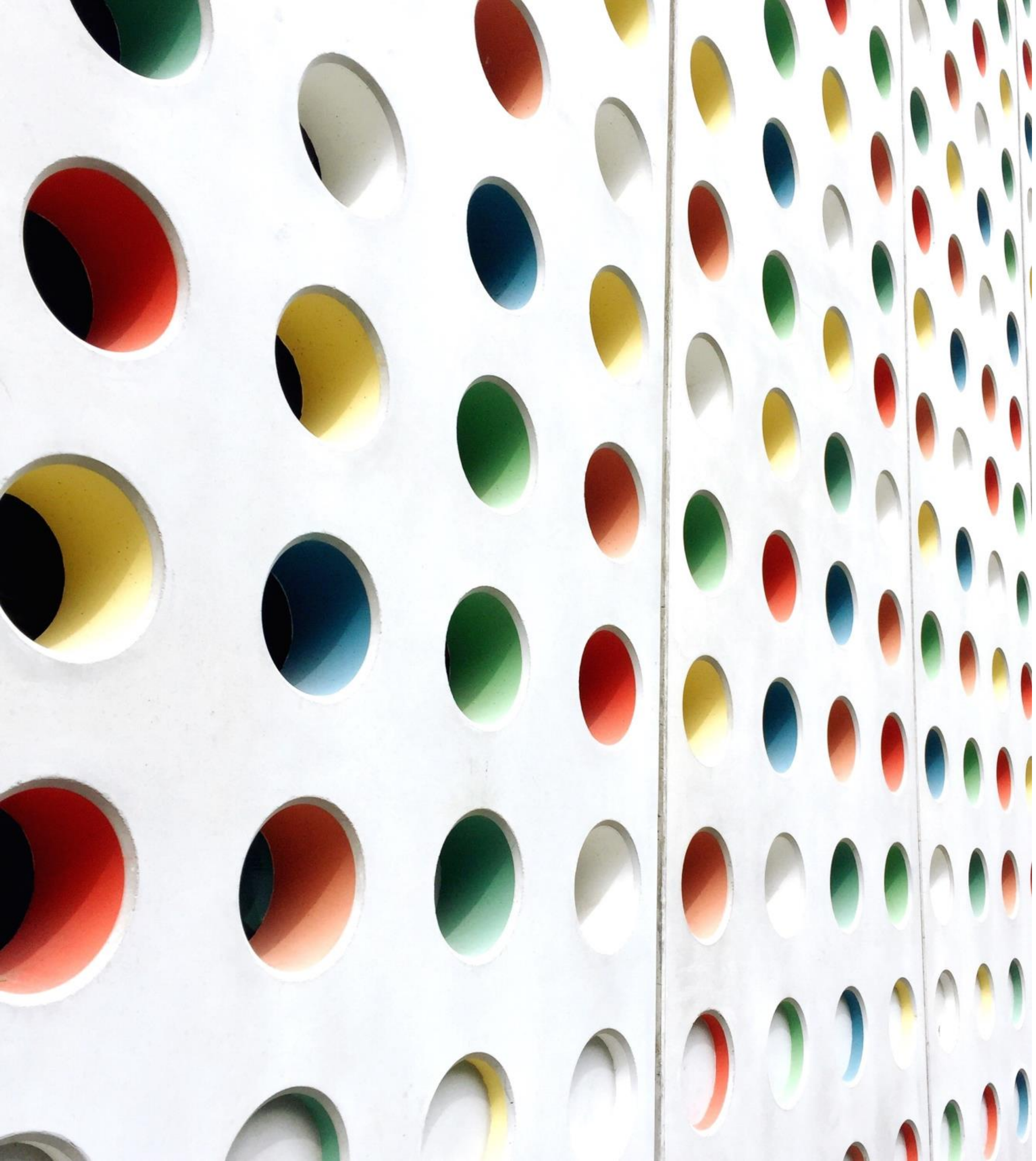
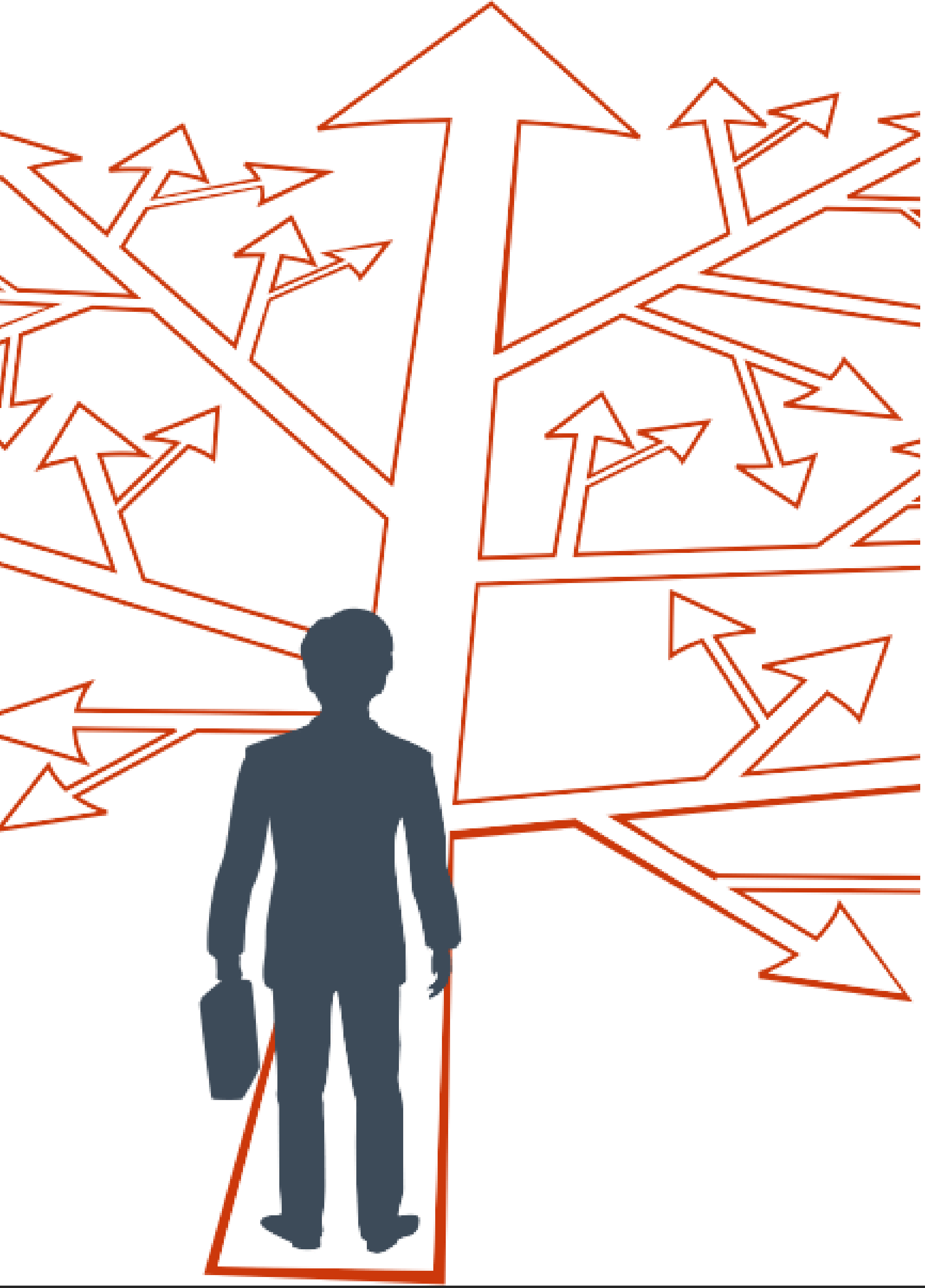


