Project: Text Excel Part A

Introduction

The very first "killer app" for the personal computer that made it essential for business was VisiCalc[1]. It was a spreadsheet program that showed the number crunching prowess and automation capabilities of the personal computer. It moved the computer out of the hobbyist's home and into corporate America. The objective of this assignment will be to create a lightweight version of the spreadsheet program on the console window.

[1] Available: http://www.bricklin.com/history/vcexecutable.htm

Overview

A spreadsheet is a two dimensional series of cells indexed by column letters and row numbers. A letter followed by a number identifies cells within spreadsheets (e.g., "D13" or "F9"). The cell designated by "C2" means the third column (labeled "C") and the 2nd row, as in this partial printout of a spreadsheet:

```
    |A          |B          |C          |D
1   |           |           |           |
2   |           |           |(cell C2)  |
3   |           |           |           |
4   |           |           |           |
```

Your program will repeatedly accept commands from the user (to change values stored in cells, perform operations on cells, etc.), until the user types 'quit', at which point your program will end. After some commands, your program will re-print the updated spreadsheet, showing the changes caused by the user. Commands are described in detail later on in this document.

In Part B, some commands will specify not just a single cell, but "cell ranges". A cell range is a group of cells in a rectangular region. A1-B3, A1-A7 and A1-B1 are all valid cell ranges. Cell ranges always specify the two opposite corners of the rectangle of cells in the range, and for this project the upper-left corner always comes first as in the preceding examples. Details on which commands allow cell ranges are below in the Formulas section. Note that, in Part A, you will lay the groundwork for formulas, but formulas will not be evaluated until Part B.

Your spreadsheet will be able to store 3 major types of cells: empty, text, and real. All cells begin as empty cells. Text cells represent text strings that are input with double quotes but are printed on the screen without them. Real cells contain decimal numbers or percentages, and can have formulas in them. Details on these cells are provided later on in this document.

An example (partial) spreadsheet is shown below. The following shows non-empty cells in the sheet:

- C2: the text value "hello"
- C3: the real value 2.0
- D3: the real value 4.0
- A1: the percent value 3%
- F3: the average of cell C3 and D3, represented as (avg C3-D3)
- Cell range B5-E7 has been highlighted as an example cell range.

```
    |A          |B          |C          |D          |E          |F
1   |3%         |           |           |           |           |
2   |           |           |hello      |           |           |
3   |           |           |2.0        |4.0        |           |3.0
4   |           |           |           |           |           |
5   |           |           |           |           |           |
6   |           |           |           |           |           |
7   |               |          |          |          |          |
```

Specifications

Your spreadsheet will not have a GUI (Graphical User Interface) like Microsoft Excel, but will instead be more similar to VisiCalc and will be built into the console window. To ensure that our output will fit well within the console window, our spreadsheet will only be **12 columns (A-L) by 20 rows** (unlike the unlimited scrollable version of the modern Microsoft Excel spreadsheet program).

To facilitate design and testing aspects of the project, the starter project we provide will include interfaces for you to implement and test classes that your code must pass. The code you submit for each checkpoint and the final project must work with unmodified copies of those supporting files. More details on those interfaces and tests will appear later in this document.

Upon starting your spreadsheet program, an empty spreadsheet will be generated and displayed on the console. (See Examples section below.) After this, your program will enter a loop where it waits for a command, acts based on the command, and prints either the result of the command or the updated spreadsheet depending on the specific command. The program exits when the user enters quit.

As per the examples, each row of the spreadsheet must be numbered and each column lettered. Horizontally, cells needs to be separated by |'s and need to have equal length (**the width of each cell is 10 characters**, not including the | on each side). If the value doesn't fit, it is truncated in the display. The internal representation of a value should be complete; values should only be truncated while being displayed in the spreadsheet. The entire value should be used whenever it is displayed on the console via a command to display only that cell, or the cell is used for a calculation, whether or not it is truncated in the spreadsheet display.

Commands

The following table lists all the possible commands that the user may enter into the program to perform some actions. Note that commands, methods, cell references, and ranges are not case-sensitive (AVG, aVg, and avg all mean the same thing, as do A5 and a5). However both case and whitespace are important in text values:

- "`Hello`" is different from "`hello`"
- "`hi fi`" is different from "`hi    fi`".

After each command is executed, either the entire spreadsheet is re-printed, or a single value is printed. The table on the next page describes which to print.

