Sparse Linear System Solvers Comparison

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Course: *Methods of Scientific Calculus*

1.
PROBLEM

WHICH IS THE BEST TOOL TO SOLVE SPARSE LINEAR PROBLEMS WITH **CHOLESKY DECOMPOSITION**?

Windows or Linux?

We'll test both.

WHICH IS THE BEST TOOL TO SOLVE SPARSE LINEAR PROBLEMS WITH **CHOLESKY DECOMPOSITION**?

MATLAB or some other open source software?

We'll try out:

- C++
- Python

2.
CHOLESKY AVAILABLE LIBRARIES

MATLAB

MATLAB has built-in capabilities to solve sparse linear problems using the Cholesky method.

As you can find here, whenever you do `x = A \ B` (where A and B are matrices of equal number of rows), MATLAB internally operates a resolution choice based on matrices shapes and symmetries, that always gives the optimal solver, thus the minimum computation time.

C++

PYTHON

3.
COMPARISON TESTS

SAMPLES

All tests you can find in this presentation are made solving the equation Ax = b, where b is chosen for having the exact solution composed as xe = [1 1 1 1 1...]. In other words, b = A * xe.

SAMPLES

All input sample are positive-definite and symmetric matrices that come from the SuiteSparse Matrix Collection.

In particular, the following matrices have been used:

- ex15
- shallow_water1
- cfd1
- cfd2
- parabolic_fem
- apache2
- StocF-1465
- Flan_1565
- G3_circuit

PERFORMANCES

In order to declare the best library and operating system that fit your needs, we have developed some scripts you can find in this GitHub repository.

For each library, we'll consider three performances:

- Resolution Time
- Used Memory
- Relative Error

ENVIRONMENTS

We'll soon present the results of our study. We ran our tests on Azure Virtual Machines.

The following are both the Windows and Linux virtual machines technical specifications:

- 8 VCPUs
- 56 GB of RAM

We used Ubuntu 18.04 and Windows 10 Pro 1803.

4.
RESULTS

SOME NOTES

We ran MATLAB and Eigen scripts both on Windows and Linux, while Scikit-Sparse was only tested on Linux, because of the impossibility of installing it on Windows. Specifically, we had problem obtaining SuiteSparse library and compiling cholmod.h to run it with Python.

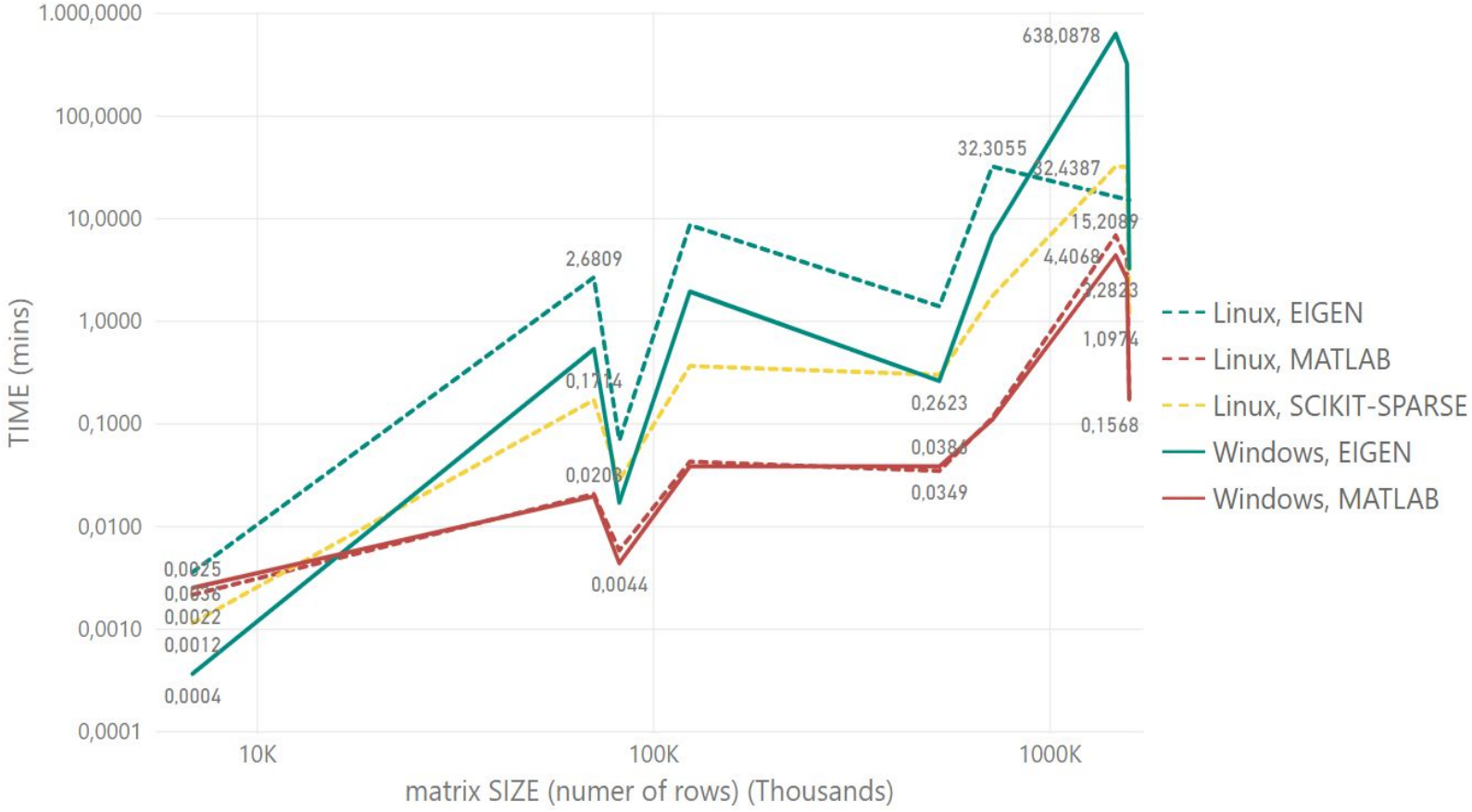
Also, you will notice that some value are missing for the two largest matrices with C++ Eigen library.