How to make better decisions under uncertainty for supply chain resilience?

Dr Danny Ho

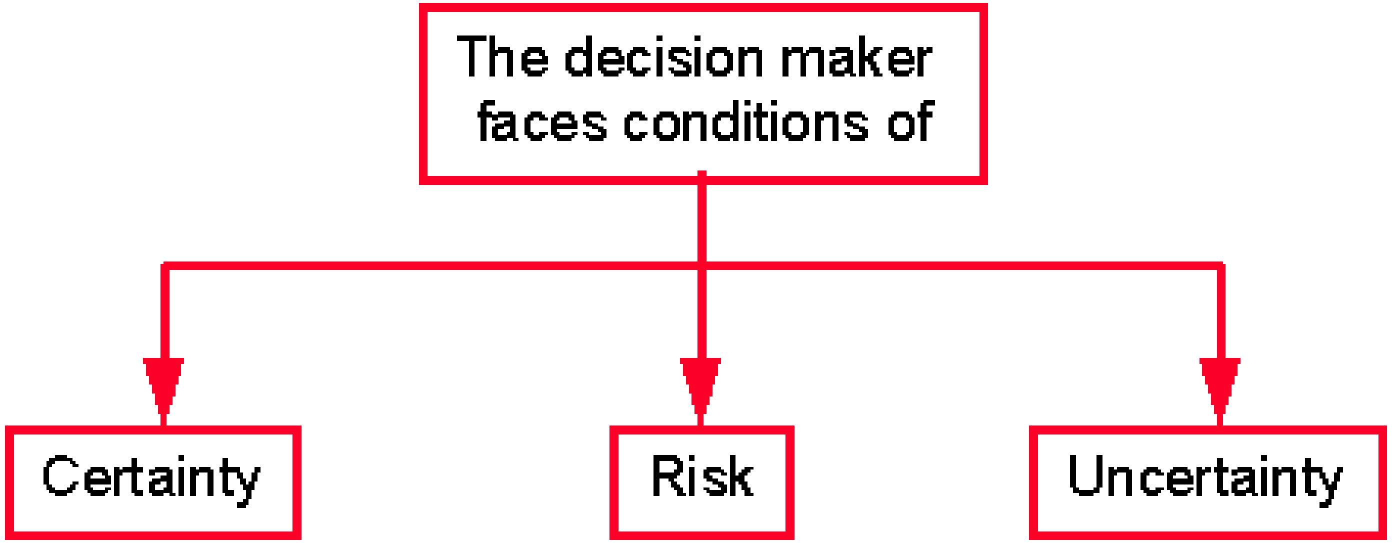
The Hang Seng University of Hong Kong



Agenda

1. Three conditions of decision making
2. Cognitive biases in decision making
3. Decision making under uncertainty

