

The Concept of Diversity

Diversity Index as Business KPI The Concept of Diversity

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Diversity Index as KPI
The Simpson Index



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The Concept of Diversity

Richness - number of differing elements, variety of characteristics

Abundance - plentiful or over sufficient quantity or supply

Evenness - free from variations, equal in measure or quantity

Diversity Index as KPI The Simpson Index

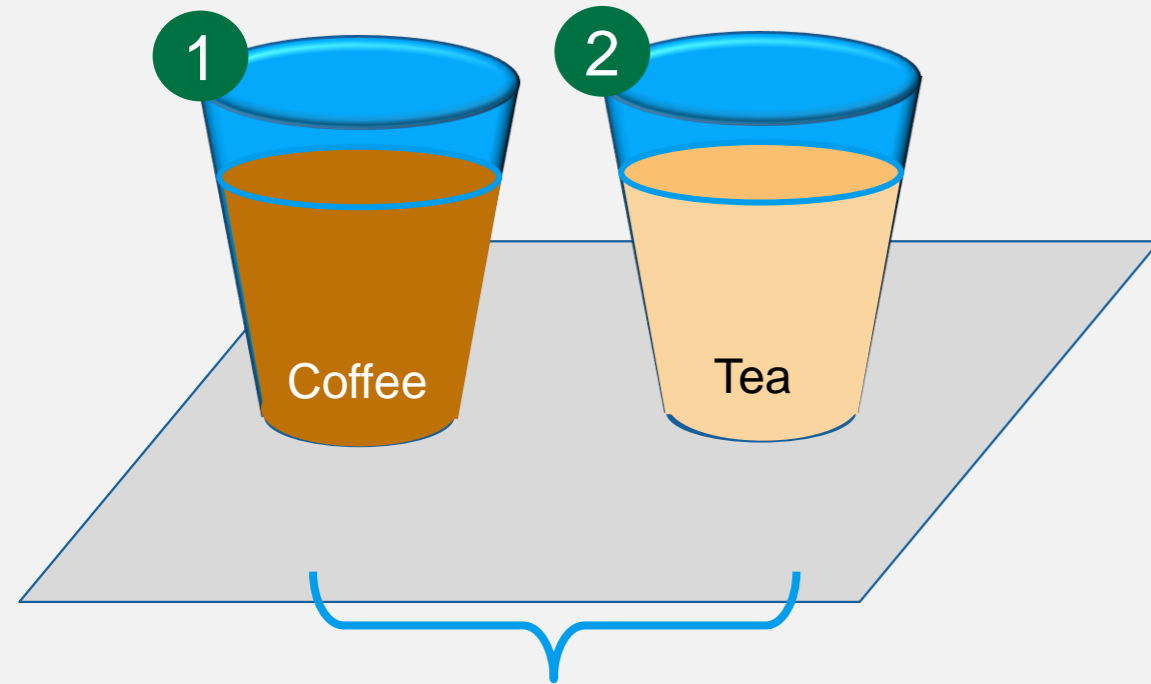


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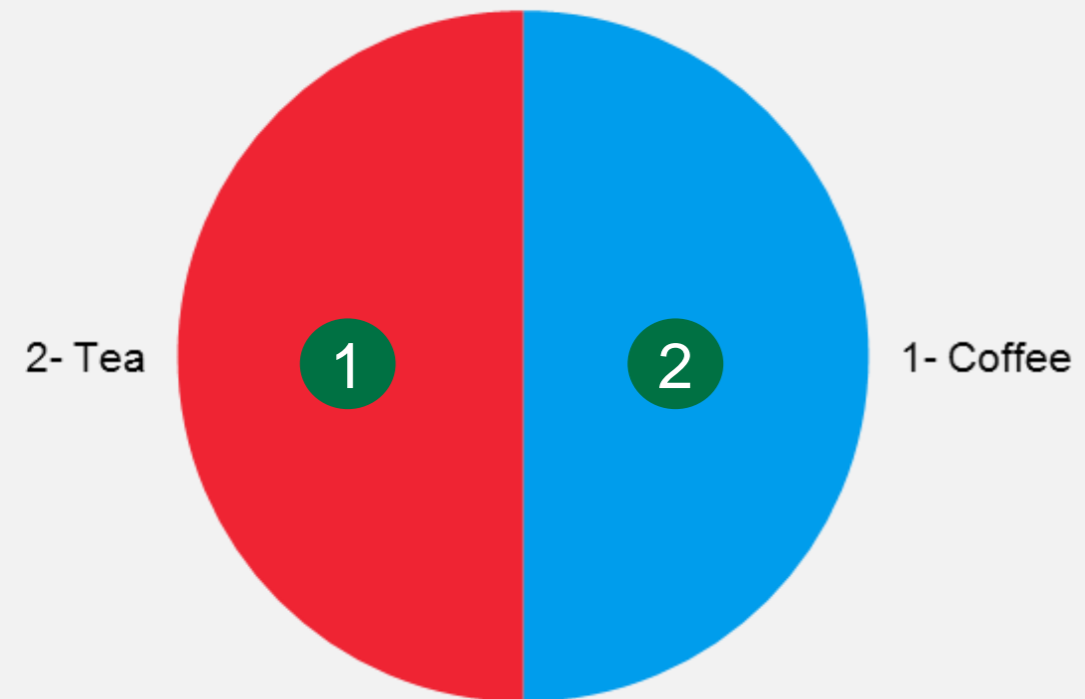
Diversity