SOME NOTES

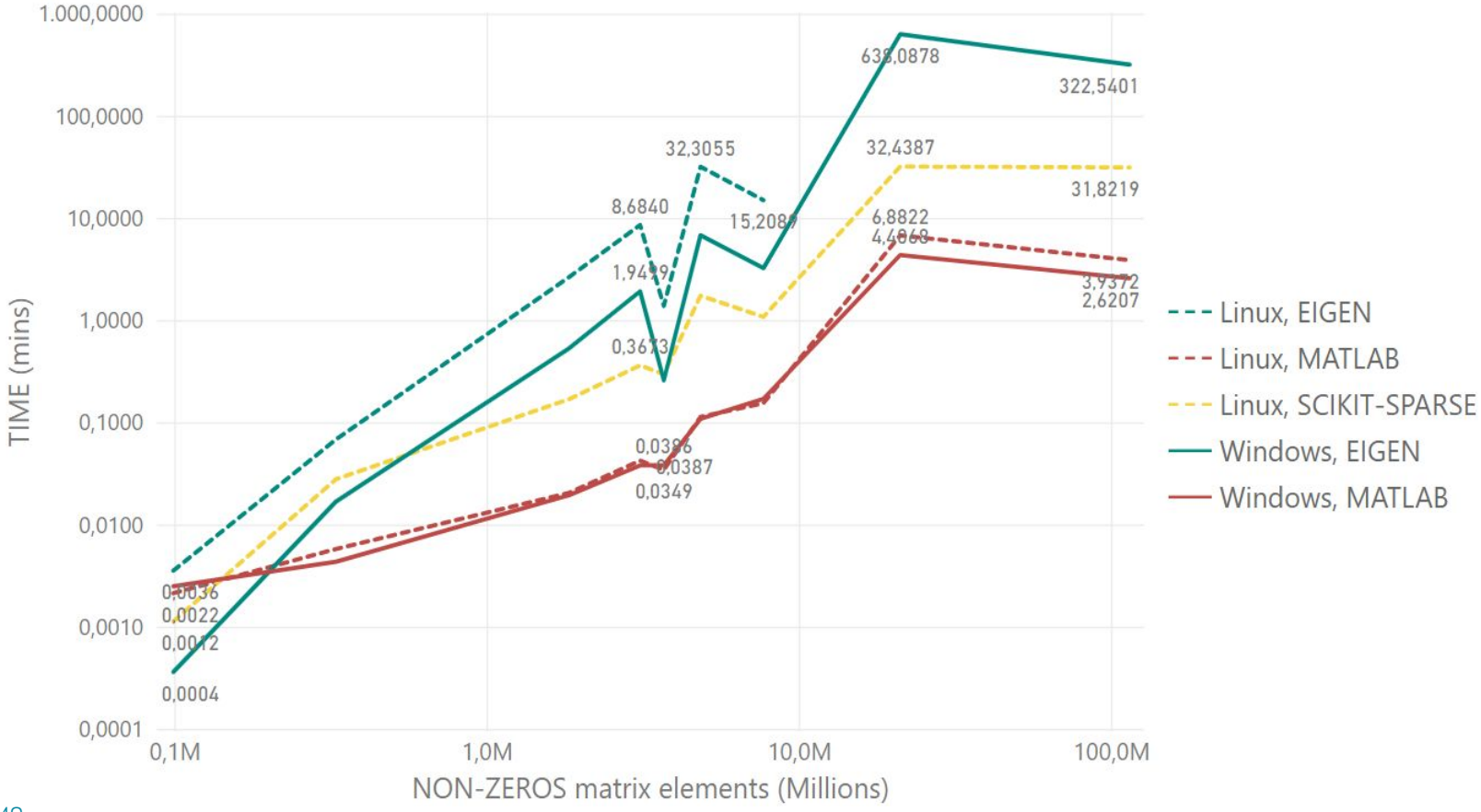
Although the first idea of plotting some matrices resolution result charts could be to put the matrix size on the X-axis, the most natural way to present this type of data for **sparse matrices** is to consider, for the abscissa, the number of non-zero elements that appear in each matrix.

However, we'll show you both size and non-zeros based charts.