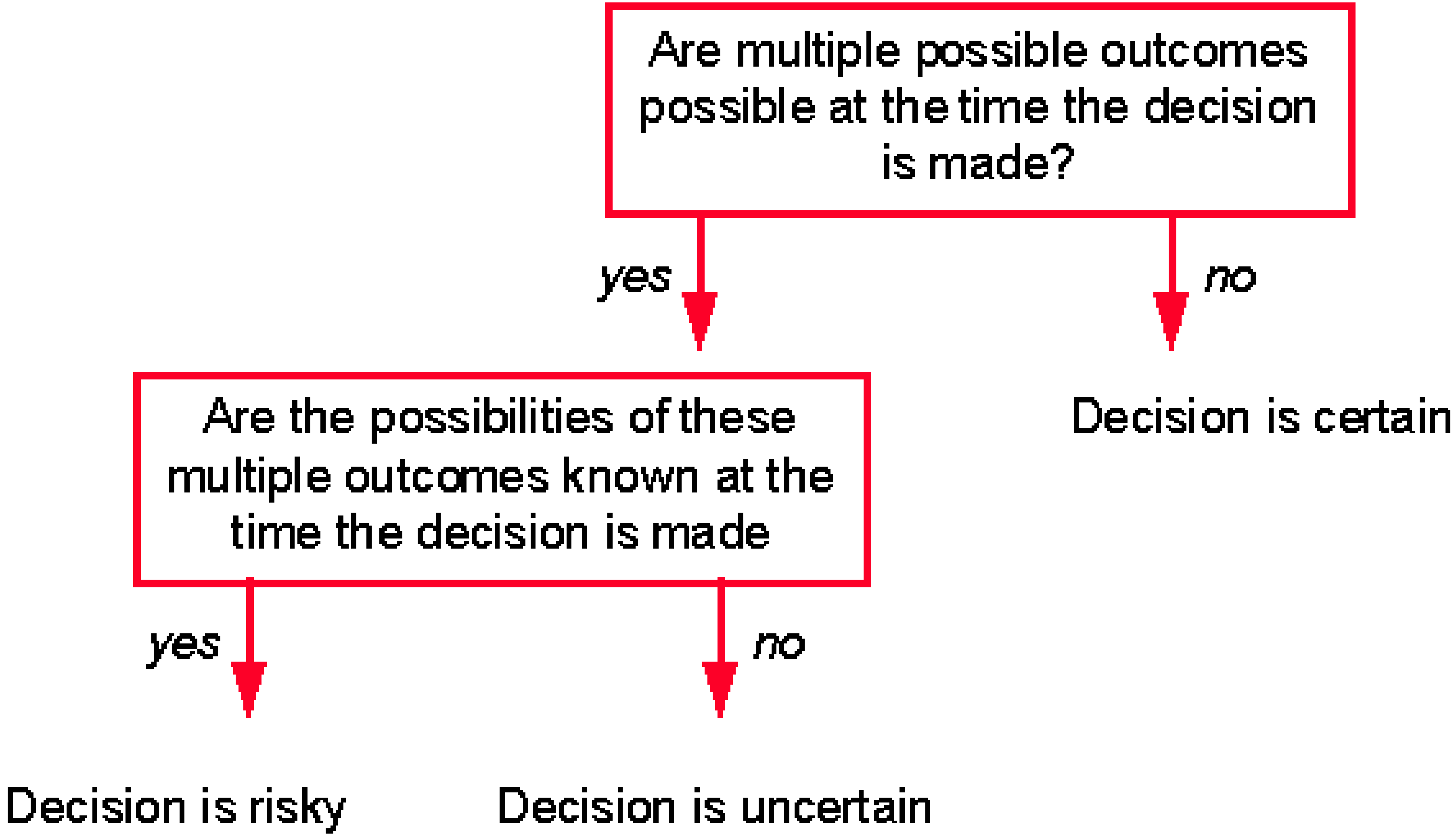
Three conditions of decision making



Level of ambigutity and chances of making a bad decision

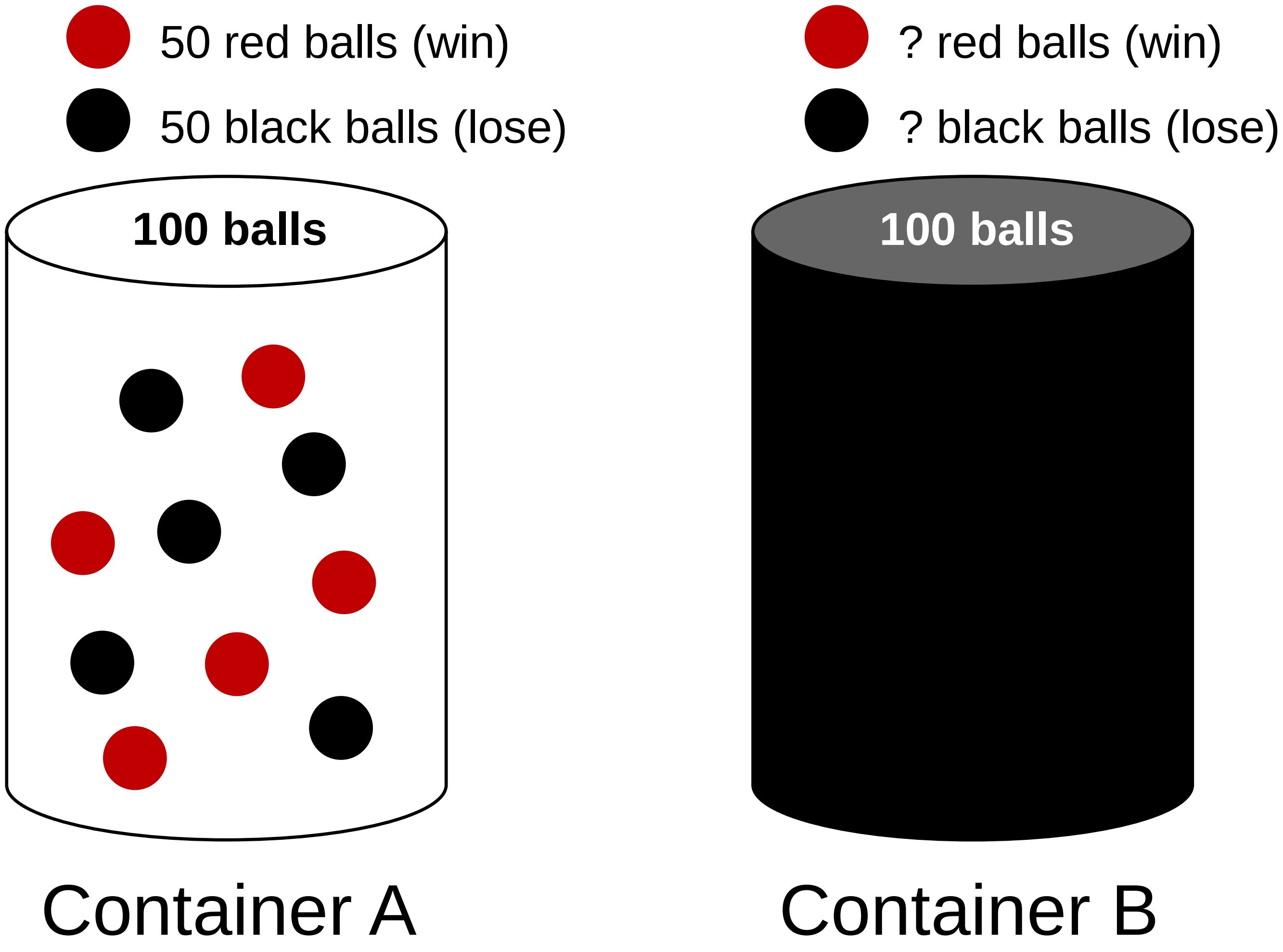
lower *moderate* *higher*

Certain, Risky, and Uncertain Decisions



Let’s make a decision.

Which container will you draw a ball from?