- Richness
- Abundance
- Evenness

Richness



Richness: Tea or Coffee $R = 2$

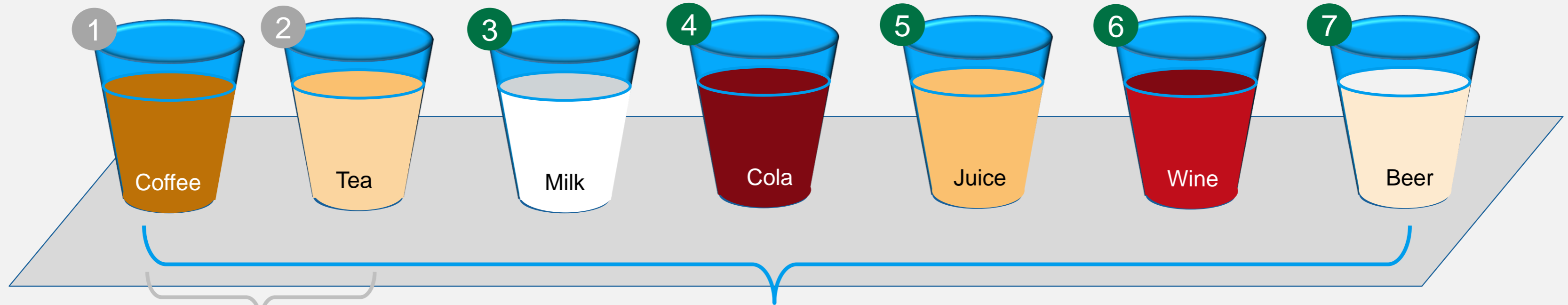


Diversity Index as KPI The Simpson Index



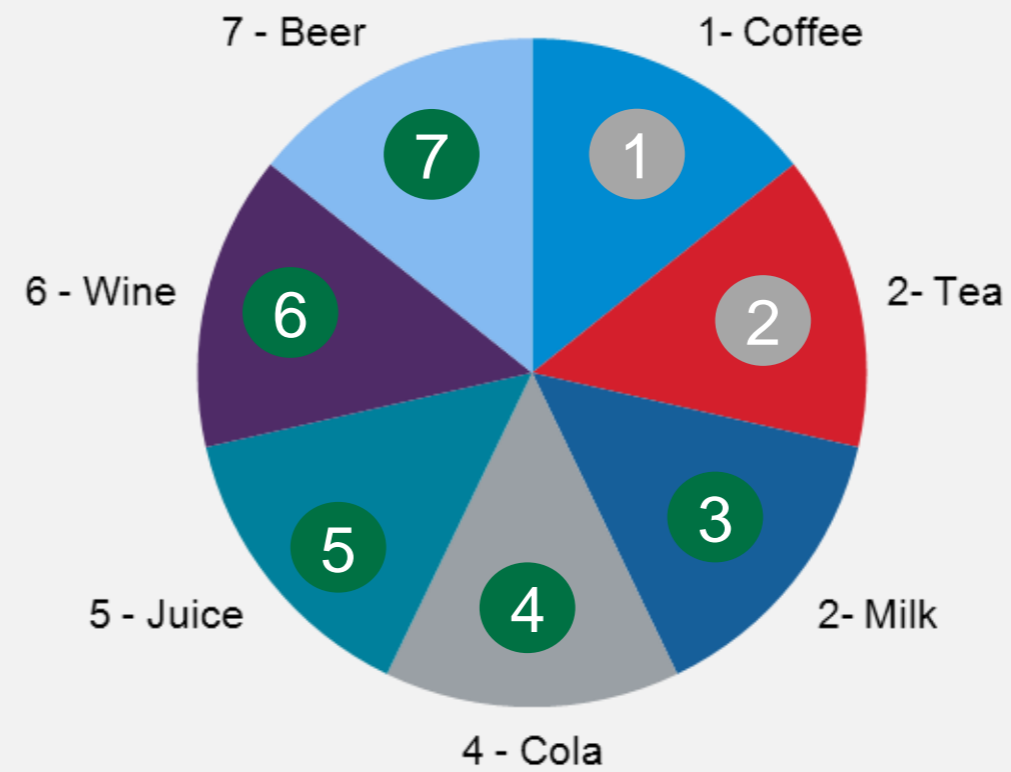
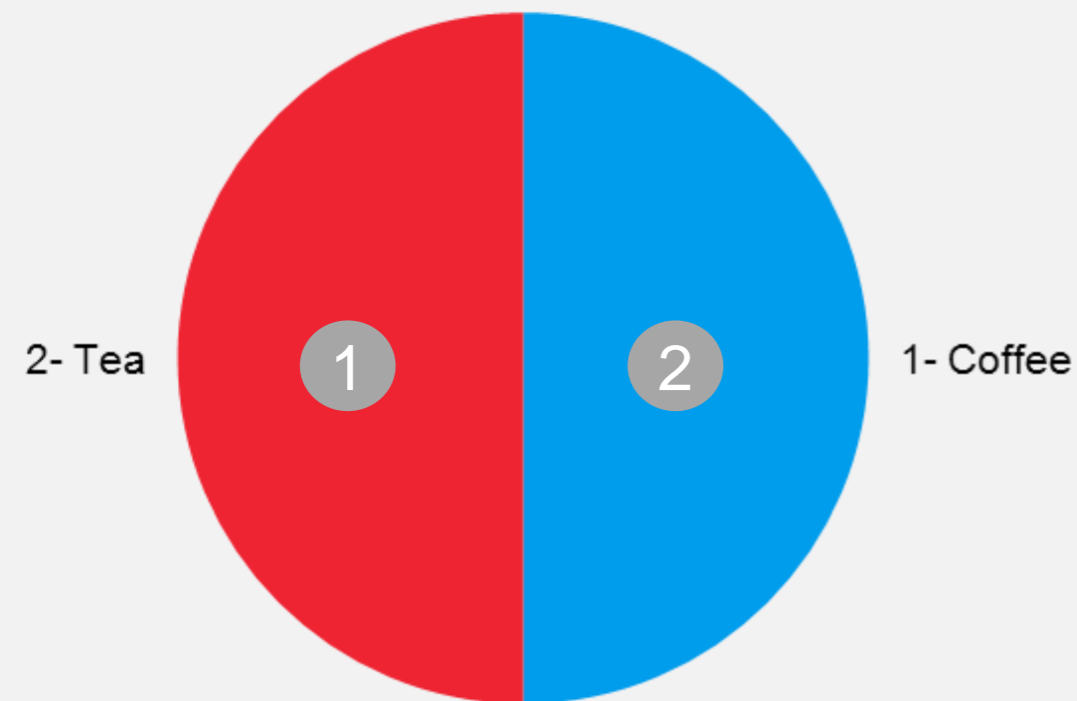
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Richness

