The design of a Master Thesis

Andrea Donini (curso organizado y supervisado con Pilar Hernández)

Motivation

- Scientific writing is not taught at school, nor during the undergraduate learning
- WE professional scientists LEARN how to write by TRIALS AND ERRORS, after many years of scientific papers publication and refereeing
- Many of us NEVER LEARN! You can be a very good scientist and a poor writer....

However,

we may learn from more experienced professional scientists

and

we may learn from more experienced professional writers

A Pulitzer Prize's suggestion

The 2006 Pulitzer Prize's winner Cormac McCarthy wrote a basic set of rules (suggestions...) on how to write a scientific article (in english)

Nature **574**, 441-442 (2019)

Some of them:

On the choice of the subject:

Decide on your paper's theme and two or three points you want every reader to remember. This theme and these points form the single thread that runs through your piece.

On simplicity:

If something isn't needed to help the reader to understand the main theme omit it.

Keep sentences short, simply constructed and direct.

Concise, clear sentences work well for scientific explanations.

On the style:

Inject questions and less-formal language to break up tone and maintain a friendly feeling. [...] Similarly, use a personal tone because it can help to engage a reader. If you must talk about arbitrary colours of an abstract sphere, it's more gripping to speak of this sphere as a red balloon or a blue billiard ball.

Maybe the most important:

Just enjoy writing.

Not everybody enjoys writing!

Accelerated learning

Our main objective is that you may learn the basic rules to write your Master's Thesis by this summer...

Our final goal is to have a uniform (minimum) level in the Theses, so as to simplify reading both for referees and normal readers (this may be useful for us to read your theses, and for you to sell your thesis outside the academy)

Starting from a "standard recipe", you may then evolve into your own scientific style

General view

- 1. (Online?) class(es) on basic rules to write the Master's thesis
- 2. Practical exercise: organising the Thesis (email submission)
- 3. Correction of the practical exercise (either by mail or skype?)
- 4. Presentation to the class of one or two exercises
- 5. (Online?) class on basic rules to present your Master's thesis

1. STARTING

- 1. Choosing a language
- 2. Choosing an editing language
- 3. Choosing an editor

2. ORGANIZATION OF THE THESIS

- 1. Understanding your subject
- 2. What is "old"
- 3. Appendices
- 4. What is "new"
- 5. Introduction and conclusions

- 1. Drawing and inserting plots
- 2. Explaining plots (captions!)
- 3. Equations
- 4. REFERENCING

1. STARTING

- 1. Choosing a language
- 2. Choosing an editing language
- 3. Choosing an editor

2. ORGANIZATION OF THE THESIS

- 1. Understanding your subject
- 2. What is "old"
- 3. Appendices
- 4. What is "new"
- 5. Introduction and conclusions

- 1. Drawing and inserting plots
- 2. Explaining plots (captions!)
- 3. Equations
- 4. REFERENCING

1. STARTING

- 1. Choosing a language
- 2. Choosing an editing language
- 3. Choosing an editor

2. ORGANIZATION OF THE THESIS

- 1. Understanding your subject
- 2. What is "old"
- 3. Appendices
- 4. What is "new"
- 5. Introduction and conclusions

- 1. Drawing and inserting plots
- 2. Explaining plots (captions!)
- 3. Equations
- 4. REFERENCING

What this class it is not

We are not teaching you to write

We are not teaching you the language you use to write: scientists write in a non-uniform language that approximately resembles English

We are not teaching you physics

1. STARTING

- 1. Choosing a language
- 2. Choosing an editing language
- 3. Choosing an editor

2. ORGANIZATION OF THE THESIS

- 1. Understanding your subject
- 2. What is "old"
- 3. Appendices
- 4. What is "new"
- 5. Introduction and conclusions

- 1. Drawing and inserting plots
- 2. Explaining plots (captions!)
- 3. Equations
- 4. REFERENCING

1. Choose a language to write

Possible choices:

ENGLISH

CASTELLANO

VALENCIÁ

1. Choose a language to write

Possible choices:

ENGLISH

CASTELLANO

VALENCIÁ

I strongly suggest ENGLISH:

- 1. It is the (current) language of science
- 2. You read books and articles in english
- 3. It may be your first (or last) chance to write in english
- 4. Your thesis will be easier to show outside (to do a PhD abroad, to go to a private company, ...)

