



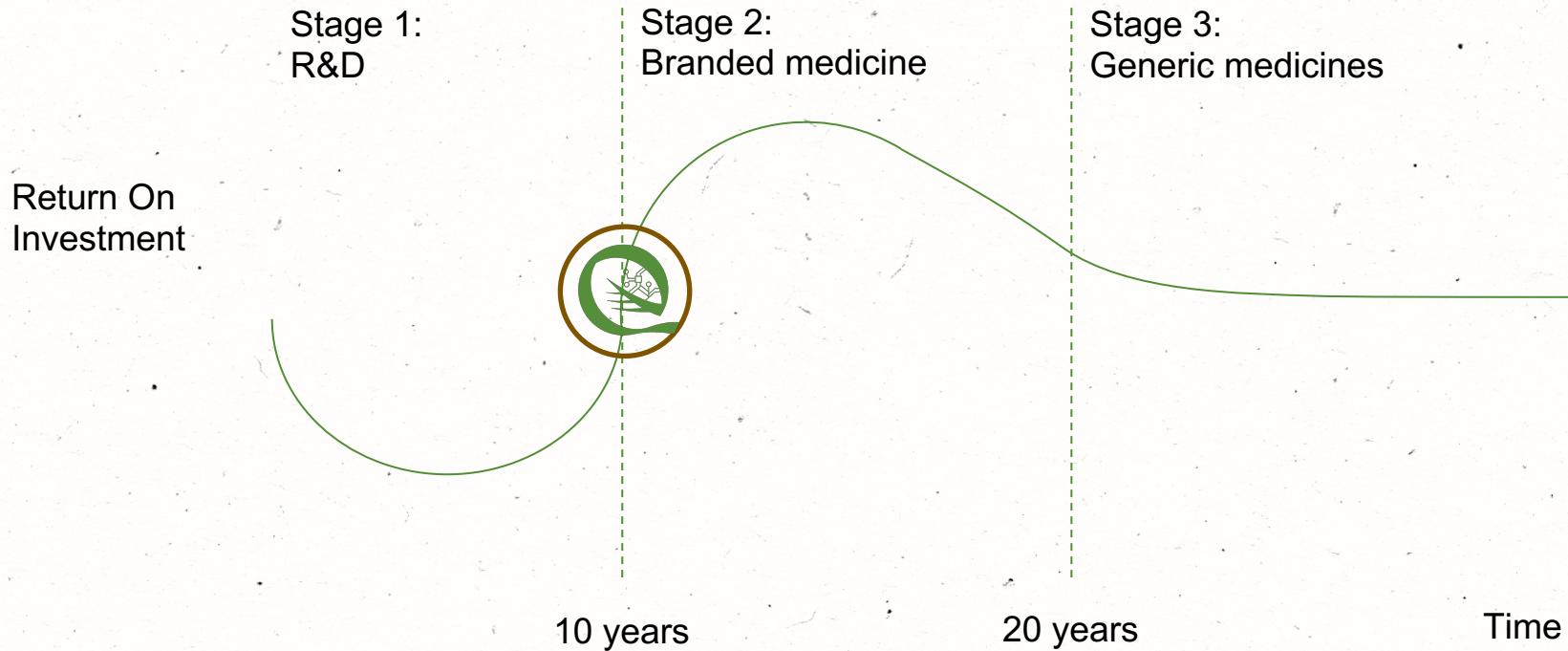
# QUEST

QUantum-Enabled SustainabiliTy



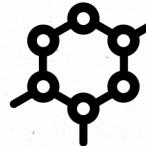
UNTER  
NEHMER *PushQuantum*  
TUM

# THE LIFE OF A DRUG FORMULATION



# PROBLEMS WE SOLVE

Dimensions



Profit/Sustainability



Reporting



Quantity



Transparency



Lead-time