Command	Examples	Action
<cell>	`B3`	Displays the content of the cell • Empty cell: Displays the empty string • Text cell: String content *with* enclosing quotes (though when the Text cell is displayed in the sheet, quotes are not shown) • Real cell: If the cell contains a **formula**, display the formula as it was entered by the user, including the outer parentheses (not the result of the formula). **Otherwise**, display the decimal value of the cell. • The entire table should *not* be displayed afterwards
<cell> = <*value*>	`F7 = “hi”` `B2 = ( avg B5-D6 )` `E9 = 5` `C2 = 4.5` `D1 = ( 2 * 7 / 3 )` `D2 = ( C2 + 1 )` `F5 = 6.2837%`	This sets the contents of the cell to the provided input and determines the type of the cell. In the examples shown, F7 would be a TextCell; B2, E9, C2, D1, D2, and F5 would each be a RealCell. • The entire table should be displayed afterwards
clear	`clear`	Clears all cells in the spreadsheet (i.e. makes them all EmptyCells) • The entire table should be displayed afterwards
clear <cell>	`clear H13`	Makes the specific cell empty • The entire table should be displayed afterwards
quit	`quit`	Quits the program. • The entire table should *not* be displayed afterwards

Text Cells

You **create** a TextCell when the assignment command specifies double-quotes around its value:

```
A1 = "zoopadawowow"
```

When the user **inspects** a TextCell, you print the complete value, with the double-quotes:

```
A1
```

causes you to print: `"zoopadawowow"`

When the **full spreadsheet prints**, the value is always truncated to fit inside the cell width.

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |zoopadawow|          |          |          |          |          |          |          |          |          |          |          |
```

Real Cells: Values, Percents, and Formulas

Real cells are the cells that hold numbers, and participate in calculations. You will implement three classes to implement these: *ValueCell*, *PercentCell*, and *FormulaCell*.

ValueCell

You **create** a ValueCell when the assignment command specifies a simple decimal value:

```
A1 = 8.42259265958979
```

When the user **inspects** a ValueCell, you print the complete value, to full precision:

```
A1
```
causes you to print: `8.42259265958979`

When the **full spreadsheet prints**, the value is always truncated to fit inside the cell width. Notice the value is *not rounded*, it's just truncated.

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |8.42259265|          |          |          |          |          |          |          |          |          |          |          |
```

PercentCell

You **create** a PercentCell when the assignment command specifies a decimal value followed by a %

```
A1 = 8.92259265958979%
```

When the user **inspects** a *PercentCell*, you print the complete value, to full precision, in decimal form (not percent form):

```
A1
```
causes you to print: `0.0892259265958979`

When the **full spreadsheet prints**, the value is always printed in percent form, and the decimal portion is truncated, not rounded.

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |8%        |          |          |          |          |          |          |          |          |          |          |          |
```

FormulaCell

You **create** a *FormulaCell* when the assignment command specifies an expression contained in parentheses:

```
A1 = ( 1 + B5 + 3 )
```

An arithmetic formula is an expression involving real (Java's `double`) constants, cell references, and the operators +, -, *, and /. Order of operations must either be strictly left-to-right (no operator precedence) for full credit, or for extension you may follow standard operator precedence rules. Numbers in formulas can only be doubles (not fractions).

If a formula contains a cell inside it, that is called a "reference" to the cell. When a cell that is referenced by a formula is changed, the change will affect the result displayed in the formula's cell. In the above example of `A1 = ( 1 + B5 + 3 )`, if B5 has the value 0.0, then A1 would be displayed in the spreadsheet as 4.0. But if B5 is later changed to 1.5, then A1 would change to display itself as 5.5. Circular references with formulas are not permitted and will not be tested.

A formula may also be a **method** formula, as in

```
B1 = ( AVG A2-A5 )
```

A method formula can only contain one method (either `SUM` or `AVG`) and cannot contain arithmetic operations.

Some example formulas are shown below.

Input Example	Action
`B3 = ( 4 * 6 + 3 )`	Assigns formula to cell B3, which displays 27.0 when evaluated.
`A9 = ( B3 * 6 + 3 )`	Assigns formula to cell A9, which when evaluated retrieves the value of cell B3, multiplies the retrieved value by 6, and adds 3.
`L14 = ( SUM B6-C12 )`	This formula calculates the sum of the values in cell range B6-C12.
`C12 = ( AVG A1-A5 )`	This formula calculates the average of the values in cell range A1-A5.

When you parse formulas entered by the user, note that formulas always start with a left parenthesis followed by a space, and that all operators and operands are separated from each other with a space, and that the formula ends with a space and then a right parenthesis. Although the formula is surrounded by parentheses, we will not allow parentheses inside the formula, and they will not be tested.

When the user **inspects** a *FormulaCell*, you print the complete formula, including the outer parentheses:

```
B1
```

causes you to print: `( AVG A2-A5 )`

In Part B, when the **full spreadsheet prints**, the formula will be evaluated, and the final value printed in the spreadsheet, truncated to fit inside the cell width. As always, the value is *not rounded*, it's just truncated.

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |          |13.5      |          |          |          |          |          |          |          |          |          |          |
```

Note that, in Part A, when the full spreadsheet prints, you may print any value you like for the *FormulaCell*, so long as it fits within the cell width, and is school appropriate.

