Lincoln Financial Group®

You're In Charge®

Summer 2017

End of Summer Presentation

Davis Vaughan

Actuarial Development Intern

Asset Liability Management

[Audience Disclosure]

WHO AM I?

- **Master's student at UNC Charlotte**
  - Mathematical Finance
- **ALM intern**
  - Asset – Patrick Lokken
  - Liability – Wen Li
- **I really like R**

WHAT CAN R DO FOR LINCOLN?

- **Dashboards**
  - Analyzing portfolio book value and yield data
  - Visualizing cash flows
- **Speed**
  - IRR calculations
  - Direct database connections
- **Predictive analytics**
  - Predicting worst 10% of scenarios from 2000
- **Visualizations**
  - Waterfall graph creator
  - Branded charts
- **MG-ALFA**
  - Input efficiency
  - Atb2 file generation
- **Miscellaneous analyses**
  - Copying / renaming 1500 files
  - Complex data manipulation

DASHBOARDS

Interactive reporting using R and Shiny

- ***Project:***
  - Visualize 50 years of forecasted book value and yield data for a set of 60 Lincoln portfolios
  - Create an automated process for cleaning, performing calculations, and loading the data into the dashboard
  - Make the analysis easy to run next quarter with new data

DASHBOARDS

Interactive reporting using R and Shiny

- ***Project:***
  - Visualize 50 years of forecasted book value and yield data for a set of 60 Lincoln portfolios
  - Create an automated process for cleaning, performing calculations, and loading the data into the dashboard
  - Make the analysis easy to run next quarter with new data
  - I could explain further, or…

DASHBOARDS

Interactive reporting using R and Shiny

- ***Benefits:***
  - *Very little work* – Raw output from ALFA is dumped in a folder each quarter
  - *Maintain history* – Compare multiple years of projections as opposed to just two

DASHBOARDS

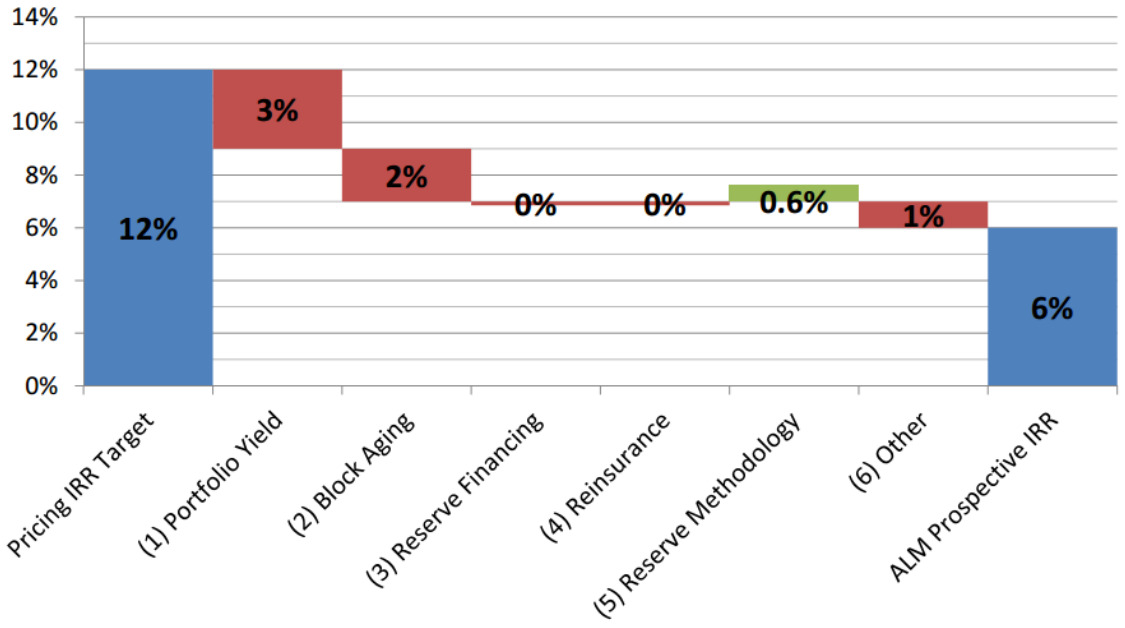
Visualizing cash flows

- ***Project:***
  - *tbc*

VISUALIZATIONS

Waterfall graphs

- Loved by senior management
- Difficult to create
- Not all that appealing…



VISUALIZATIONS

Waterfall graphs – Let R do the work for you

- Pass in Excel data that looks like this:

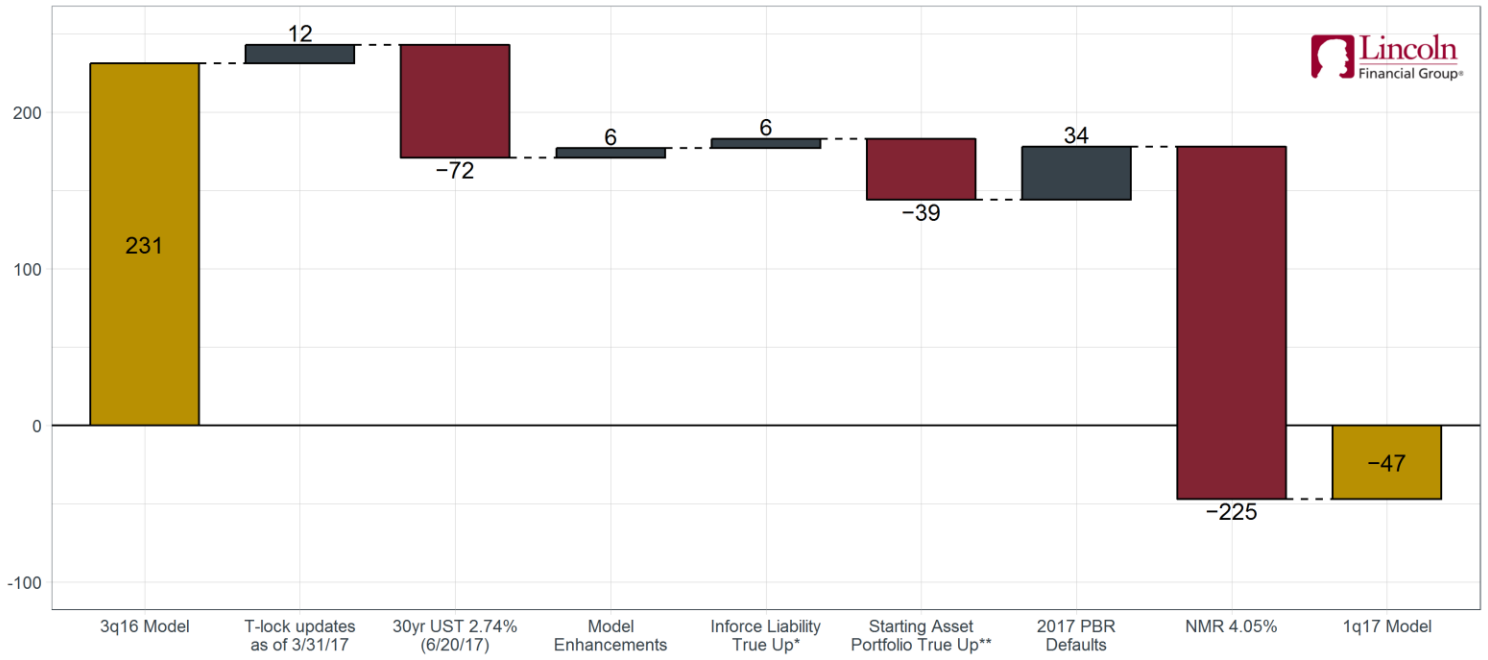
X Axis Label	Value
3q16 Model	231
T-lock updates as of 3/31/17	12
30yr UST 2.74% (6/20/17)	-72
Model Enhancements	6
Inforce Liability True Up*	6
Starting Asset Portfolio True Up**	-39
2017 PBR Defaults	34
NMR 4.05%	-225
1q17 Model	-47