The 1st decision

If you have drawn a red ball from the selected container, you win.

Which container will you draw a ball from?
A or B

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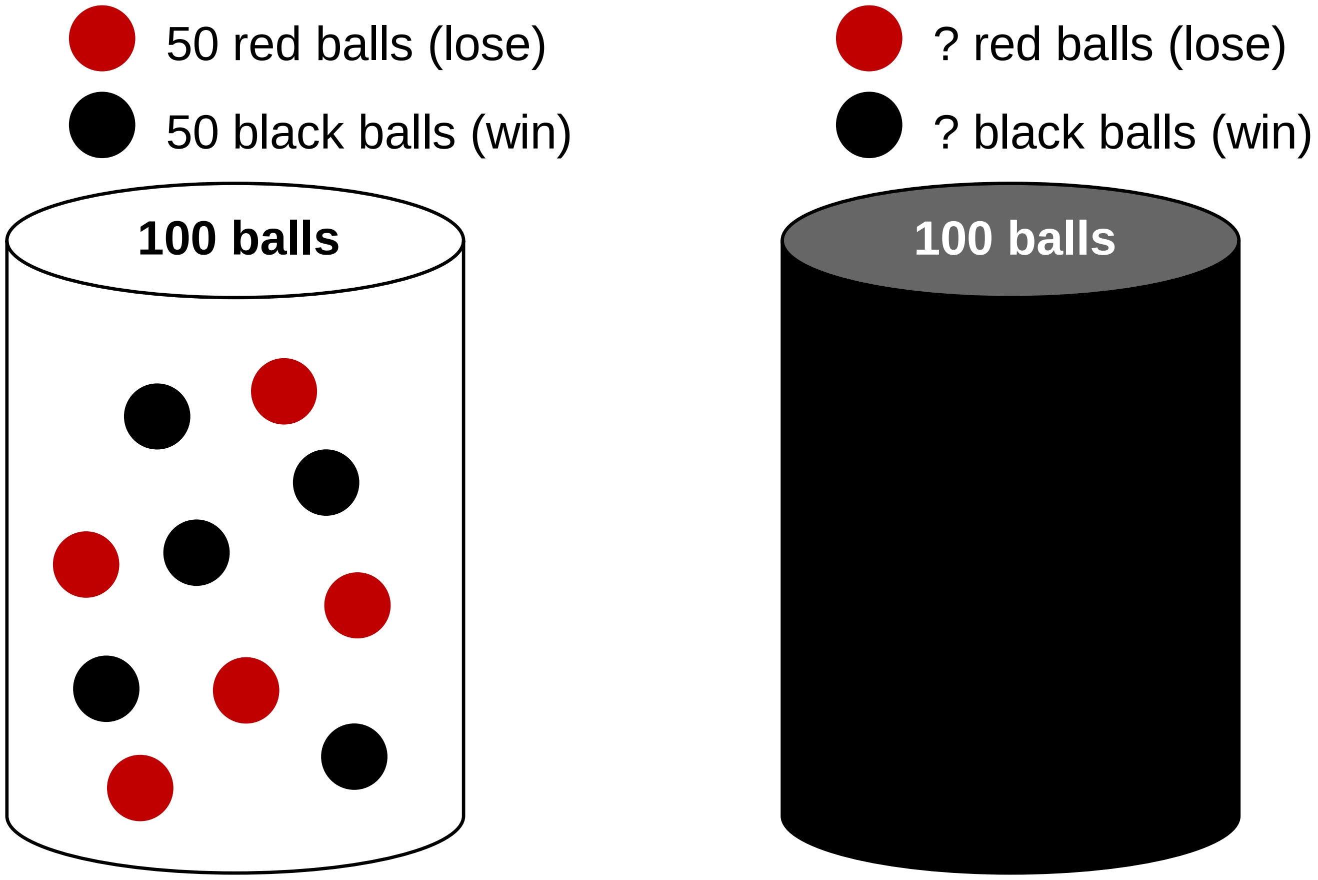
Which container will you draw a ball from?



Container A

Container B

The 2nd decision

Everything remains unchanged, except if you have drawn a black ball from the selected container, you win.

Which container will you draw a ball from?
A or B

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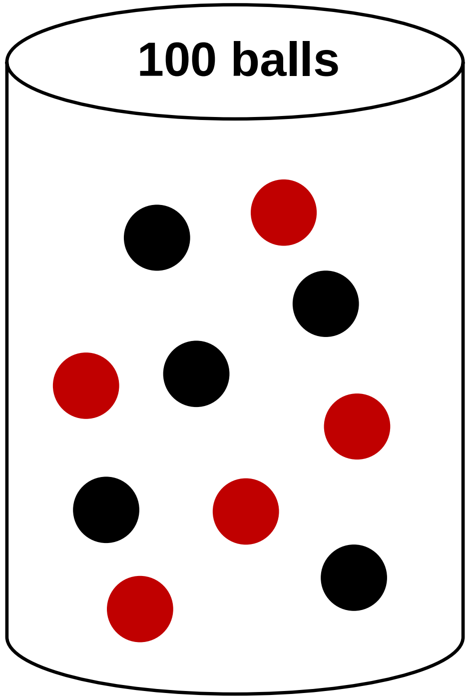
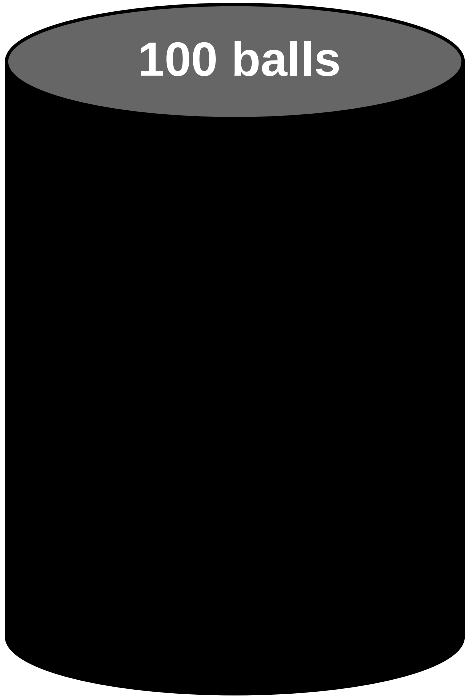
The Ellsberg paradox

Known probabilities



Container A

Unknown probabilities



Container B

- For both decisions, most will select Container A because people prefer known probabilities over unknown probabilities.
- This game (experiment) illustrates the **Ellsberg paradox**.
- The bias is called the **uncertainty or ambiguity aversion**. It refers to the fact that we try as much as possible to avoid uncertainty.