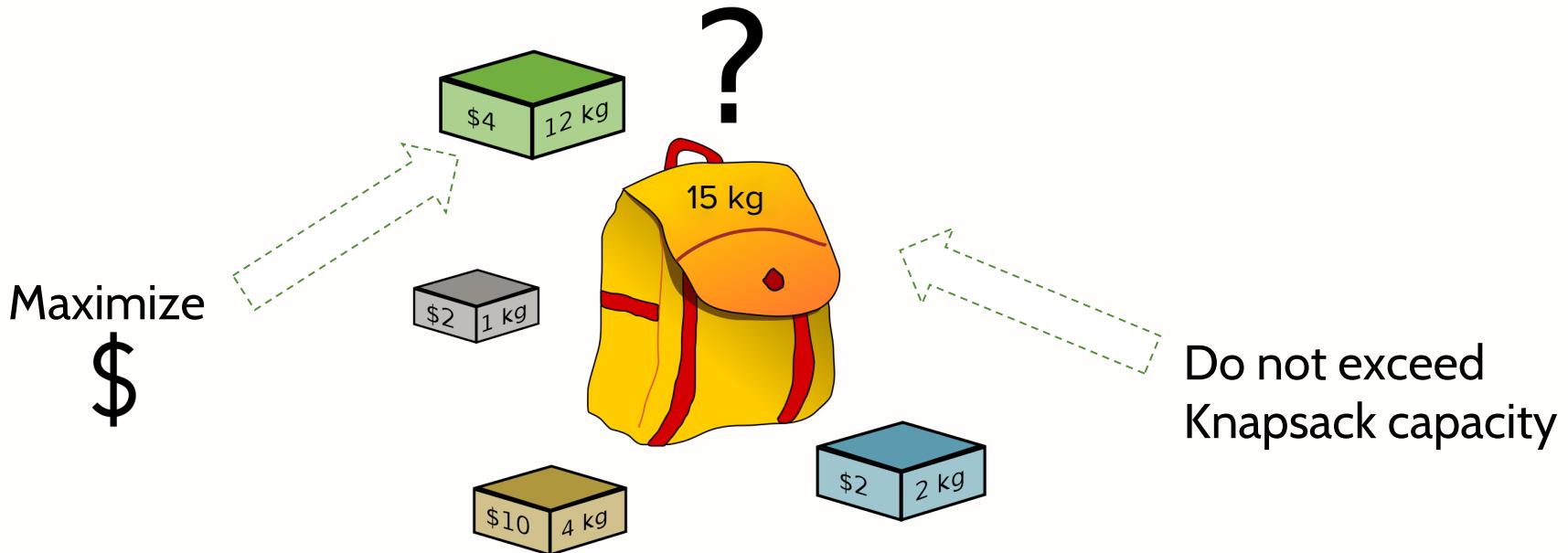
# What does Quest do?

Quest is a platform that consolidates and analyzes end-to-end production metrics in the pharmaceutical industry from suppliers and producers to drive sustainability, cost-effectiveness and transparency in product value chain through optimization.

