$$\gamma : [0, 1] \longrightarrow X$$

Crash Course Approach & Tips

Bambordé Baldé | Co-Founder at Zaiku Group | Twitter: @zaikubalde • **zaikugroup.com** • May 28, 2021

Crash Course Motivation

Lie Groups, Lie Algebras & Representations

Module II (October - January?)

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Lie group

From Wikipedia, the free encyclopedia

Not to be confused with Group of Lie type.

In mathematics, a **Lie group** (pronounced /liː/ "Lee") is a group that is also a differentiable manifold. A manifold is a space that locally resembles Euclidean space, whereas groups define the abstract, generic concept of multiplication and the taking of inverses (division). Combining these two ideas, one obtains a continuous group where points can be multiplied together, and their inverse can be taken. If, in addition, the multiplication and taking of inverses are defined to be smooth (differentiable), one obtains a Lie group.

Lie groups provide a natural model for the concept of continuous symmetry, a celebrated example of which is the rotational symmetry in three dimensions (given by the special orthogonal group $\mathrm{SO}(3)$). Lie groups are widely used in many parts of modern mathematics and physics.

Lie groups were first found by studying matrix subgroups G contained in $\mathrm{GL}_n(\mathbb{R})$ or $\mathrm{GL}_n(\mathbb{C})$, the groups of $n \times n$ invertible matrices over $\mathbb{R}$ or $\mathbb{C}$. These are now called the classical groups, as the concept has been extended far beyond these origins. Lie groups are named after Norwegian mathematician Sophus Lie (1842–1899), who laid the foundations of the theory of continuous transformation groups. Lie's original motivation for introducing Lie groups was to model the continuous symmetries of differential equations, in much the same way that finite groups are used in Galois theory to model the discrete symmetries of algebraic equations.

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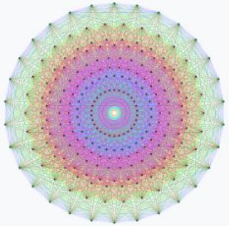
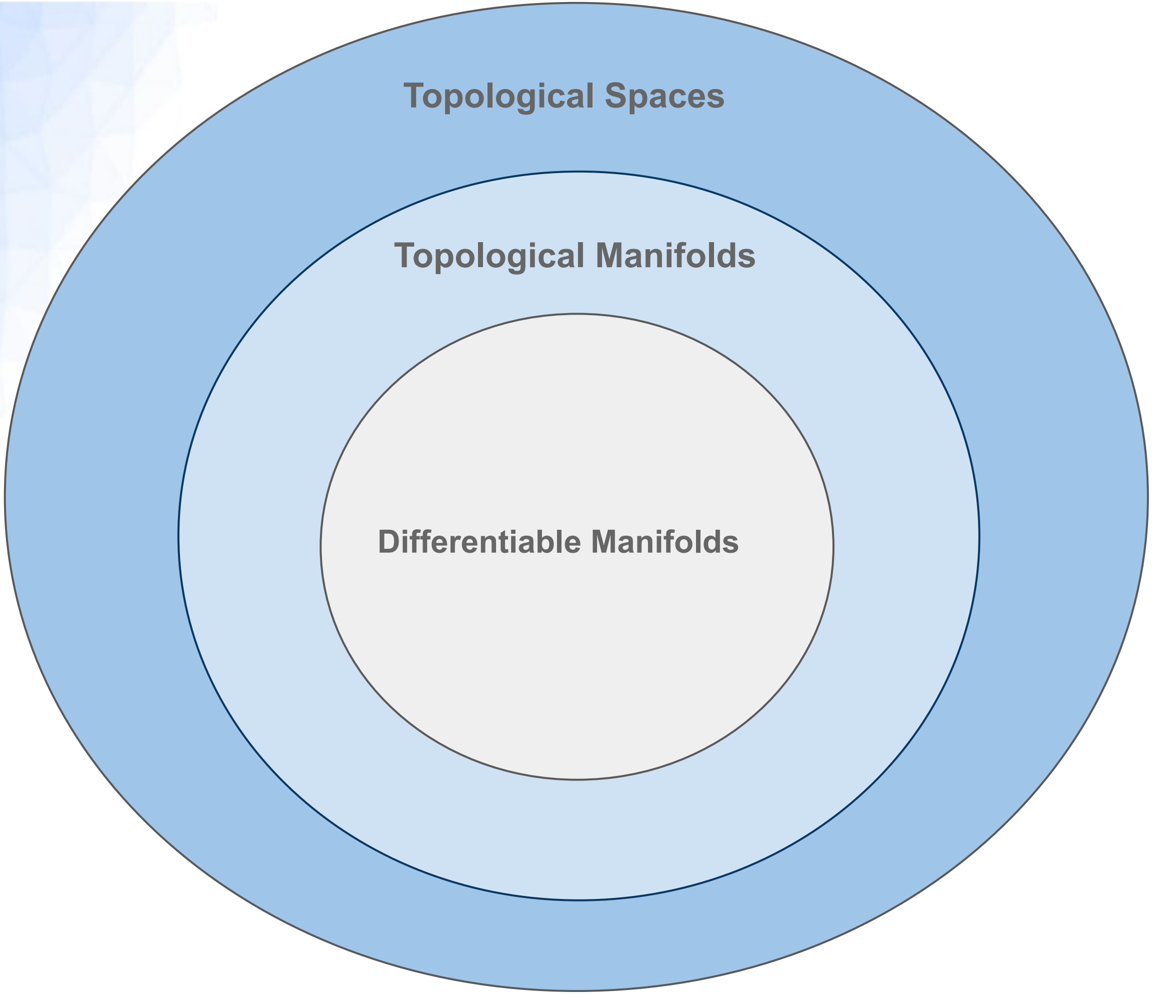
Lie groups

