

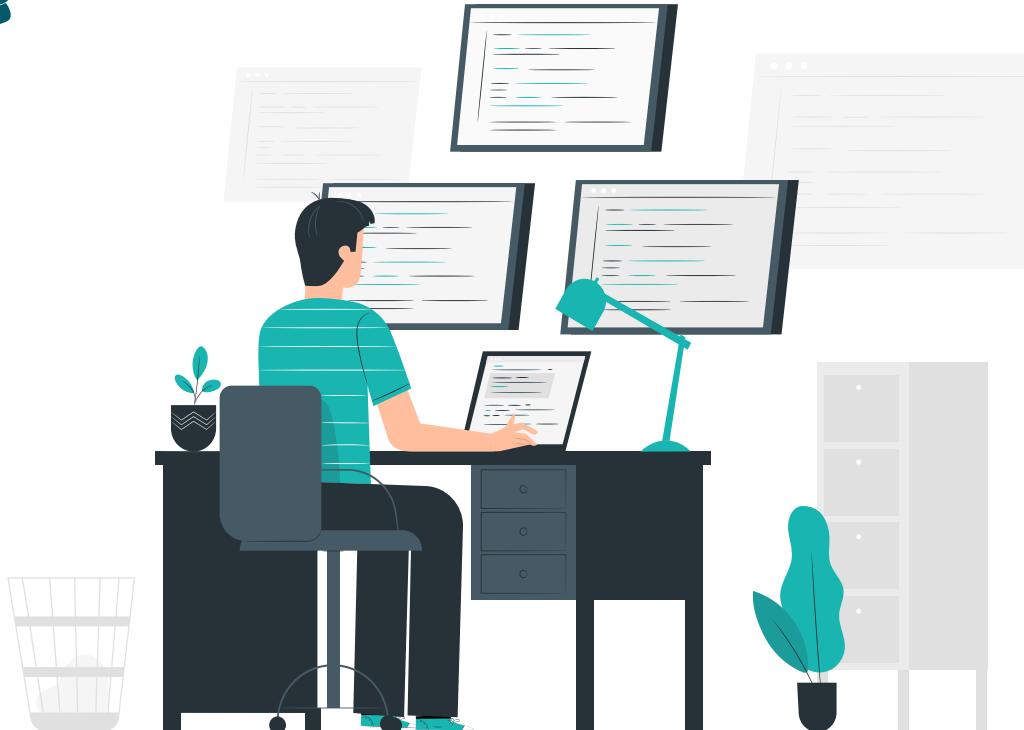
# *Practical tips for Master of Science Dissertation*



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# *Practical tips for* **Master of Science Dissertation**

## **Introduction**

Vocabulary...  
M.Sc. vs PhD...  
Engineering process  
Decisions and maturity

## **State-of-Art (SoA)**

What, how, ...  
Do's, Don't's  
Taxonomy  
References...

## **Dazzle!**

Kahoot

## **Evaluation(s)**

M.Sc.  
Tips & Warnings...  
After success ;) ...

## **Working Tips**

Supervisor & Meetings

## **F.A.Q. & Tips**

Power Engineer  
Work approach

## **Dazzle!**

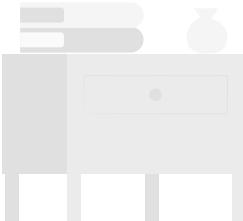
Kahoot



# **INTRODUCTION**

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## **Vocabulary**



*"A man who does not plan long ahead  
will find trouble at his door."*

**Confucius**

# Vocabulary



## Engineering

*ingenium*, "cleverness"  
*ingeniare*, "devise"

## Dissertation in company environment

[Dissertação em Ambiente Empresarial (DAE)]

~~Internship (estágio)~~

Same as all others M.Sc.

## Master of Science (M. Sc.) (Mestrado)

Dissertation  
(not a thesis)



# M.Sc. vs. Ph.D.

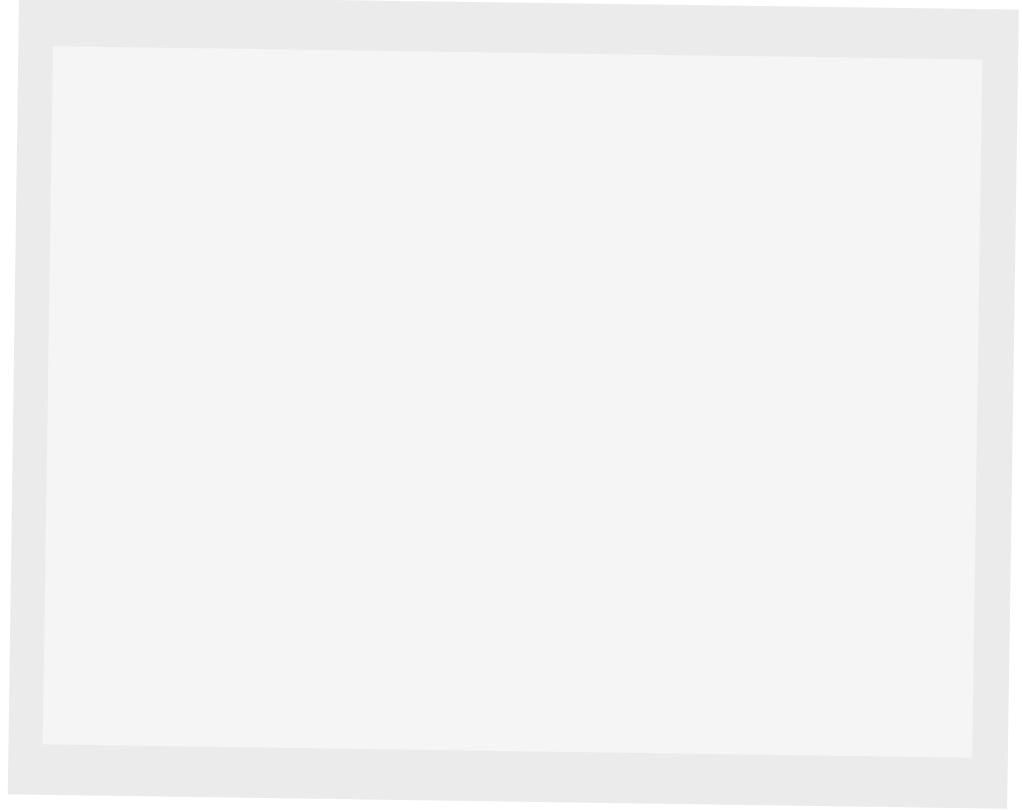
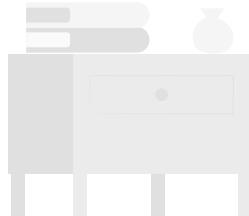
- M.Sc. - Proficiency in Engineering (dissertation)
- Ph.D. - Philosophiae Doctor [Doutoramento] - Innovation (thesis)
- Fullano, PhD [Doutor Fullano]
- Prof. Fullano (*teacher is for secondary school*)
- Fullano, M.D. - Medical Doctor (Dr. Fullano)
- Full Professor - Professor Catedrático



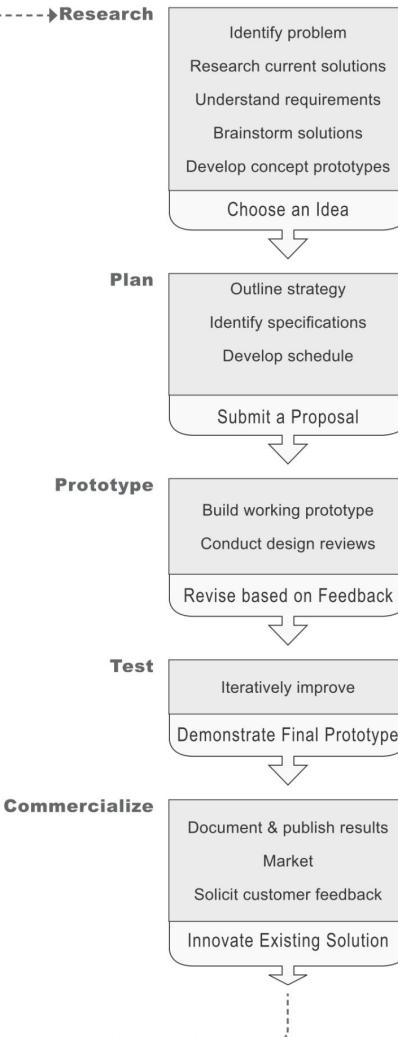
# **INTRODUCTION**

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## **Eng. Process**



Improve based on customer feedback



The dictionary describes a “process” as a series of actions, changes, or functions bringing about a result. Engineers, scientist, and researchers use a process when they solve a problem.

The first step in solving a problem is to clearly define the problem. The team may think that they have identified the problem, when in fact they may have only considered part of the problem, which typically leads to a partial solution. Once the problem has been clearly identified, the team can begin to brainstorm and propose solutions.

The first three steps of the problem-solving model: define the problem, brainstorm, and propose solutions, may be done concurrently. If the team moves too quickly from one step to the next, they may not have thoroughly identified the problem, brainstormed sufficiently, or proposed enough potential solutions to consider all of the alternatives available. When that happens, most teams find themselves returning to the beginning and to start over again. The next couple of steps: developing prototypes, testing, design reviews, and receiving feedback from others, are all important steps in the engineering process. Before a team begins to build their final solution, it is important that they model and test several ideas.

After that is done they will want to present their ideas to others. Sometimes, problem solvers miss potential solutions because they haven't considered all options.

Preparation for the design review and the feedback the team receives will move them closer to a working solution. Design is an iterative process. Even when the team has a working solution, they will want to consider improvements based on their testing.

# Eng. Process, by CMU



# Sci. Method vs. Eng. Process

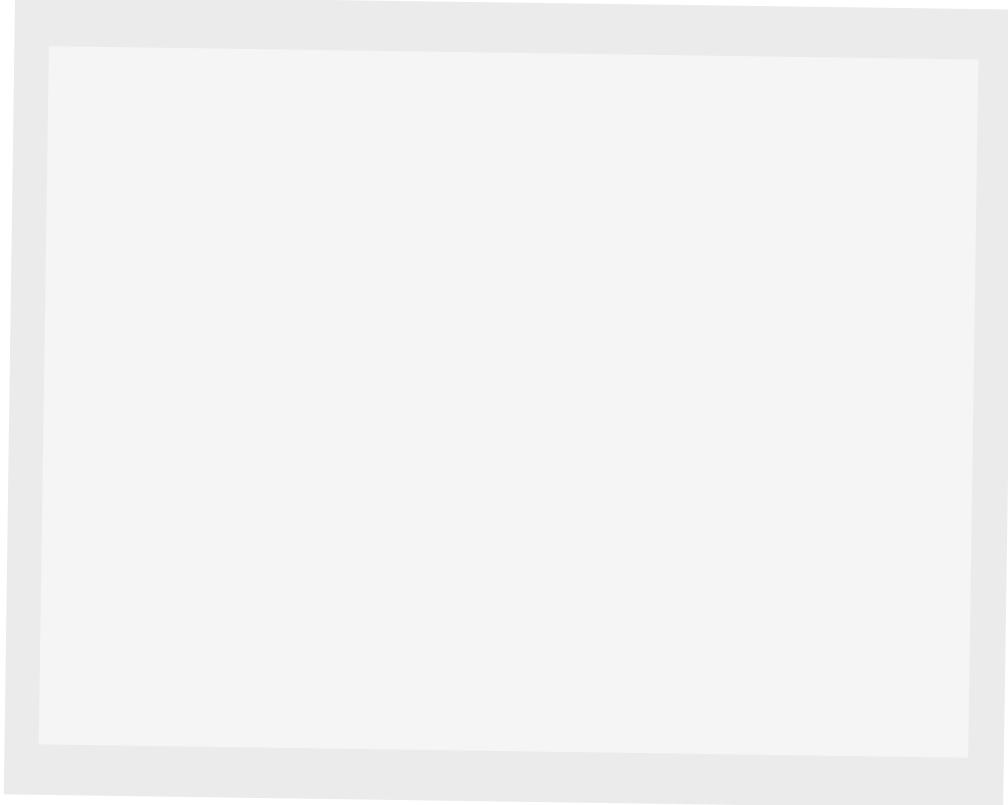




# **INTRODUCTION**

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## **Validation Levels**

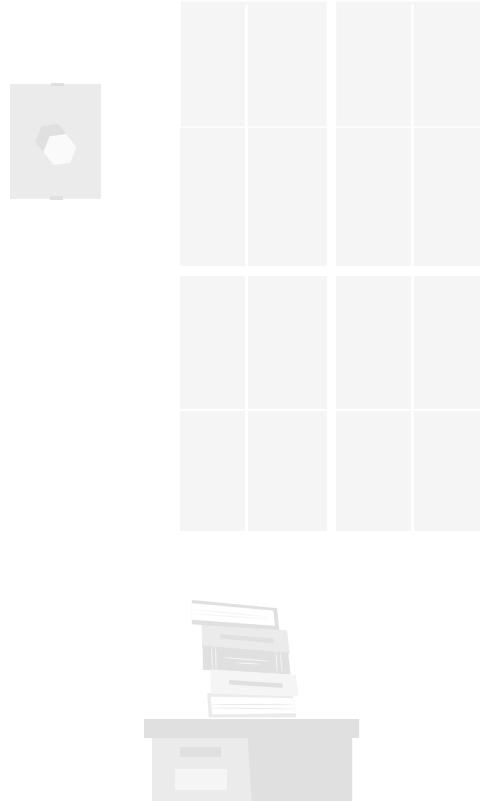


- Requirements
- (...)
- Validation

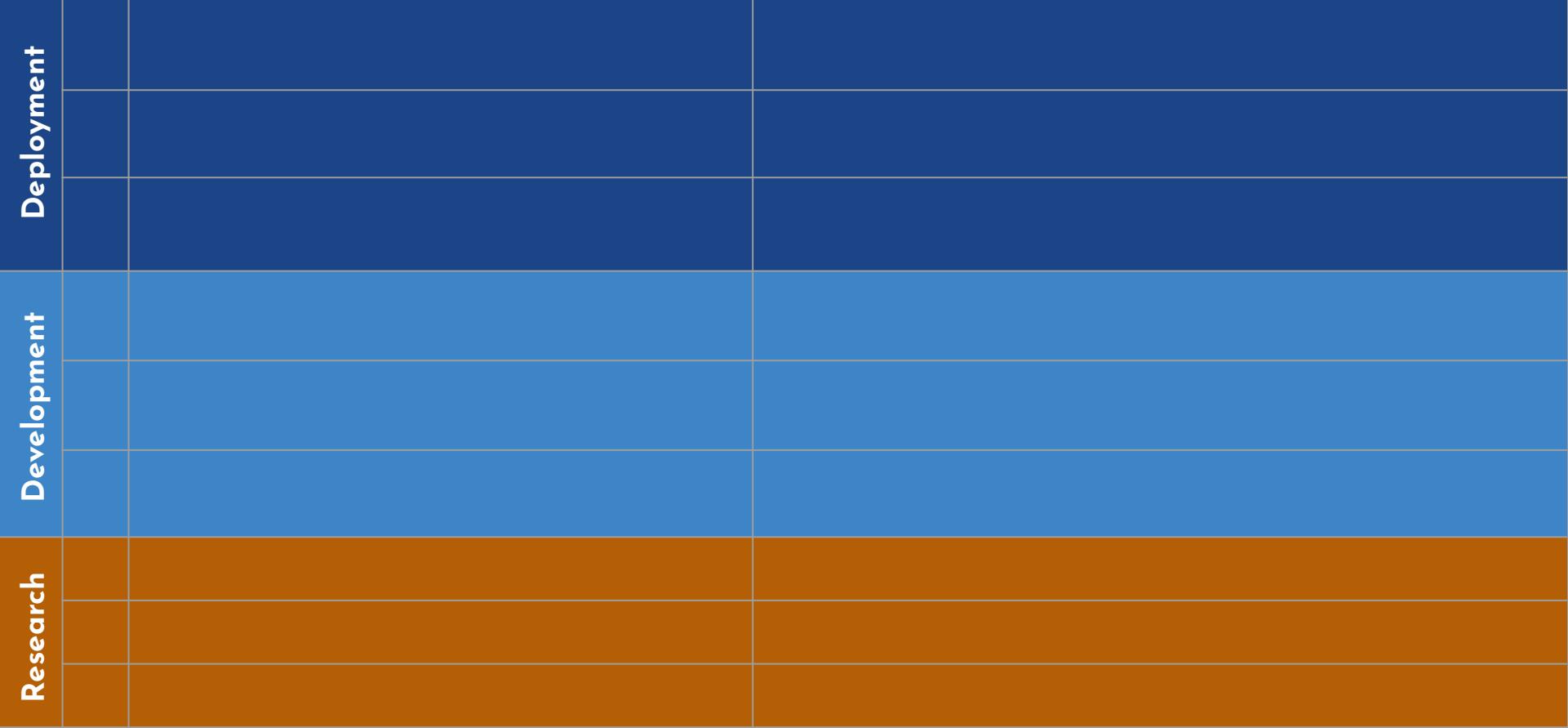
# Eng Process

*I am testing to see if the robotic arm works when it picks up a ball.*

Criteria	Perfectly: works 100 of the time	Well; works most of the time	Mediocre; works half the time	Poorly; only worked a few times	Not At All
Robot gets to Ball		X			
Gears Stay Meshed			X		
Arm returns to its original position				X	



# Technology Readiness Level (TRL)



# Technology Readiness Level (TRL)

Research		Development	Deployment	
3	<b>Experimental proof of concept</b>			Effective research and development initiated. Examples include studies and laboratory measurements to validate analytical predictions.
2	<b>Technology concept formulated</b>			Envisioned applications are speculative at this stage. Examples are often limited to analytical studies.
1	<b>Basic principles observed</b>			Scientific observations made and reported. Examples could include paper-based studies of a technology's basic properties.