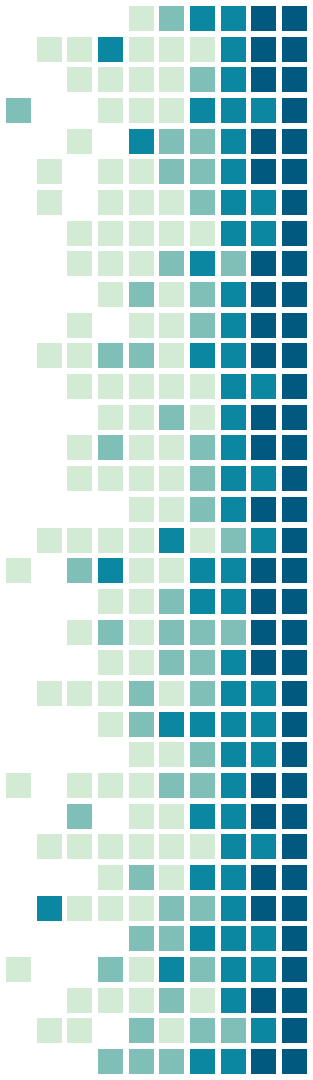
RESOLUTION TIME BY MATRIX SIZE



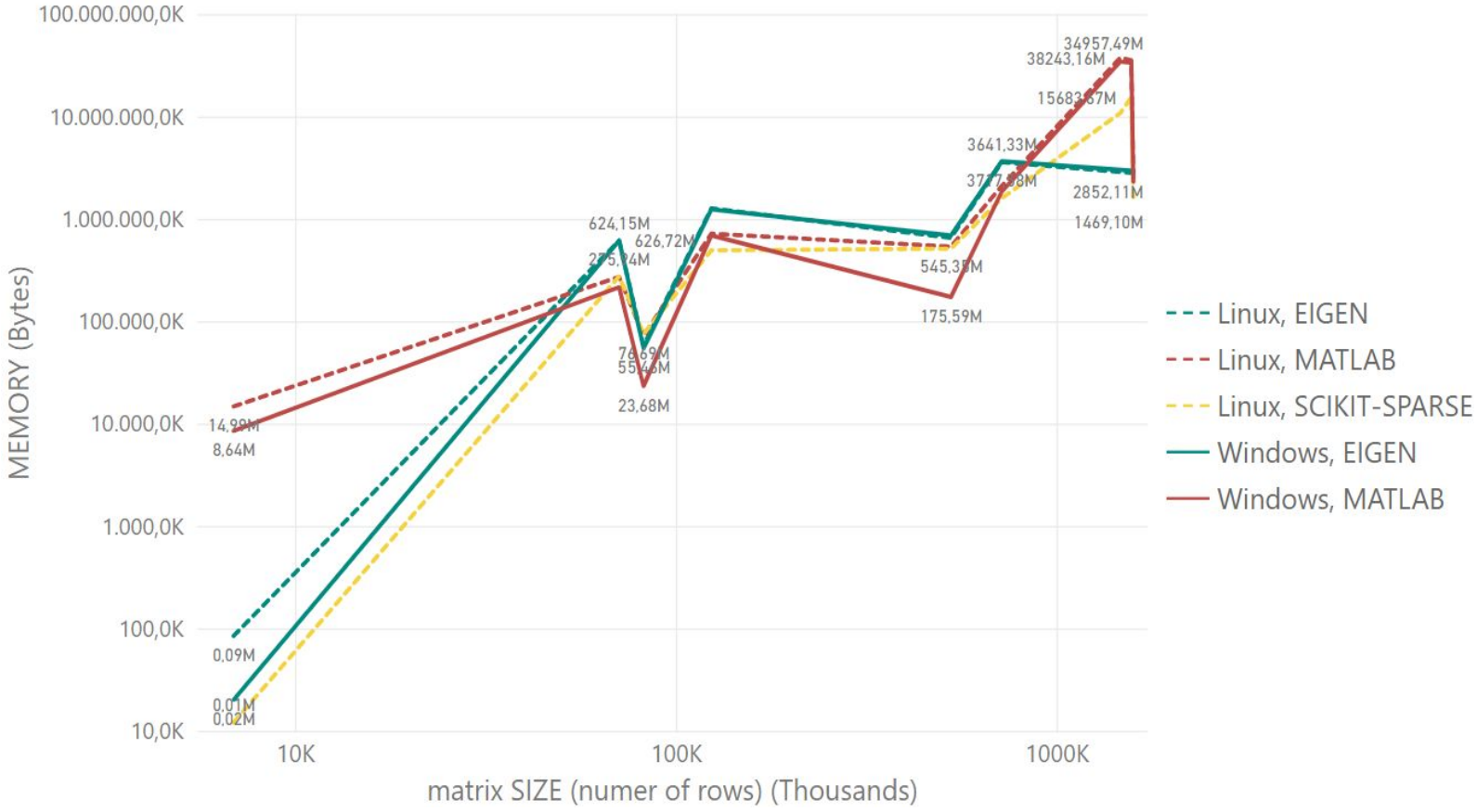
RESOLUTION TIME BY MATRIX NON-ZEROS ELEMENTS