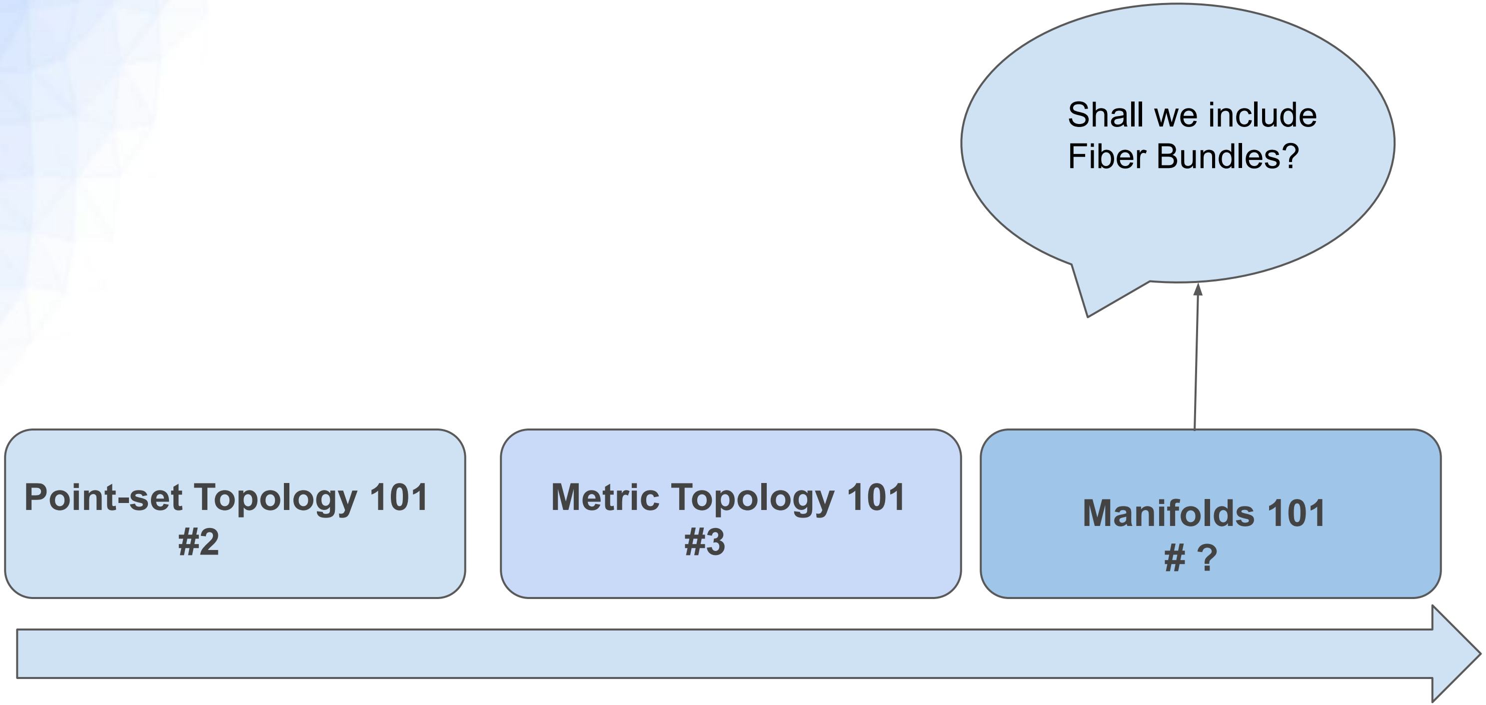


Classical groups [show]
Simple Lie groups [show]
Other Lie groups [show]
Lie algebras [show]
Semisimple Lie algebra [show]
Representation theory [show]
Lie groups in physics [show]
Scientists [show]
Glossary
Table of Lie groups
V · T · E

Algebraic structure → Group theory
Group theory


Topological Spaces
Topological Manifolds
Differentiable Manifolds

Crash Course Approach



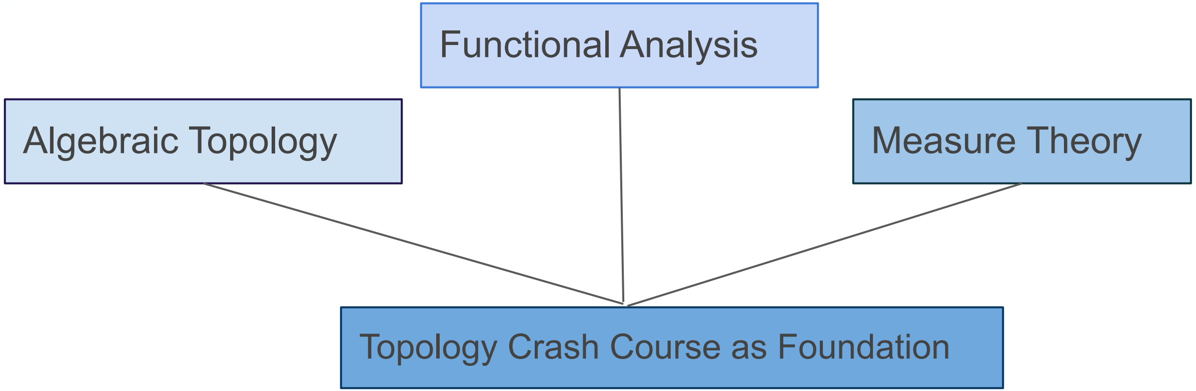
#n is the number of live lectures.