# Technology Readiness Level (TRL)

Deployment		
Development	6	Technology demonstrated in relevant environment Prototype system verified. Examples might include a prototype system/model being produced and demonstrated in a simulated environment.
Development	5	Technology validated in relevant environment Reliability of technology significantly increases. Examples could involve validation of a semi-integrated system/model of technological and supporting elements in a simulated environment.
Research	4	Technology validated in lab Technology validated through designed investigation. Examples might include analysis of the technology parameter operating range. The results provide evidence that envisioned application performance requirements might be attainable.

# Technology Readiness Level (TRL)

Deployment	Actual system proven in operational environment	System/model proven and ready for full commercial deployment. An example includes the actual system/model being successfully deployed for multiple missions by end users.
8	<b>System complete and qualified</b>	System/model produced and qualified. An example might include the knowledge generated from TRL 7 being used to manufacture an actual system/model, which is subsequently qualified in an operational environment.
7	<b>System model or prototype demonstration in operational environment</b>	A major step increase in technological maturity. Examples could include a prototype model/system being verified in an operational environment.
Development		
Research		

# Technology Readiness Level (TRL)

Deployment	9 <b>Actual system proven in operational environment</b>	System/model proven and ready for full commercial deployment. An example includes the actual system/model being successfully deployed for multiple missions by end users.
	8 <b>System complete and qualified</b>	System/model produced and qualified. An example might include the knowledge generated from TRL 7 being used to manufacture an actual system/model, which is subsequently qualified in an operational environment.
	7 <b>System model or prototype demonstration in operational environment</b>	A major step increase in technological maturity. Examples could include a prototype model/system being verified in an operational environment.
	6 <b>Technology demonstrated in relevant environment</b>	Prototype system verified. Examples might include a prototype system/model being produced and demonstrated in a simulated environment.
	5 <b>Technology validated in relevant environment</b>	Reliability of technology significantly increases. Examples could involve validation of a semi-integrated system/model of technological and supporting elements in a simulated environment.
	4 <b>Technology validated in lab</b>	Technology validated through designed investigation. Examples might include analysis of the technology parameter operating range. The results provide evidence that envisioned application performance requirements might be attainable.
	3 <b>Experimental proof of concept</b>	Effective research and development initiated. Examples include studies and laboratory measurements to validate analytical predictions.
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	1 <b>Basic principles observed</b>	Scientific observations made and reported. Examples could include paper-based studies of a technology's basic properties.



# **INTRODUCTION**

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## **Decision Process**



A hallmark of design is that many decisions must be made throughout the process. Typically, there are alternative solutions to a problem from which the best one relative to some criteria is selected. This appendix presents the Analytical Hierarchy Process (AHP) approach to decision making. AHP is a flexible quantitative and qualitative method, applicable to many problems, which provides a numerical score for the alternatives considered. Different aspects of AHP are applied throughout the text, and this appendix is structured to teach AHP via example. A summary of AHP is provided at the conclusion of the appendix.

To apply AHP there must be a decision to be made, criteria against which the decision is based, and a set of competing decisions from which one must be selected. This process is encapsulated in a decision matrix (shown in Table B.1) and therefore is sometimes referred to as the *decision-matrix method*. The row headings are the criteria against which the decision is made and the column headings represent the alternatives. The criteria can have differing levels of importance and their relative weightings are reflected by  $\omega_i$  values in the matrix. The entries in the matrix  $\alpha_{ij}$  are ratings for each  $j$ th alternative relative to  $i$ th criterion. Each alternative receives a score  $S_j$ , which is a weighted sum of the ratings computed as

$$S_j = \sum_{i=1}^m \omega_i \alpha_{ij}. \quad (1)$$

**Table B.1** A decision matrix.

		Alternative 1	Alternative 2	...	Alternative $n$
Criteria 1	$\omega_1$	$\alpha_{11}$	$\alpha_{12}$	...	$\alpha_{1n}$
Criteria 2	$\omega_2$	$\alpha_{21}$	$\alpha_{22}$	...	$\alpha_{2n}$
:	:	:	:	...	:
Criteria $m$	$\omega_m$	$\alpha_{m1}$	$\alpha_{m2}$	...	$\alpha_{mn}$
Score		$S_1 = \sum_{i=1}^m \omega_i \alpha_{i1}$	$S_2 = \sum_{i=1}^m \omega_i \alpha_{i2}$	...	$S_n = \sum_{i=1}^m \omega_i \alpha_{in}$

# Decision–Making

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## Analytical Hierarchy Process (AHP)

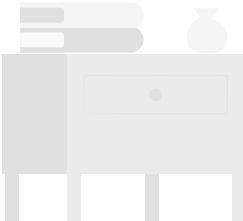
		Honda CR-V	Hyundai Tucson	Toyota RAV4
Cost	0.37	0.32	0.37	0.31
Safety	0.46	0.34	0.34	0.32
Design styling	0.12	0.11	0.31	0.58
Brand name	0.05	0.44	0.12	0.44
Score	0.31	0.34	0.35	



# RESEARCH

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## Starting



*"As engineers,  
we were going to be in a position to change the world –  
- not just study it."*

— **Henry Petroski**

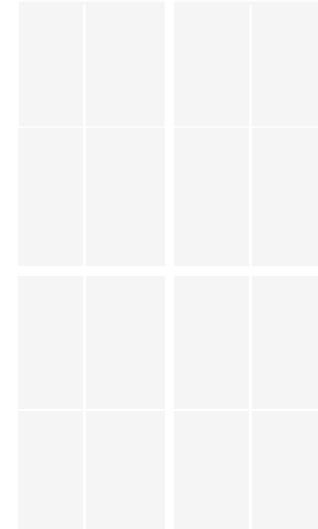
*American engineer and author specializing in failure analysis*

# Goals of the course

## Introduction to Research (M.Sc.)

### Be useful

Start your work  
(SoA, Tools, Preliminary Work, etc)



### Writing

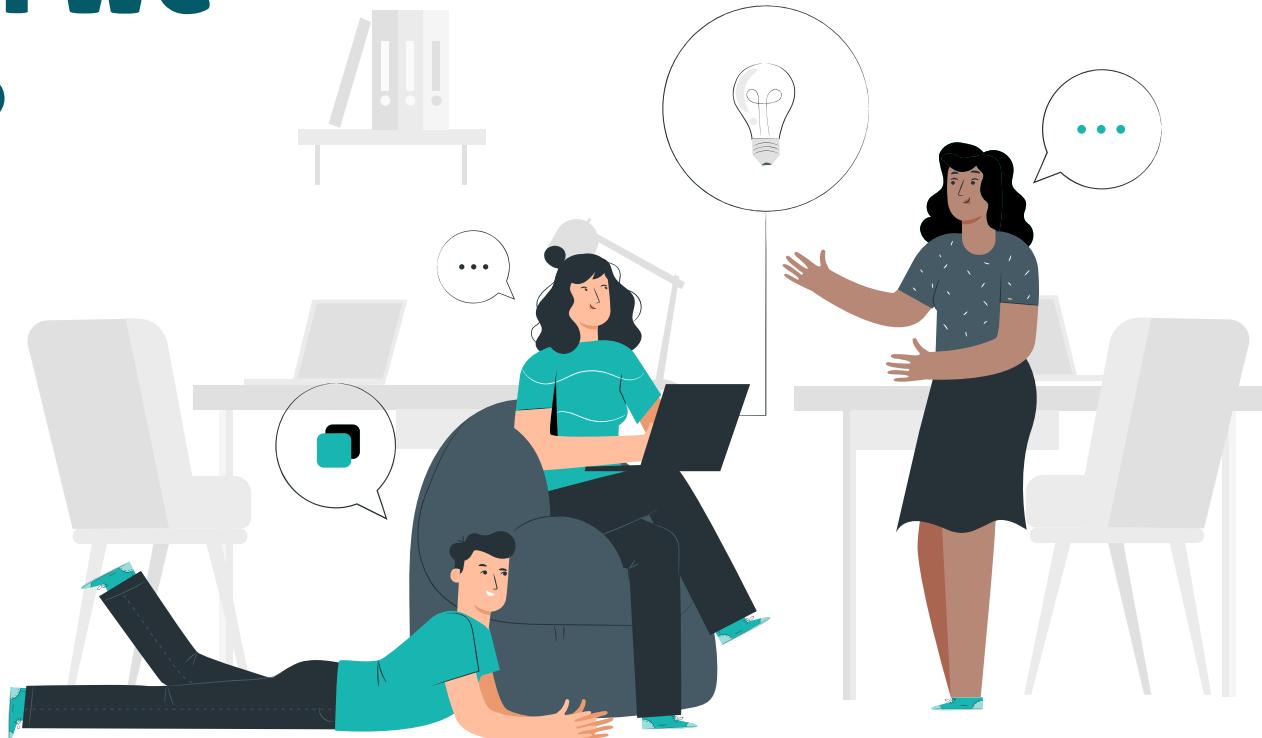
Sci Writing vs Tech Report



### Know where to start

Get acquainted... and really start!

# How can we do this?



# Don't panic



- At least browse at least one GOOD dissertation & Preferably watch a defense of another MSc (preferably in your technical area)
- Re-read the proposal
- Talk with fellows, stakeholders and supervisor
- Prepare, read, write in your own words, ...
- **Invest invest invest!!!**

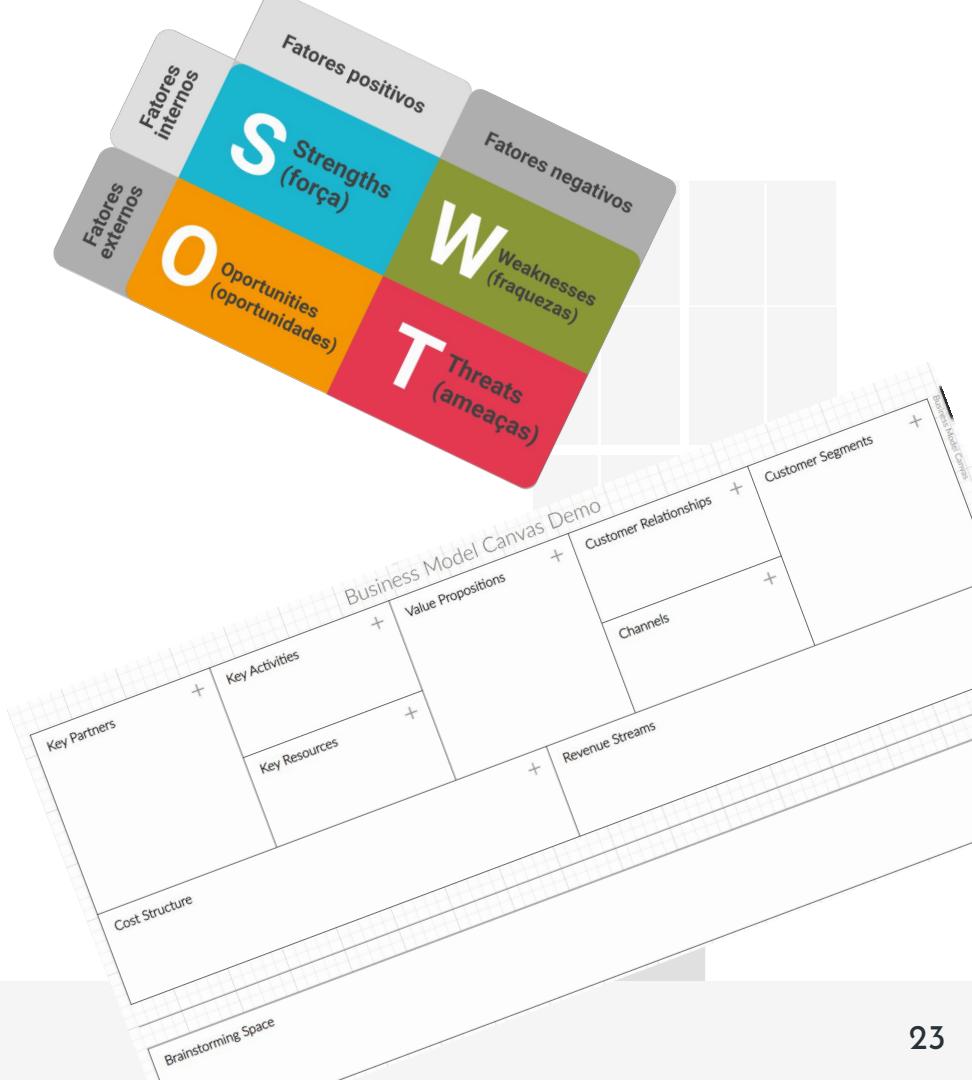
# Starting Preparation Tips

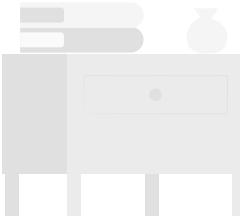
- Learn about area and client
- Manage your supervisor and all stakeholders
- Learn how you will be graded
- Install ALL tools
- Be professional, plan, be safe (backups, etc)
- Personally, I use and advise:
  - [freefilesync.org/](http://freefilesync.org/) or [rclone.org](http://rclone.org)
  - Latex, <https://www.overleaf.com/>
- Be ethical (don't steal other's work!)
  - Assess Limitations
  - Read EULA
- Setup hardware, software, debugging and data
  - Dry run and tune development cycle
- Plan for efficiency
  - Example: **automate evaluation of results**



# Know Your Project

- Market research, different prices -  
PT | FEUP, EU, US, CN
- SWOT -  
<https://canvanizer.com/new/swot-canvas>
- Business model canvas -  
<https://canvanizer.com/new/business-model-canvas>
- Product Vision /  
Dissertation Statement /  
Summarize in a sentence





# **RESEARCH**

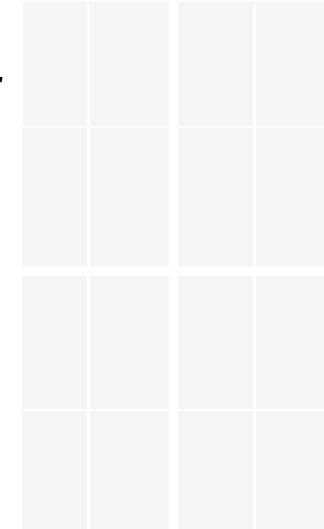
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## **State Of Art (SoA)**

# State of the Art (SoA)

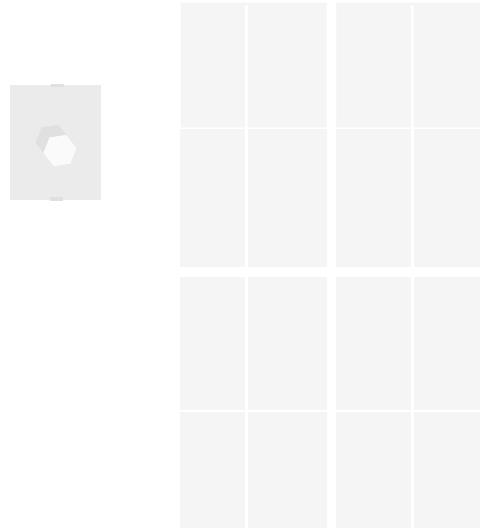
- Within the scope of the SoA, regarding both the ***final report of Introduction to Research*** and the **dissertation text** itself, explicitly detail:
  - Starting Point
  - Scope
  - What has been done in this area...
- The writings of the ***final report of Introduction to Research*** will be reused in your dissertation!

*Goals, expected outcomes, etc. are out of scope of this slide ;)*



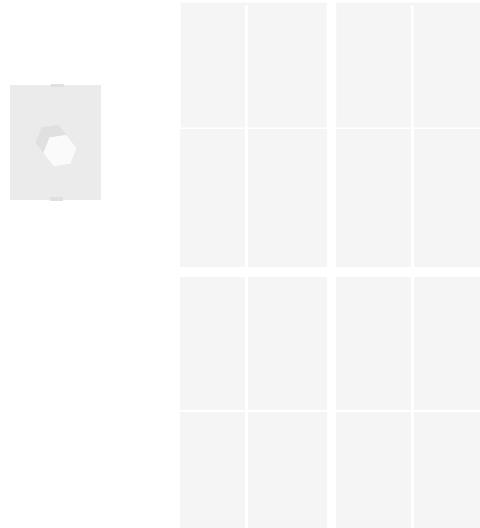
# State of the Art (SoA)

- You know how to search, but don't forget:
  - Nice, recent surveys!
  - <https://www.scopus.com/> (VPN)
  - <https://www.engineeringvillage.com> (VPN)
  - Full text... ask around or ask authors...  
Or try: <https://www.researchgate.net/> ("social")
  - <https://patentscope.wipo.int/> - patents
  - Market Search ⇔ Google + online stores ?
  - Cited articles ⇔ Google Scholar
  - Research Groups (Funding, Ph.D., M.Sc.)
- Follow citation trail!!!



