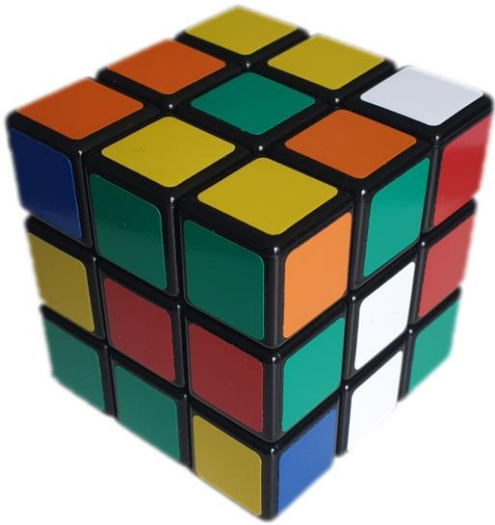


# Algorithmic Approaches for Finding Better QUBO Formulations

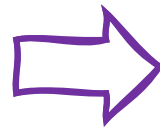
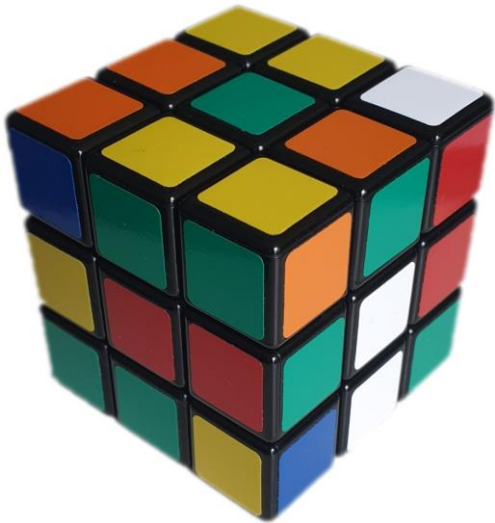
Jonas Nüßlein, Sebastian Zielinski,  
Sebastian Feld, Claudia Linnhoff-Popien

IEEE Quantum Week (IEEE QCE'23)  
September 18, 2023

# Intuition

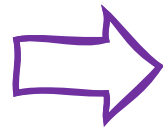
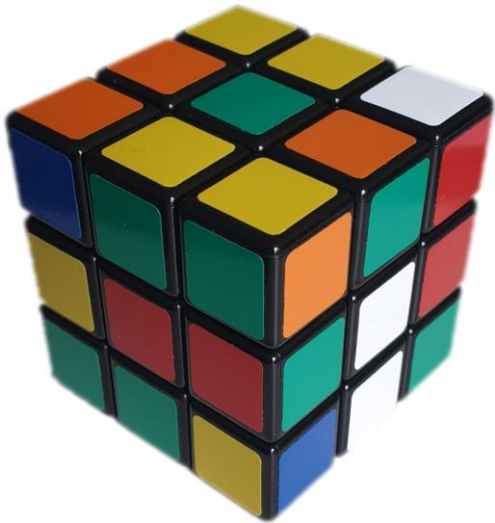


# Intuition

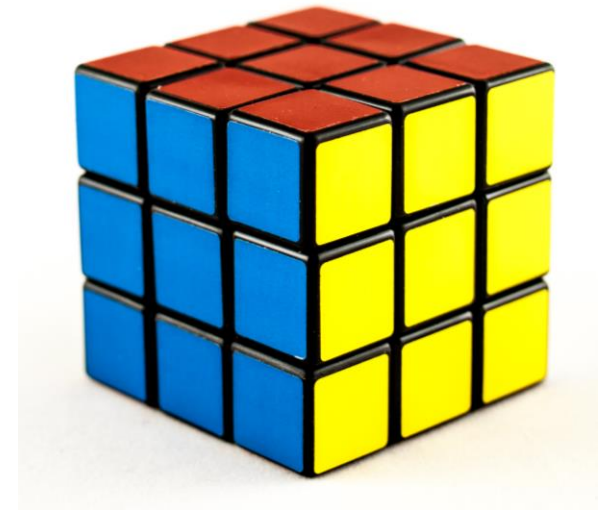
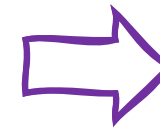


	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
A1	-1 -1	2	2	2	2	$D_{ab}$	0	$D_{ba}$	2	$D_{ac}$	0	$D_{ca}$
A2		-1 -1	2	2	$D_{ba}$	2	$D_{ab}$	0	$D_{ca}$	2	$D_{ac}$	0
A3			-1 -1	2	0	$D_{ba}$	2	$D_{ab}$	0	$D_{ca}$	2	$D_{ac}$
A4				-1 -1	$D_{ab}$	0	$D_{ba}$	2	$D_{ac}$	0	$D_{ca}$	2
B1					-1 -1	2	2	2	2	$D_{bc}$	0	$D_{cb}$
B2						-1 -1	2	2	$D_{cb}$	2	$D_{bc}$	0
B3							-1 -1	2	0	$D_{cb}$	2	$D_{bc}$
B4								-1 -1	$D_{bc}$	0	$D_{cb}$	2
C1									-1 -1	2	2	2
C2										-1 -1	2	2
C3											-1 -1	2
C4												-1 -1

