

Last name _____

First name _____

LARSON—MATH 310—CLASSROOM WORKSHEET 15
The Vec and Mat Classes.

1. Set up your CoCalc JUPYTER notebook for today's work.
 - (a) Start the Chrome browser.
 - (b) Go to `https://cocalc.com`
 - (c) Log in.
 - (d) You should see an existing Project for our class. Click on that.
 - (e) Make sure you are in your Home directory (if you work in your Handouts directory, your work could get overwritten).
 - (f) Click “New”, then “Jupyter Notebook”, then call it **310-c15**.
 - (g) Make sure you have PYTHON as the *kernel*.

From: Chapter 2 of Klein's *Coding the Matrix* text

2. Go to your Handouts folder and copy the file “Vec_c15.py” to your Home directory. That has all our work from the last class, plus a working version of the `__repr__` method, which prints representations of objects in a Class, and a working `print` method. Open that.
3. Run/evaluate to import everything from that file to memory.

```
1 from Vec_15 import *
```

4. Make vectors \hat{v}, \hat{w} to test that it's working:

```
1 v = Vec({1,2},{1:3})
2 w = Vec({1,2},{1:5})
3 print(v)
4 print(w)
```

5. Try adding, scalar multiplication, etc. We now get the proper results, *and* get those results displayed.

From: Chapter 4 of Klein's *Coding the Matrix* text

6. Recall that we can view a matrix as a collection of (row number, column number) pairs, each associated to a real number (or any field element). So in that sense we could code a “matrix” (or think about a matrix) very similarly to how we thought about and represented vectors:

```
1 class Mat:
2     def __init__(self, labels, function):
3         self.D = labels
4         self.f = function
```

Example 4.1.3: Here is an example in which $R = \{'a', 'b'\}$ and $C = \{'\#', '@', '?'\}$:

	@	#	?
a	1	2	3
b	10	20	30

The column labels are given atop the columns, and the row labels are listed to the left of the rows.

Formally, this matrix is a function from $R \times C$ to \mathbb{R} . We can represent the function using Python's dictionary notation:

```
{('a', '@'):1, ('a', '#'):2, ('a', '?'):3, ('b', '@'):10, ('b', '#'):20,
```

7. Code, evaluate/run, and test:

```
1 M=Mat(({'a', 'b'}, {'@', '#', '?'}), {('a', '@'):1, ('a', '#'):2, ('a', '?')
      :3, ('b', '@'):10, ('b', '#'):20, ('b', '?'):30})
```

8. **(Quiz 4.1.8)** Write a one-line procedure `identity(D)` that, given a finite set D , returns the $D \times D$ identity matrix represented as an instance of `Mat`.

Dict-of-rows representation

Since I have said that each row of a matrix is a vector, we can represent each row by an instance of `Vec`. To map row-labels to the rows, we use a dictionary. I call this representation a *rowdict*. For example, the rowdict representation of the matrix of Example 4.1.3 (Page 187) is:

```
{'a': Vec({'@', '#', '?'}, {'@':1, '#':2, '?':3}),
 'b': Vec({'@', '#', '?'}, {'@':10, '#':20, '?':30})}
```

9. Code, evaluate/run, and test:

Quiz 4.1.9: Write a one-line procedure `mat2rowdict(A)` that, given an instance of `Mat`, returns the rowdict representation of the same matrix. Use dictionary comprehensions.

```
>>> mat2rowdict(M)
{'a': Vec({'@', '#', '?'}, {'@': 1, '#': 2, '?': 3}),
 'b': Vec({'@', '#', '?'}, {'@': 10, '#': 20, '?': 30})}
```

Hint: First write the expression whose value is the row r `Vec`; the F field's value is defined by a dictionary comprehension. Second, use that expression in a dictionary comprehension in which r is the control variable.

Dict-of-columns representation of M

```
{'#': Vec({'a','b'}, {'a':2, 'b':20}),  
'@': Vec({'a','b'}, {'a':1, 'b':10}),  
'?': Vec({'a','b'}, {'a':3, 'b':30})}
```

10. Code, evaluate/run, and test:

Quiz 4.1.10: Write a one-line procedure `mat2coldict(A)` that, given an instance of `Mat`, returns the coldict representation of the same matrix. Use dictionary comprehensions.

```
>>> mat2coldict(M)  
{'@': Vec({'a', 'b'},{'a': 1, 'b': 10}),  
'#': Vec({'a', 'b'},{'a': 2, 'b': 20}),  
'?': Vec({'a', 'b'},{'a': 3, 'b': 30})}
```

Getting your classwork recorded

When you are done, before you leave class...

- Click the “Print” menu choice (under “File”) and make a pdf of this worksheet (html is OK too).
- Send me an email (clarson@vcu.edu) with an informative header like “Math 310 - c15 worksheet attached” (so that it will be properly recorded).
- Remember to attach today’s classroom worksheet!