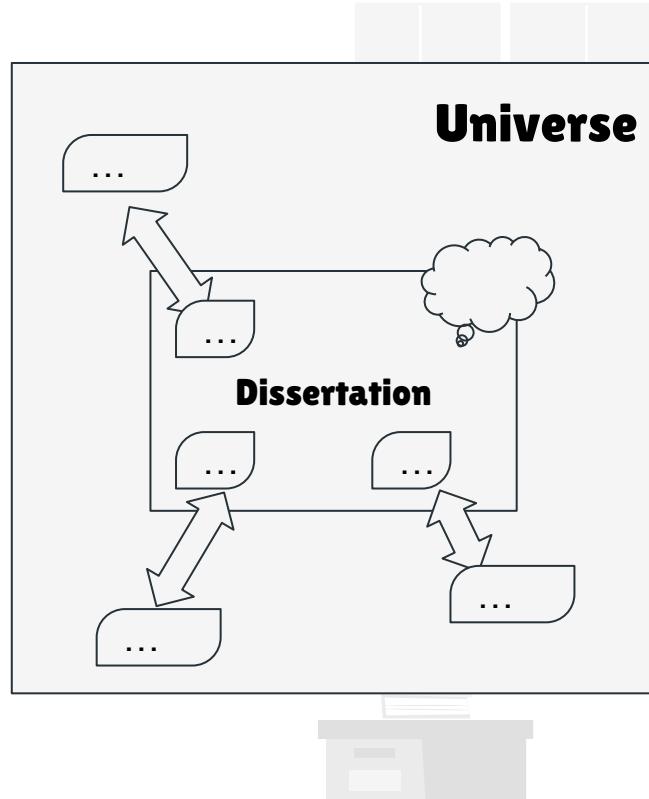
# State of the Art (SoA) – Code & Datasets

- Code & DataSets
  - <https://www.kaggle.com>
  - <https://datasetsearch.research.google.com/>
  - Also, search EU funded projects & PhD
- Open Source Code?
  - Follow the trail...
  - SourceForge...
  - GitHub, GitLab, ...
  - List: <https://wparena.com/top-source-code-search-engines/>
  - Be careful with Licence Agreement / Terms of Service for reuse/adaptation/close



# State of the Art (SoA) – Tips

- Limits:  
Where dissertation starts and its limits  
(scope)
- Draw a figure!
- Ask supervisor!
- Keywords?

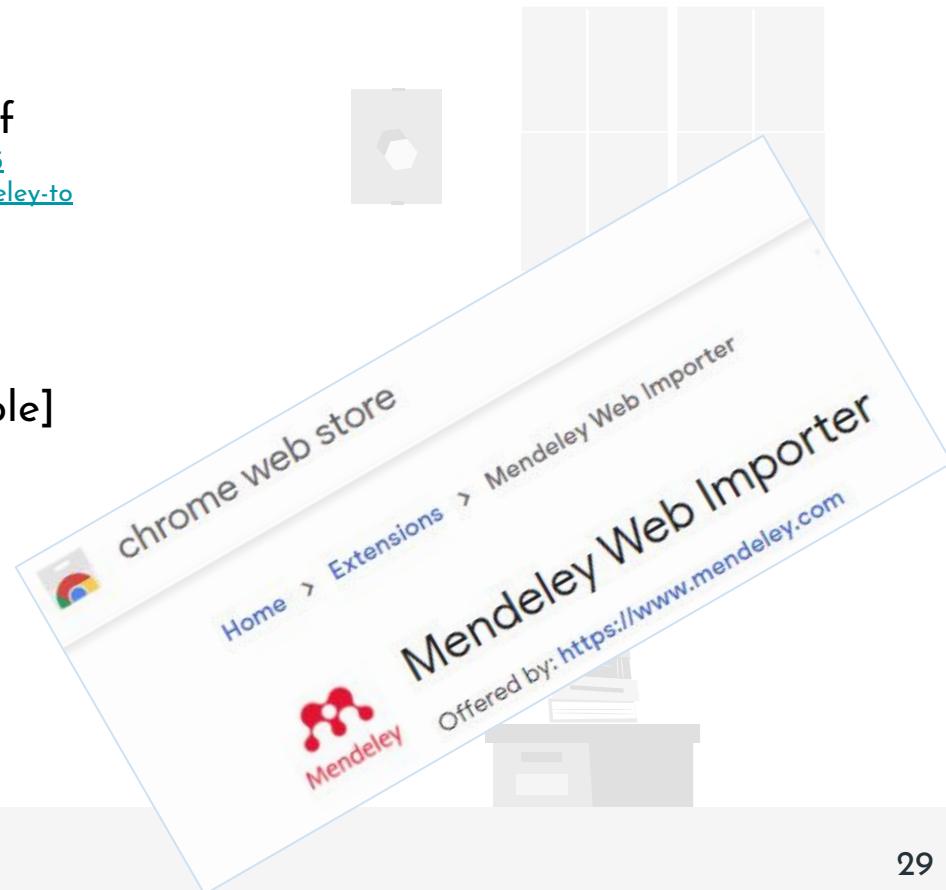


# State of the Art (SoA) – Tips

- Related to Scientific Publications... Tools:
  - Mendeley / EndNote / Zotero / JabRef
    - <https://feup.libguides.com/c.php?g=675351&p=4807565>
    - <https://blog.mendeley.com/2011/10/25/howto-use-mendeley-to-create-citations-using-latex-and-bibtex/>
    - <https://www.jabref.org/>
- Web pages should be footnotes  
[date of access and permanent link if possible]

Tip:

Automate  
importing  
articles!



# **State of the Art (SoA) – not...**

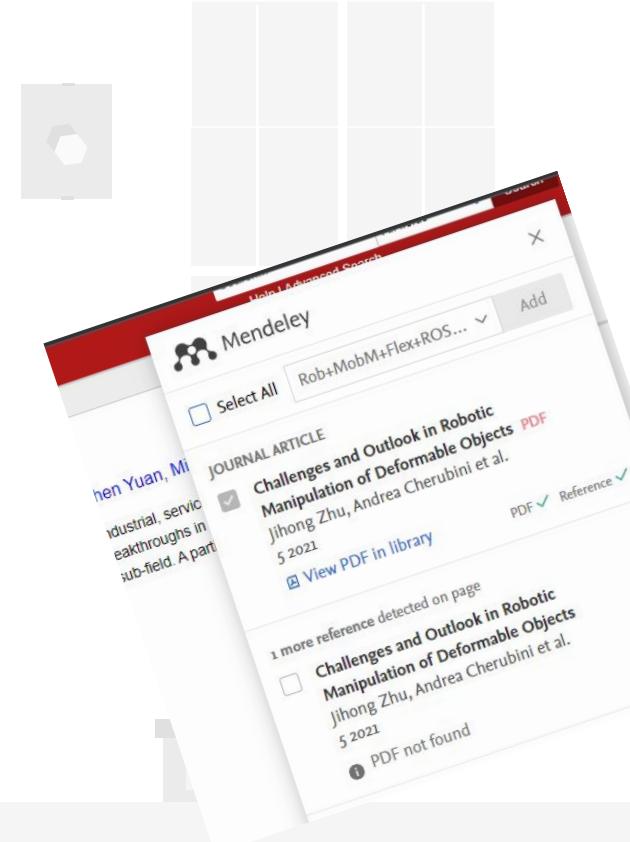
- Not: Summarize all you read
  - No need to reference it all!
- Not: Acritically
  - Use critical thinking
- Not: Random opinions
  - The best is... because...
- Not: One paragraph per article
  - Not very useful



# State of the Art (SoA)

Tip: systematic Literature Review

- “Systematic Literature Review”
  - Hannah Snyder, Literature review as a research methodology: An overview and guidelines, Journal of Business Research, Volume 104, 2019, Pages 333-339, ISSN 0148-2963 <https://doi.org/10.1016/j.jbusres.2019.07.039>
  - Catherine Pickering & Jason Byrne (2014) The benefits of publishing **systematic quantitative literature reviews** for PhD candidates and other early-career researchers, Higher Education Research & Development, 33:3, 534-548, <https://doi.org/10.1080/07294360.2013.841651>
  - Kai Petersen, Sairam Vakkalanka, Ludwik Kuzniarz, Guidelines for conducting systematic mapping studies in software engineering: An update, Information and Software Technology, Vol 64, 2015, P. 1-18, ISSN 0950-5849, <https://doi.org/10.1016/j.infsof.2015.03.007>
- Find a previous taxonomy or review or survey!
  - Search such keywords!
- Find previous GOOD Dissertation or Thesis!
- Not everything is totally true nor of good quality
  - Be aware of sponsored works
- Check the reference section!



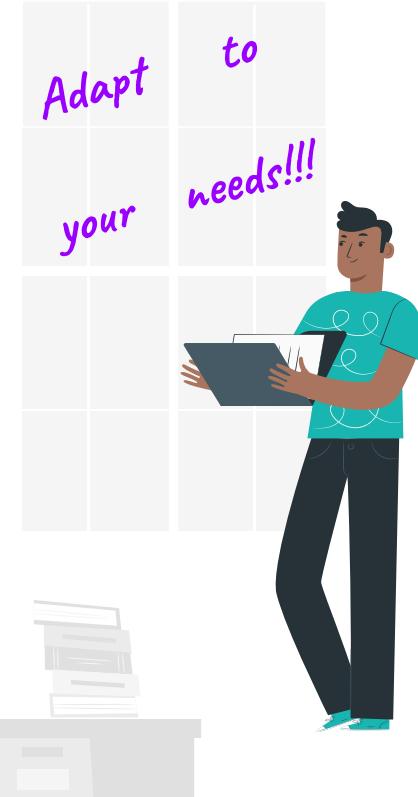
# State of the Art (SoA) – Taxonomy & Table

- Refine search Keywords
  - Keep within the scope!
- Search Healthily
- Build a taxonomy table...



	Stuff A	Stuff B	...	Stuff ZZZ
Work 1		Uses		
Work 2				<i>Great success! Lots of References!</i>
...				
Work M	<i>Bad?</i>			<i>Also successful!</i>

Works → → → → ↓



# State of the Art (SoA) – Taxonomy & Table

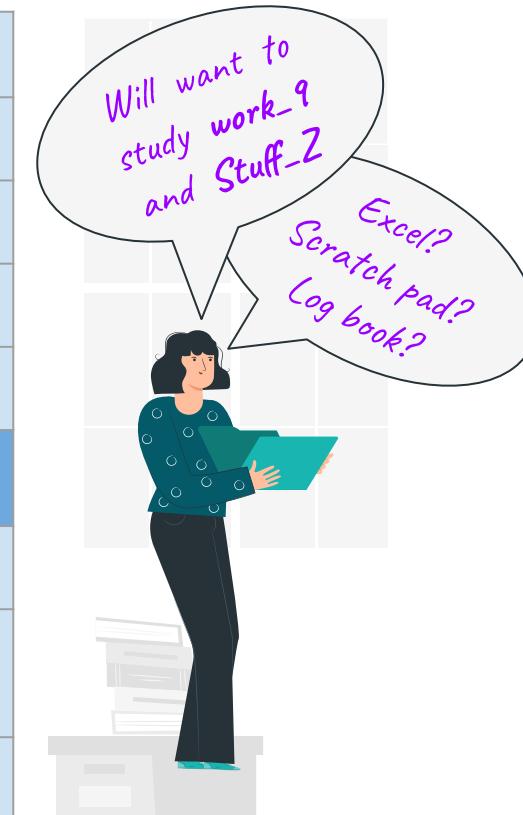
Stuff → → → → →

	Year	A	B	C	D	...	Z	...	ZZZ
1	1900	x			old		+		
2			✓					...	
3				+			++		
...						✓	✓		Nope...
9	2021	usable	free	open			+++		
...		similar				--			
...							Well explained		
999		paid					Journal		Limited



# State of the Art (SoA) – Taxonomy & Table

	Year	A	B	C	D	...	Z	...	ZZZ
1					old		+		
2			-					...	
3				+			++		✓
...							✓		Nope...
<b>9</b>	<b>2021</b>	<b>usable</b>	<b>free</b>	<b>open</b>			<b>Success</b>		<b>dataset</b>
...		similar				X			
...							Well explained		
999		paid					Journal		Limited



# State of the Art (SoA) – “Taxonomy” Analysis Table

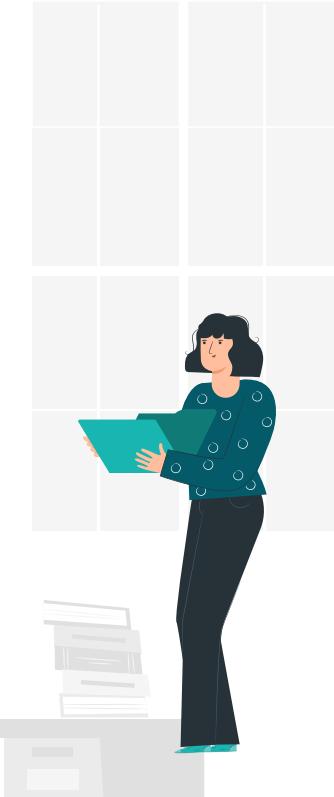
Taxonomy Level 1		A				B				...
Taxonomy Level 2		X		Y		X		Y		...
Taxonomy Level 3		1	2	1	2	α	β	γ	δ	...
...	...									
Grp of works	[ref],[ref]									
	[ref]									
Grp of works	[refs...]									
	[refs...]									
...										

Adaptable to market research, gap analysis, etc.; be systematic...

# Grouping stuff together

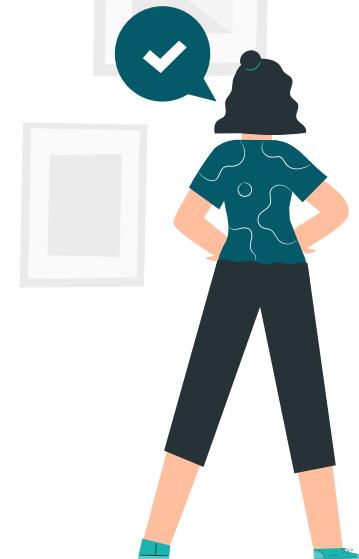
Examples of group by:

- Approach (Operation Research / Optimal control / AI / ML)
- Algorithm (math, numerical, ...)
- Need
- Area of application
- Author's background
- DataSet / Source Code availability
- Type of data collected
- Mind maps?
- Qualitative analysis???



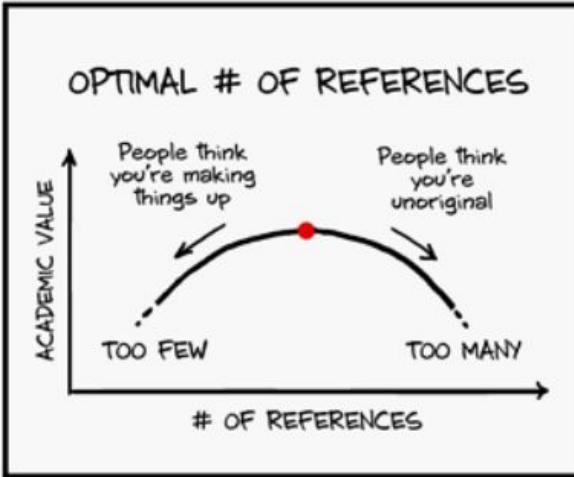
# Scientific “Quality” – Use Critical Thinking & Your Best Judgement

- Journal - <https://www.scimagojr.com/journalrank.php>
- Conference - <http://portal.core.edu.au/conf-ranks/>
- Patents - <https://patentscope.wipo.int/>
- Date / Number of Citations / Transparency
- Whitepaper / Technical Report
- Dissertations & Thesis / University
- Funded projects / Research Group
- Research Gate (Social network)
- Be aware of blog / web page owner's hidden agenda
- Researcher's CVs: OrcID / CienciaVitae / Authenticus



# Reference Quantity

Piled Higher and Deeper by Jorge Cham



[www.phdcomics.com](http://www.phdcomics.com)



title: "Optimal Number of References" - originally published 9/16/2015

## References

- Quality, not quantity
- State of Art
- Pertinent to text (must be used!)
- Preferably peer reviewed documents / books

## Footnotes

- Interesting websites / blogs / etc.  
→ access date!

## Bibliography

- Context and further information (not commonly used)



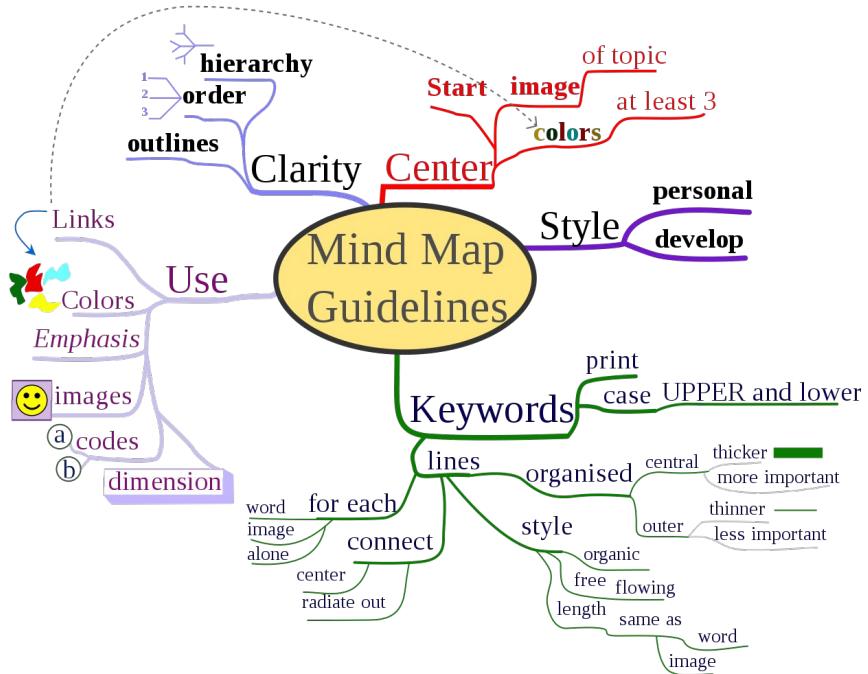
# **RESEARCH**

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## **Even more starting tools!**



# Mind Map



[https://en.wikipedia.org/wiki/Mind\\_map](https://en.wikipedia.org/wiki/Mind_map)

<https://commons.wikimedia.org/wiki/File:MindMapGuidelines.svg>

<https://izwanismailblog.wordpress.com/2013/01/11/design-thinking-method-1-post-its/>

# Qualitative Analysis

# Differences between...

## Qualitative Research



It explains attitudes and behaviors of the market in detail.