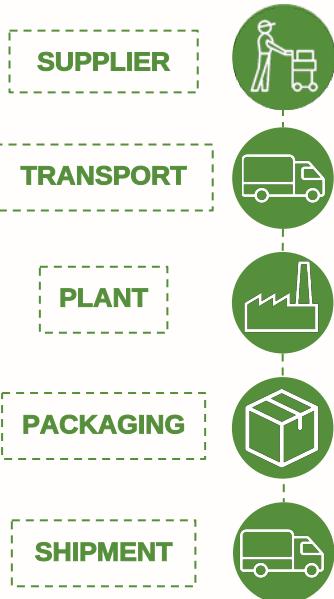
# DEMO



# OPTIMIZATION USING KNAPSACK



# TAYLORING THE KNAPSACK



Click to add text

SUPPLIER 1

S = 80  
P = 1M



SUPPLIER 2

S = 99  
P = 1.5M



SUPPLIER 3

S = 35  
P = 100k

SUPPLIER 4

S = 50  
P = 300k

# “SHOULDERING” KNAPSACK WITH QUANTUM



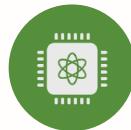
## KNAPSACK-TAILORED QAOA

QAOA-Extension allows for Knapsack-specific approach



## PROMISING SUCCESS RATE

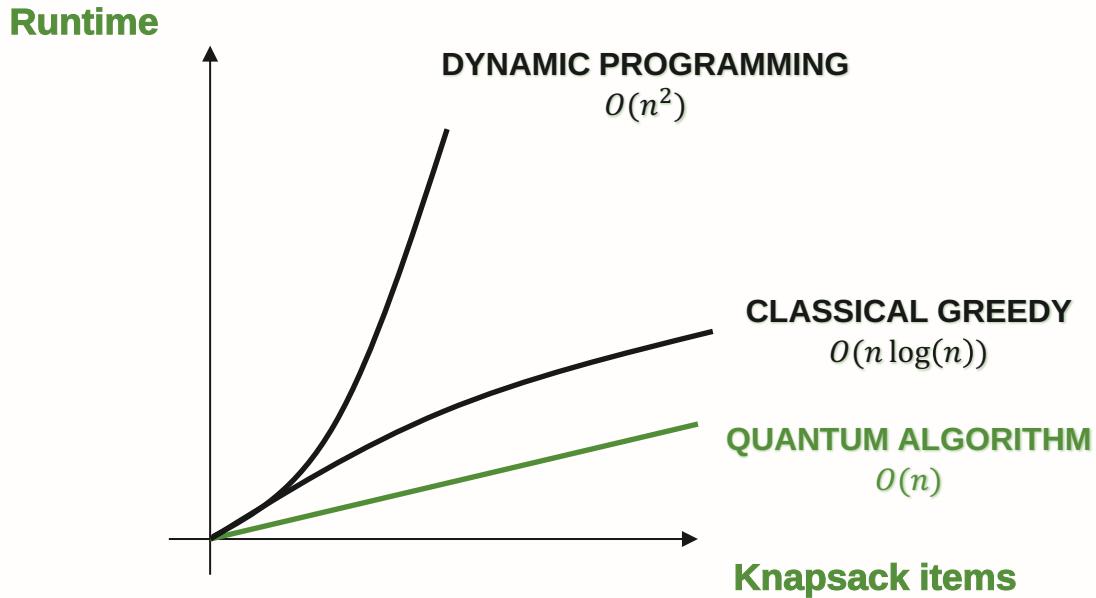
Prototype of algorithm already competes very well



## QUANTUM ADVANTAGE

The runtime is linear in the qubit size and uses a constant amount of gates

# QUANTUM ALGORITHM IMPROVES SPEED



# WHY NOW?



## DIGITALIZATION

Digitalization provides data that allow for optimization



## CHANGING REGULATIONS

Governments around the world moving toward carbon-neutrality



## PRODUCT-LEVEL SUSTAINABILITY

Pharma companies move to product-level for full optimization potential

## Carbon dioxide levels in atmosphere reach record high

The  
Guardian

Concentrations are 50% above pre-industrial levels despite dip in emissions during Covid pandemic

The last 7 years have been the warmest on record as planet approaches critical threshold



*"The pharmaceutical industry emission intensity is about 55% higher than the automotive's."*

Carbon footprint of the global pharmaceutical industry and relative impact of its major players

Lotfi Belkhir Ahmed Elmeligi

Climate change: For 25th year in a row, Greenland ice sheet shrinks



United  
Nations

UN News

Global perspective Human stories

Jan 11, 2022, 08:00am EST | 1,253 views

## ESG Is Here And There's No Turning Back

Forbes

Proposal for a

### DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

amending Directive 2013/34/EU, Directive 2004/109/EC, Directive 2006/43/EC and Regulation (EU) No 537/2014, as regards corporate sustainability reporting



EUROPEAN COMMISSION

*In absolute terms in 2015 the pharmaceutical industry generated 52 million tons of CO<sub>2</sub>*

“Sustainability is a vital element of our business and a responsibility we want to fulfill every day. Through our innovation power, we strive to create long-term value for society...

— Belén Garijo

Chair of the Executive Board and CEO of Merck



# BUSINESS MODEL

## ANALYSIS

Offer product-level analysis for products at the end of R&D



## VARIABLE COST

Depends on data source validity and customers



## TRANSPARENCY

Give an alternative to current ways of procurement



## CO-CREATION

Quest platform co-creates value with its partner



**60,000,000\$**

Pre-production pharmaceutical product - cost per formulation

# MARKET ANALYSIS

**100 million \$**

Serviceable Obtainable Market

**~500 million \$**

Serviceable Available Market

**1200 billion \$**

Total Available Market

# Pricing Model



Producer



Supplier

## Subscription Model

- Volume
- Complexity of supply chain
- Detail of analysis
- Calculation speed



## Freemium Model

- No entry cost
- Additional analysis at a cost

## **WHERE WE ARE**

Lookalike prototype  
Functional Prototype  
Validation of the business case

## **WHERE WE WANT TO BE**

A market place of raw materials in pharmaceutical industry and be the golden standard in production planning