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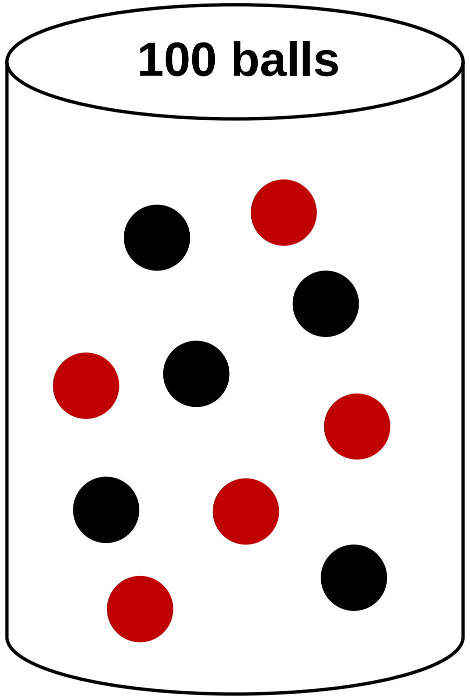
Do you see the contradiction?

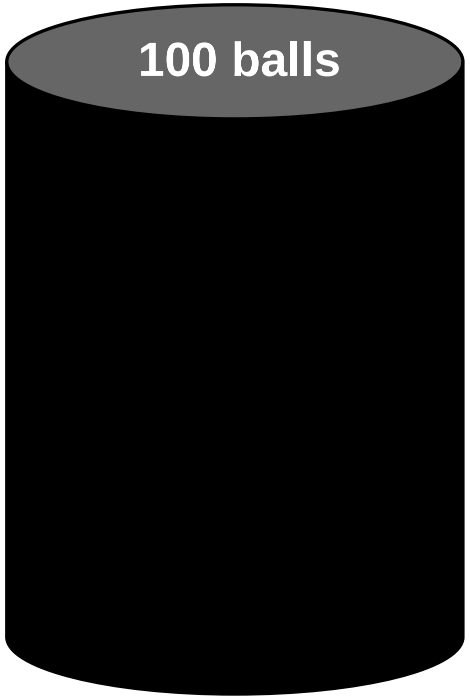
Assume that:

- 50 red balls (win)
- 50 black balls (lose)



Container A

- 40 red balls (win)
- 60 black balls (lose)



Container B

The 1st decision

We have no information on Container B, so we need to make hypotheses about the chance of success.

Let's assume that the number of red balls in Container B is smaller than 50.

The chance of winning is higher, if you select Container A.

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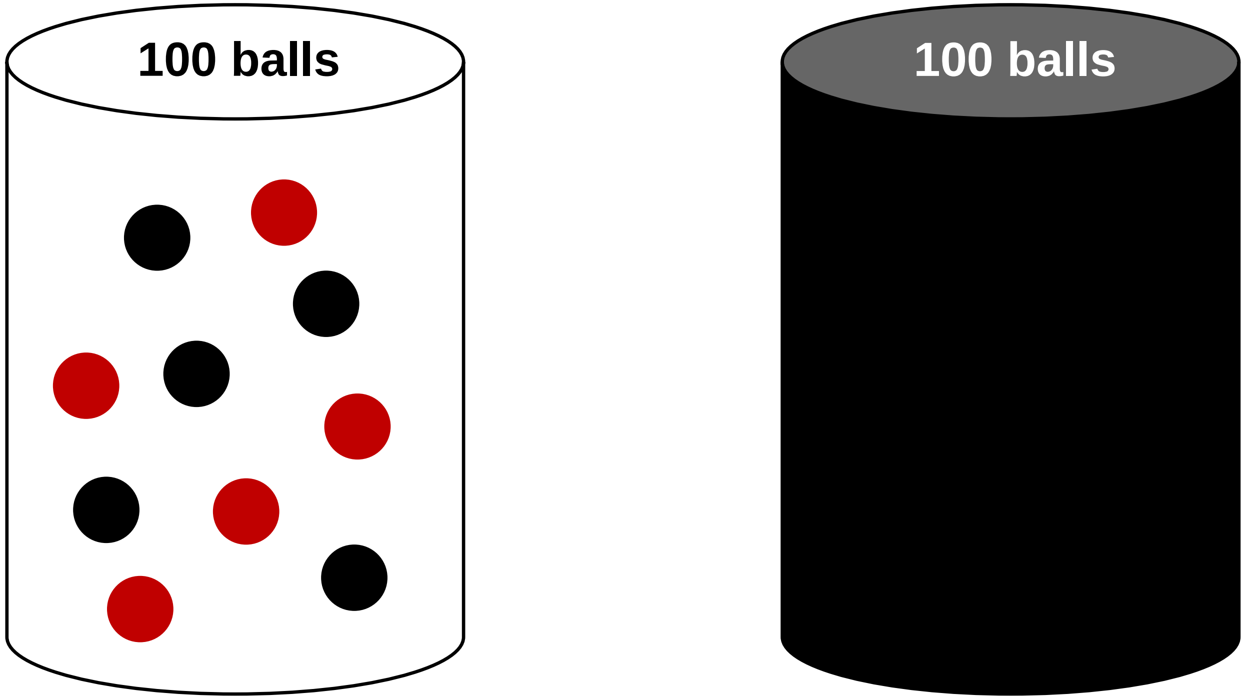
Do you see the contradiction?

Assume that:

- 50 red balls (lose)
- 50 black balls (win)

- 40 red balls (lose)
- 60 black balls (win)



Container A

Container B

<u>The 2nd decision</u>
Based on the assumption you made, now you should have selected container B to increase the chance of winning. Yet, you still select Container A. That is not rational!

