Qiskit Advocate Mentorship Program

Implement a special converter of Quadratic Program of Qiskit Aqua Optimization #24

https://github.com/qiskit-community/qiskit-advocate-mentorship-program/issues/24

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Problem definition

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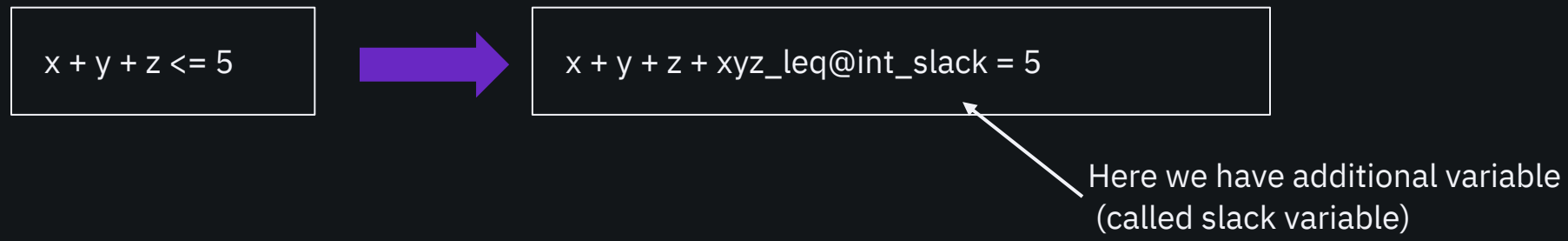
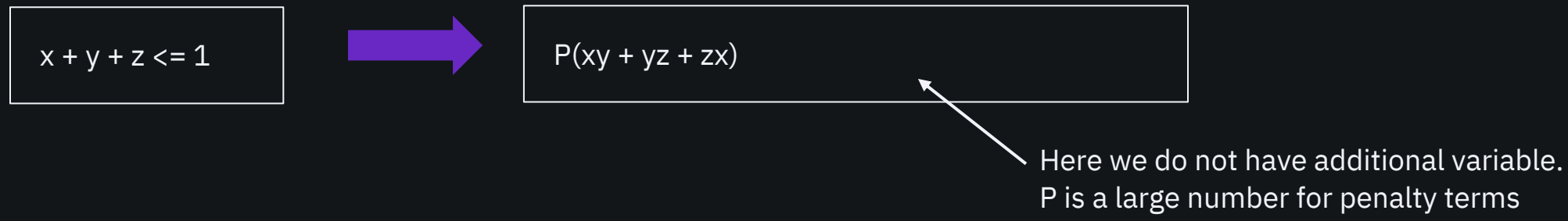
- Current Optimization converter requires additional variables to convert non-equal constraints to equal constraints. Additional variables mean to use additional qubits.



- Special Converter convert specific constraints into penalty terms without adding new variables. These penalty terms are removed from constraints (added to objective function), hence can be directly converted to Ising model.



Our project

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- Develop new converter for specific constraint listed in the figure (right).

- Although classical constraint is limited to binary variables and constant ‘1’, it is known that there are many use cases of this kind of constraint.
  - ✓ Just one building can be build on a place.
  - ✓ One of men must watch a machine

Classical Constraint	Equivalent Penalty
$x + y \leq 1$	$P(xy)$
$x + y \geq 1$	$P(1 - x - y + xy)$
$x + y = 1$	$P(1 - x - y + 2xy)$
$x \leq y$	$P(x - xy)$
$x_1 + x_2 + x_3 \leq 1$	$P(x_1x_2 + x_1x_3 + x_2x_3)$
$x = y$	$P(x + y - 2xy)$

Table of a few Known constraint/penalty pairs

Source: A Tutorial on Formulating and Using QUBO Modell , Fred Glover, Gary Kochenberger, Yu Du, https://arxiv.org/abs/1811.11538

Our initial prototype result.

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$x+y \leq 1$	$P(xy)$

```
\ This file has been generated by DOcplex
\ ENCODING=ISO-8859-1
\Problem name: CPLEX
Maximize
 obj: 2 x + y + 2
Subject To
 c0: x + y <= 1
 c1: y = 1
Bounds
 0 <= x <= 1
 0 <= y <= 1
Binaries
 x y
End
```

```
\ This file has been generated by DOcplex
\ ENCODING=ISO-8859-1
\Problem name: CPLEX
Maximize
 obj: 2 x + y + [ - 8 x*y ]/2 +2
Subject To
 c1: y = 1
Bounds
 0 <= x <= 1
 0 <= y <= 1
Binaries
 x y
End
```

Thank you !!