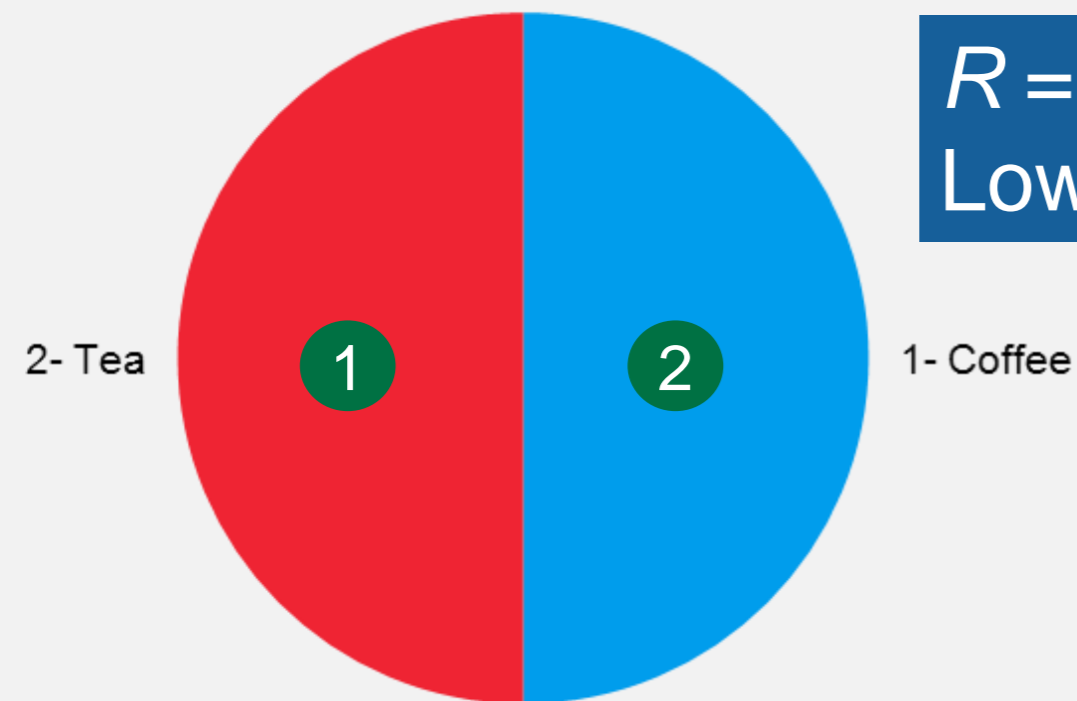
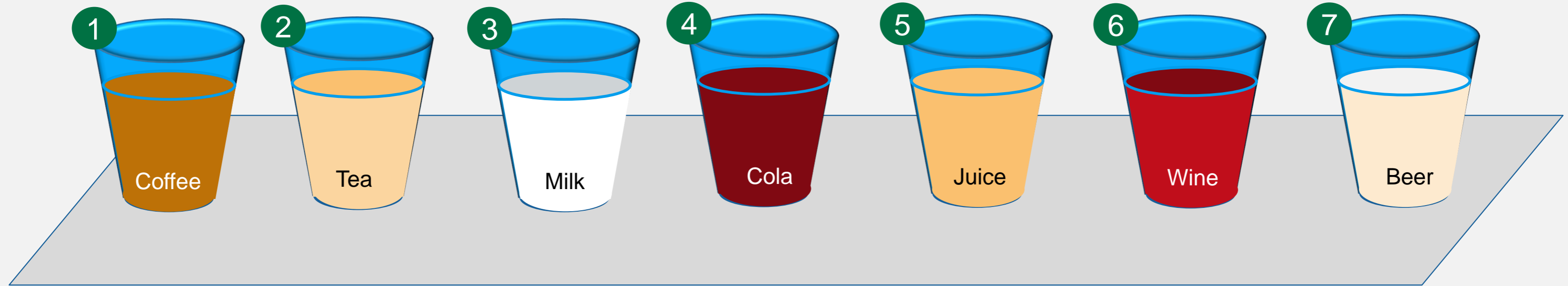