# PROJECT TIMELINE

Present our MVP and receive feedback

**Pitching**

Improve product to user needs

**2<sup>nd</sup> Iteration**

Q1  
2022

Q1  
2023

Q2  
2023

Q1  
2025

**Pilot Project**

Pilot project with MERCK with generics

**Product Launch**

Expansion to related industries

# OUR TEAM



**Franz von  
Silva-Tarouca**

Quantum  
Specialist



**Cristian  
Godinez**

Quantum  
Specialist



**Benjamin  
Classen**

Quantum  
Specialist



**Yiyun  
Tong**

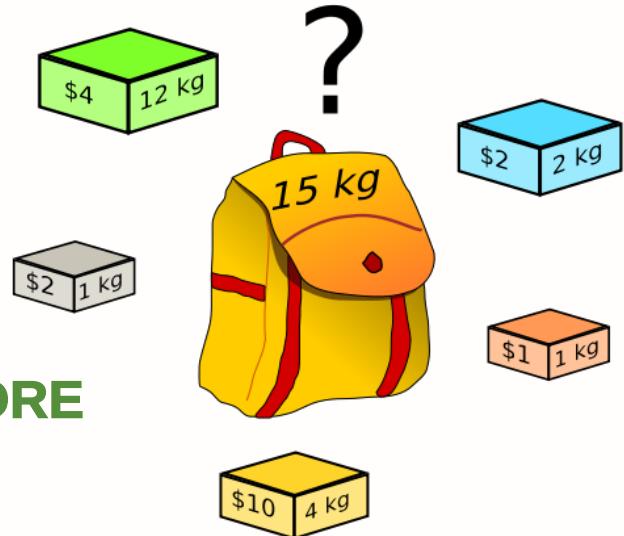
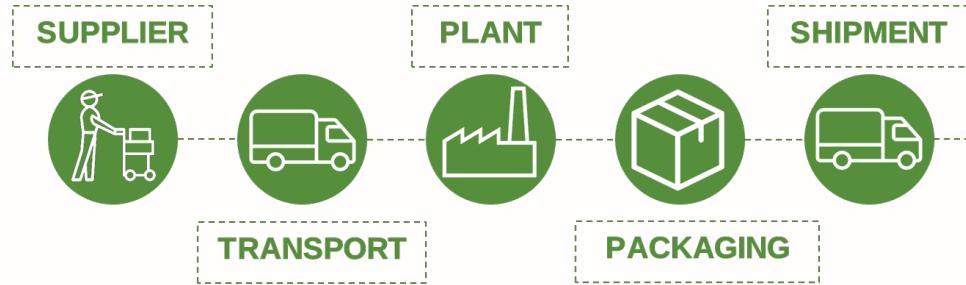
Not a Quantum  
Specialist

# **THANK YOU**

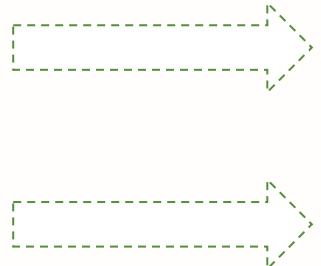
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Do you have any questions,  
comments or feedback?