2. Choose a editing language

Possible choices:

NONE

2. Choose a editing language

There is only one choice possible:

Possible choices:

NONE

LATEX

MAC: TEXSHOP https://pages.uoregon.edu/koch/texshop/

WINDOWS: MIKTEX https://miktex.org/download

LINUX: TEXLive (depends on which Linux)

https://repology.org/project/texlive/versions

3. Choose an editor

This is up to you (however, most Latex releases have their own editor)

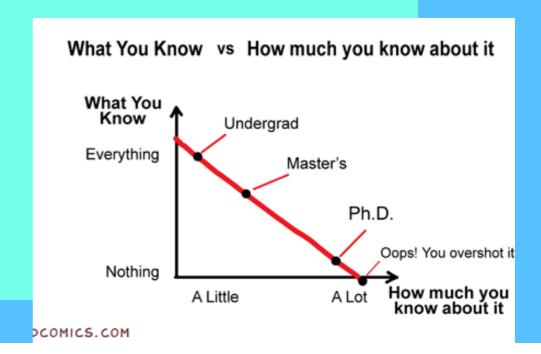
1. Understanding your subject

Usually, you and your advisor are the two persons that understand most of your thesis

1. Understanding your subject

Usually, you and your advisor are the two persons that understand most of your thesis

Sometimes, only your advisor understand (most of) your thesis



1. Understanding your subject

Usually, you and your advisor are the two persons that understand most of your thesis

The rest of the physicists that read your thesis divide into:

those that know the subject and those that do not know the subject

1. Understanding your subject

Usually, you and your advisor are the two persons that understand most of your thesis

The rest of the physicists that read your thesis divide into:

those that know the subject and those that do not know the subject

The jury that will examine you will be composed by both

WRITE FOR THE LATTER GROUP!

r subject

re the two

persons that understand most of your thesis

The rest of the physicists that read your thesis divide into:

those that know the subject

and those that do not know the subject

The jury that will examine you will be composed by both

1. Understanding your subject

You should imagine that those that read

DO NOT KNOW DEEPLY THE SUBJECT OF YOUR THESIS

(give an overview of the subject)

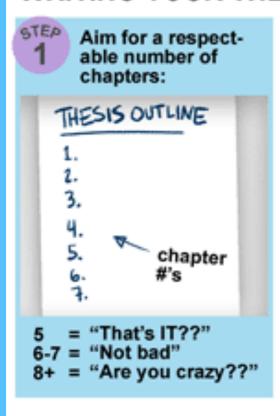
but

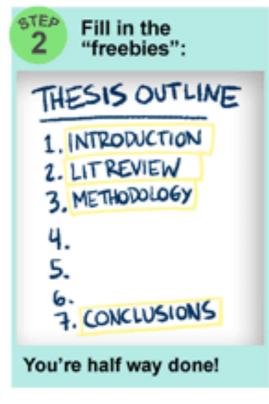
THEY KNOW AND UNDERSTAND THE BASICS (do not start with undergraduate stuff)

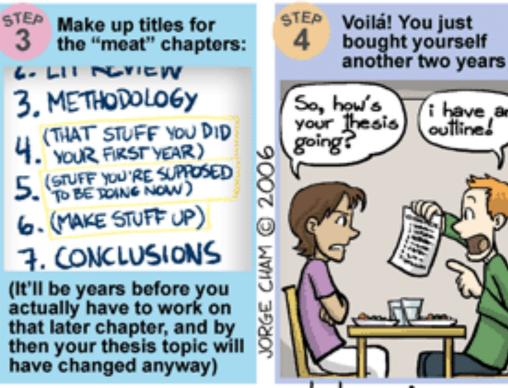
1. Understanding your subject

WRITING YOUR THESIS OUTLINE

NOTHING SAYS "I'M ALMOST DONE" TO YOUR ADVISOR/ SPOUSE/PARENTS LIKE PRETENDING YOU HAVE A PLAN







www.phdcomics.com

i have an

outline!