Richness: Tea or Coffee = 2

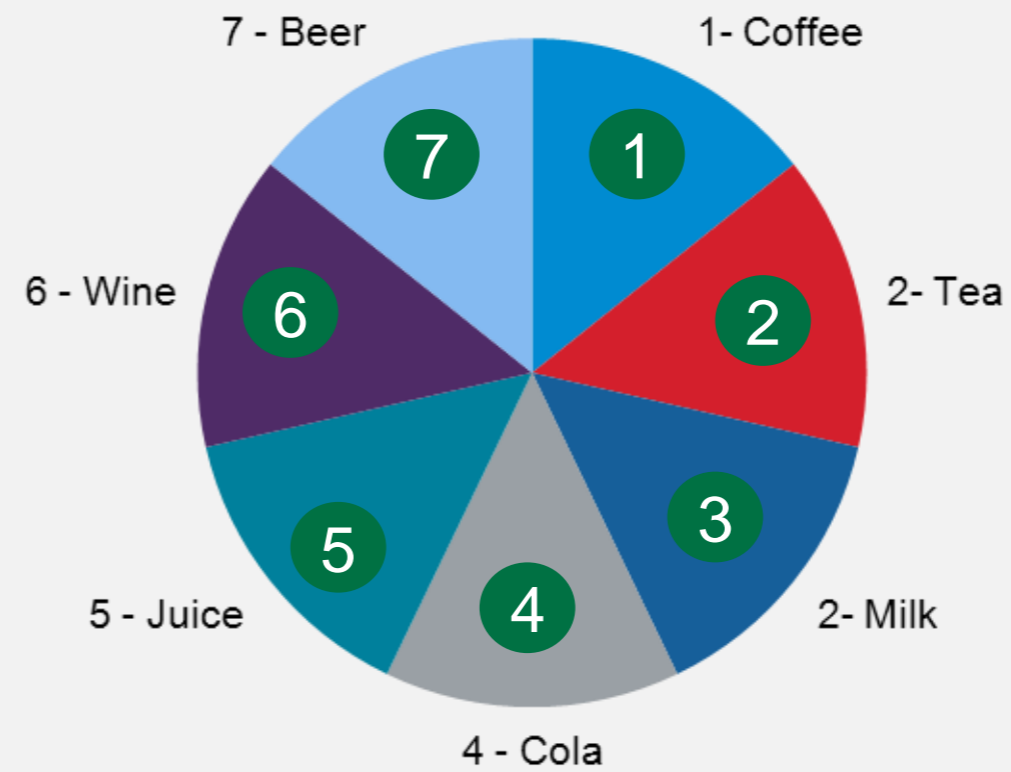
Richness: Tea, Coffee, Cola, Milk Juice, Wine Beer $R = 7$