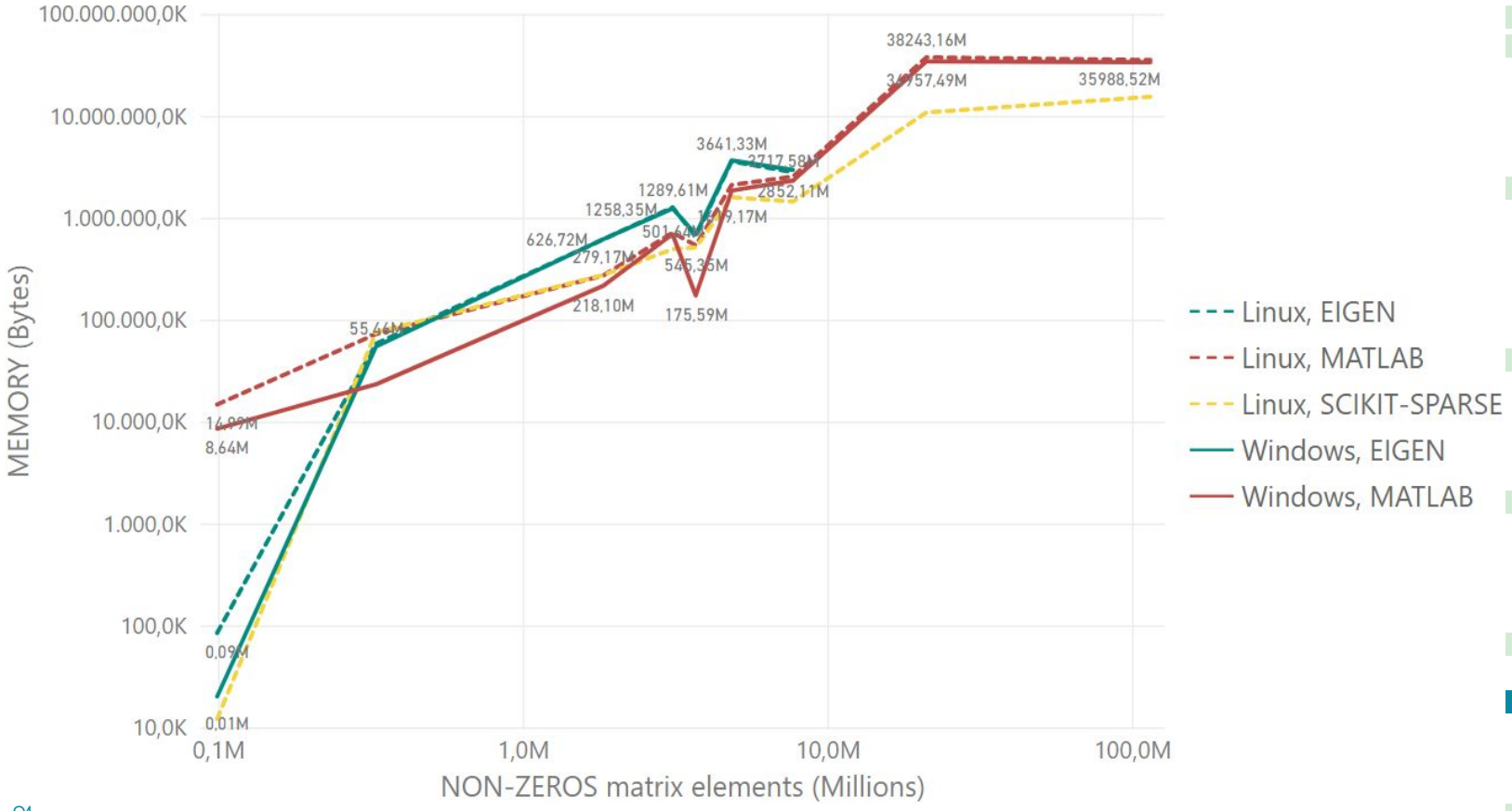
RESOLUTION TIME CONSIDERATIONS



MEMORY BY MATRIX SIZE

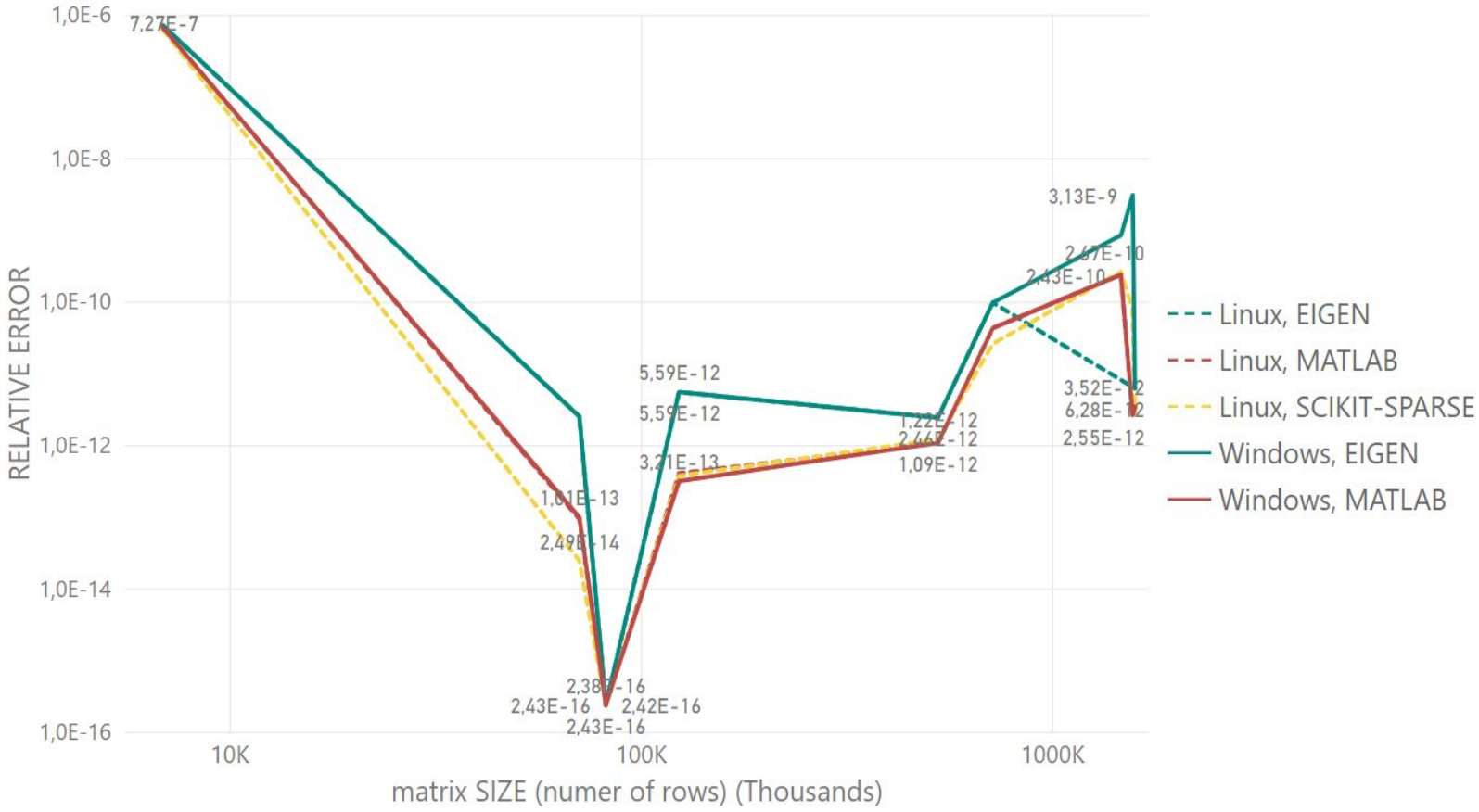


MEMORY BY MATRIX NON-ZEROS ELEMENTS

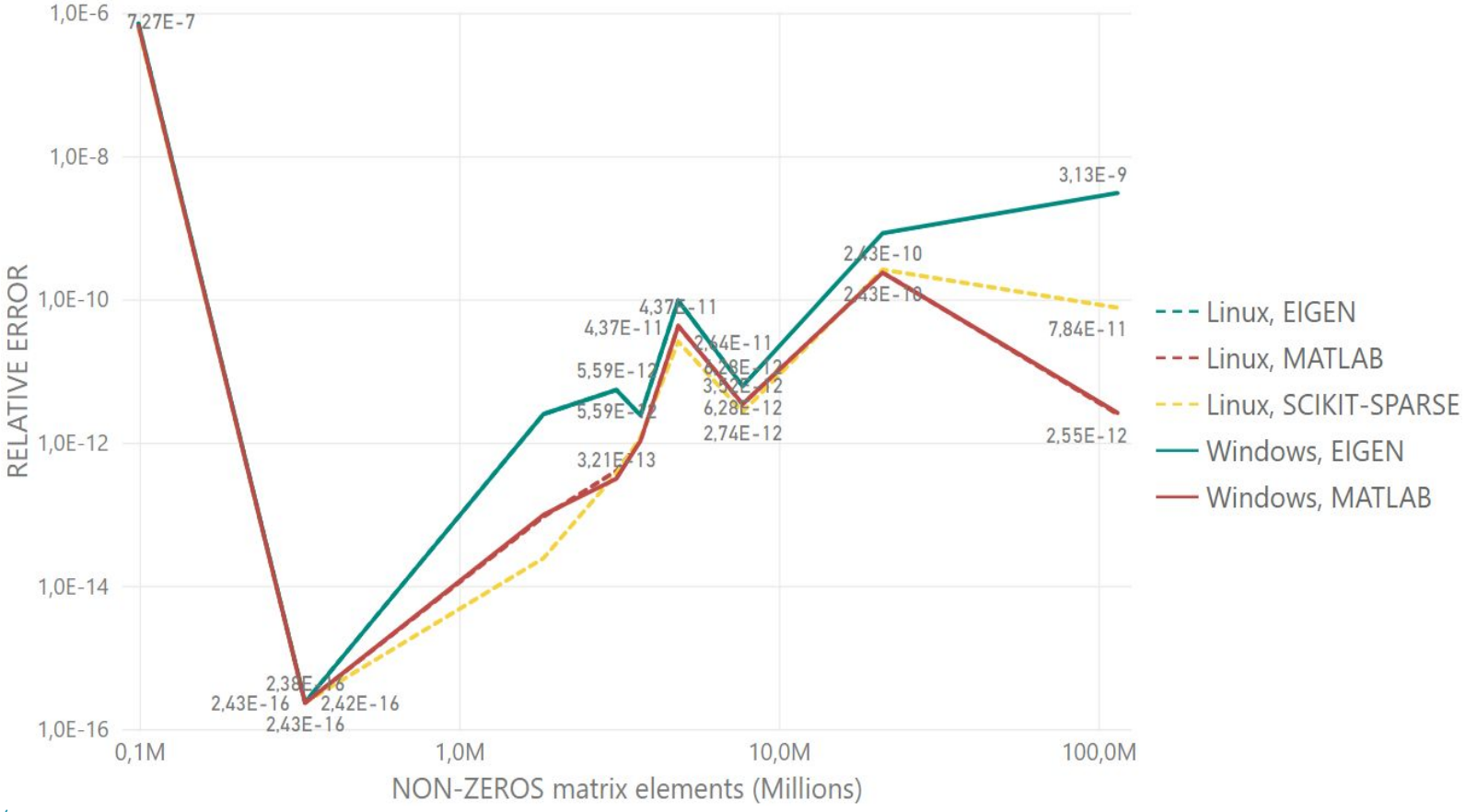


MEMORY CONSIDERATIONS

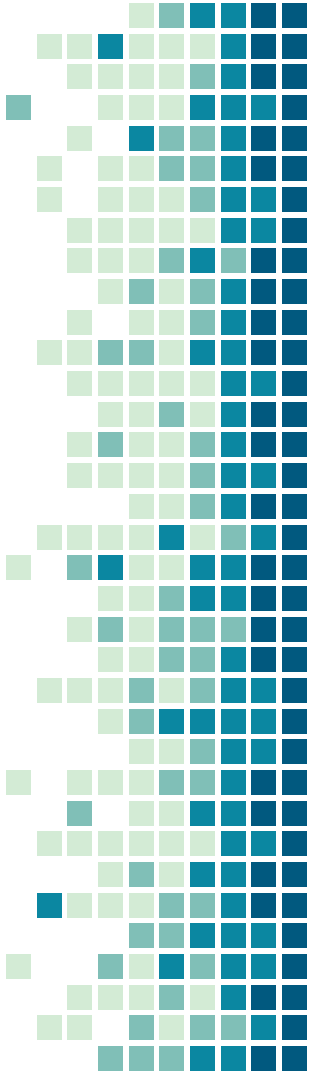
RELATIVE ERROR BY MATRIX SIZE



RELATIVE ERROR BY MATRIX NON-ZEROS ELEMENTS



RELATIVE ERROR CONSIDERATIONS



5. CONCLUSIONS

CONCLUSIONS

Lorem ipsum dolor sit amet.

THANKS!

Any questions?

You can find us at:

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n.habbash@campus.unimib.it

https://github.com/dodicin/slss-comparison-test