1. Understanding your subject



An example from old theses

Thesis on SUSY

1	M Problems
	.1 Observable Problems
	1.1.1 Neutrino Masses
	1.1.2 Dark Matter
	1.1.3 Baryon Asymmetry (Baryogenesis)
	1.1.4 Inflation Mechanism
	.2 Hierarchy Problem
	.3 Thoretical and Phenomenological Problems
2 '	The SUSY Way
	.1 LSP - Dark Matter
	2.1.1 R-parity
	.2 Stability in the Hierarchy Problem
	.3 Grand Unification
	.4 Untification of Couplings
	.5 Locality and Supergravity
3	ntroducing SUSY
	.1 SUSY Algebra
	3.1.1 Massless Supermultiplet
	3.1.2 Massive Supermultiplet
	.2 SUSY Lagrangians
	3.2.1 Non-interacting Wess-Zumino model
	3.2.2 Interacting chiral supermultiplet
	3.2.3 Gauge supermultiplet lagrangians
	3.2.4 Gauge and Chiral interactions
	.3 Necessity of Soft SUSY Breaking
4	MSSM
	.1 Electroweak symmetry breaking in the MSSM
	.2 MSSM mass spectrum
	4.2.1 Gluinos
	4.2.2 Neutralinos

An example from old theses

Introduction (motivation)

Thesis on SUSY

Cont	ents	
1 SM 1.1 1.2 1.3	Problems	
2 Th 2.1 2.2 2.3 2.4 2.5	e SUSY Way 9 LSP - Dark Matter 11 2.1.1 R-parity 12 Stability in the Hierarchy Problem 13 Grand Unification 15 Unification of Couplings 15 Locality and Supergravity 16	
3 Int 3.1 3.2	roducing SUSY 17 SUSY Algebra 17 3.1.1 Massless Supermultiplet 18 3.1.2 Massive Supermultiplet 19 SUSY Lagrangians 20 3.2.1 Non-interacting Wess-Zumino model 20 3.2.2 Interacting chiral supermultiplet 22 3.2.3 Gauge supermultiplet lagrangians 24 3.2.4 Gauge and Chiral interactions 26 Necessity of Soft SUSY Breaking 27	
4 MS 4.1 4.2	SSM Electroweak symmetry breaking in the MSSM 29	