- Call the waterfall function: lfg_waterfall(*data*)

VISUALIZATIONS

Waterfall graphs – Let R do the work for you

- With a little more effort…



SPEED

IRR calculations

- ***Project:***
  - Calculate IRR for 2400 potential economic scenarios
    - 12 Lincoln products, 200 scenarios each
    - 40 years of predicted distributable earnings per scenario (cash flows)
    - 1 GAAP Equity value per product (initial investment)
  - Calculation has too many conditions for Excel's IRR function. Goal Seek needed.

SPEED

IRR calculations

- ***Project:***
  - Calculate IRR for 2400 potential economic scenarios
    - 12 Lincoln products, 200 scenarios each
    - 40 years of predicted distributable earnings per scenario (cash flows)
    - 1 GAAP Equity value per product (initial investment)
  - Calculation has too many conditions for Excel's IRR function. Goal Seek needed.
  - **3 hours** to run all 2400 scenarios
  - Can R do this faster?

SPEED

IRR calculations

- ***Solution:***
  - Optimization problem – For each of the 2400 scenarios, minimize:
    - PV(distributable earnings) – GAAP_equity
    - By varying the IRR to discount with
    - Use the R function, optimize()

SPEED

IRR calculations

- ***Solution:***
  - Optimization problem – For each of the 2400 scenarios, minimize:
    - PV(distributable earnings) – GAAP_equity
    - By varying the IRR to discount with
    - Use the R function, optimize()
  - 3 hours -> **9 seconds in R**
  - Calculations are *vectorized* and run *in parallel*
  - Report generated at the end of each run