# OPTIMIZATION USING KNASPACK



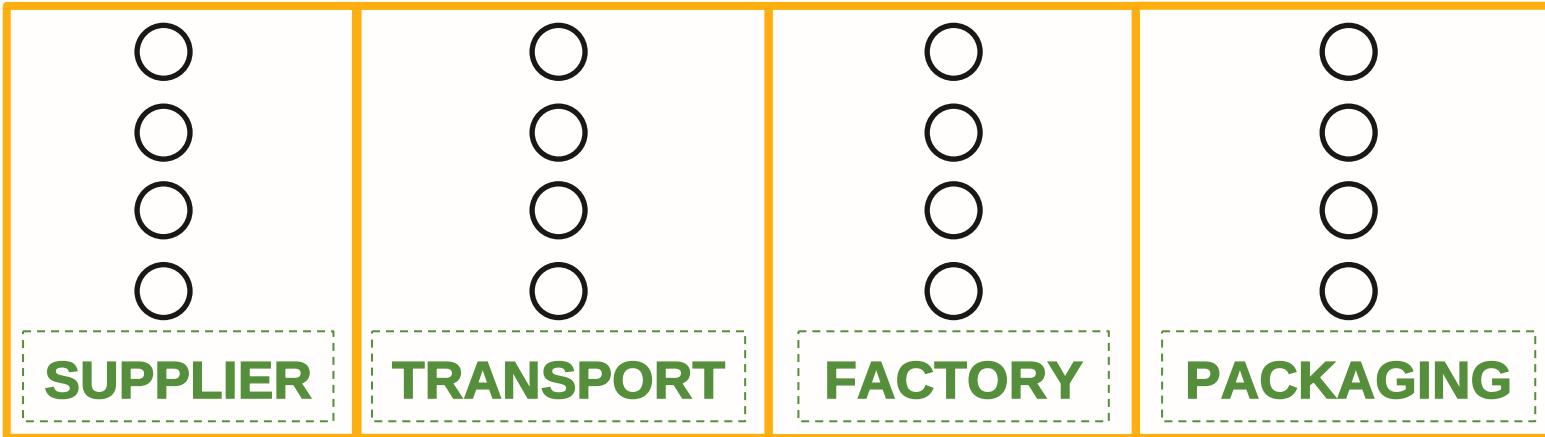
\$  
kg



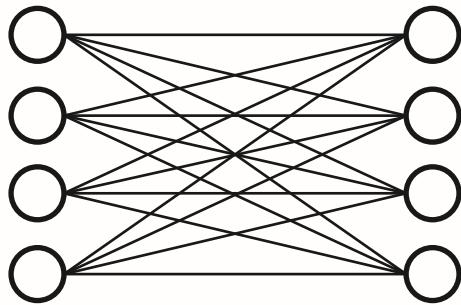
**SUSTAINABILITY SCORE**

**COST SCORE**

# ALGORITHMIC FORMULATION



# ALGORITHMIC FORMULATION



SUPPLIER

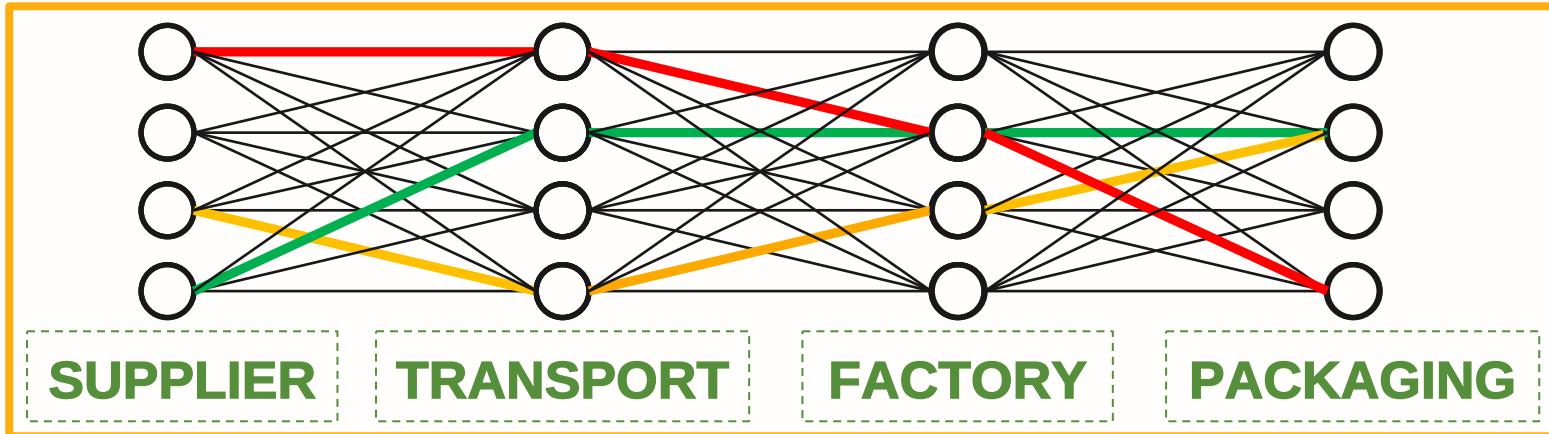
TRANSPORT

FACTORY

PACKAGING



# ALGORITHMIC FORMULATION



# Back up - PRODUCT FEATURES

## SUPPLIER

- Data collection
- Assistance in reporting standards
- Competitor analysis
- PLA analysis
- Supplier onboarding