An example from old theses

Introduction/ Motivation

Thesis on SUSY

" Lil' " review

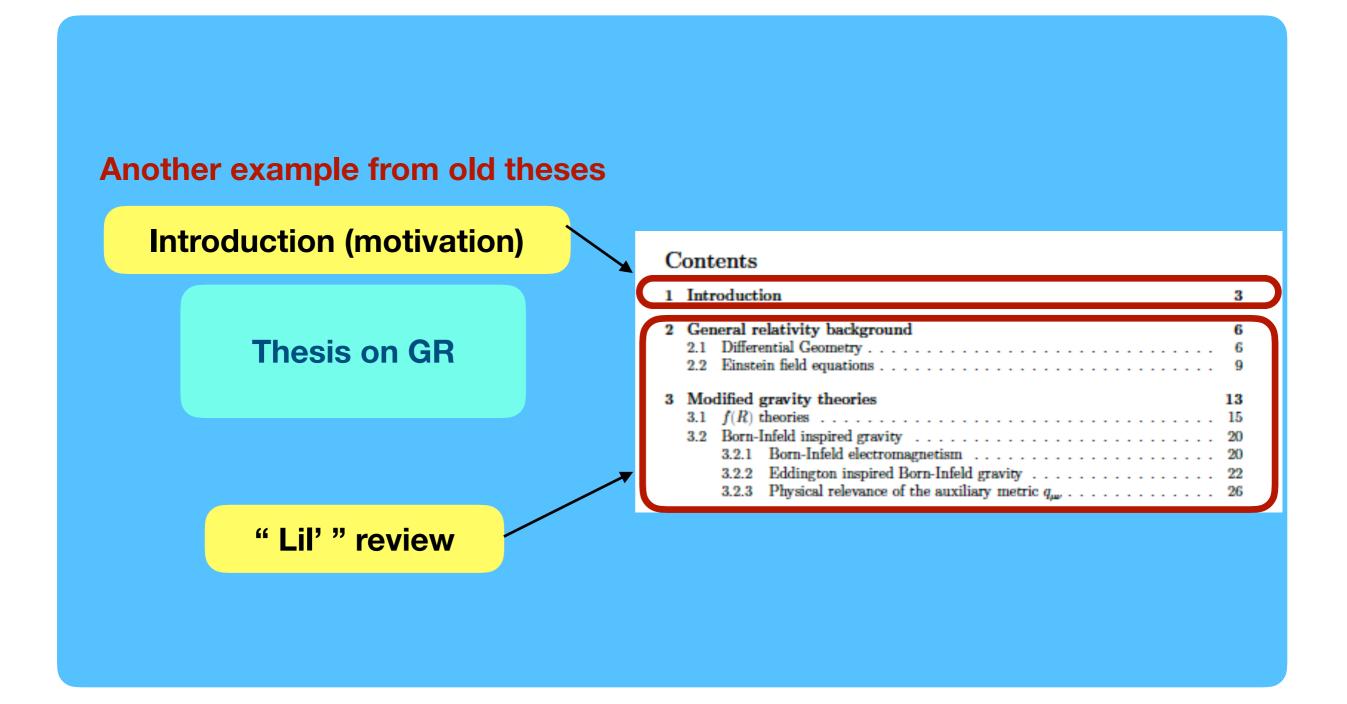
Contents	
1 SM Problems 1 1.1 Observable Problems 3 1.1.1 Neutrino Masses 3 1.1.2 Dark Matter 4 1.1.3 Baryon Asymmetry (Baryogenesis) 5 1.1.4 Inflation Mechanism 5 1.2 Hierarchy Problem 5 1.3 Thoretical and Phenomenological Problems 8	
2 The SUSY Way 9 2.1 LSP - Dark Matter 11 2.1.1 R-parity 12 2.2 Stability in the Hierarchy Problem 13 2.3 Grand Unification 15 2.4 Unification of Couplings 15 2.5 Locality and Supergravity 16	
3 Introducing SUSY 17 3.1 SUSY Algebra 17 3.1.1 Massless Supermultiplet 18 3.1.2 Massive Supermultiplet 19 3.2 SUSY Lagrangians 20 3.2.1 Non-interacting Wess-Zumino model 20 3.2.2 Interacting chiral supermultiplet 22 3.2.3 Gauge supermultiplet lagrangians 24 3.2.4 Gauge and Chiral interactions 26 3.3 Necessity of Soft SUSY Breaking 27	
4 MSSM 4.1 Electroweak symmetry breaking in the MSSM 29 4.2 MSSM mass spectrum 30 4.2.1 Gluinos 30 4.2.2 Neutralinos 31 4.2.3 Charginos 31 4.2.4 Chiral supermultiplet mixing 32	

Another example from old theses

Thesis on GR

Contents

1	Inti	roduction	3
2	Ger	neral relativity background	6
		Differential Geometry	6
	2.2	Einstein field equations	9
3		dified gravity theories	13
	3.1	f(R) theories	15
	3.2	Born-Infeld inspired gravity	20
		3.2.1 Born-Infeld electromagnetism	20
		3.2.2 Eddington inspired Born-Infeld gravity	22
		3.2.3 Physical relevance of the auxiliary metric q	26



Introduction/Motivation: 3-6 pages

"Old" Literature: 10 to 20 pages (from textbooks and articles)

START FROM HERE! START NOW!

Your stuff: 10 to 20 pages

Introduction/Motivation: 3-6 pages

"Old" Literature: 10 to 20 pages (from textbooks and articles)

START FROM HERE! START NOW!