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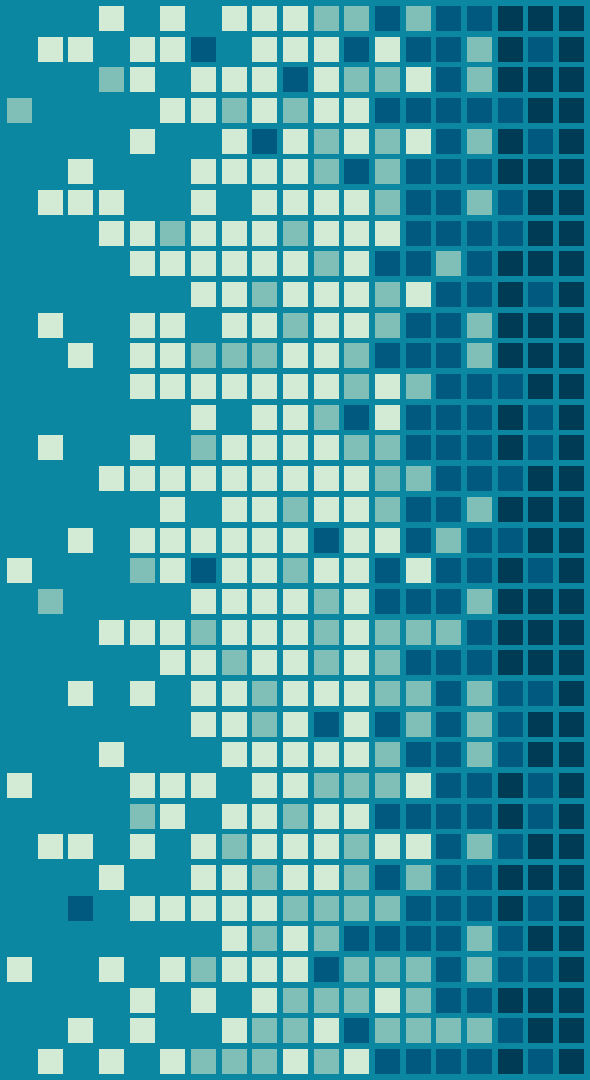
1.
TRANSITION HEADLINE

Let’s start with the first set of slides

“Quotations are commonly printed as a means of inspiration and to invoke philosophical thoughts from the reader.



THIS IS A SLIDE TITLE

- Here you have a list of items
- And some text
- But remember not to overload your slides with content

Your audience will listen to you or read the content, but won’t do both.

BIG CONCEPT

Bring the attention of your audience over a key concept using icons or illustrations

YOU CAN ALSO SPLIT YOUR CONTENT

White