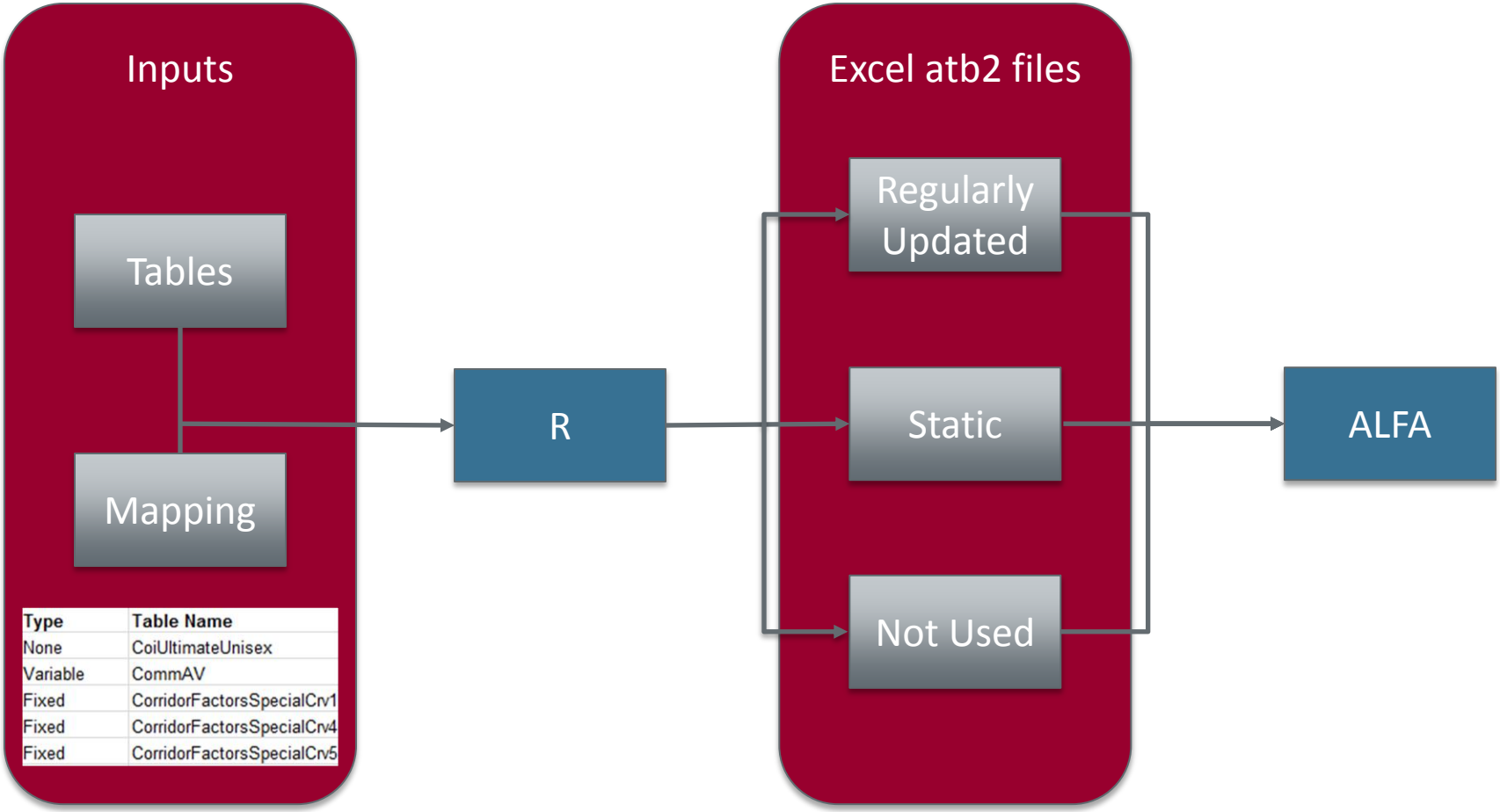
MG-ALFA

Input efficiency

- ***Project:***
  - *Efficiency* – Each line of business has 1 atb2 file containing model assumptions
    - Some assumptions are updated regularly, others are never touched
    - Separate updated tables from static tables to make assumption updating easier
  - *Flexibility*
    - Needs to work for multiple lines of business
    - Iterative process