Your stuff: 10 to 20 pages

SECOND PART TO WRITE...

Introduction/Motivation: 3-6 pages

MOST IMPORTANT PART OF THE THESIS!
LAST TO WRITE!

"Old" Literature: 10 to 20 pages (from textbooks and articles)

START FROM HERE! START NOW!

Your stuff: 10 to 20 pages

SECOND PART TO WRITE...

You should determine which amount of basic information is needed to introduce the subject

Who is your reader: a physicist that understand what you are doing, but do not know the basic literature on the subject (except for textbooks)

Example: Thesis on some topic in General Relativity

Do not explain what is General Relativity from scratch

If you need some non-standard formalism,

introduce it

2	General relativity background 2.1 Differential Geometry	
3	Modified gravity theories 3.1 $f(R)$ theories 3.2 Born-Infeld inspired gravity 3.2.1 Born-Infeld electromagnetism 3.2.2 Eddington inspired Born-Infeld gravity 3.2.3 Physical relevance of the auxiliary metric $q_{\mu\nu}$	20 20 22

Example: Thesis on some topic in General Relativity

Do not explain what is General Relativity from scratch

If you need some non-standard formalism,
introduce it

STANDARD: 3 pages

(2	2.1	neral relativity background Differential Geometry	
	3	3.1	dified gravity theories $f(R)$ theories Born-Infeld inspired gravity 3.2.1 Born-Infeld electromagnetism 3.2.2 Eddington inspired Born-Infeld gravity	20 20
			3.2.3 Physical relevance of the auxiliary metric $q_{\mu\nu}$	

Example: Thesis on some topic in General Relativity

Do not explain what is General Relativity from scratch

If you need some non-standard formalism,

introduce it

STANDARD: 3 pages

2 General relativity background
2.1 Differential Geometry
6
2.2 Einstein field equations
9

3 Modified gravity theories
3.1 f(R) theories
3.2 Born-Infeld inspired gravity
3.2.1 Born-Infeld electromagnetism
20
3.2.2 Eddington inspired Born-Infeld gravity
21
3.2.3 Physical relevance of the auxiliary metric $q_{\mu\nu}$ 26

First: no Cut&Paste

This part of the thesis is the place where it is most probable to take a short-cut:

Cut&Pasting from holy books and articles

First: no Cut&Paste

This part of the thesis is the place where it is most probable to take a short-cut:

Cut&Pasting from holy books and articles

A sensible excuse: how may I write something about THIS better than THEM?

First: no Cut&Paste

This part of the thesis is the place where it is most probable to take a short-cut:

Cut&Pasting from holy books and articles

A sensible excuse: how may I write something about THIS better than THEM?

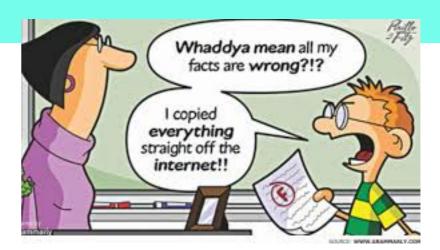
This is NOT ALLOWED!

It is better to read the holy sources,
try to understand and
TRY TO WRITE BY YOURSELF

First: no Cut&Paste

https://top-papers.com/how-to-avoid-plagiarism-in-research-papers/

- 1. Paraphrasing: your own words, same concept
- 2. Citing: (small) text from other paper [citenumber]
- 3. Quoting: "(complete) text from other paper" [citenumber]



Second: Appendices

They are the place where you must move TECHNICAL STUFF that you used but is:

- A) boring to read in the main text
- B) something that may be skipped

Thesis on Quantum Systems

Appendices															
A	Weak coupling ME calculations														
	A.1 $\text{Tr}_E[V_tH_I(t), \hat{\rho}(0)] = 0$ for an arbitrary state of the environment														
	A.2 Computation of $\text{Tr}_E [V_t^0 H_I(t), [V_\tau^0 H_I(\tau), \hat{\rho}(0)]]$														
	A.3 Switching to the Schrödinger picture														
	A.5 Switching to the Schrodinger picture														
В	Commutators of weak coupling ME for different OQS operators L														
	B.1 $L = \sigma (L^{\dagger} = \sigma_+)$														
	D.1 $L = 0 - \{L = 0 + \}$														
	R2 $L = L^{\dagger} = \sigma_{-}$														
	B.2 $L = L^{\dagger} = \sigma_z$ B.3 $[H_S, \rho_S(t)]$														

Second: Appendices

They are the place where you must move TECHNICAL STUFF that you used but is:

- A) boring to read in the main text
- B) something that may be skipped

As many as you need....

No more than a couple of pages each

Appendices													
A.1 A.2	k coupling ME calculations $\operatorname{Tr}_E[V_tH_I(t),\hat{\rho}(0)]=0$ for an arbitrary state of the environment Computation of $\operatorname{Tr}_E[V_t^0H_I(t),[V_\tau^0H_I(\tau),\hat{\rho}(0)]]$	38											
B.1 B.2	mutators of weak coupling ME for different OQS operators L $L = \sigma (L^\dagger = \sigma_+) \dots \dots$	40											

Second: Appendices

These are the place where you must move TECHNICAL STUFF that you used but is:

- A) boring to read in the main text
- B) something that may be skipped

As many as you need....

Thesis on Quantum Systems

Write these SECOND! TOMORROW!

ΑĮ	pen	dices																				3
	A 1	Tre	upling V _t H _I (t putati ching t	$\hat{a}(0)$	11 =	0 fc	or ar	n ar	bitra /pH ctur	ary I _I (τ	sta), <i>į</i>	ate 6(0)	of t	he	envi	ron	me	nt.	:	 	- 1	3 2 2 2
)\	W	!	etors $\begin{bmatrix} L^{\dagger} \\ \dot{t} = 0 \end{bmatrix}$ $S_{S}(t)$	$=\sigma$. (: :	-		: :	: :						:		-	

It must be very clear WHAT is NEW, and WHAT is NOT NEW

A typical question at the defense:

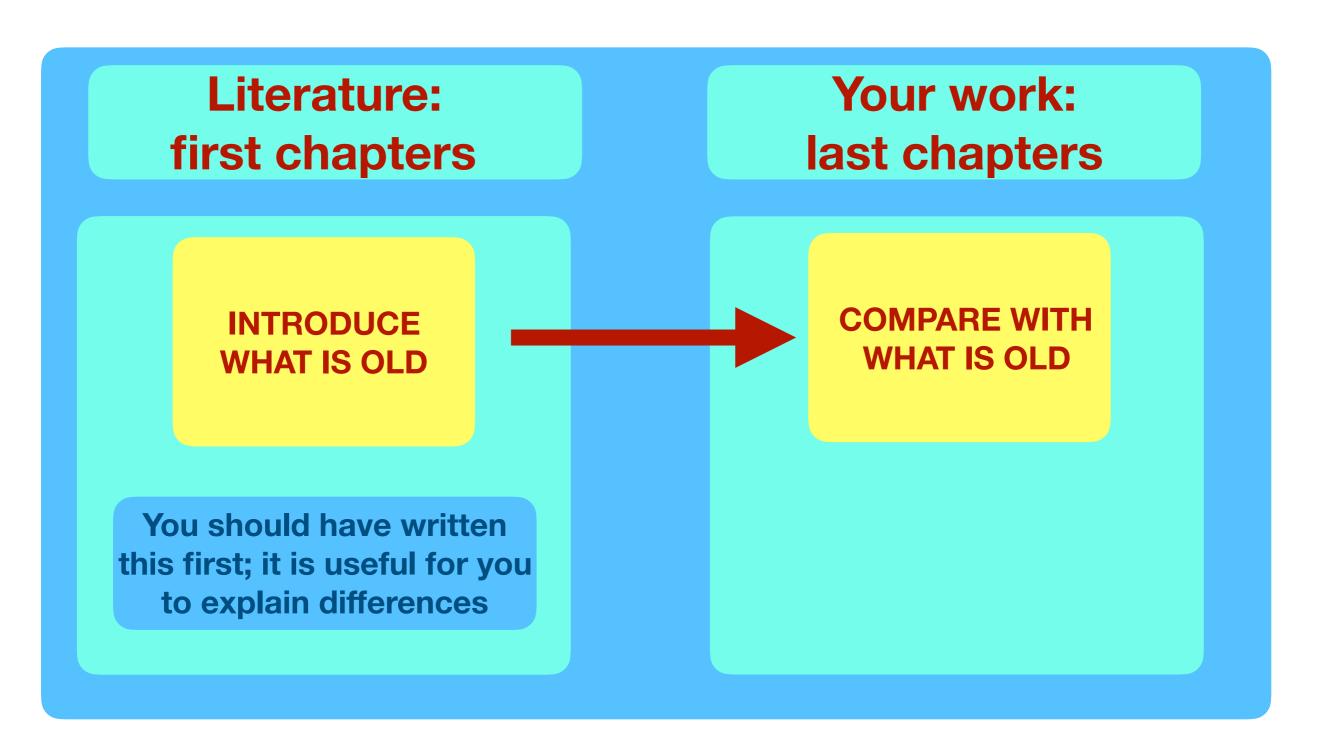
"Ok, very nice. But....
Can you explain me PRECISELY which is the difference between what YOU have done and the LITERATURE?"