Is the color of milk and fresh snow, the color produced by the combination of all the colors of the visible spectrum.

Black

Is the color of coal, ebony, and of outer space. It is the darkest color, the result of the absence of or complete absorption of light.

IN TWO OR THREE COLUMNS

Yellow

Is the color of gold, butter and ripe lemons. In the spectrum of visible light, yellow is found between green and orange.

Blue

Is the colour of the clear sky and the deep sea. It is located between violet and green on the optical spectrum.

Red

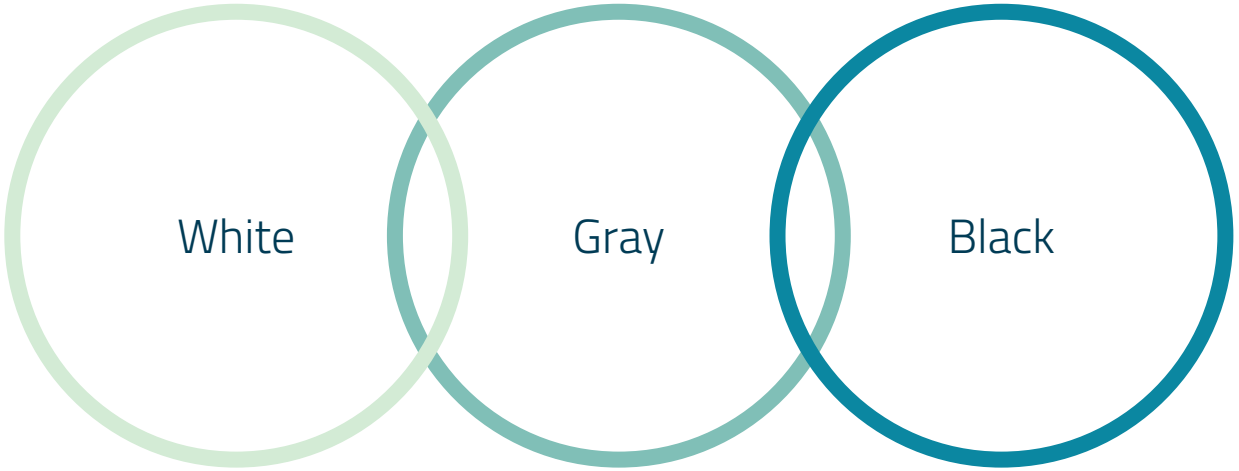
Is the color of blood, and because of this it has historically been associated with sacrifice, danger and courage.