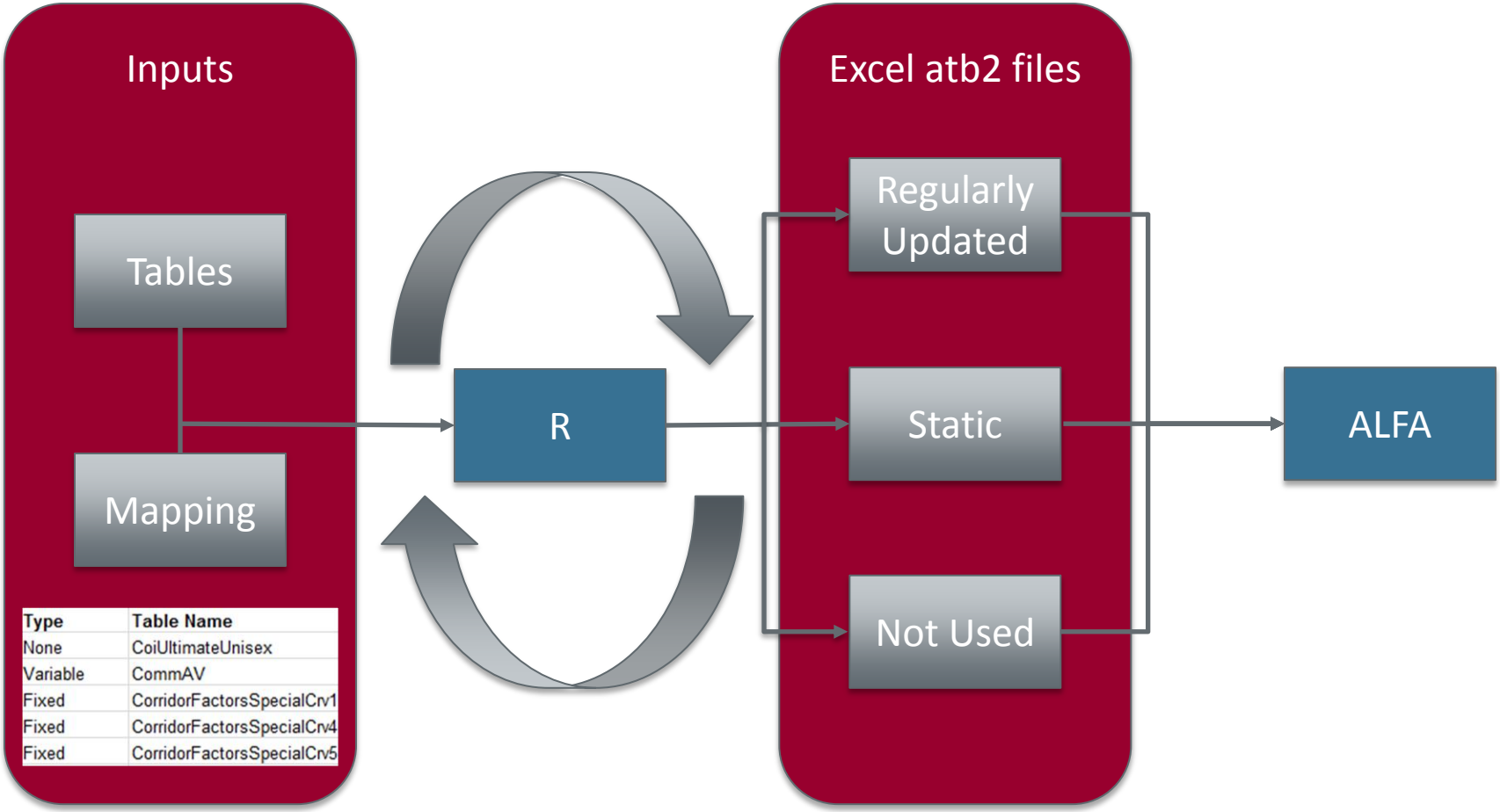
MG-ALFA

Input efficiency



MG-ALFA

Input efficiency



SPEED

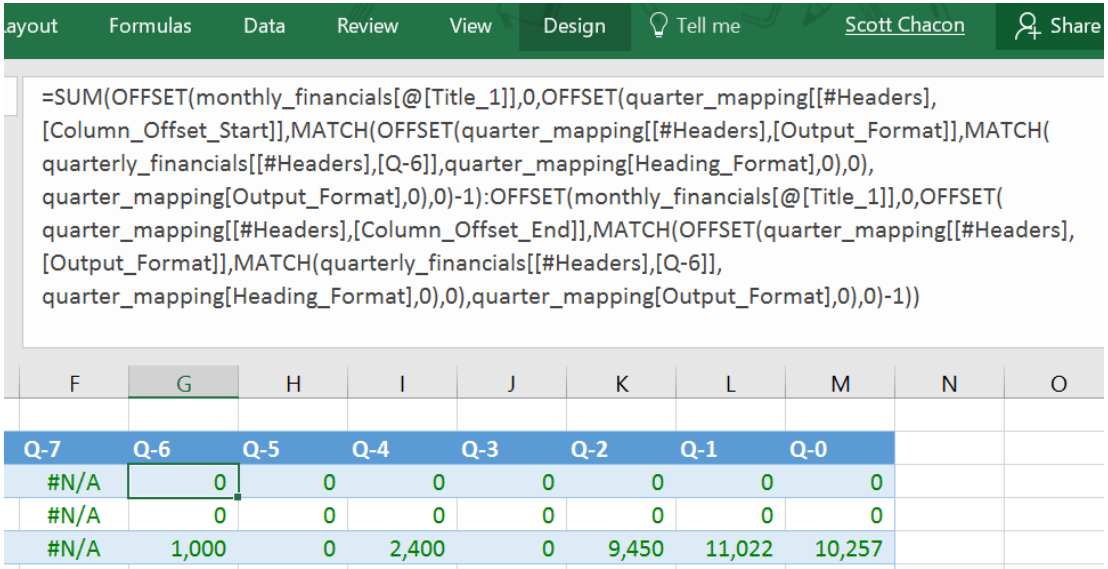
Direct connections to databases

- ***Project:***
  - Tackling a problem we all have. Working with databases from Excel/VBA isn't fun.
  - Great support in R for connecting to *any* type of database
    - There just needs to be a "SQL translation"
    - Added that SQL translation for Access
  - Let's have some fun