Lecture Gaps

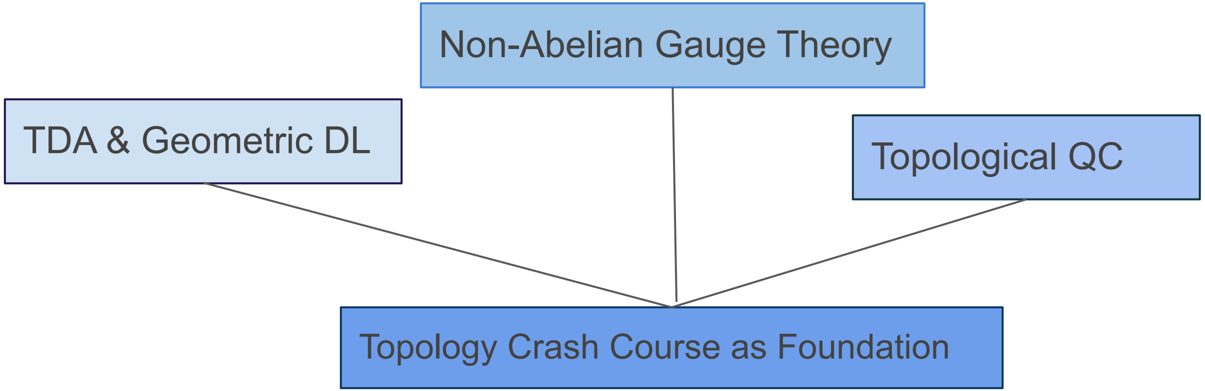
1 Week Gap **versus** 2 Weeks Gap

To be decided at the end of each live session via poll?

Benefits (Pure Mathematics)



Benefits (Applied Topics)



Baseline Knowledge Requirements

Must know the basic concepts of naive set theory including:

- The power set.
- Intersections and unions.
- Complements.
- Cartesian products.
- Indexing sets as well as their unions and intersections.
- Maps between sets including; pre-images, composition of maps, injectiveness, surjectiveness, bijection etc.

Source for revising:
https://github.com/quantumformalism/math-lectures/blob/master/foundation-module/lecture-01/SWDM.pdf

Recommended focus on pages **80 - 115 and pages **157 - 196****

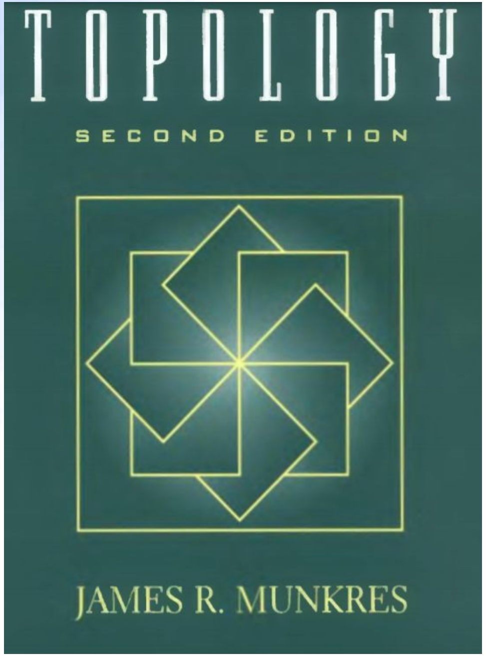
Extra Baseline Knowledge

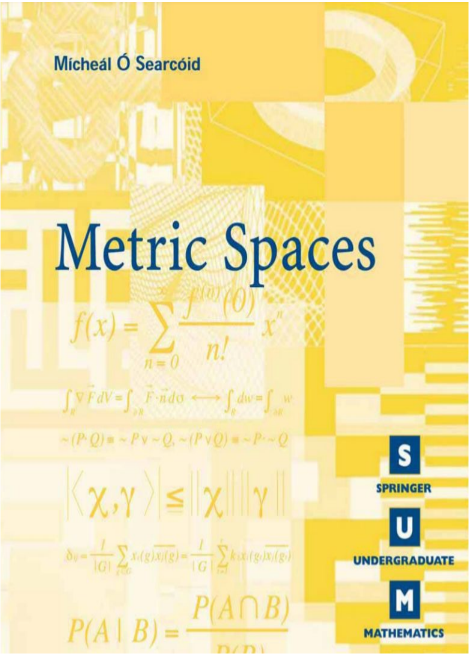
Ideal to know basic real analysis concepts including:

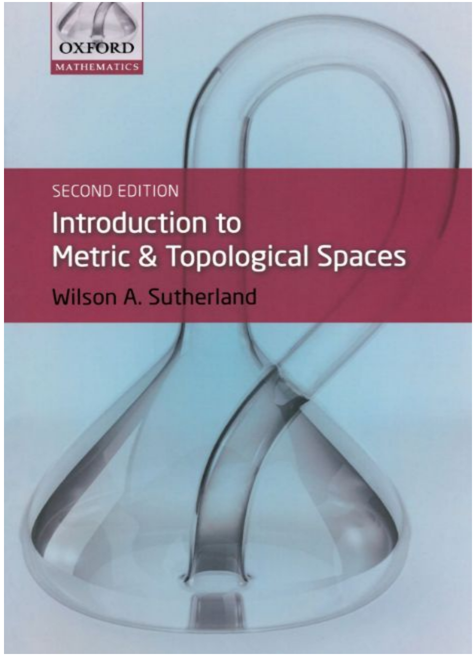
- Open intervals.
- Closed intervals.
- Half-open intervals.

Source for revising (John K. Hunter):

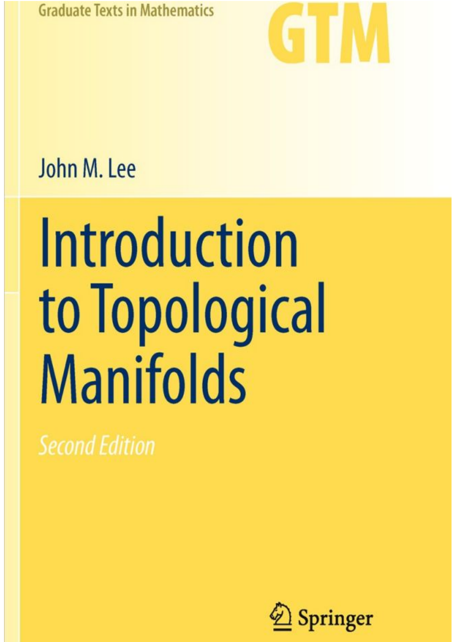
https://www.math.ucdavis.edu/~hunter/intro_analysis_pdf/intro_analysis.pdf

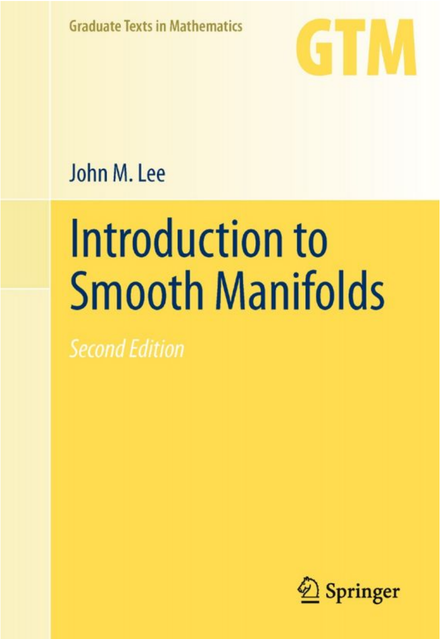






Point-set Topology & Metric Spaces





Topological & Diff. Manifolds

Some Practical Tips

1. Embrace abstraction i.e. take the abstraction red pill!:)
2. One step at a time approach to abstract concepts.
3. Build your own intuition of the abstract concepts.
4. Try do proofs by yourself before checking other people’s proofs.
5. If you struggle to understand a concept, cross reference different sources.
6. Try setup a study group where you can present proofs to each other.
7. Whenever you feel frustrated with abstraction, remember the following quote:

‘’Mathematicians are like Frenchmen: whatever you say to them they translate into their own language and forthwith it is something entirely different.”

Johann Wolfgang von Goethe

QUANTUM FORMALISM

- **GitHub:** *github.com/quantumformalism*
- **YouTube:** youtube.com/zaikugroup
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