A PICTURE IS WORTH A THOUSAND WORDS

A complex idea can be conveyed with just a single still image, namely making it possible to absorb large amounts of data quickly.

Want big impact?
Use big image.

USE CHARTS TO EXPLAIN YOUR IDEAS



AND TABLES TO COMPARE DATA

	A	B	C
Yellow	**10**	**20**	**7**
Blue	**30**	**15**	**10**
Orange	**5**	**24**	**16**

MAPS

89,526,124

Whoa! That’s a big number, aren’t you proud?

89,526,124$

That’s a lot of money

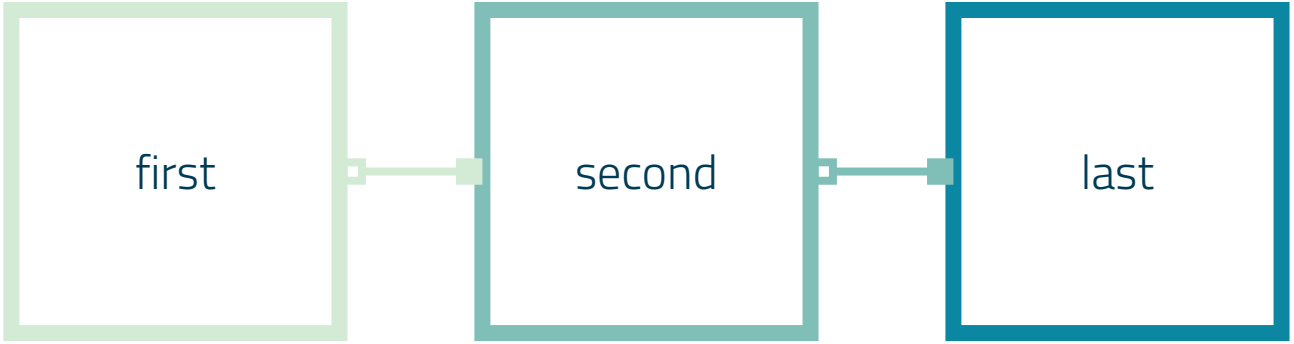
185,244 users

And a lot of users

100%

Total success!

OUR PROCESS IS EASY



LET'S REVIEW SOME CONCEPTS

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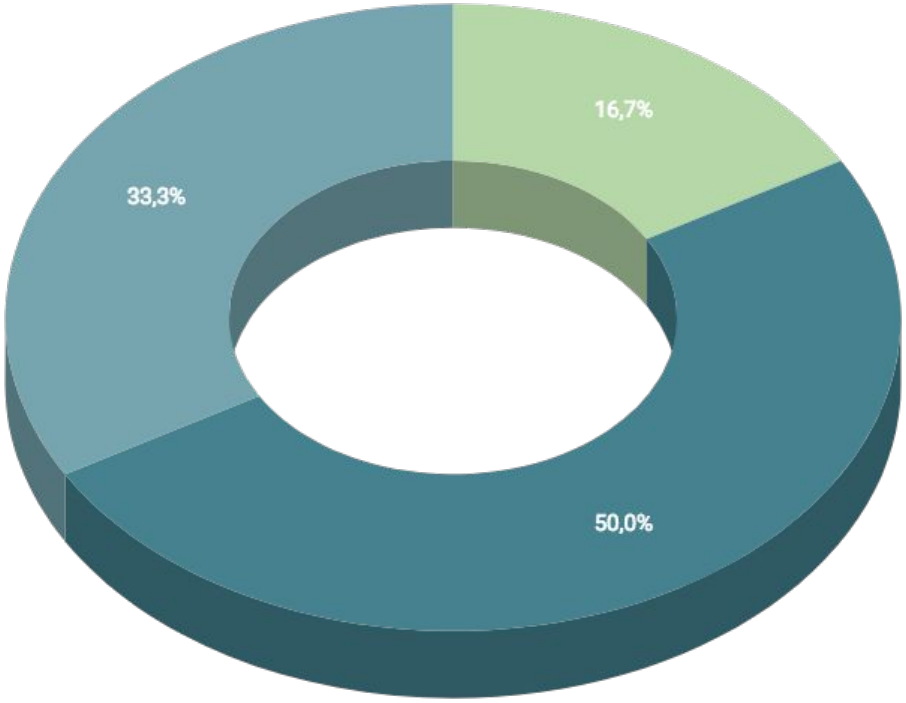

You can insert graphs from Google Sheets

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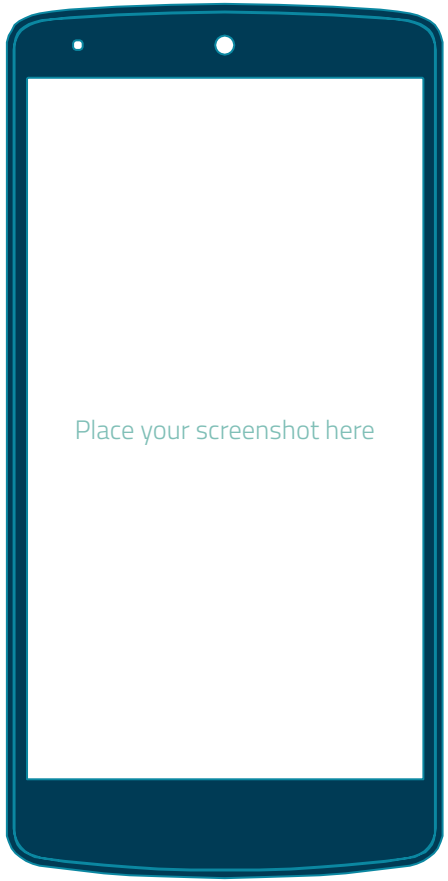

