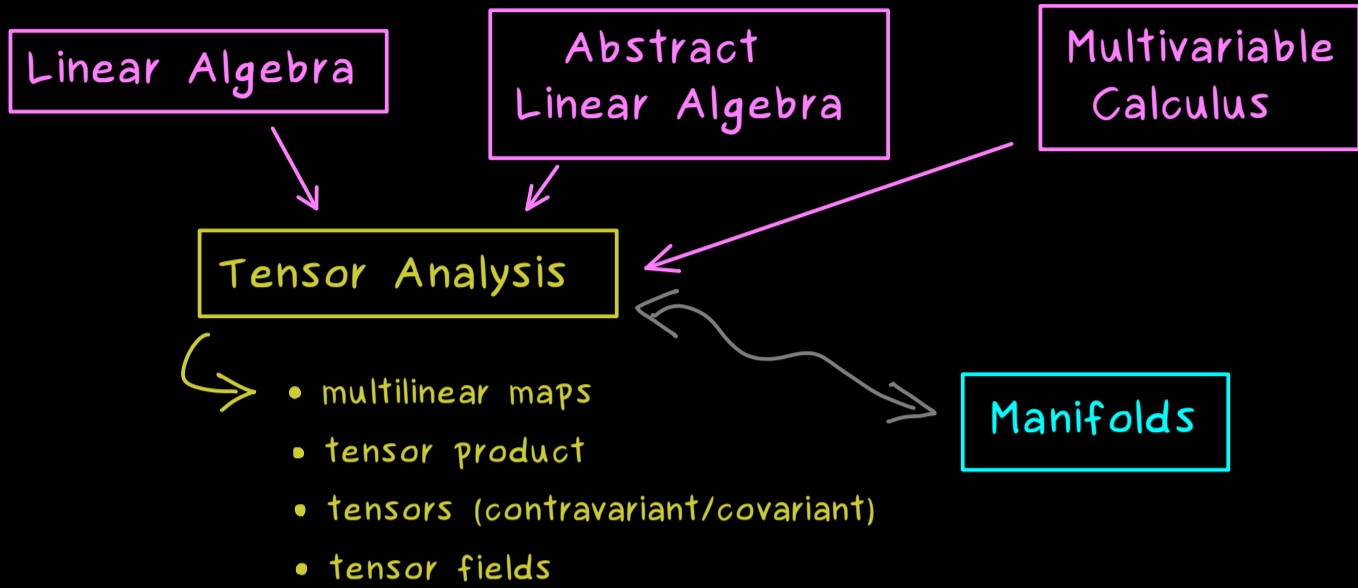


# Tensor Analysis - Part 1



## Roughly explained concept:

	concrete (w.r.t. a basis)	abstract
	$\begin{pmatrix} x^1 \\ x^2 \\ \vdots \\ x^n \end{pmatrix} \in \mathbb{R}^n$	vector $v \in V$
matrix	$\begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & \dots & \dots & a_{mn} \end{pmatrix}$	linear map $\ell: V \rightarrow W$
components	$\varphi_{\mu_1 \mu_2 \dots \mu_n}^{\nu}$	multilinear map $\varphi: \underbrace{V \times V \times \dots \times V}_{n \text{ times}} \rightarrow W$
components	$\varphi_{\mu_1 \mu_2 \dots \mu_n}^{\nu_1 \nu_2 \dots \nu_m}$	multilinear map $\varphi: \underbrace{V^* \times \dots \times V^*}_{\text{dual space}} \times V \times \dots \times V \rightarrow \mathbb{R}$
	tensors	tensors

Example:  $\epsilon_{\mu_1 \mu_2 \mu_3}$  Levi-Civita tensor (on  $\{1, 2, 3\}$ ):  $\epsilon_{\mu_1 \mu_2 \mu_3} := \begin{cases} 1, & (\mu_1, \mu_2, \mu_3) \text{ even permutation} \\ -1, & (\mu_1, \mu_2, \mu_3) \text{ odd permutation} \\ 0, & \text{else} \end{cases}$

for example:  $(2, 1, 3)$  odd permutation

## Visualization:

