false
  for each i in 0 to length(A) - 2 do
    if A[i] > A[i+1] then
      swap(A[i], A[i+1])
      swapped := true
    end if
  end for
end if
while swapped
end procedure
```

```plaintext
procedure func_B(B: list)
do
  n := n - 1
  swapped := false
  for each i in 0 to n - 1 do
    if B[i] > B[i+1] then
      swap(B[i], B[i+1])
      swapped := true
    end if
  end for
while swapped
end procedure
```

As clearly and succinctly as possible, explain in plain English what `func_A` and `func_B` do:

**Complexity**
Retention

Hypothesis is that these activities will lead to greater retention and improved performance overall.

A pre-test was provided to the incoming Fall 2009 CPSC 320 students, whose intake consists of CPSC 221 students.

Results are preliminary...
### Fall 2009 Pre-Test Results

#### t-Test: Two-Sample Assuming Unequal Variances

<table>
<thead>
<tr>
<th>Activity content</th>
<th>Summer 2009</th>
<th>Spring 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>18.48*</td>
<td>13.79*</td>
</tr>
<tr>
<td># students</td>
<td>21</td>
<td>27</td>
</tr>
<tr>
<td>t Stat</td>
<td>2.6569</td>
<td></td>
</tr>
<tr>
<td>P(T&lt;=t) two-tail</td>
<td>98.92%</td>
<td></td>
</tr>
</tbody>
</table>

### Retention after one year (traditional course)

<table>
<thead>
<tr>
<th>Activity content</th>
<th>Summer–Fall 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>10.5*</td>
</tr>
<tr>
<td># students</td>
<td>21</td>
</tr>
</tbody>
</table>

*out of 34
Overall performance

<table>
<thead>
<tr>
<th></th>
<th>no activities</th>
<th>no activities</th>
<th>low activities</th>
<th>high activities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Summer 2007</td>
<td>Summer 2008</td>
<td>Spring 2009</td>
<td>Summer 2009</td>
</tr>
<tr>
<td>Final grade</td>
<td>71.77</td>
<td>78.92</td>
<td>72.98</td>
<td>76.24</td>
</tr>
<tr>
<td>Final exam</td>
<td>69.69</td>
<td>82.05</td>
<td>69.60</td>
<td>70.98</td>
</tr>
</tbody>
</table>
Conclusions

Students report **high enjoyment/utility** of in-class activities:

“More activities please!”

“These really helped me understand what I didn’t understand”

“These are a great study guide”

Longer term follow-up is needed

The summer 2009 term clearly outperformed spring 2009; awaiting final grades from spring 2010

Confounding factors need to be addressed