Example

A short, basic code execution example is shown below. This is starting from the initial launch of the program. Lines entered by the user are shown below in **bold red**, larger than the program output.

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |          |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |          |          |          |          |          |          |          |          |          |          |          |          |
4  |          |          |          |          |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |          |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |


A1 = "Hello"
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |Hello     |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |          |          |          |          |          |          |          |          |          |          |          |          |
4  |          |          |          |          |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |          |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |

A1
"Hello"
```

B3 = 17

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |Hello     |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |          |17.0      |          |          |          |          |          |          |          |          |          |          |
4  |          |          |          |          |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |          |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |
```

A3 = "this is a really long string"

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |Hello     |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |this is a |17.0      |          |          |          |          |          |          |          |          |          |          |
4  |          |          |          |          |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |          |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |
```

A3

```
"this is a really long string"
```

C3 = 12

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |Hello     |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |this is a |17.0      |12.0      |          |          |          |          |          |          |          |          |          |
4  |          |          |          |          |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |          |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |
```

C4 = 9

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |Hello     |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |this is a |17.0      |12.0      |          |          |          |          |          |          |          |          |          |
4  |          |          |9.0       |          |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |          |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |
```

B4 = 103

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |Hello     |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |this is a |17.0      |12.0      |          |          |          |          |          |          |          |          |          |
4  |          |103.0     |9.0       |          |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |          |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |
```

D4 = (avg B3-C4)

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |Hello     |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |this is a |17.0      |12.0      |          |          |          |          |          |          |          |          |          |
4  |          |103.0     |9.0       |35.25     |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |          |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |
```

D3 = 0

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |Hello     |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |this is a |17.0      |12.0      |0.0       |          |          |          |          |          |          |          |          |
4  |          |103.0     |9.0       |35.25     |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |          |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |
```

F5 = (sum B3-D4)

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |Hello     |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |this is a |17.0      |12.0      |0.0       |          |          |          |          |          |          |          |          |
4  |          |103.0     |9.0       |35.25     |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |176.25    |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |
```

F5

```
( sum B3-D4 )
```

D4

```
( avg B3-C4 )
```

clear A3

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |Hello     |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |          |17.0      |12.0      |0.0       |          |          |          |          |          |          |          |          |
4  |          |103.0     |9.0       |35.25     |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |176.25    |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |
```

C3 = 1000

```
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |Hello     |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |          |17.0      |1000.0    |0.0       |          |          |          |          |          |          |          |          |
4  |          |103.0     |9.0       |282.25    |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |1411.25   |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |


clear
   |A         |B         |C         |D         |E         |F         |G         |H         |I         |J         |K         |L         |
1  |          |          |          |          |          |          |          |          |          |          |          |          |
2  |          |          |          |          |          |          |          |          |          |          |          |          |
3  |          |          |          |          |          |          |          |          |          |          |          |          |
4  |          |          |          |          |          |          |          |          |          |          |          |          |
5  |          |          |          |          |          |          |          |          |          |          |          |          |
6  |          |          |          |          |          |          |          |          |          |          |          |          |
7  |          |          |          |          |          |          |          |          |          |          |          |          |
8  |          |          |          |          |          |          |          |          |          |          |          |          |
9  |          |          |          |          |          |          |          |          |          |          |          |          |
10 |          |          |          |          |          |          |          |          |          |          |          |          |
11 |          |          |          |          |          |          |          |          |          |          |          |          |
12 |          |          |          |          |          |          |          |          |          |          |          |          |
13 |          |          |          |          |          |          |          |          |          |          |          |          |
14 |          |          |          |          |          |          |          |          |          |          |          |          |
15 |          |          |          |          |          |          |          |          |          |          |          |          |
16 |          |          |          |          |          |          |          |          |          |          |          |          |
17 |          |          |          |          |          |          |          |          |          |          |          |          |
18 |          |          |          |          |          |          |          |          |          |          |          |          |
19 |          |          |          |          |          |          |          |          |          |          |          |          |
20 |          |          |          |          |          |          |          |          |          |          |          |          |
Quit
```