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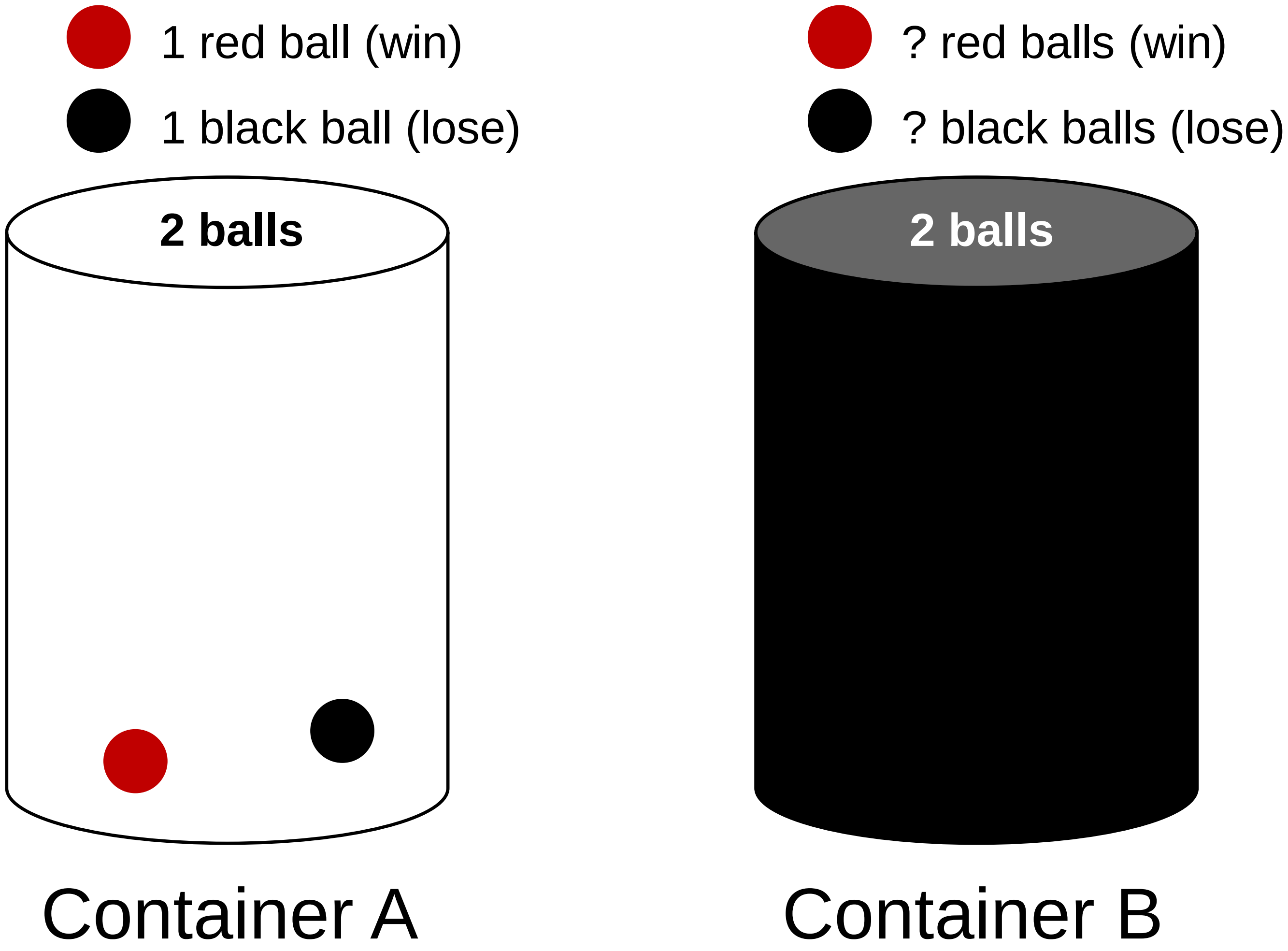
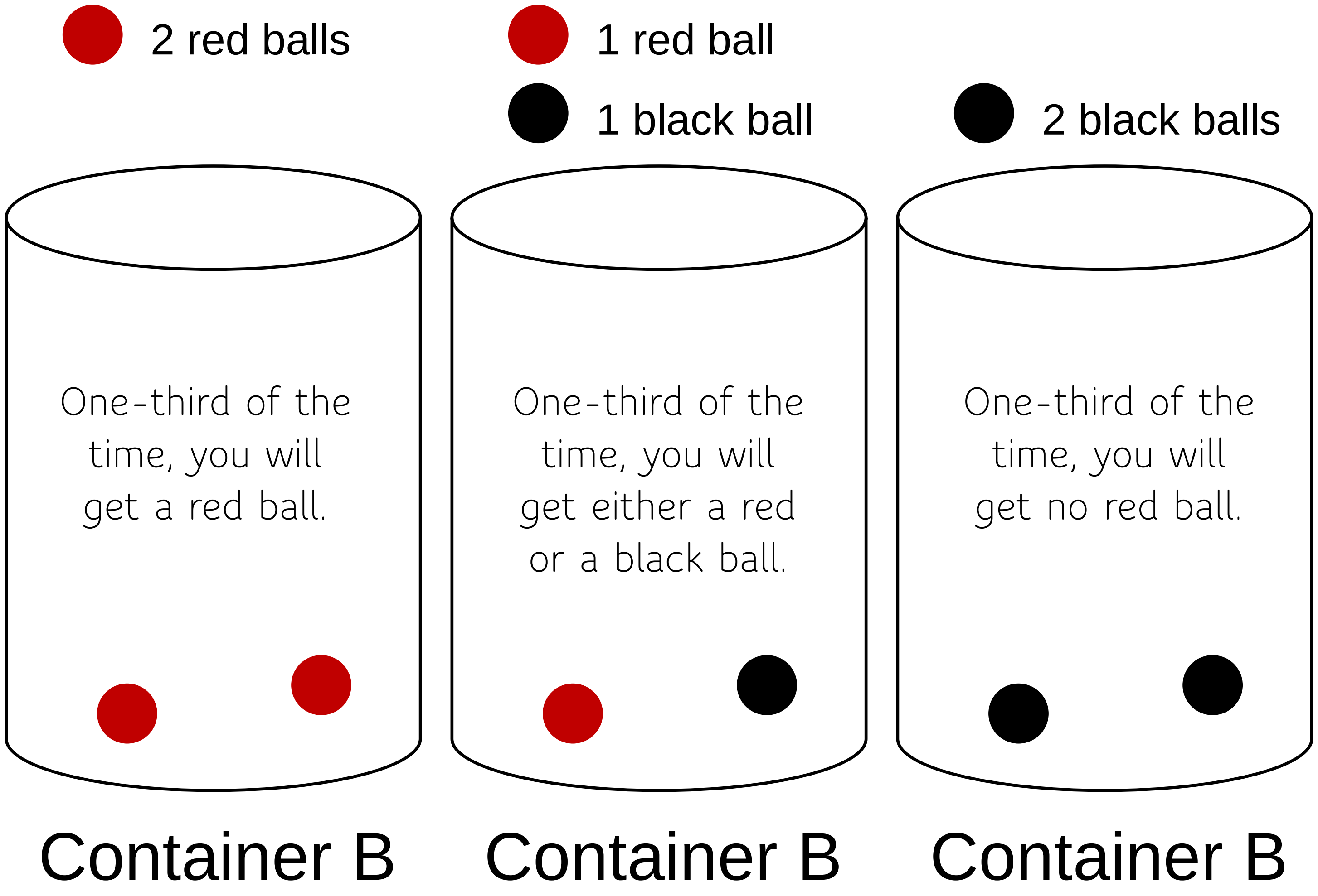
Let's play another game and draw a ball from a container