Richness

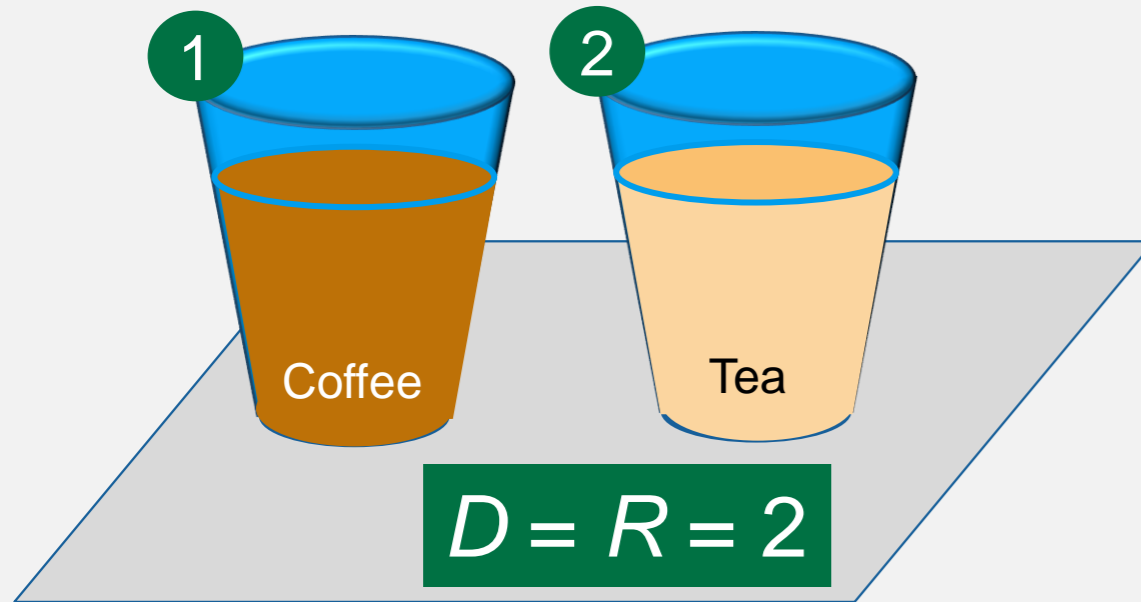


$R = 2$
Low Richness



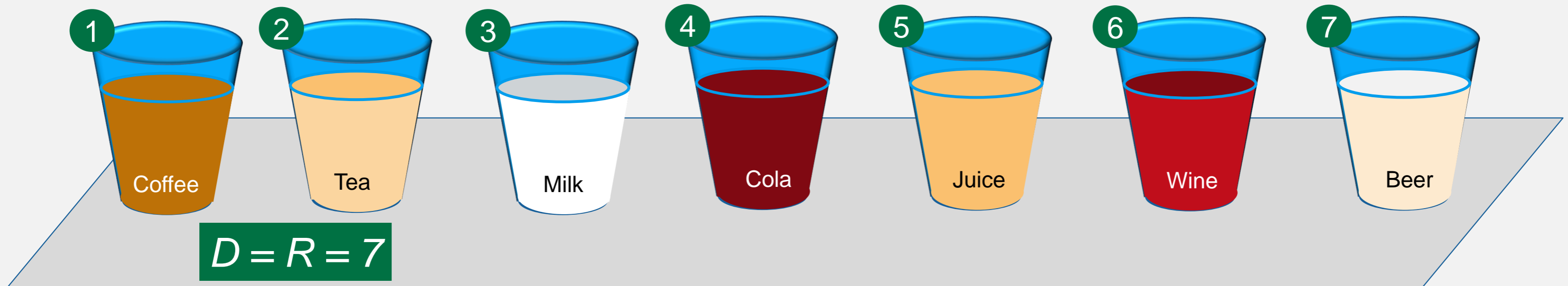
$R = 7$
Higher Richness

Diversity $D =$ Richness R

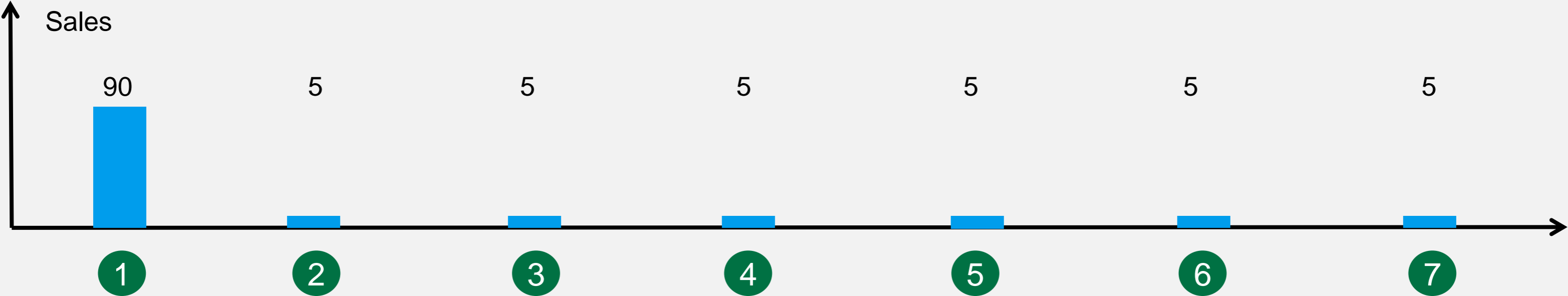
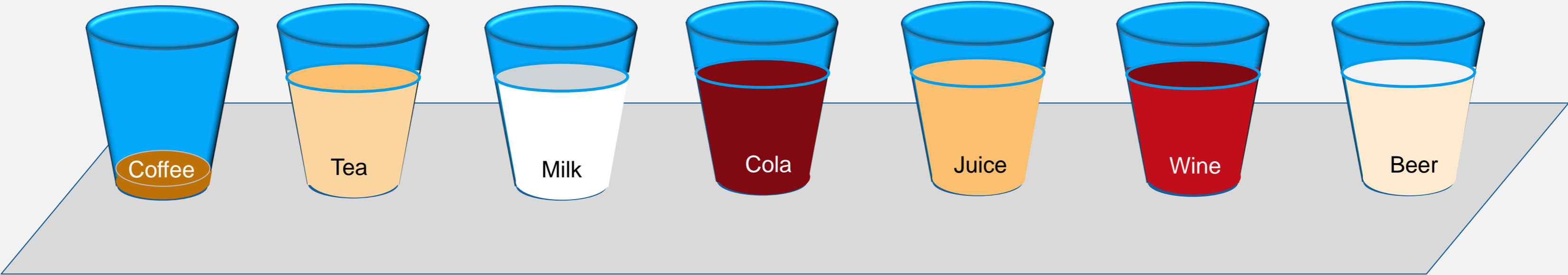