Getting Started

You will create your TextExcel project using a procedure similar to what you used for your Fraction Calculator: We will provide you with a starter-project in class. This project will contain the interfaces you must implement, and the tests you will need to pass. The interfaces include:

- `Grid`, to be implemented by your Spreadsheet class
- `Cell`, to be implemented by all of your cell classes (EmptyCell, TextCell, RealCell, ValueCell, PercentCell, FormulaCell)
- `Location`, to be implemented by your SpreadsheetLocation class

Open up these files, look them over, and read the comments. They give a partial recipe on how you will design your classes, and also state what our tests require. ***Do not change these interfaces.***

If you have any questions about how your program should behave, look at the tests first, or try running the tests and see what prints as the "expected" output if they fail. If your checkpoints or final submissions are incompatible with the tests, they will not be graded. Ensure the appropriate tests run and pass before you submit.

Checkpoints

Note that the checkpoints are cumulative. When you submit each checkpoint, the submitted program should pass the details in the current checkpoint as well as all objectives in previous checkpoints. To facilitate testing, put all your classes in the project you imported (with the interfaces and tests).

Checkpoint 1: Main command loop, Spreadsheet, SpreadsheetLocation

In this checkpoint, you must hand in four Java source files:

- **Spreadsheet.java:** A class that implements part of the provided Grid interface, with correct implementations of the getRows() and getCols() methods. None of the other Grid methods will be tested in this checkpoint, so you may put in whatever dummy implementations you like as long as they compile.
    - Your Spreadsheet constructor should initialize a 2D array of cells with all elements containing EmptyCell objects.

- **SpreadsheetLocation.java**: A class that fully implements the Location interface, and contains a constructor taking a single String parameter (e.g., “D20”).

- **TextExcel.java:** A class with a main method that constructs a Spreadsheet, and has the command loop (reading commands, calling the spreadsheet’s processCommand method to process each line of input, printing the String returned from processCommand, repeating until “quit” is read). *This has already been provided for you*

- **EmptyCell.java:** A class that implements the provided Cell interface, and represents an empty cell. The implementations of both methods can be extremely simple.

Testing: You must pass all the tests in the provided Checkpoint1 class, plus you should ensure your program works as specified when run interactively.

Checkpoint 2: Assign and inspect TextCells, clear cells, and print sheet

For this checkpoint, you must do the following:

- Implement a **TextCell** class that implements the Cell interface. A TextCell stores string values.

- Implement the **getGridText**() method on your Spreadsheet class, to return a string containing the *entire sheet grid* in the form described in the spec. See below for a hint.

- Implement enough of the **processCommand** method on your Spreadsheet class to handle the following four commands:
    - **Cell inspection** (e.g., `A1`). This should return the value at that cell; see above for examples.

- o **Assignment to string values** (e.g., `A1 = "Hello"`). This should return the String of the entire sheet (reflecting the new cell assignment), as returned by getGridText().
- o **Clearing the entire sheet** (e.g., `clear`). This should return the String of the entire sheet (reflecting the clear command), as returned by getGridText().
- o **Clearing a particular cell** (e.g., `clear A1`). This should return the String of the entire sheet (reflecting the clear cell command), as returned by GetGridText().

Please break functionality up into different methods as appropriate.

- Implement the getCell method on the Spreadsheet class. The getCell method accepts a Location, and returns the Cell at that location. For this checkpoint, the Cell returned should either be an EmptyCell or a TextCell, depending on whether that cell was assigned a string value (or is empty). For future checkpoints, other types of Cells may get returned.

For this checkpoint, you do not need to support entering real-valued cells (decimal values, percents, or formulas).

Testing: You must pass all the tests in the provided Checkpoint2 class and previous tests.

Hints

- When you are parsing commands, you may find the *split* method (on the *String* class) useful. When you call *split* on a string, and give it a delimiter string, such as " " (i.e., a String with a space), it will return an array of Strings split up by the delimiter you passed in. For example:

```
String str ="Apple Banana Orange";
String[] arr = s.split(" ");
```

  will set arr to an array consisting of three strings: “Apple”, “Banana”, and “Orange”. There’s also an overload with a second parameter to set a limit on the number of strings returned, for example "Apple Banana Orange".split(" ", 2) will return an array consisting of two strings: “Apple” and “Banana Orange”.