Generates verbal information to understand opinions and motivations.

It can be done with open questions,  
observation, focus group, among  
others.

It can provide a deeper understanding of the object of study.

## Quantitative Research



It's ideal for discovering who, what, when and where.

Generate numerical data to get effective statistics.

It's done through surveys or other data collection techniques.

Provides hard data and useful information for making business decisions.

The collage features a red banner at the top with the text "Engenharia Eletrotécnica e Computadores". Below the banner, several fields of study are listed in a grid format:

- Sistemas digitais
- Energias renováveis
- Android
- Robotica
- Telecomunicações
- Automação
- Microeletrônica
- VLSI
- Energia

Below these, specific applications are shown:

- Comunicações móveis
- Produção de energia
- Energia elétrica
- Segurança
- Televisão
- Microwaves
- Processamento de Sinal
- Bases de dados
- Redes de computadores
- Apps
- Sistemas
- Comunicações ópticas

A large central image shows a collage of various engineering and technological scenes, including a train, a robot, a wind turbine, and a smartphone.

At the bottom left, there is a logo for U.PORTO FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO. At the bottom right, there is a URL: <http://tagcrowd.com/> and a URL: [fe.up.pt/mieec](http://fe.up.pt/mieec).

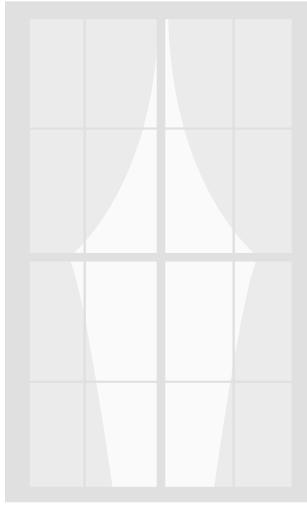
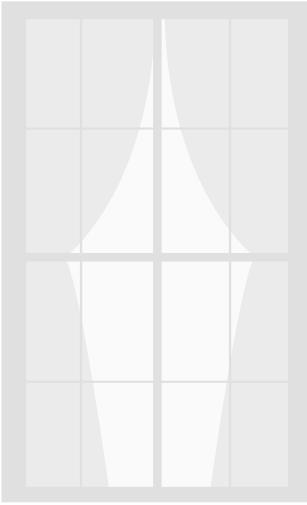
# In the final report of Introduction to Research, you might...

- Produce a SoA table
- Position yourself on SoA
- Produce Taxonomy
- Find gaps
- Target a market

(or simply understand better the proposal,  
the path and the expected contributions!)

# End of class 1

See you next week!



# M.Sc. Evaluation



# MSc

# Evaluation



## Composição do Júri:

- Presidente do Júri
- Orientador
- Arguente Externo

(1) Avaliar segundo a escala:

- A - Excelente;
- B - Muito bom;
- C - Bom;
- D - Suficiente;
- E - Insuficiente.

(2) Avaliar na escala inteira de 0 a 20, refletindo as classificações qualitativas dos respetivos fatores, de acordo com:

Tudo A	19 a 20
Nota mínima B	17 a 18
Nota mínima C	14 a 16
Nota mínima D	10 a 13
Nota mínima E	<10

## (i) Componente "Qualidade técnico-científica do trabalho desenvolvido"

50%

Dificuldade e profundidade do trabalho realizado

(1)

A.E

Relevância e originalidade das contribuições

(1)

A.E

Grau de cumprimento dos objetivos e nível de autonomia e pró-atividade demonstrados durante realização do trabalho

(1)

A.E

Global (i)

(2)

0..20

## (ii) Componente "Qualidade do documento de dissertação"

35%

Forma (escrita, estrutura, grafismo, formatação)

(1)

A.E

Conteúdo nuclear (estruturação do problema, análise crítica do estado da arte, metodologia, contribuições, análise crítica dos resultados obtidos)

(1)

A.E

Qualidade do resumo, introdução, conclusões e referências bibliográficas

(1)

A.E

Global (ii)

(2)

0..20

## (iii) Componente "Qualidade da apresentação e discussão pública"

15%

Qualidade da apresentação oral (clareza, rigor, postura)

(1)

A.E

Qualidade dos suportes da apresentação

(1)

A.E

Qualidade da discussão (segurança, capac. de argumentação)

(1)

A.E

Global (iii)

(2)

0..20

# MSc Evaluation



## (i) Componente "Qualidade técnico-científica do trabalho desenvolvido"

50%

Dificuldade e profundidade do trabalho realizado

(1)

A.E

Relevância e originalidade da contribuição

(1)

A.E

# WORK

Grau de cumprimento dos objetivos estabelecidos e nível de competência demonstrados durante realização do trabalho

(1)

A.E

Global (i) (2)

0..20

## (ii) Componente "Qualidade do documento de dissertação"

35%

Forma (escrita, estrutura, grafismo, formatação)

(1)

A.E

# DOCUMENT

Qualidade do resumo, introdução, conclusões e referências bibliográficas

(1)

A.E

Global (ii) (2)

0..20

## (iii) Componente "Qualidade da apresentação e discussão pública"

15%

Qualidade da apresentação oral (clareza, rigor, postura)

(1)

A.E

# DEFENSE

Qualidade da discussão pública (clareza, coerção, segurança)

(1)

A.E

Qualidade da defesa (clareza, coerção, segurança)

(1)

A.E

Global (iii) (2)

0..20

Composição do Júri:

- Presidente do Júri
- Orientador
- Arguente Externo

(1) Avaliar segundo a escala:

- A - Excelente;
- B - Muito bom;
- C - Bom;
- D - Suficiente;
- E - Insuficiente.

(2) Avaliar na escala inteira de 0

a 20, refletindo as classificações qualitativas dos respectivos fatores, de acordo com:

Tudo A	19 a 20
Nota mínima B	17 a 18
Nota mínima C	14 a 16
Nota mínima D	10 a 13
Nota mínima E	<10

(i) "Qualidade técnico-científica do trabalho desenvolvido"	50%	0..20
(ii) "Qualidade do documento de dissertação"	35%	0..20
(iii) "Qualidade da apresentação e discussão pública"	15%	0..20

# MSc Evaluation



## (i) Componente "Qualidade técnico-científica do trabalho desenvolvido"

**50%**

Dificuldade e profundidade do trabalho realizado

(1)

**A.E**

Relevância e originalidade das contribuições

(1)

**A.E**

Grau de cumprimento dos objetivos e nível de autonomia e pró-atividade demonstrados durante realização do trabalho

(1)

**A.E**

Global (i)

(2)

**0..20**

## (ii) Componente "Qualidade do documento de dissertação"

**35%**

Forma (escrita, estrutura, grafismo, formatação)

(1)

**A.E**

Conteúdo nuclear (estruturação do problema, análise crítica do estado da arte, metodologia, contribuições, análise crítica dos resultados obtidos)

(1)

**A.E**

Qualidade do resumo, introdução, conclusões e referências bibliográficas

(1)

**A.E**

Global (ii)

(2)

**0..20**

## (iii) Componente "Qualidade da apresentação e discussão pública"

**15%**

Qualidade da apresentação oral (clareza, rigor, postura)

(1)

**A.E**

Qualidade dos suportes da apresentação

(1)

**A.E**

Qualidade da discussão (segurança, capac. de argumentação)

(1)

**A.E**

Global (iii)

(2)

**0..20**

Composição do Júri:

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Composição do Júri:

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- A - Excelente;**
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<b>(i) Componente "Qualidade técnico-científica do trabalho desenvolvido"</b>		<b>50%</b>
<i>Dificuldade e profundidade do trabalho realizado</i>	<sup>(1)</sup>	<b>A.E</b>
<i>Relevância e originalidade das contribuições</i>	<sup>(1)</sup>	<b>A.E</b>
<i>Grau de cumprimento dos objetivos e nível de autonomia e pró-atividade demonstrados durante realização do trabalho</i>	<sup>(1)</sup>	<b>A.E</b>
<i>Global (i)</i>	<sup>(2)</sup>	<b>0..20</b>
<b>(ii) Componente "Qualidade do documento de dissertação"</b>		<b>35%</b>
<i>Forma (escrita, estrutura, grafismo, formatação)</i>	<sup>(1)</sup>	<b>A.E</b>
<i>Conteúdo nuclear (estruturação do problema, análise crítica do estado da arte, metodologia, contribuições, análise crítica dos resultados obtidos)</i>	<sup>(1)</sup>	<b>A.E</b>
<i>Qualidade do resumo, introdução, conclusões e referências bibliográficas</i>	<sup>(1)</sup>	<b>A.E</b>
<i>Global (ii)</i>	<sup>(2)</sup>	<b>0..20</b>
<b>(iii) Componente "Qualidade da apresentação e discussão pública"</b>		<b>15%</b>
<i>Qualidade da apresentação oral (clareza, rigor, postura)</i>	<sup>(1)</sup>	<b>A.E</b>
<i>Qualidade dos suportes da apresentação</i>	<sup>(1)</sup>	<b>A.E</b>
<i>Qualidade da discussão (segurança, capac. de argumentação)</i>	<sup>(1)</sup>	<b>A.E</b>
<i>Global (iii)</i>	<sup>(2)</sup>	<b>0..20</b>

# MSc Evaluation



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Global (i)	(2)	0..20
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Forma (escrita, estrutura, grafismo, formatação)	(1)	A.E
Conteúdo nuclear (estruturação do problema, análise crítica do estado da arte, metodologia, contribuições, análise crítica dos resultados obtidos)	(1)	A.E
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Qualidade da apresentação oral (clareza, rigor, postura)	(1)	A.E
Qualidade dos suportes da apresentação	(1)	A.E
Qualidade da discussão (segurança, capac. de argumentação)	(1)	A.E
Global (iii)	(2)	0..20

# MSc Evaluation



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Qualidade da apresentação oral (clareza, rigor, postura)	(1)	A.E
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Global (iii) (2)	0..20	

# MSc Evaluation



## (i) Componente "Qualidade técnico-científica do trabalho desenvolvido"

50%

Dificuldade e profundidade do trabalho realizado

(1)

A.E

Relevância e originalidade das contribuições

(1)

A..E

Grau de cumprimento dos objetivos e nível de autonomia e pró-atividade demonstrados durante realização do trabalho

(1)

A..E

Global (i) (2)

0..20

## (ii) Componente "Qualidade do documento de dissertação"

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Forma (escrita, estrutura, grafismo, formatação)

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(1)

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(1)

A..E

Qualidade dos suportes da apresentação

(1)

A..E

Qualidade da discussão (segurança, capac. de argumentação)

(1)

A..E

Global (iii) (2)

0..20

### Composição do Júri:

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### (1) Avaliar segundo a escala:

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Tudo **A** 19 a 20

Nota mínima **B** 17 a 18

Nota mínima **C** 14 a 16

Nota mínima **D** 10 a 13

Nota mínima **E** <10

# More Tips



- A lot of the grade comes from the writing (that depends on the work!)
- A lot of the grade ( $\frac{2}{3}$ ) comes from people that had no contact with the student's work except the document

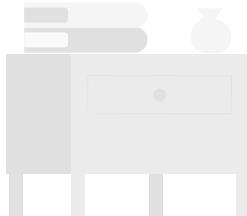
## Obvious tips:

- Make it easy to read (size, figs, appendices)
- Re-read document before defense
- Have it handy during defense Q&A





# Practical Tips (summary & recollection)



Come back here  
and re-read  
before doing  
heavy writing...



# Writing Tips...



## Title and keywords:

- Well indexable by Google (SEO)

## Writing Style:

- Scientific writing: facts & numbers!
  - ~~"Bue de cenas fixes desse género..."~~
  - ~~Muito bom~~
  - ~~Great stuff~~
- No repetitions ⇒ Link within document
- Right size sentences
- "Timeless" ... readable in 10 years...
- Engineering Choices (**AHP**)
- Analyze both **Good** and **Bad**
- Explicitly state **Start** and **End** points
- Use Latex + template!!!



# Dissertation (Tips...)



## Template M.EIC

- 2021/2 – <https://tinyurl.com/MEIC-template>  
<https://www.overleaf.com/latex/templates/feup-dissertation-format/qrsrxijwzrzf>
- Some more Info (By J. Correia Lopes, FEUP):  
[https://web.fe.up.pt/~jlopes/doku.php/teach/feupteses\\_feupteses LaTeX style](https://web.fe.up.pt/~jlopes/doku.php/teach/feupteses_feupteses_LaTeX_style)

## Templates MIEEC e MIEIC

- Latex, + Guia formatação Latex
- Microsoft Word + guia formatação Microsoft Word



# Writing (Tips...)

Automated retrieval:

- Keywords
- Open repository of UP  
<https://repositorio-aberto.up.pt/handle/10216/6812>
- Abstract
- Impeccable Conclusions
- ...Contributions... (no need for innovation)
- Final file will be PDF (make it nice active!)

Make it useful and friendly:

- Useful for others / continuation / appendices
- Use standard notations (**UML** / SysML ...)
- Don't forget architecture(s)
- Adequate figures
- Define acronyms, use standard acronyms

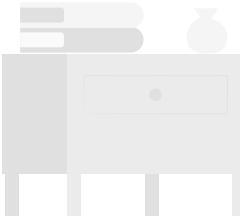
# My Tools (Tips...)

- Writing Language (student's choice):
  - Portuguese (pós acordo ortográfico)
  - English (preferable!)
- My favorite Chrome extensions:
  - LanguageTool
  - Mendeley Web Importer
  - Lib Manager

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# Oral Presentation (Tips....)



- Be professional
- Not too fast, not too slow
- SoA in Oral Presentation? -
  - suggests not (but student's choice)
- No Real Demo → use an edited **VIDEO**
  - suggest before conclusions
- Train; the real thing will be faster than train
- Avoid large tables (charts instead)
- Plenty of bullet points! :)
- Plenty of figures (NOT large tables)
- One issue per slide
- Very rough estimation: 30+ sec / slide
- Short time? Use edited (simultaneous) videos
- Prepare Q&A

# Be strict, scientific, measure, stick to facts!

## Prepare experiments

Formalize  
Store in data set

## No random opinions

Justify with facts and numbers

## Don't hide data

All real data is good

## Don't Report (merely)

The **why** is very important

## Automate processing

Batch process data

## Critical thinking

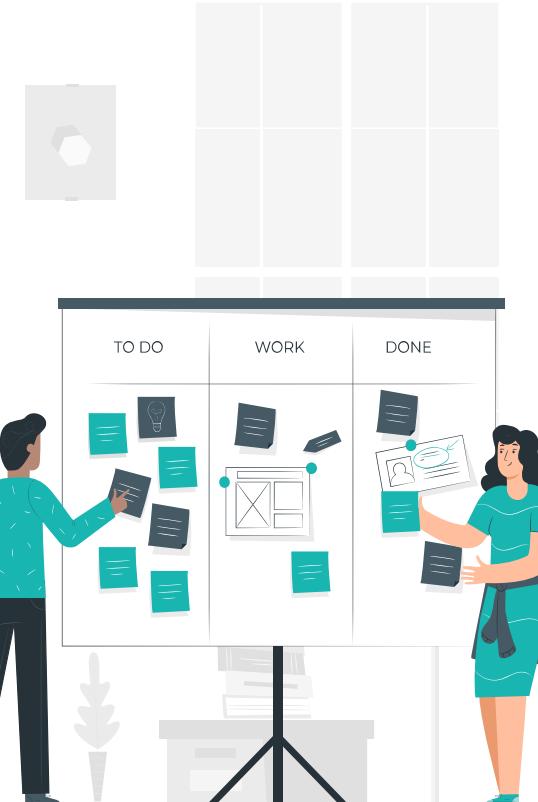
Several sources?  
Contextualize...  
think by yourself!

## Be respectful to others

Use references

## Discuss Decisions, Admit limitations

This is engineering  
(no free lunch)





## After the defense

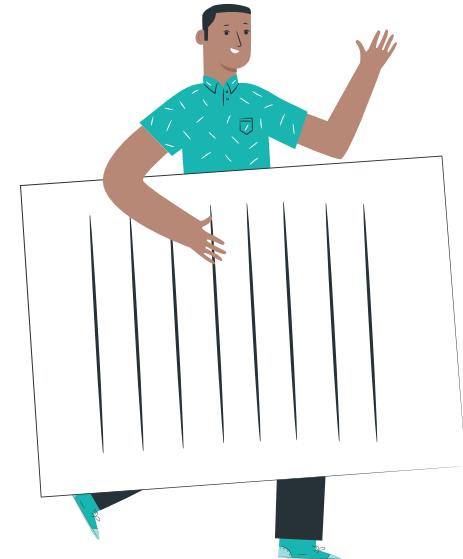


*“Successful problem-solving requires finding the right solution to the right problem. We fail more often because we solve the wrong problem than because we get the wrong solution to the right problem.”*

Russell L. Ackoff

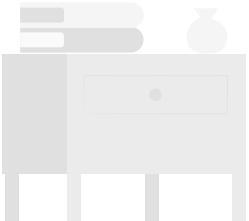
# After the Defense

- You know your grade right after
- Minor improvements are allowed (there is a deadline)
- Secrecy (max 3 years)
- Automatically sent <https://repositorio-aberto.up.pt/>
- Organize finalization with supervisor
  - Editable text and figures
  - Source code / GIT Repo
  - DataSets (ROS BAGs)
  - Developer & User Manual
  - Turn in Hardware
  - Used PDFs (articles, etc)
- Attention: Your productions **belong to UP**
- Be careful with companies...