Do you think the chance of getting a red ball from Container A and the chance of getting a red ball from Container B are the SAME?
That is, the chance is ½ or 0.5.

The chance of getting a red ball from Container B is also ½



Container B

The chance of getting a red ball is ½ or 0.5.

1/3 * 1 = 1/3 or 2/6

1/3 * ½ = 1/6

1/3 * 0 = 0

2/6 + 1/6 + 0 = 3/6 = ½

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Which project do you choose?

Investment 1: if an industrial project A is successful, you can earn a profit of $1.2M. If the project is not successful, you get your money back. You do not lose or win anything. You have no information about the chance of success of the project.

Investment 2: if an industrial project B is successful, you can earn a profit of $1M. If the project is not successful, you get your money back. You do not lose or win anything. You know that the chance of success of the project is 50%.

Which project do you choose?

Investment 1: if an industrial project A is successful, you can earn a profit of $1.2M. If the project is not successful, you get your money back. You do not lose or win anything. You have no information about the chance of success of the project.

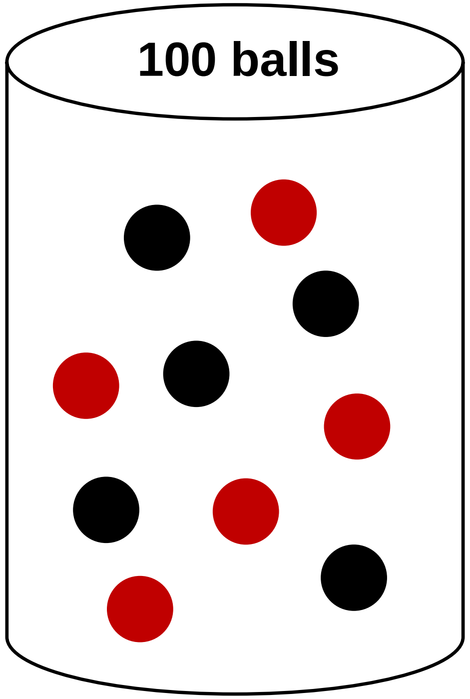
As we are indifferent to bet on the success or on the failure of the industrial project, we can say the probability is 1/2. If so, we should choose Project A since its expected return ($0.6M) is higher than Project B.

Investment 2: if an industrial project B is successful, you can earn a profit of $1M. If the project is not successful, you get your money back. You do not lose or win anything. You know that the chance of success of the project is 50%.

The expected return = 0.5*$1M + 0.5*$0
= $0.5M

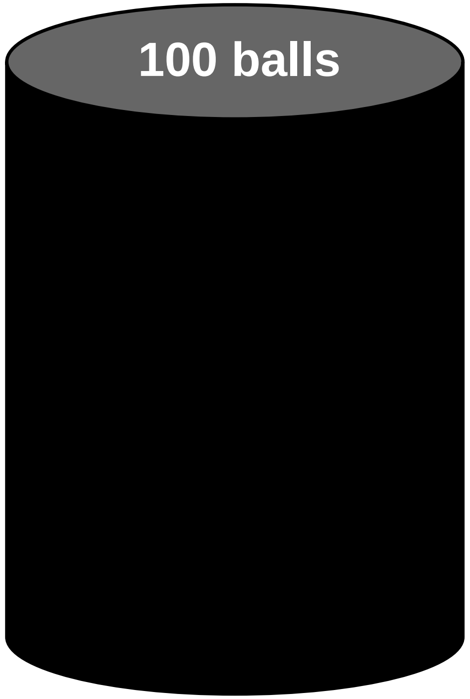
Decision-Making Under Uncertainty Versus Under Risk

Decision-Making Under Risk
The probability distribution governing the outcome is **known**.



Container A

Decision-Making Under Uncertainty
The probability distribution governing the outcome is **unknown**.



Container B

When asked to choose, individuals *prefer risk over uncertainty*.

We often think we are making decisions under risk, but we live in the post-pandemic world full of uncertainty!