- Your spreadsheet output from getGridText must match *exactly* what the test expects, including spaces. An easy way to see what is expected is to run this code in your main() *temporarily*

```
TestsALL.Helper th = new TestsALL.Helper();
System.out.println(th.getText());
```

  and then output your spreadsheet’s text immediately after so you can see how they line up.
    - *Note! Be sure to remove the above (and any other code you add to help yourself debug) before you submit to us! You must write your own grid formatting code.*

- When parsing cell identifiers (such as B3) you will need to convert the column letter (in this case B) into a column number. You may find code such as the following a useful way to do this. If you expect the column letter to appear at index i in the String str, you could use:

```
int colNumber = Character.toUpperCase(str.charAt(i)) - 'A';
```

  to grab the character at that index, and “subtract” ‘A’ from it, giving you 0 for ‘A’, 1 for ‘B’, etc. This works because the char data type stores characters as numbers, and all the capital letters appear together in alphabetical order.

- For cell inspection commands (such as A1), your processCommand method should use the fullCellText method on the Cell interface. The getGridText() method should use the abbreviatedCellText method on the Cell interface. abbreviatedCellText should return a String of length 10

Checkpoint 3: RealCell & getDoubleValue(), ValueCell, PercentCell, and FormulaCell (no parsing or calculating)

For this checkpoint, you must do the following:

- Implement a RealCell super class, that implements the Cell interface. In addition, create three subclasses that extend RealCell: ValueCell, PercentCell, and FormulaCell, as defined above in this document.

  The RealCell super class should also store the string representing what the user entered, in the same format you will print when the user asks to inspect a single cell. (For example, "5.8" for ValueCell, "0.02" for a PercentCell, and "(5 + 3 * A2)" or "(sum A6-B7)" for a FormulaCell.) It also needs a getDoubleValue method that returns the calculated value of the cell. The getDoubleValue method must be overridden in your ValueCell, PercentCell, and FormulaCell subclasses.

  However, for this checkpoint, getDoubleValue() only has to work correctly in ValueCell and PercentCell. In FormulaCell, it can return anything you want (for this checkpoint) as long as the program compiles and does not crash. **This means you do not have to parse formulas yet for this checkpoint – that will come in Part B.** However, the fullCellText method (from the Cell interface) must return the full formula if the cell is a formula. See hints below.

- Continue implementing the processCommand function, so that it handles
  - Percent assignment (e.g. `A1 = 5.2%`)
  - Real value assignment (e.g. `A1 = 5.2`, or `A1 = ( A2 + A3 * 4 )`, or `A1 = ( sum A1-D4 )`). Again, you do **not** need to parse formulas for this checkpoint; you just need to store them so they can be inspected.

- Note that for ValueCells and PercentCells, cell inspection commands (e.g. `A1`) and the full sheet (returned by getGridText()) should show the correct value.

- For FormulaCells, cell inspection commands should return the correct formula. But it does not matter what is printed within that cell when getGridText() is called (as long as the width of the cell continues to be 10 characters).

Testing: You must pass all tests in the Checkpoint3 class and previous tests.

Hint

Although PercentCell must extend RealCell, you may find it easier to do so indirectly (by extending ValueCell and overriding key portions of ValueCell). It is up to you to find the way you are most comfortable with.

Extensions

There are two opportunities for extensions. You can attempt either or both. ***It is recommended that you do the rest of the project first, and that you save a version of your project without the extensions (in case doing the extensions makes the rest of your program not work correctly).***

1. Command error handling

If the user enters an invalid command, an error (e.g. "ERROR: Invalid command.") should be printed to the display, no other action should be taken, and the program should wait for the next command. Make sure to consider all cases such as a user entering a command that does not exist, entering a cell that is outside of the spreadsheet, or otherwise not following the specified command format.

2. Command history

If the user types `history start n`, where n is a positive number, your program should keep track of the most recent *n* commands the user entered. When the user types `history display`, your program should display the most recent `n` commands the user entered, one per line, in descending order (most recent first, followed by next most recent, etc). If the user entered fewer than `n` commands up to this point, it should show all commands that the user entered so far. If the user types `history clear m`, where m is a positive number, it should clear the oldest `m` commands from the history. (If there are fewer than `m` commands in the history, it should clear all of them.) Finally, if the user types `history stop`, the program should clear the entire history and no longer keep track of commands the user entered (until the user enters the `history start n` command). The command history should not record history commands themselves (`history display`, etc).

For example, if the user first enters the following commands

```
History start 4
A1 = 1
A2 = 2
A3 = 3
B1 = 4
clear B1
B2 = 5
history display
```

Then your program should return the following from *processCommand:*

```
B2 = 5
clear B1
B1 = 4
A3 = 3
```

Then, if the user enters `history clear 2` and then types `history display` again, your program should return the following from *processCommand*:

```
B2 = 5
clear B1
```