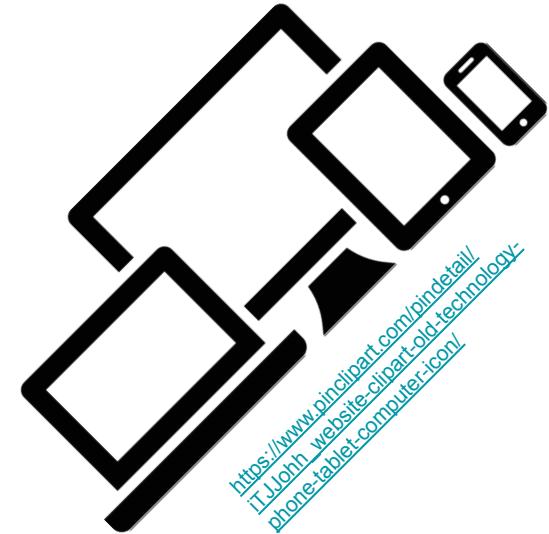
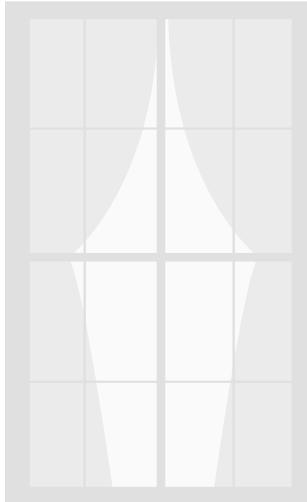
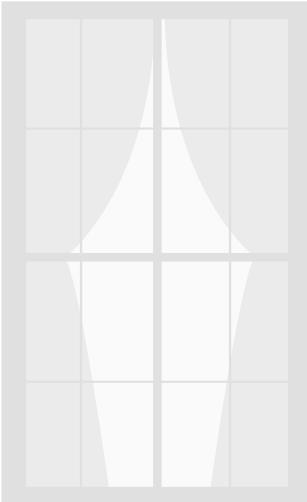


# F.A.Q. & Tips



*“The greatest challenge to any thinker is stating the problem in a way that will allow a solution.”*

**Bertrand Russell**



## FEUP's Rules require a *WebSite*

Conform to regulations

Register in Sigarra

Don't overengineer!

Use the simplest tool

[Careful with companies]

Simplest Suggestions:

- <https://sites.google.com/> - g.upto.pt
- <https://www.wix.com/>
- MS Word + samba.fe.up.pt



# FAQ

- Prevent Plagiarism (even unintentional) using Turnitin

- <https://elearning.up.pt/tecnologias/antiplagio/>
- Interpretation:  
[https://intranet.exeter.ac.uk/socialsciences/media/universityofexeter/collegeofsocialsciencesandinternationalstudies/intranet/studentintranet/postgraduateresearch/documents/Guide\\_on\\_How\\_to\\_Read\\_a\\_Turnitin\\_Report.pdf](https://intranet.exeter.ac.uk/socialsciences/media/universityofexeter/collegeofsocialsciencesandinternationalstudies/intranet/studentintranet/postgraduateresearch/documents/Guide_on_How_to_Read_a_Turnitin_Report.pdf)

- Learn Latex:

- [https://pt.overleaf.com/learn/latex/  
Learn\\_LaTeX\\_in\\_30\\_minutes](https://pt.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes)
- Overleaf now has richtext “2 way” editor

- Publication from your MSc:

- Very well received but hard  
(short time span)

# FAQ

## Corporate look



FACULDADE DE ENGENHARIA  
UNIVERSIDADE DO PORTO



Universidade do Porto  
Faculdade de Engenharia  
**FEUP**



. Logótipo utilizado a partir de 2000 - versões vertical e horizontal

- Respect template and graphical rules
- FEUP's logos:  
[https://sigarra.up.pt/feup/pt/WEB\\_BASE.GERA\\_PAGINA?p\\_pagina=242608](https://sigarra.up.pt/feup/pt/WEB_BASE.GERA_PAGINA?p_pagina=242608)
- Always use high quality figures
- Respect colors and spaces



. Versão oficial do logótipo a partir de 2007



# Tips: Figures Tables Source code Math

- Use vector graphics
- Include external PDF inside Latex
- Always use high quality figures
- Preferably readable in B&W
- Always use chart labels (with units)
- Make charts compatible with each other
- Figure "legend" below
- Table "legend" above the table
- Use UML / SysML
- Use algorithms, not flowcharts
- Leave full table of results to appendices
- Refer all figs, tables and appendices in text
- Keep math notation coherent
- Number equations
- Use standard acronyms and abbreviations





# Tips: Clip art Templates



- Templates: <https://slidesgo.com/>
- Clipart:
  - <https://pixabay.com/>
  - <https://unsplash.com/>
  - <https://freesvg.org/>
- Stay within the same style!

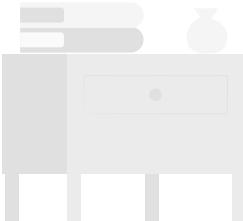
*Read the Licence, it changes over time...  
Some licences require attribution...*



## FAQ

—

# Manage Things



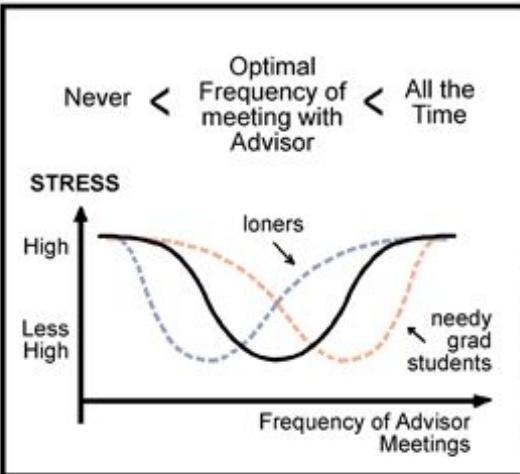
*“Successful problem-solving requires finding the right solution to the right problem. We fail more often because we solve the wrong problem than because we get the wrong solution to the right problem.”*

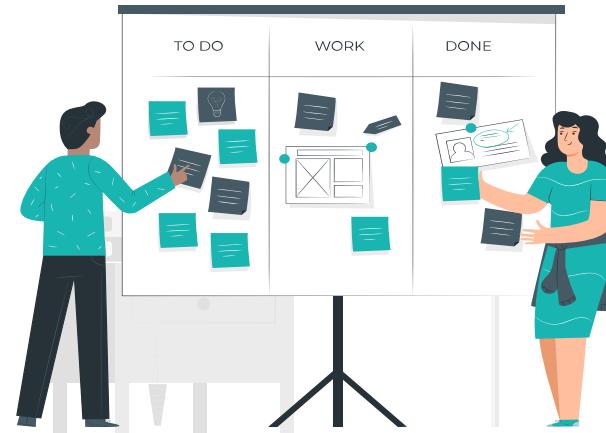
Russell L. Ackoff



<https://www.policechiefmagazine.org/360-degrees-self-survival/work-health-and-life-balance-concept-work-life-balance/>

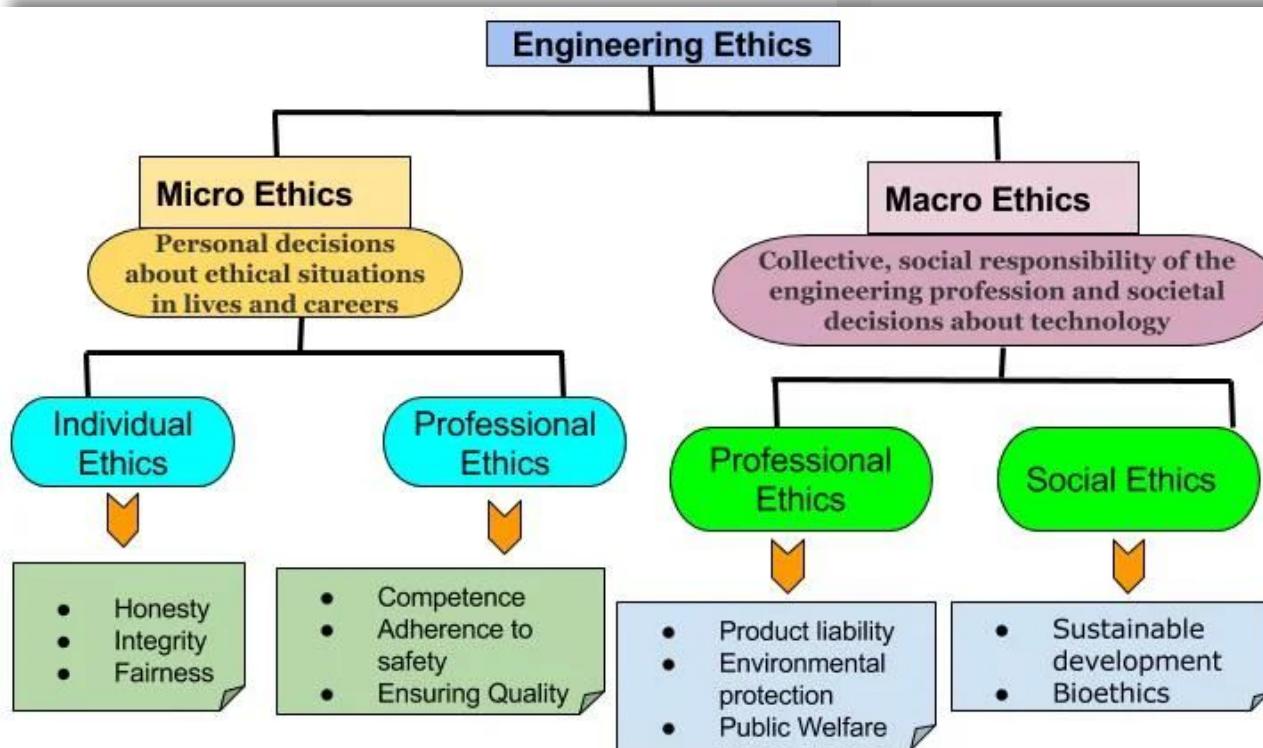
- Arrange meetings with supervisor(s)
  - Suggest weekly internal dissertations
  - Suggest weekly in company + monthly FEUP's supervisor
  - Please use calendar invitations
  - Agenda / Plan meeting
  - Action Items / After meeting
- Try to make all stakeholders happy!
  - Don't always expect the supervisor to answer quickly...
  - Don't always expect the answer during meeting
  - Write decent emails (with right subject)





- Plan ahead! Most important first!
- Maybe 2 threads of work?
- Write along the way
- **Logbook / scratch pad text file?**
- Shared task list?
- Shared Repo?
- Git is better than backup  
But at least backup
- Read before connecting (RTFM)
- Don't move hardware  
broken / burned hardware is bad...
- Make the best out of meeting time
- If possible, avoid meetings with many people...

- Be aware of what you start with; be careful with what you use and reuse and its rights



- Plan to be legal
- Use legal software
- Care with limited Licenses

## **Additionally...**

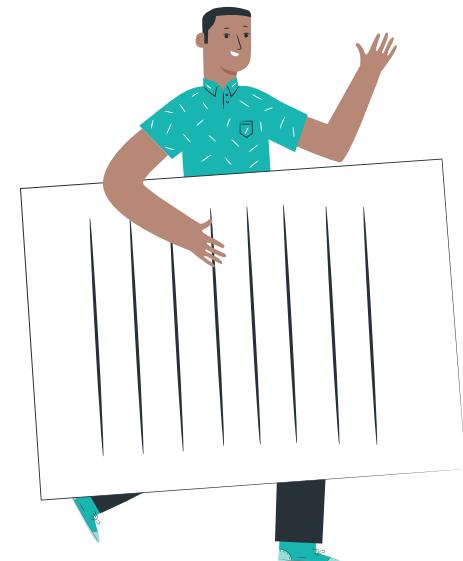


*“When your memories exceed your dreams,  
the end is near.”*

**Andy Stanley**

# During Dissertation Work

- Organize your CV
- Ask your supervisor about PhD and research opportunities!
- Apply at FEUP's job market
- Go to trade / job fairs



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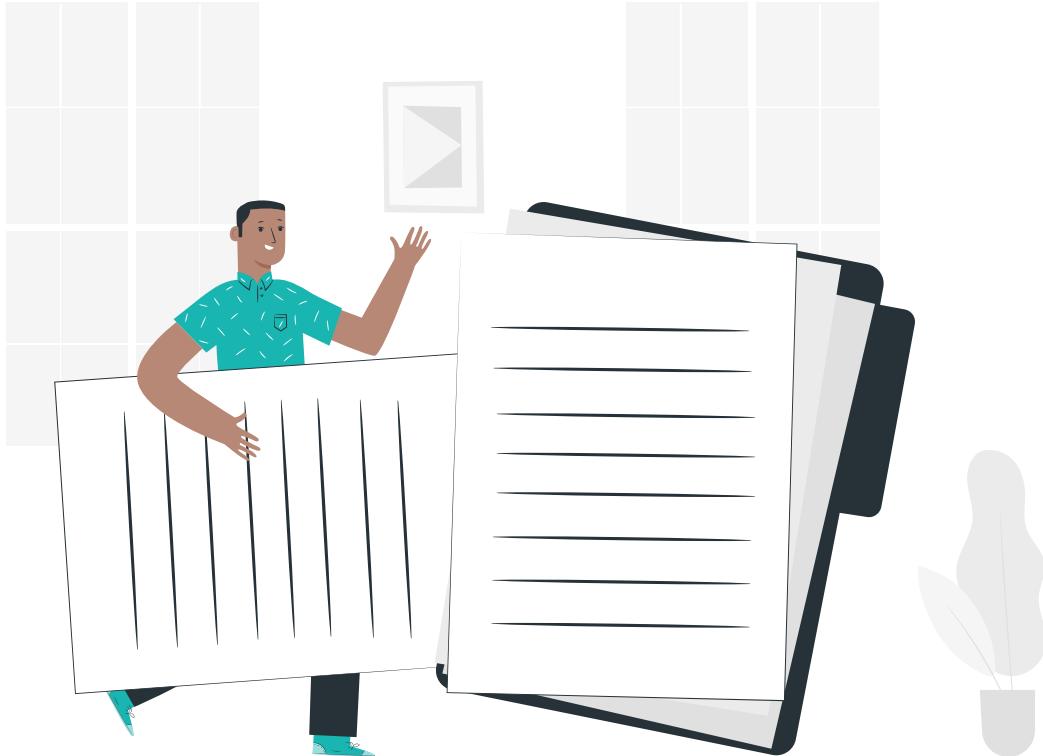
Armando Sousa  
Prof. Axuliar, DEEC / UP FEUP  
[asousa@fe.up.pt](mailto:asousa@fe.up.pt)

U.PORTO  
FEUP FACULDADE DE ENGENHARIA  
UNIVERSIDADE DO PORTO



# Ready?

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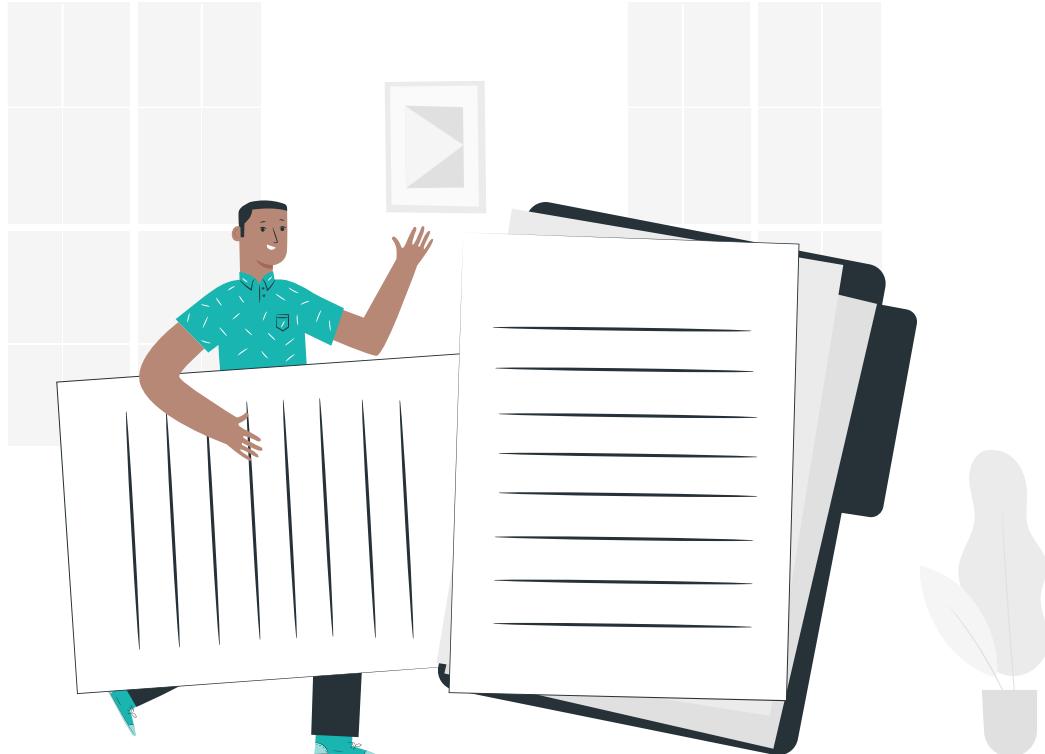