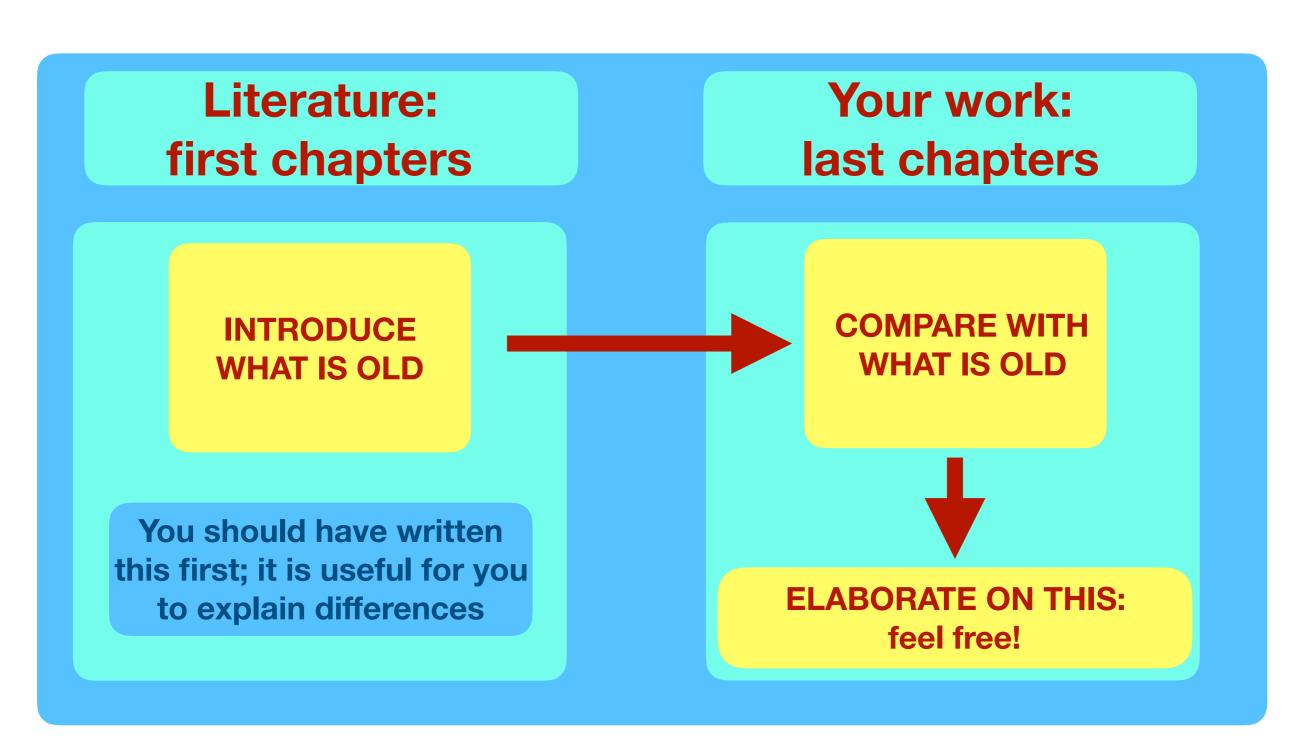
Literature: first chapters

Your work: last chapters

INTRODUCE WHAT IS OLD

You should have written this first; it is useful for you to explain differences





YOUR THESIS COMMITTEE

Also known as: an impossibly difficult group to get together in one room but who nevertheless hold your future in their hands depending on their ability to reach a civilized consensus.



Your Professor

Simultaneously your biggest ally and your worst enemy. Will be the first to suggest you do more work.



The Guru

Only here for the free cookies. Don't forget to bring cookies.



Adversary The:Accircle

Has bitter rivalry with your Professor and will argue the exact opposite view. Work this to your advantage.



The Strawman/woman

Nice guy. No opinions.



The Assistant Professor

Still doesn't believe just a few months ago they were on the other side just like you. Pretends to be an adult.

NONE OF THEM WILL ACTUALLY READ YOUR ENTIRE THESIS.

YOUR THESIS COMMITTEE

Also known as: an impossibly difficult group to get together in one room but who nevertheless hold your future in their hands depending on their ability to reach a civilized consensus.



Your Professor

Simultaneously your biggest ally and your worst enemy. Will be the first to suggest you do more work.



The Guru

Only here for the free cookies.

Don't forget to bring cookies.



Adversary The Accircle

Has bitter rivalry with your Professor and will argue the exact opposite view. Work this to your advantage.



The Strawman/woman

Nice guy. No opinions.



The Assistant Professor

Still doesn't believe just a few months ago they were on the other side just like you. Pretends to be an adult. This sounds
as a joke,
but
many times
overlaps
one-to-one
with reality

NONE OF THEM WILL ACTUALLY READ YOUR ENTIRE THESIS.

It is a complete summary of the thesis: one should understand what is written in the main body just from reading this. If you succeed, the reader will feel happy!