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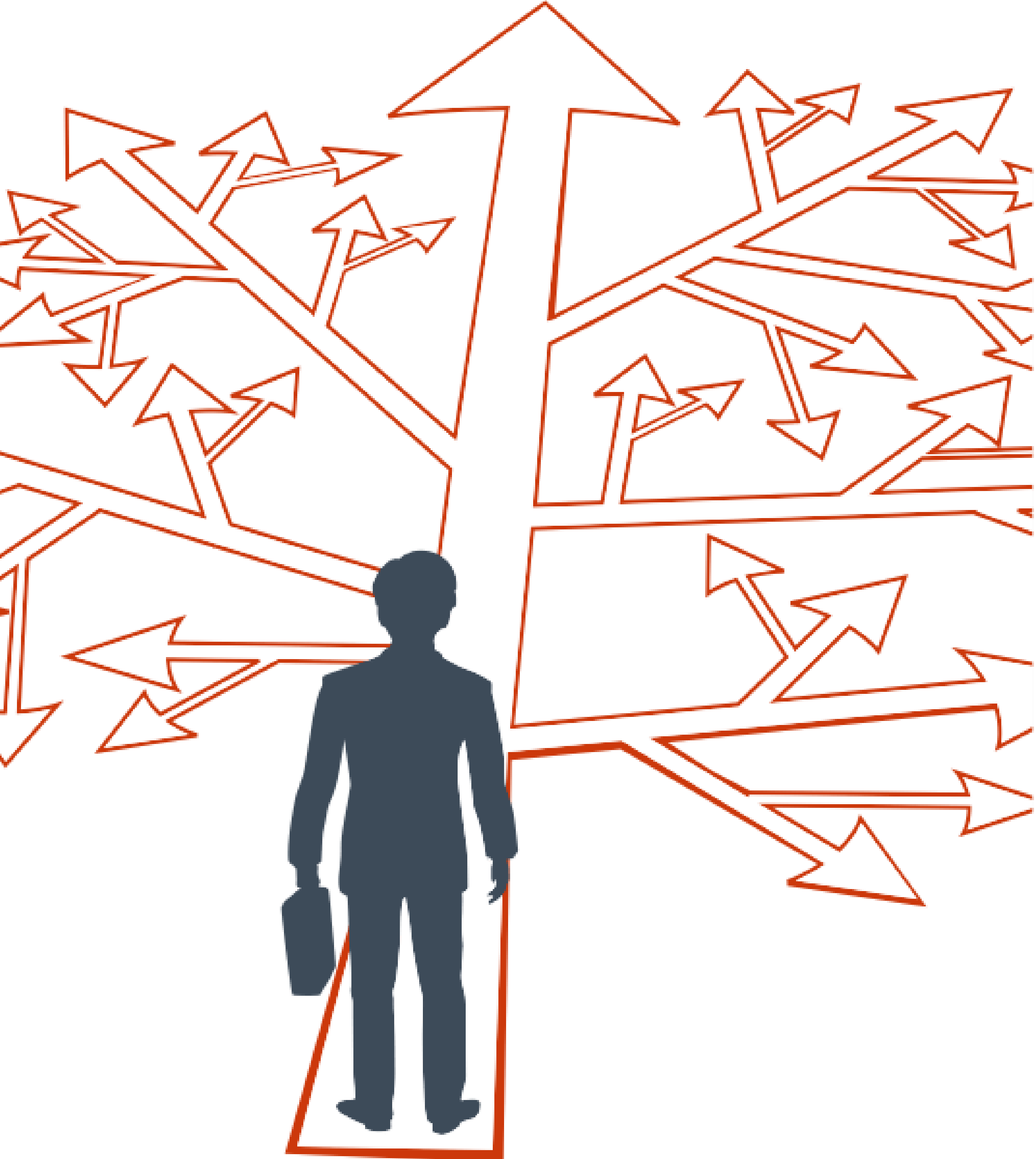
Would anyone expect the capsizing of HK's Jumbo Floating Restaurant?



How to Make Better Decisions Under Uncertainty for Supply Chain Resilience?

Making Better Decisions Under Uncertainty for Supply Chain Resilience

Considering three potential disruptions and three possible strategies to follow. Their combination results in different payoffs (profit/loss).
Which is the best strategy?

Strategy / Disruption	Port shutdown	Restricted business hours	Lockdown
1. Double inventory	220	150	-50
2. Dual sourcing	210	120	-20
3. Online sale	50	200	180

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Decision Making Criterion: Maximin

A pessimist model for decision makers who are risk-averse (dislike risk) and seek to achieve the best result if the worst happens. Select the maximum of the minimum payoffs; i.e., the lesser of evils.

Strategy / Disruption	Port shutdown	Restricted business hours	Lockdown
1. Double inventory	220	150	**-50**
2. Dual sourcing	210	120	**-20**
3. Online sale	**50**	200	180

Select Online sale which has the largest payoff (50 > -20 > -50).

Decision Making Criterion: Maximax

An optimist model for decision makers who are risk-seeking and seek to achieve the best result if the best happens. Select the maximum of the maximum payoffs; i.e., the best among the best.

Strategy / Disruption	Port shutdown	Restricted business hours	Lockdown
1. Double inventory	**220**	150	-50
2. Dual sourcing	**210**	120	-20
3. Online sale	50	**200**	180

Select Double inventory which has the largest payoff (220 > 210 > 200).

Decision Making Criterion: Minimax Regret

A model for decision makers who are risk-neutral and seek to minimize the regret (opportunity loss) from making the wrong decision. Select the minimum of the maximum regrets.

Strategy / Disruption	Port shutdown	Restricted business hours	Lockdown
1. Double inventory	220	150	-50
2. Dual sourcing	210	120	-20
3. Online sale	50	200	180
1. Double inventory	220-220 = 0	200-150 = 50	180+50 = 230
2. Dual sourcing **Regrets**	220-210 = 10	200-120 = 80	180+20 = 200
3. Online sale	220-50 = 170	200-200 = 0	180-180 = 0

Decision Making Criterion: Minimax Regret

A model for decision makers who are risk-neutral and seek to minimize the regret (opportunity loss) from making the wrong decision. Select the minimum of the maximum regrets.

Strategy / Disruption	Port shutdown	Restricted business hours	Lockdown
1. Double inventory	220-220 = 0	200-150 = 50	180+50 = **230**
2. Dual sourcing **Regrets**	220-210 = 10	200-120 = **80**	180+20 = 200
3. Online sale	220-50 = **170**	200-200 = 0	180-180 = 0

Select Dual sourcing which has the smallest regret (80 < 170 < 230).

Making Better Decisions Under Uncertainty for Supply Chain Resilience

Which is the best strategy?
Different decision rules could give us different “best” decisions.

Decision Making Criterion	Best strategy
Maximax	1. Double inventory
Minimax Regret	2. Dual sourcing
Maximin	3. Online sale

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