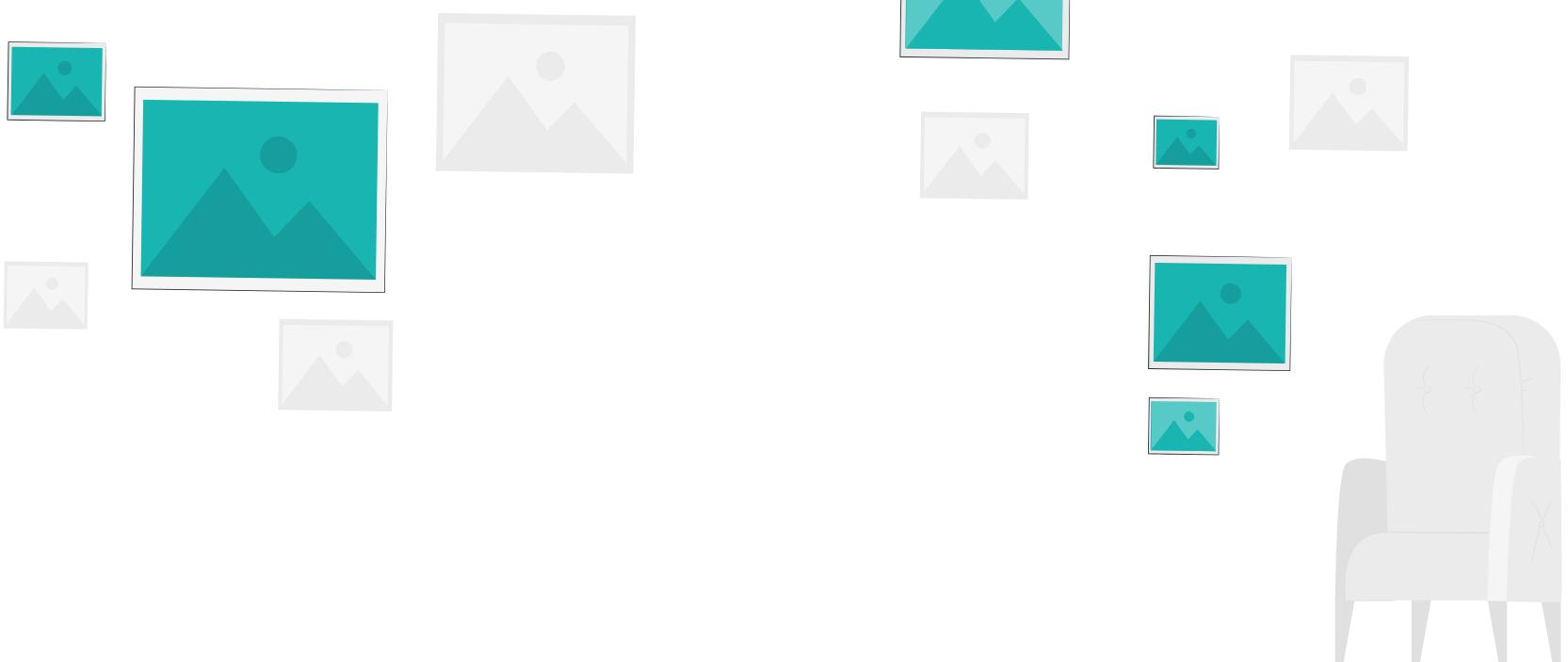
# Great work!

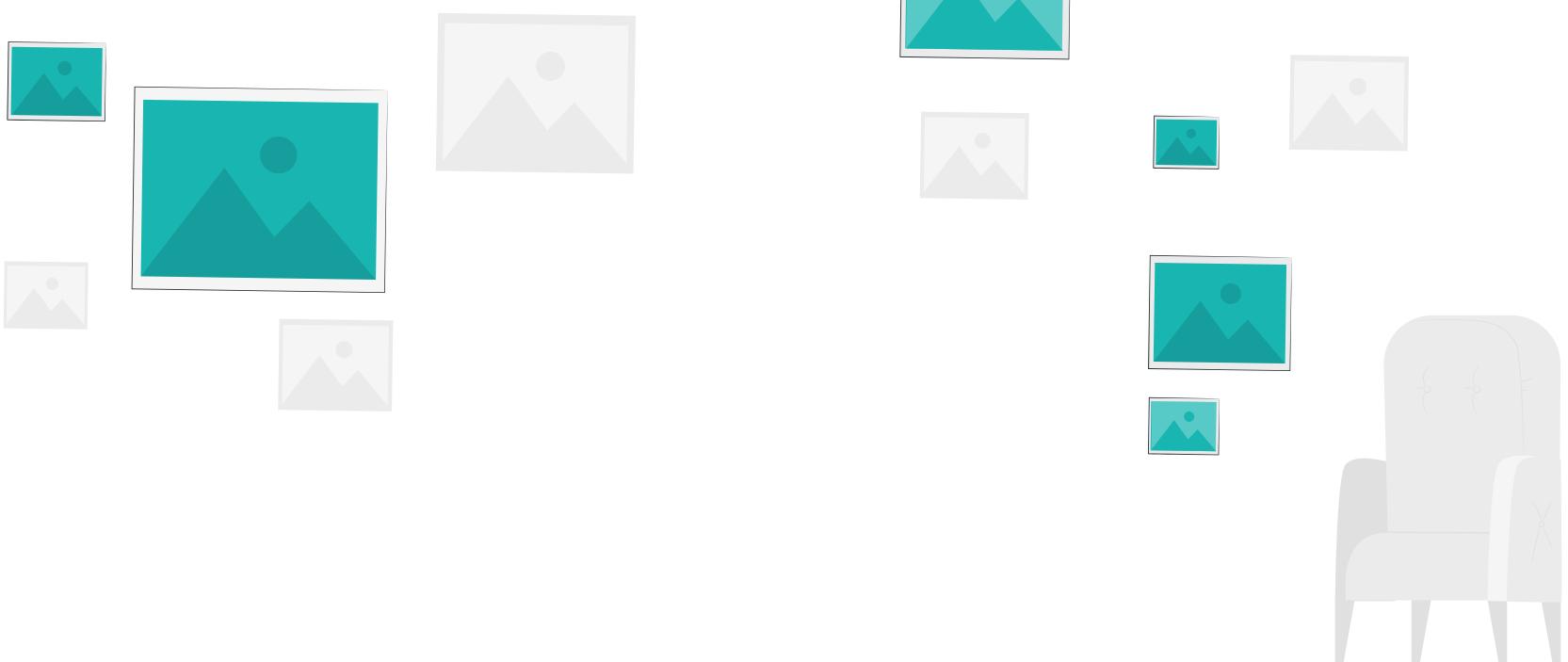
# Questions?

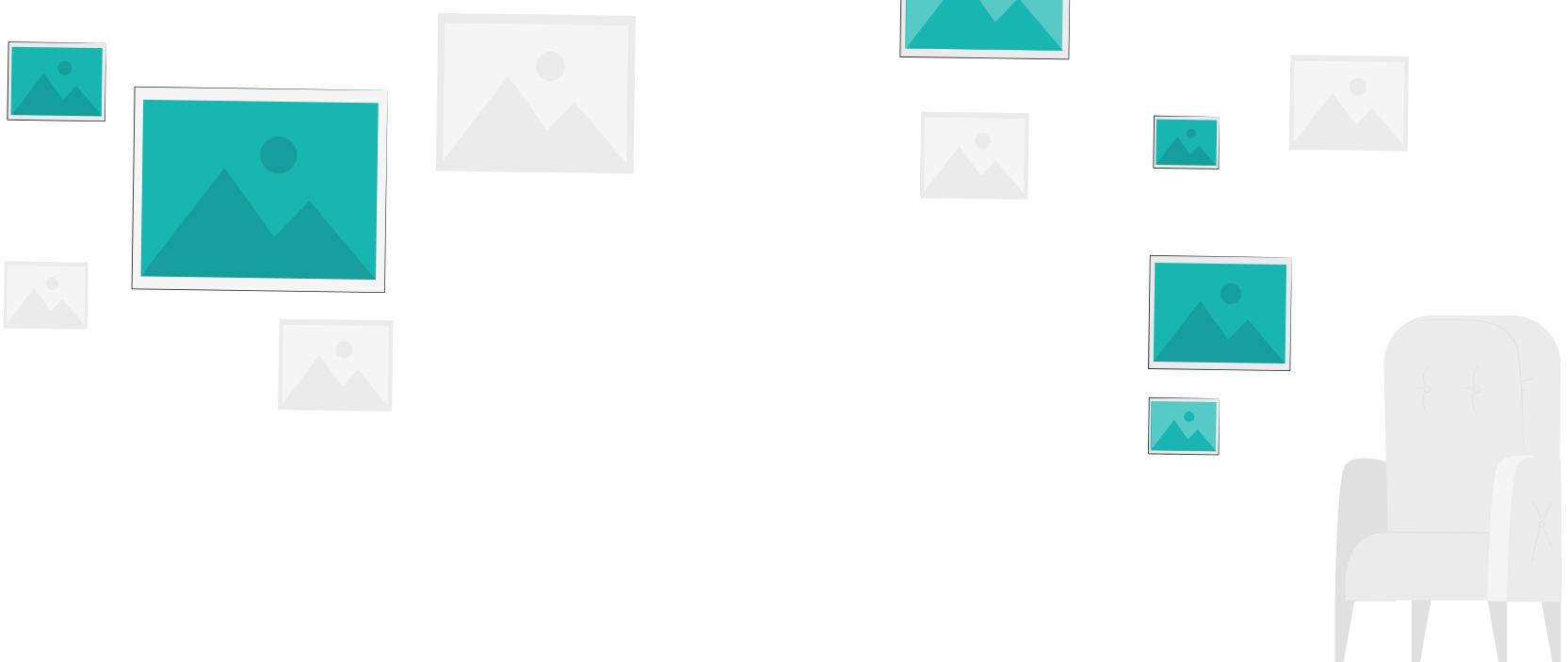
Armando Sousa  
[asousa@fe.up.pt](mailto:asousa@fe.up.pt)

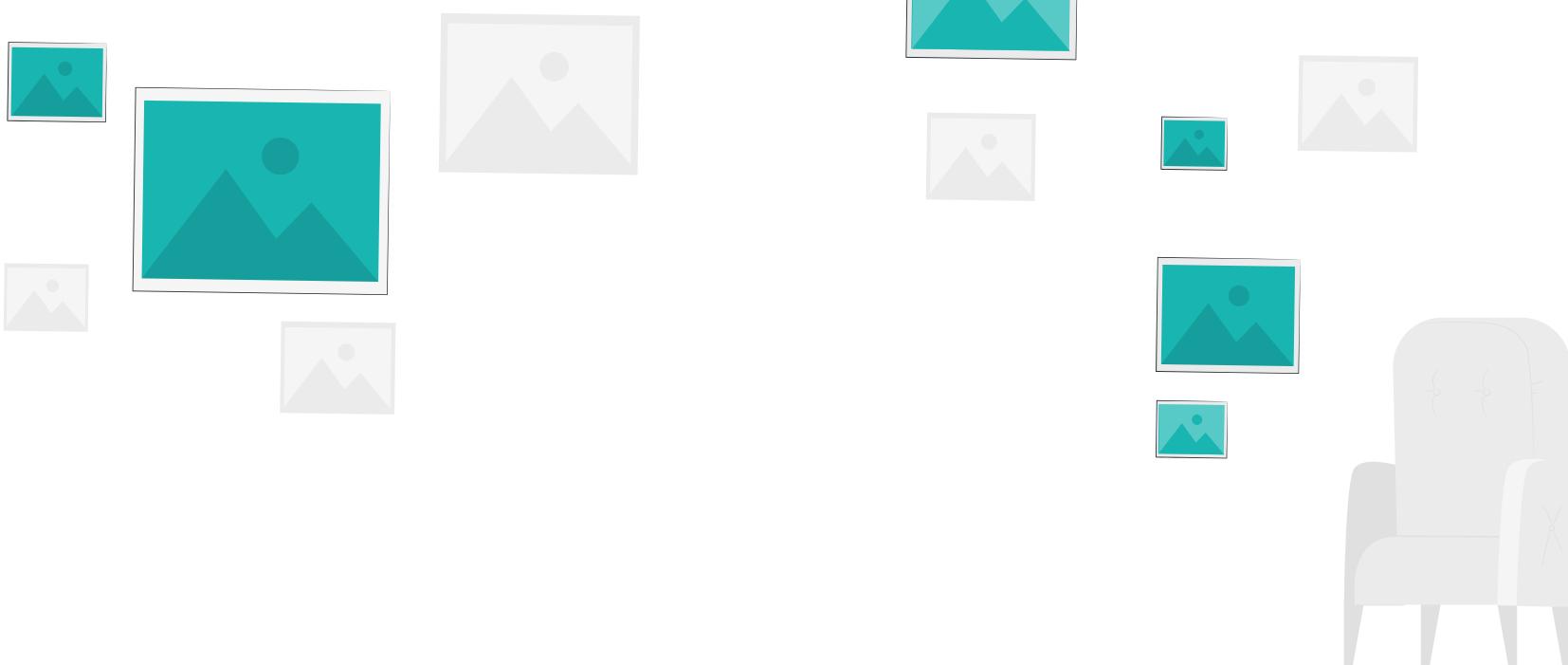
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# MAJOR REQUIREMENTS

01



## Scalable

Avoiding big infrastructures  
and investments

02



## Easy to Integrate

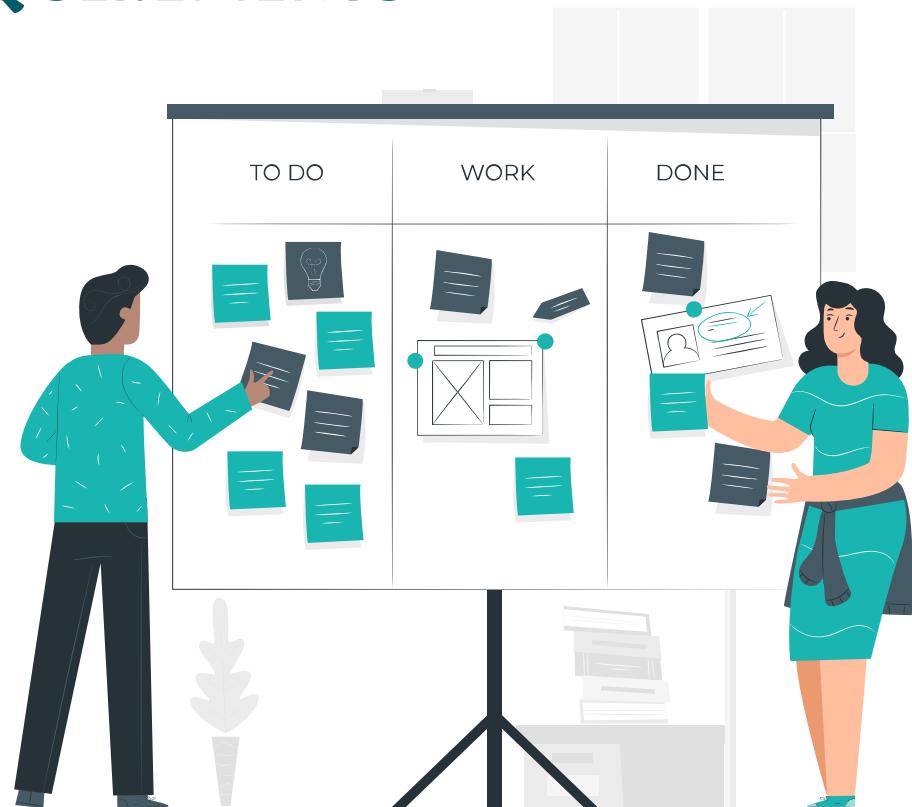
To be used in different  
scenarios

03



## Accuracy

Close to 2m



# POSSIBLE SOLUTIONS

01

## Ultra WideBand

Pros: Great Precision;  
Cons: Scalability - €

02

## Tag RFID

Pros: Good Precision  
Cons: Scalability - Range

03

## Wi-Fi

Pros: Scalability  
Cons: Accuracy

04

## Video Camera

Pros: Already installed  
Cons: Legal Factor

05

## BLE Beacons

Pros: Easy to implement  
Cons: Very low range

06

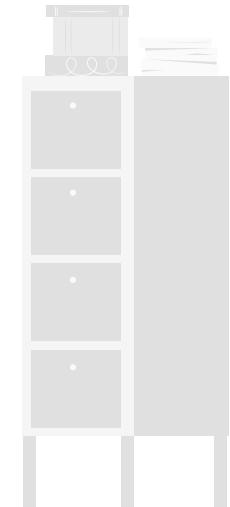
## Dead Reckoning

Pros: Scalability  
Cons: Hard Setup

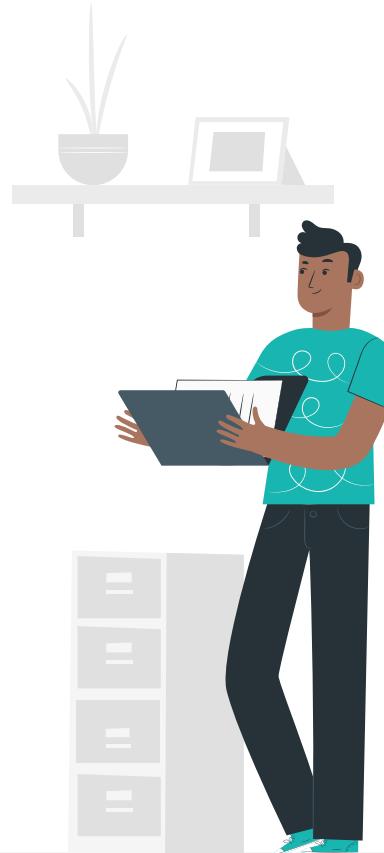


## Hypothesis

**The use of location techniques, based on radio-frequency technologies, with the measurement of the signal strength, captured by the device's antennas, allows tracking customers in the store.**



# WI-FI LOCALIZATION



The demand for better **indoor location** approaches has spawned a lot of research and development and with that some interesting **techniques** to do it.