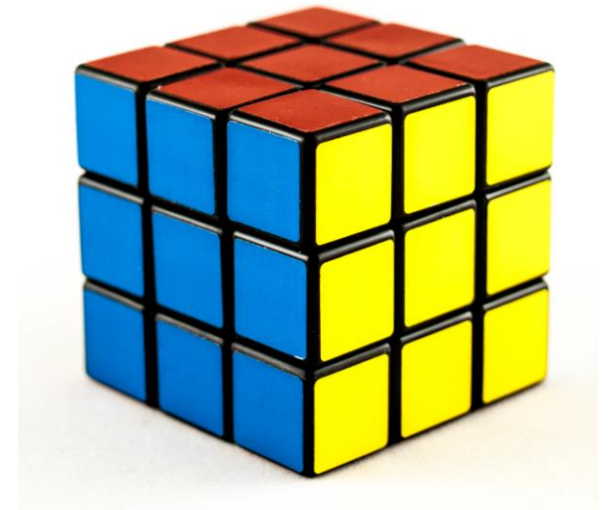
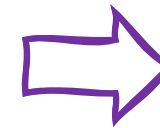
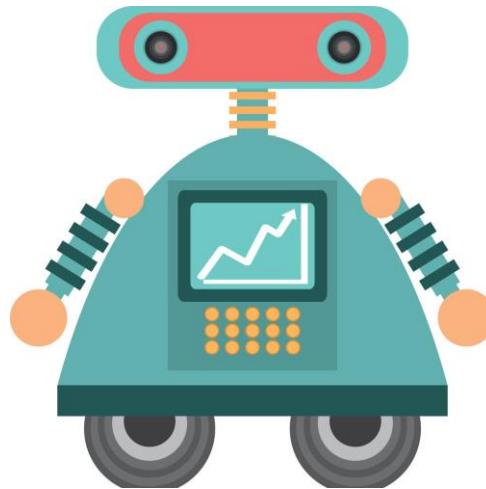
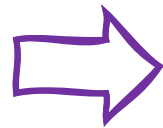
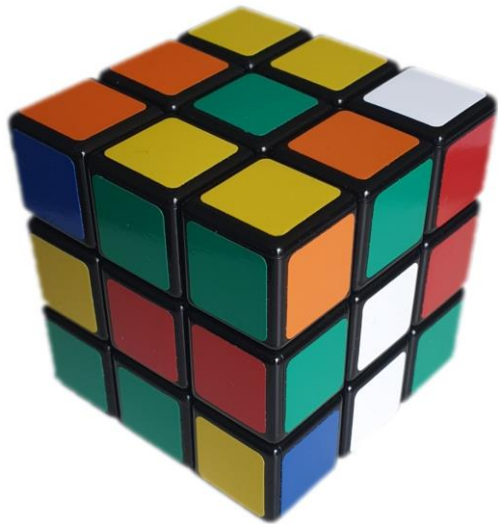
# Intuition



	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
A1	-1	2	2	2	2	$D_{ab}$	0	$D_{ba}$	2	$D_{ac}$	0	$D_{ca}$
A2		-1	2	2	$D_{ba}$	2	$D_{ab}$	0	$D_{ca}$	2	$D_{ac}$	0
A3			-1	2	0	$D_{ba}$	2	$D_{ab}$	0	$D_{ca}$	2	$D_{ac}$
A4				-1	$D_{ab}$	0	$D_{ba}$	2	$D_{ac}$	0	$D_{ca}$	2
B1					-1	2	2	2	2	$D_{bc}$	0	$D_{cb}$
B2						-1	2	2	$D_{cb}$	2	$D_{bc}$	0
B3							-1	2	0	$D_{cb}$	2	$D_{bc}$
B4								-1	$D_{bc}$	0	$D_{cb}$	2
C1									-1	2	2	2
C2										-1	2	2
C3											-1	2
C4												-1



# Intuition



# Tutorial goals

## Goal of this tutorial

- Introduce and demonstrate innovative methods for the formulation QUBO problems

## Motivation behind

- Facilitate and automate the process of their formulation

## By the end of this tutorial, you...

- Will feel confident to apply the presented formulation methods to your own use cases



# Contents and instructors

## Structure

1. Naïve QUBO formulation
2. Pattern QUBO
3. Algorithmic QUBO formulation
4. Learning QUBOs



Jonas Nüßlein



Sebastian Zielinski



Sebastian Feld



Claudia Linnhoff-Popien

Enjoy the ride!

Thank you!