## PRODUCER

- Product development visualization
- Internal PCA application integration
- Procurement analysis
- Production planning
- Optimization of product production ramp-up

# Back up slide - 100 million

With current quantum capabilities

Generics: In 2016, 89 percent of all prescriptions dispensed in the U.S. were filled with a generic drug. However, those prescriptions only accounted for 26 percent of total drug costs. Furthermore, generic manufacturers function in a vastly different market from branded companies, where the supply chain captures 64 percent of all revenue on generics, while in the brand market the manufacturers retains 76 percent of revenue

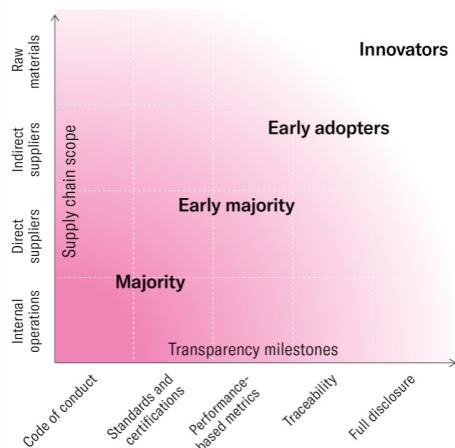
Assume 0.01% improvement that is  $0.64 * 1200 \text{ billion} = 7,680,000,000$   
If we could optimize for 1% of the generic products out there, it'll be 70 million

Excipients  
Packaging

# Back up – Benefits to Supplier

## How Transparent Is Your Supply Chain?

Transparency can be measured along two dimensions: supply chain scope (the depth of your interaction in the supply chain) and milestones on the path to complete transparency. Most companies are at the majority or early majority stages.



Source: Alexis Bateman and Leonardo Bonanni

© HBR

1. Establish shared goals between the actors along the value chain
2. Establish shared requirements and standards
3. Integrate further development of the model with development of its applications – establish way of working and tools
4. **Create market incentives**
5. Get started! And develop step by step

Pharmaceutical industry transformation is not a matter of if but **when**.

Source: IVL Swedish Environmental Research Institute, 2020

Jun 18, 2010, 11:14am EDT

## No Sustainability Without Transparency! **Forbes**

Sustainability doesn't work without transparency



True sustainability needs transparency

The  
Guardian

"Sustainability doesn't work without transparency



# THE LIFE OF A PILL

SUPPLIER



PLANT



SHIPMENT



TRANSPORT

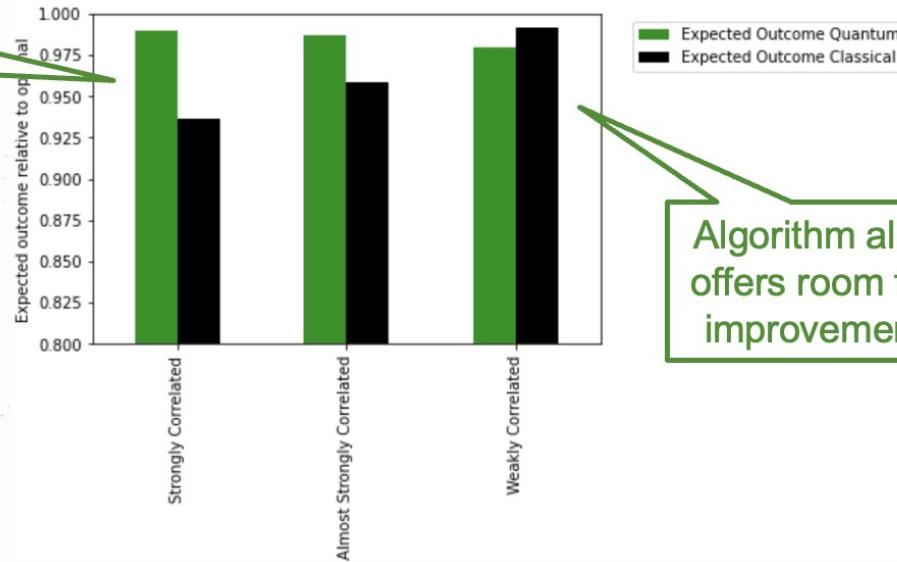


PACKAGING



# “SHOULDERING” KNAPSACK WITH QUANTUM

Promising results on hard instances



Algorithm also offers room for improvement