It is a complete summary of the thesis: one should understand what is written in the main body just from reading this. If you succeed, the reader will feel happy!

Some text framing your area of research

Examples:

"Standard Model"
"General Relativity"
"Complex systems"

It is a complete summary of the thesis: one should understand what is written in the main body just from reading this. If you succeed, the reader will feel happy!

Some text framing your area of research

Examples:

"Standard Model"
"General Relativity"
"Complex systems"

Motivation for your specific research

Most important part of the Introduction: show that you know WHY you have done what you have done!

It is a complete summary of the thesis: one should understand what is written in the main body just from reading this. If you succeed, the reader will feel happy!

Some text framing your area of research

Examples:

"Standard Model"
"General Relativity"
"Complex systems"

Motivation for your specific research

Most important part of the Introduction: show that you know WHY you have done what you have done!

Short summary of your results

"We have found that...
within this hypothesis...
this problem
may/may not
be solved"

It is a complete summary of the thesis: one should understand what is written in the main body just from reading this. If you succeed, the reader will feel happy!

Some text framing your area of research

Examples:

"Standard Model"
"General Relativity"
"Complex systems"

Motivation for your specific research

Most important part of the Introduction: show that you know WHY you have done what you have done!

Short summary of your results

"We have found that...
within this hypothesis...
this problem
may/may not
be solved"

Organization of the thesis: "In Chapt. 1 I review; in Chapt. 2...."

Five: Conclusions

It is a short summary of the thesis: remind shortly the motivation and the results with respect to the literature

This is the place to insert your work as just one single brick in a big construction

Use a few words to explain possible future development, "beyond the scope of this thesis."