Nowadays the most commonly used is **AoA**-based wireless location that makes it possible to pinpoint the location of somebody with high accuracy by leveraging the common use of mobile devices.

And others such as Cell of Origin (**CoO**), Received Signal Strength Indicator (**RSSI**), Time of Arrival (**ToA**), and Time Difference of Arrival (**TDoA**).

$$RSSI(dB) = -10n\log_{10}(d) + A$$

Eq. 1: RSSI representation with the Path Loss model as a base.



## PROPOSED SOLUTION



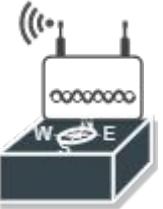
*"A man who does not plan long ahead  
will find trouble at his door."*

Confucius

# Cisco Connect Mobile Experience (CMX)

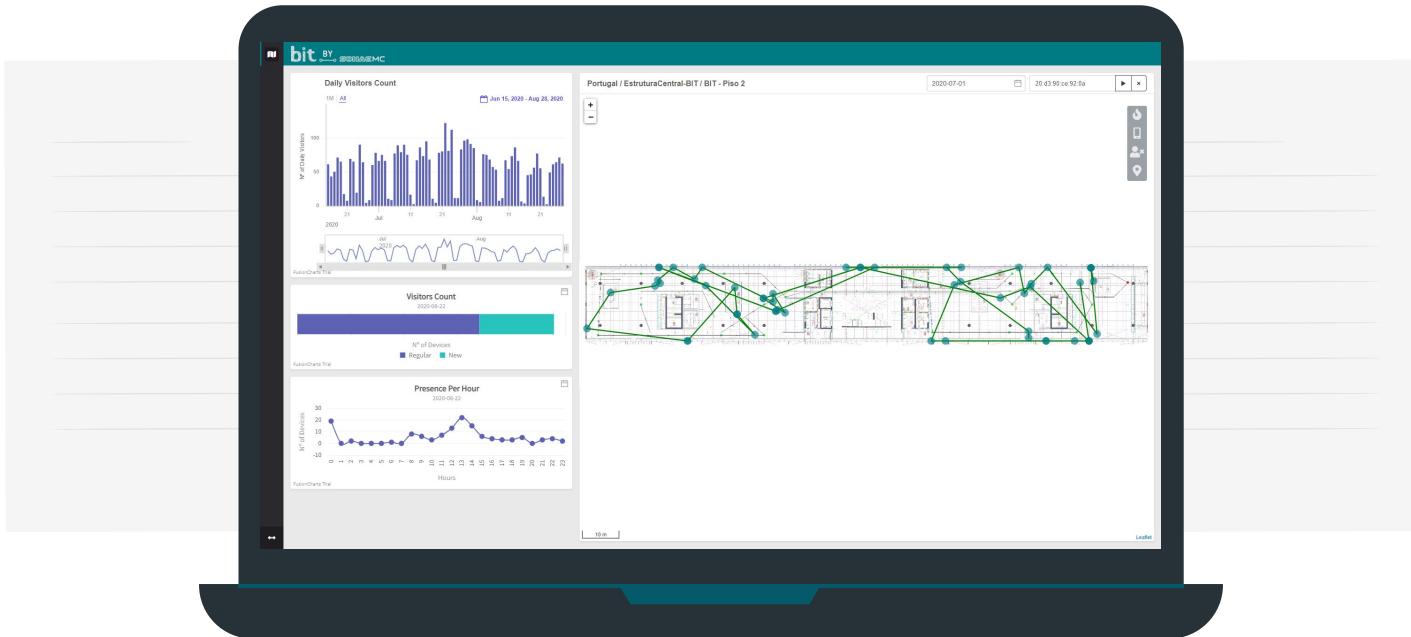


Cisco is a global enterprise infrastructure vendor that provides an indoor location service offering focused on enterprise office space, retail, hospitality, healthcare and manufacturing. Cisco CMX is a on-premises SaaS with a location engine that can calculate location via Wi-Fi. The solution mainly collects third-party location data that is transmitted over the enterprise infrastructure and makes it available via its API.

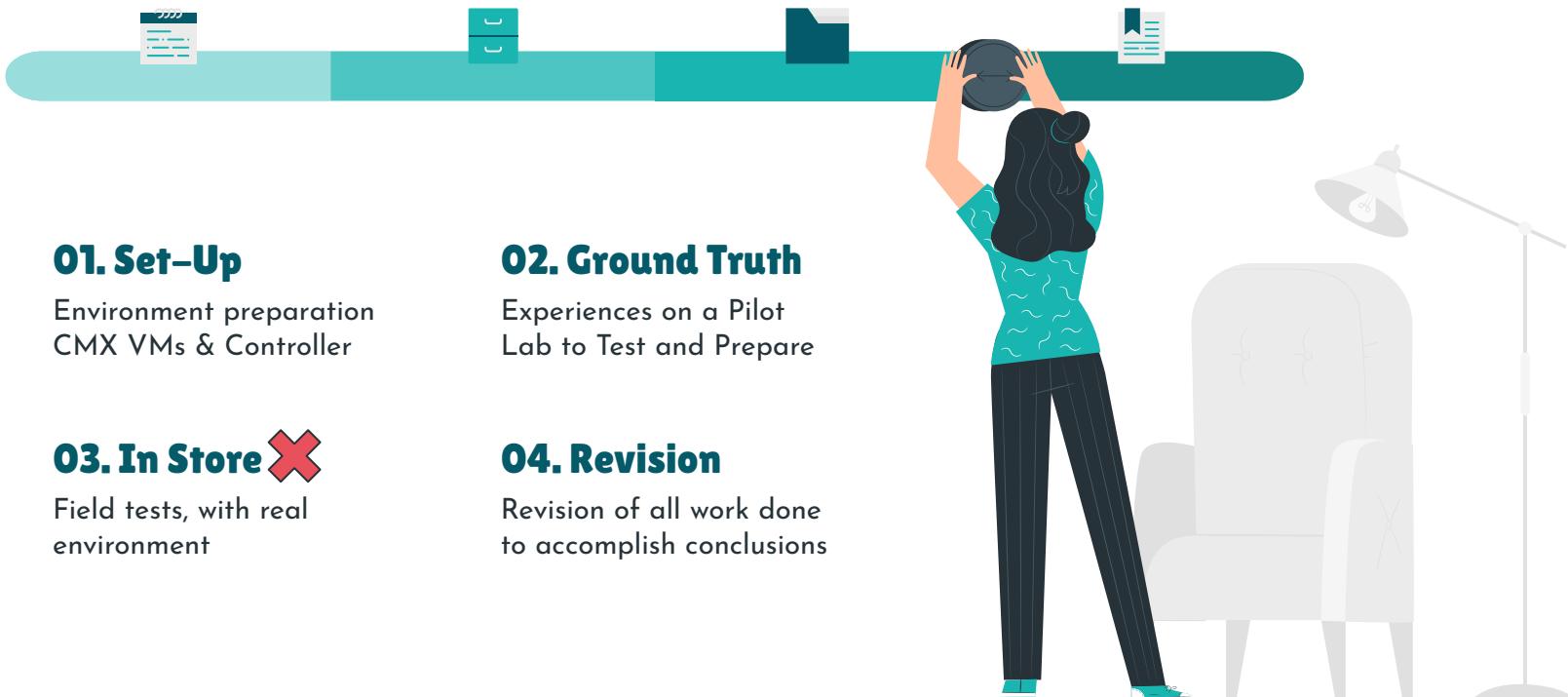


# SNEAK PEEK

Img. 1: Screenshot of the implemented dashboard.



# PROJECT STAGES



# LIMITATIONS

Admissible because business case requires sampling.



## Cisco Ecosystem

Preprocessed data and data delivery delay

## 1+ Mobile Device

Additional Processing



## 0 Mobile Device

Not detected

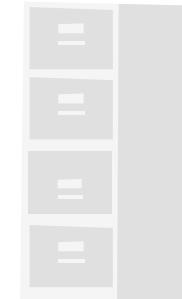
## Wifi Interface

Not detected



## Mac Address Randomization

More than 1 device can be detected



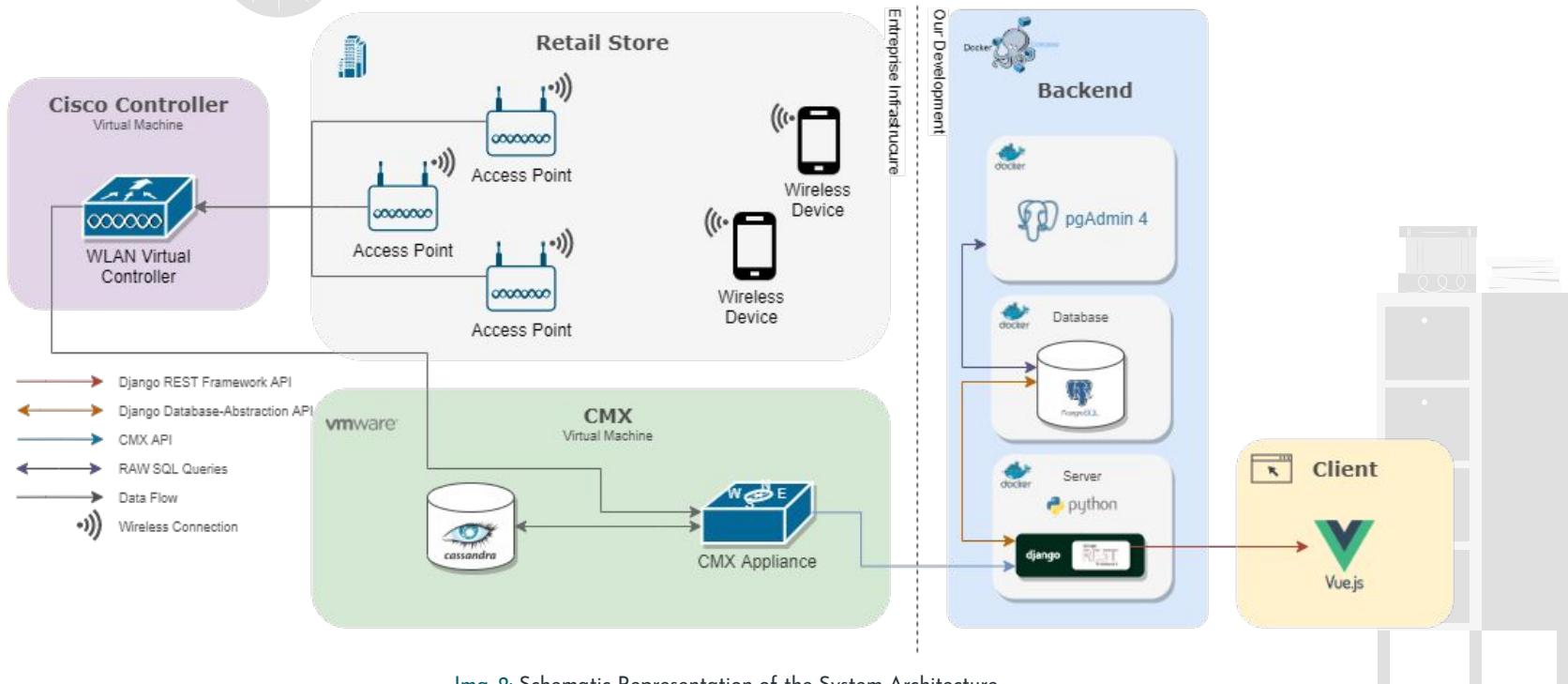
# IMPLEMENTATION



*"A man who does not plan long ahead  
will find trouble at his door."*

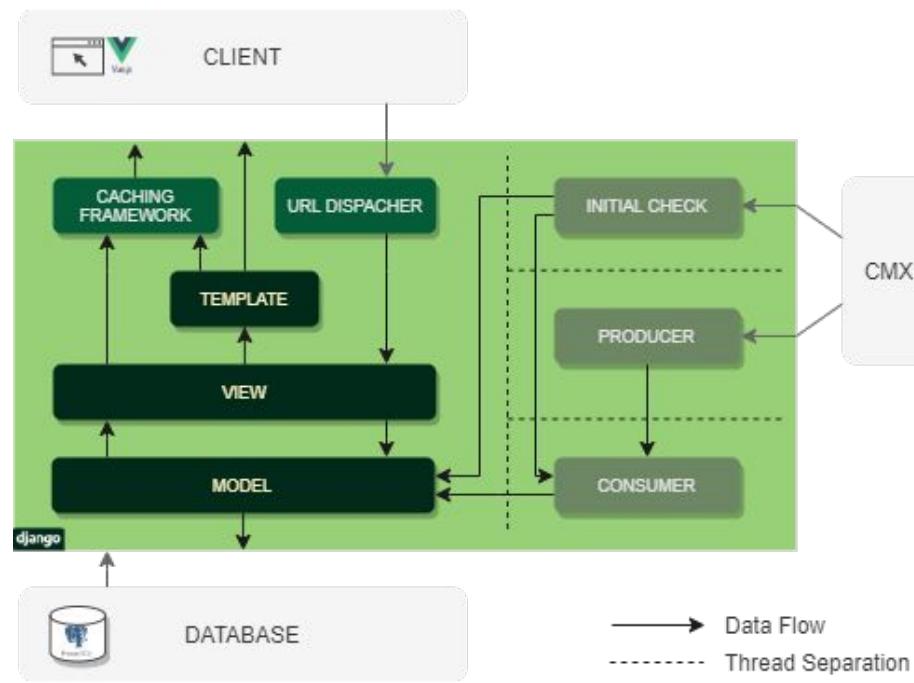
Confucius

# SYSTEM ARCHITECTURE



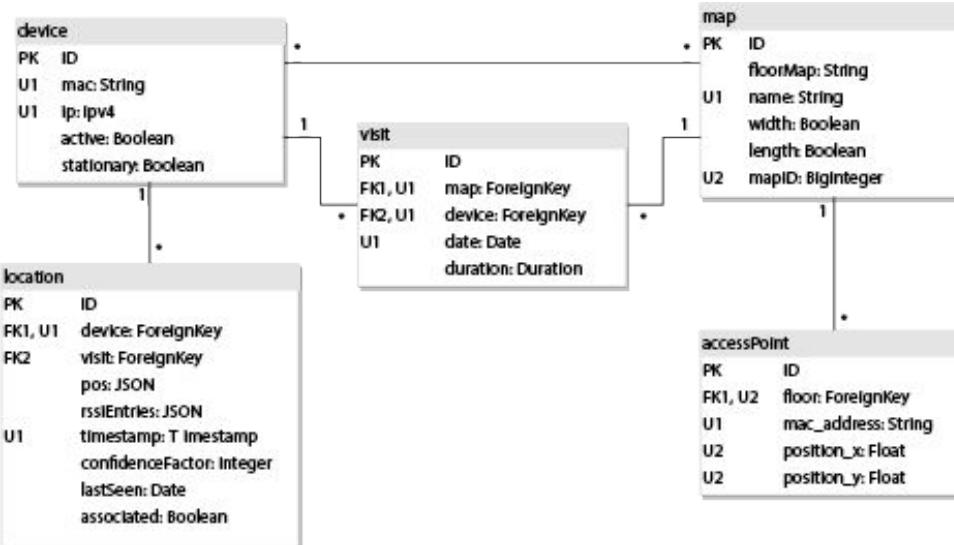
Img. 2: Schematic Representation of the System Architecture

# SERVER ARCHITECTURE



Img. 3: Schematic Representation of the Server Architecture

# DATA REPRESENTATION



Img. 4: Schematic Representation of the Database Relationships

# GROUND TRUTH

## Objectives:

- Initial validation of the error associated with the calculated locations;
- Try to figuring out main problem in the present errors and how to correct them;

## Used Devices

Huawei Honor 10 (2019)  
Samsung Galaxy Tab  
Pro 8.4(2014)

## Access Points

Cisco Aironet 2800i  
(AIR-AP2802I-E-K9)

## Lab Environment

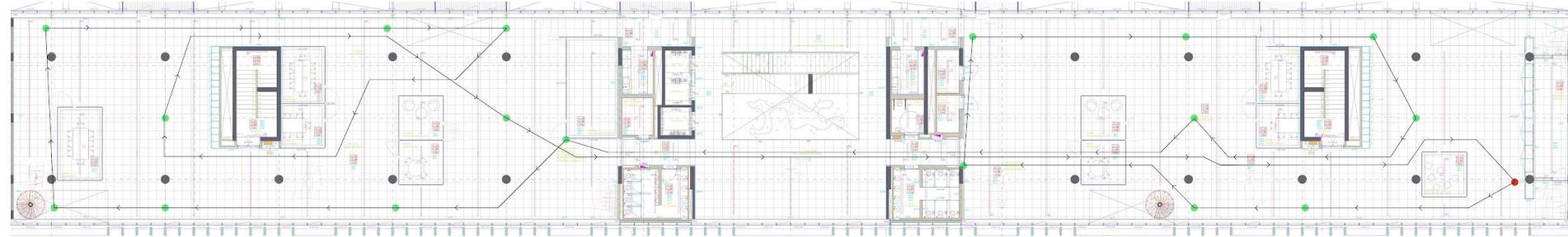
Sonae Bit Offices

## Wireless Controller

Cisco Virtual Wireless  
Controller (AIR-CTVM-K9)