We could measure Diversity by simply **counting the number of types** or categories

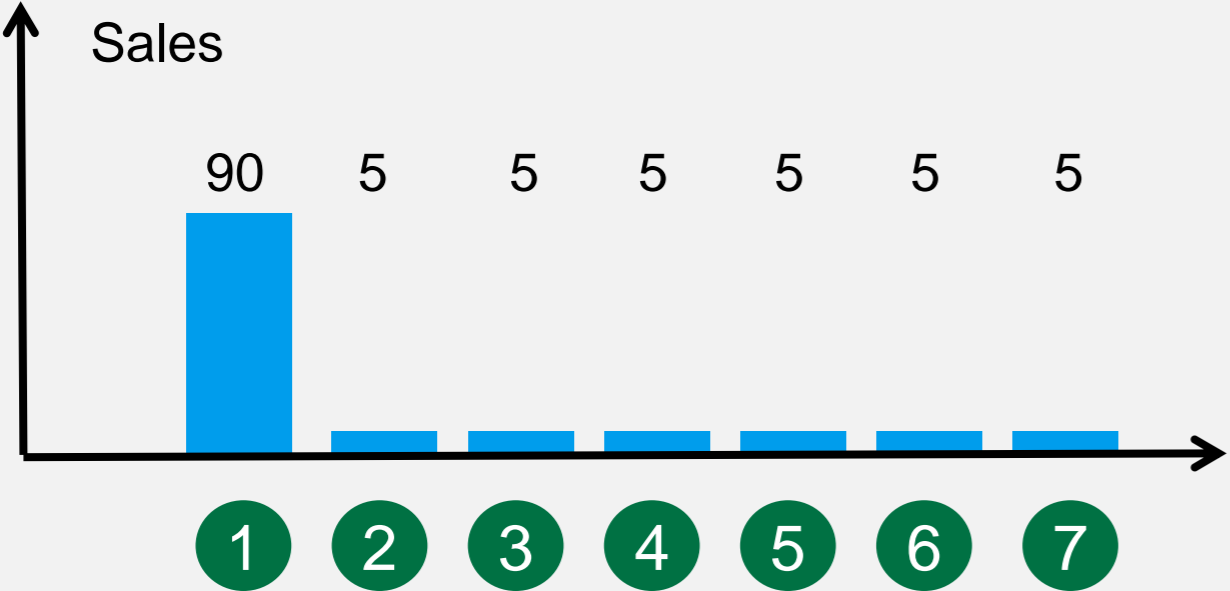
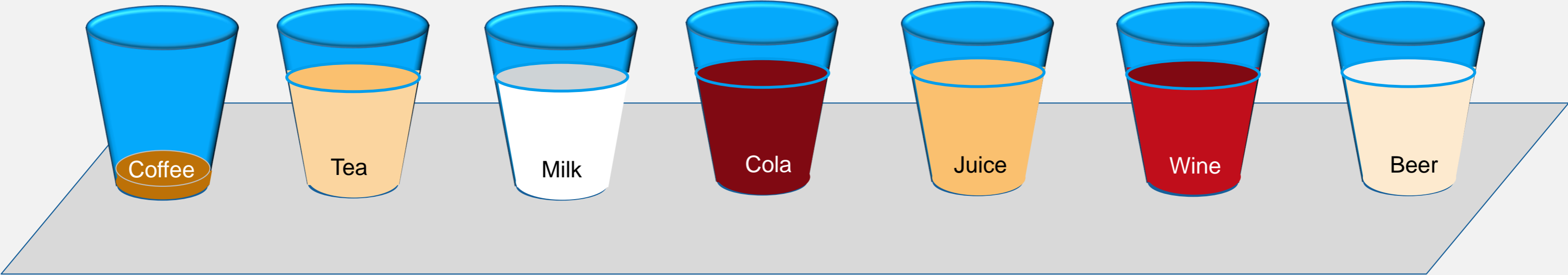
Richness has been a popular diversity index in ecology. It simply quantifies how many different types the dataset of interest contain