SPEED

Direct connections to databases

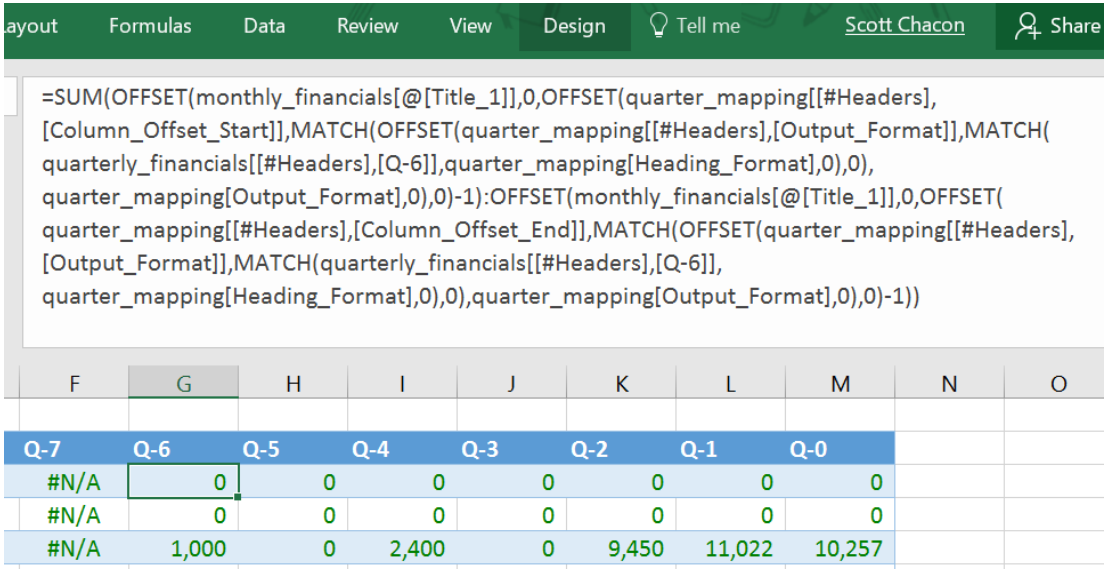
- ***Benefits:***



SPEED

Direct connections to databases

- ***Benefits:***



F	G	H	I	J	K	L	M	N	O
Q-7	Q-6	Q-5	Q-4	Q-3	Q-2	Q-1	Q-0		
#N/A	0	0	0	0	0	0	0		
#N/A	0	0	0	0	0	0	0		
#N/A	1,000	0	2,400	0	9,450	11,022	10,257		

WHY DO I CARE SO MUCH?

SOA Predictive Analytics Exam for ASA's

Predictive Analytics Exam—November or December 2018

IMPORTANT NOTICE – This version of the syllabus is presented for planning purposes. The syllabus for this exam administration is not considered official until it is posted on the Predictive Analytics (PA) Exam home page approximately six months before the exam administration. This is especially true for this exam as many of the details regarding the assessment need to be finalized.

The Predictive Analytics exam is administered as a five-hour project requiring analysis of a data set in the context of a business problem and submission of a report. Candidates will have access to a computer equipped with Microsoft Word, Microsoft Excel, and RStudio. The report will be submitted electronically. For additional details, please refer to Exam Rules (a link will be provided once specific rules for this assessment are established).

- ***Big picture:***
  - *At Lincoln you are going to have an influx of interns with these skills!*


THANK
YOU