# GROUND TRUTH



Img. 5: Representation of the Trajectory of Ground Truth Test

## 19 Points

19 checkpoints were marked on the chosen path

## 30s Each Point

On each checkpoint is needed to steady hold stand for 30 seconds to guarantee the system capture the location

## 5 Repetitions

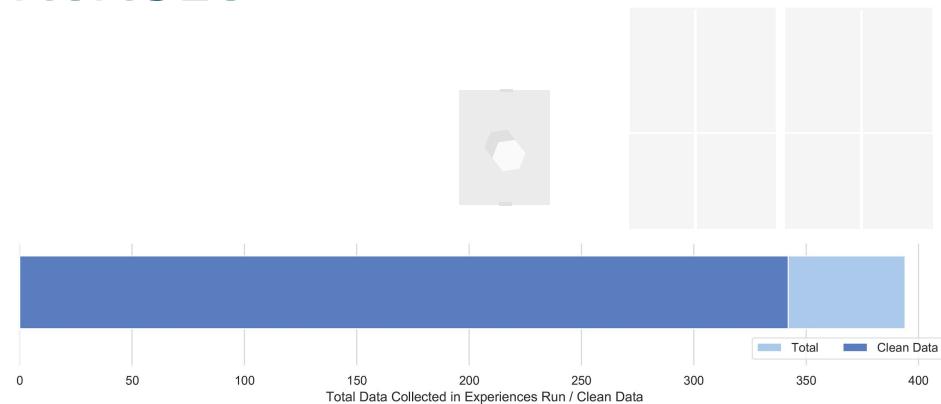
In order to increase the repeatability of the data, 5 repetitions were made with each device

# DATASET

**394**

## Total Data Collected

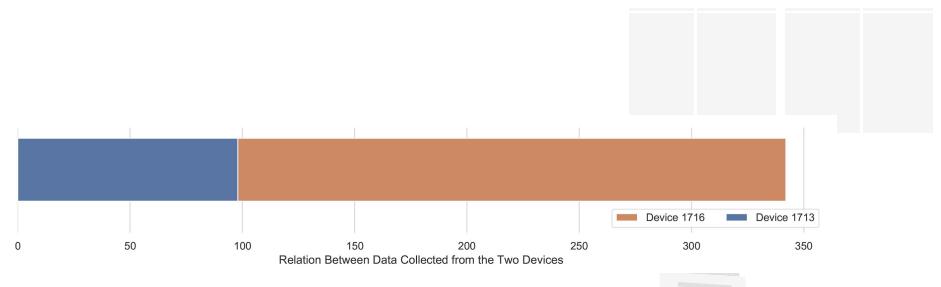
Number of locations collected  
in ground truth test



## Device 1713

Number of locations associated  
with the Smartphone

**98**



## Device 1716

Number of locations  
associated with the Tablet

**244**

# Data Band Distribution



## Device 1713

2.4 Ghz - 148 Values  
5 Ghz - 58 Values

## Device 1716

2.4 Ghz - 1039 Values  
5 Ghz - 288 Values

# Nº of AP per Location

## Device 1713

2 APs detected on average for each location record

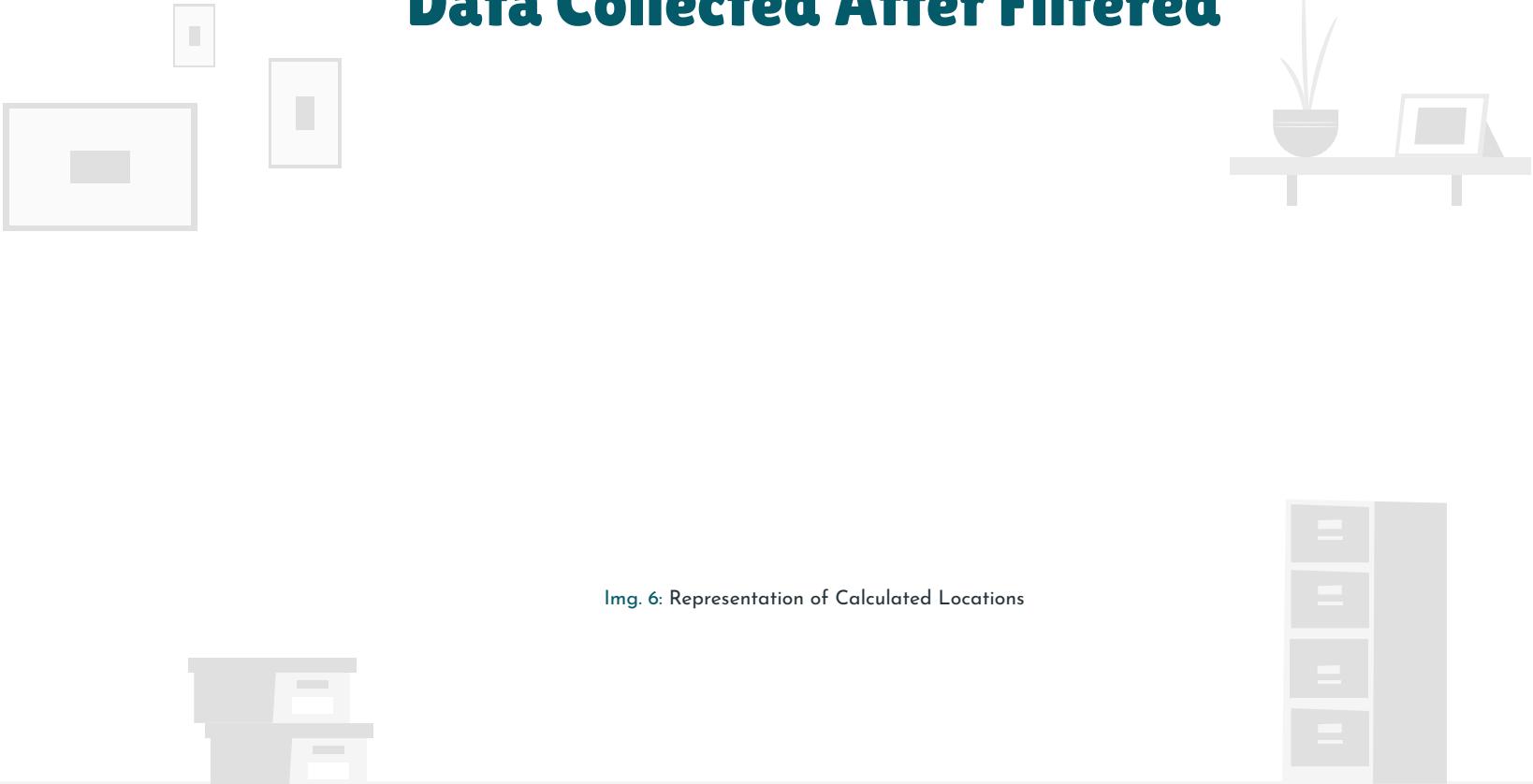
## Device 1716

5 APs detected on average for each location record



# Data Collected After Filtered

Img. 6: Representation of Calculated Locations



# Error of Ground Truth

## All Devices

Avg: 6.99m

Std Dev: 4.89m

## Device 1713

Avg: 8.7m

Std Dev: 5.9m

## Device 1716

Avg: 5.4m

Std Dev: 3.4m



# Correlations CMX Values / Error

## Linear Regression

$$y = -6.62x + 9.15$$

X → Number of AP

Y → Expected error

## Linear Regression

Not relevant, with the increase in confidence, a decrease in error was expected.

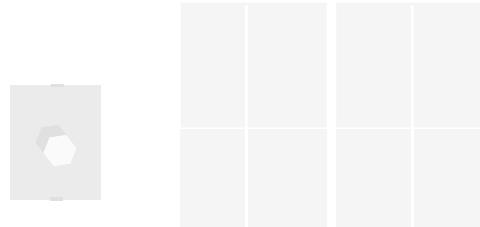
# RSSI to DISTANCE

$$\text{RSSI(dB)} = -10n\log_{10}(d) + A$$

## Try

1<sup>st</sup>

Use of Python optimization algorithms with the function to minimize to be the square of the error between the real position and the calculated position



2<sup>nd</sup>

Brute Force attempt with the function to minimize to be the error between the real position and the calculated position

3<sup>rd</sup>

Use of Python optimization algorithms with the function to minimize to be the square of the error between the real distance to the AP with the calculated distance

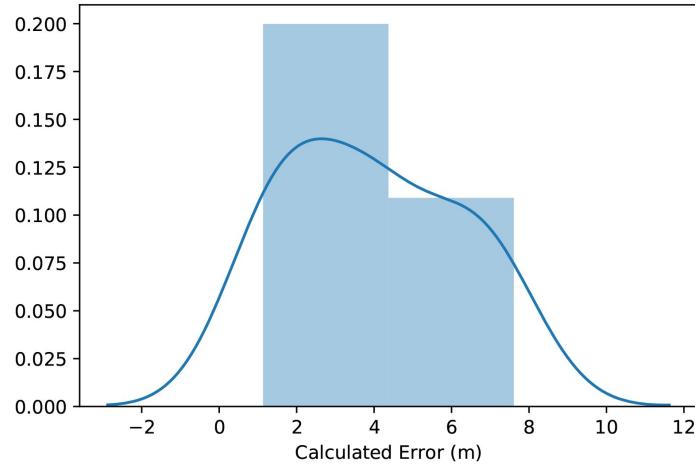
	5 GHz		2.4GHz		Error (m)	Standard Deviation (m)
	n	A (dBm)	n	A (dBm)		
1 <sup>a</sup>	2.48	-48	2.63	-37	7.01	5.03
2 <sup>a</sup>	2.9	-41	2.6	-37.5	6.98	5.02
3 <sup>a</sup>	2.4	-44.7	2.0	-44.7	7.11	5.10

Tab. 1: Comparison of the results obtained in the different set-ups



# Error with Data Aggregation

The data aggregation has been made by the mean of all locations calculated in each test run.



## Device 1713

**Avg:** 6.59m  
**Std:** 3.51m

## Device 1716

**Avg:** 3.78m  
**Std:** 1.83m

## All Devices

**Avg:** 3.94m  
**Std:** 2.22m

# CONSIDERATIONS

Img. 7: Representation of a run made in ground truth test

**Adaptable**



**Low Complexity**



**Exhaustive  
Calibration Free**



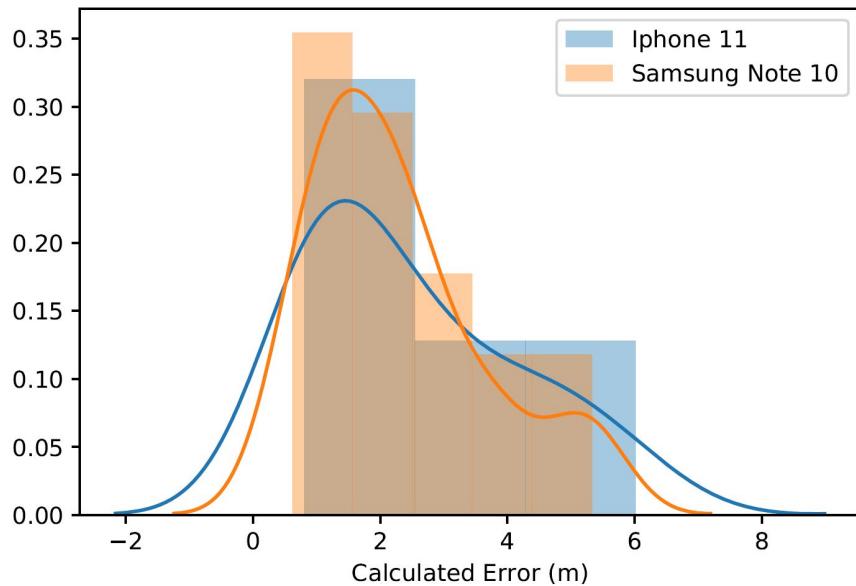
**Scalable**



**Precision**



# FINAL TESTS



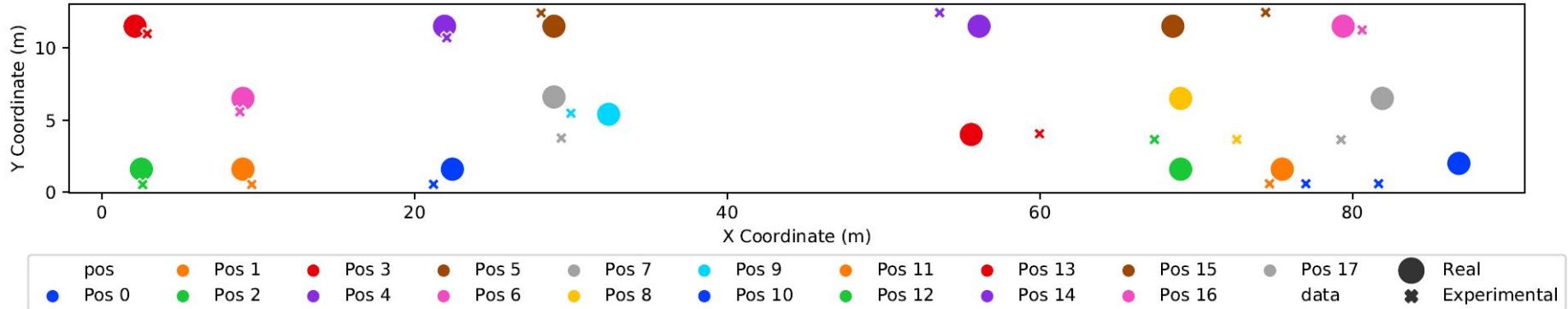
**Iphone 11**

**Avg:** 2.50m  
**Std Dev:** 1.67m

**Samsung Note 10**

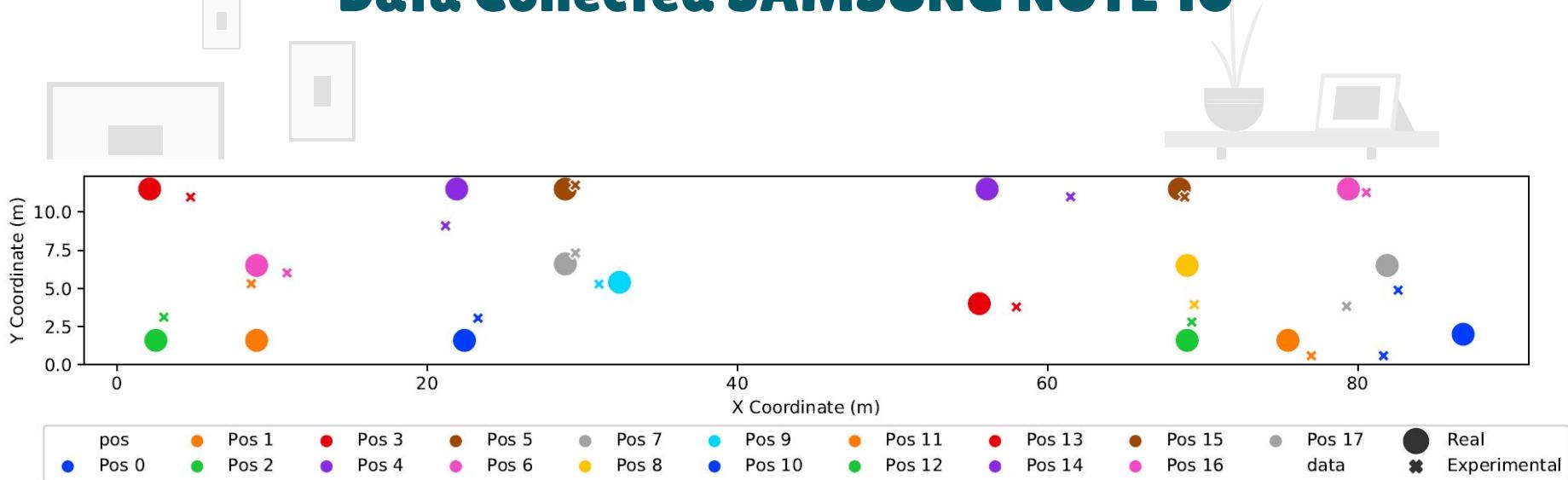
**Avg:** 2.20m  
**Std Dev:** 1.40m

# Data Collected IPHONE 11



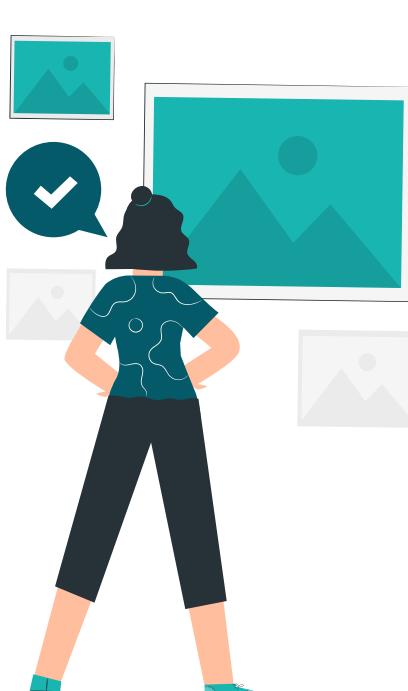
Img. 9: Representation of Calculated Locations

# Data Collected SAMSUNG NOTE 10



Img. 10: Representation of Calculated Locations

# Future Work



- More detailed exploration of the possibility of creating a big data system;
- Development of a system capable of predicting the next location of devices
- Improved dashboard with the incorporation of new data analysis features