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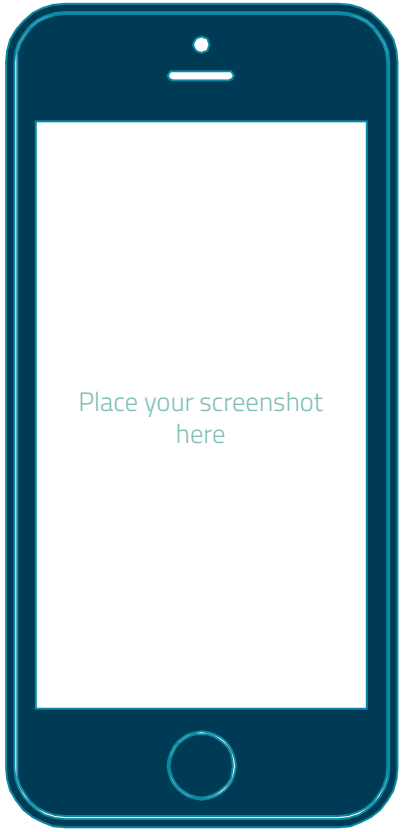

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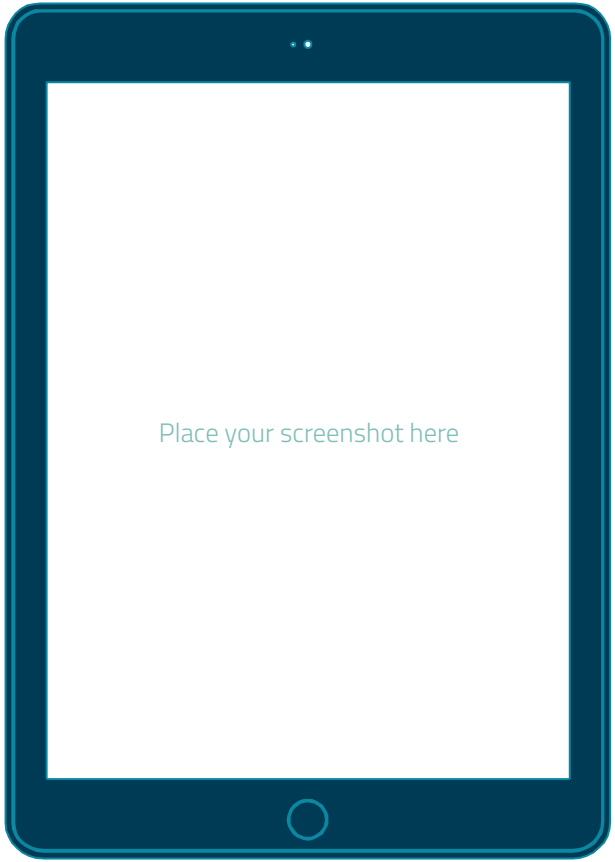

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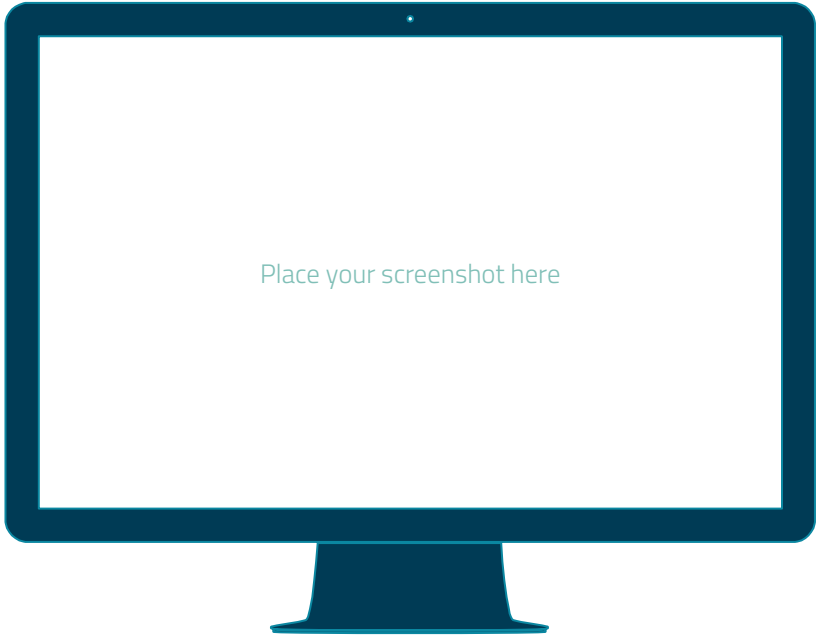

THANKS!

Any questions?

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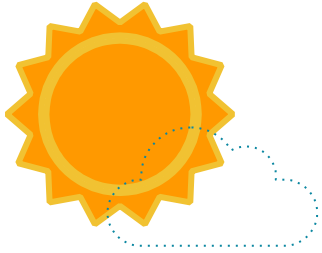

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