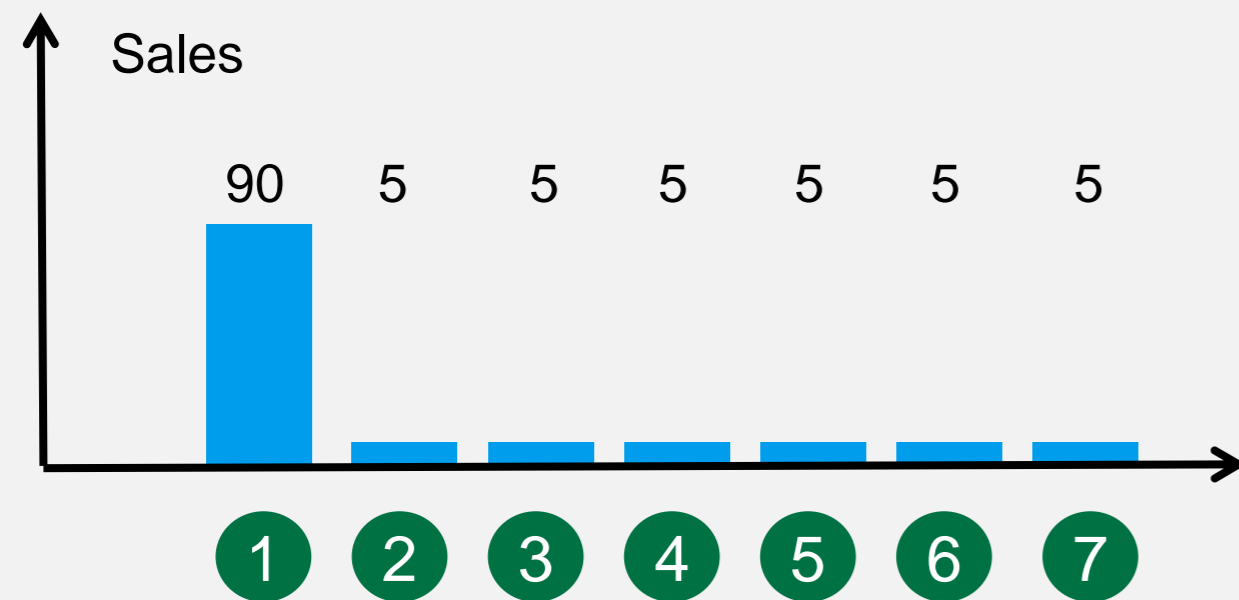
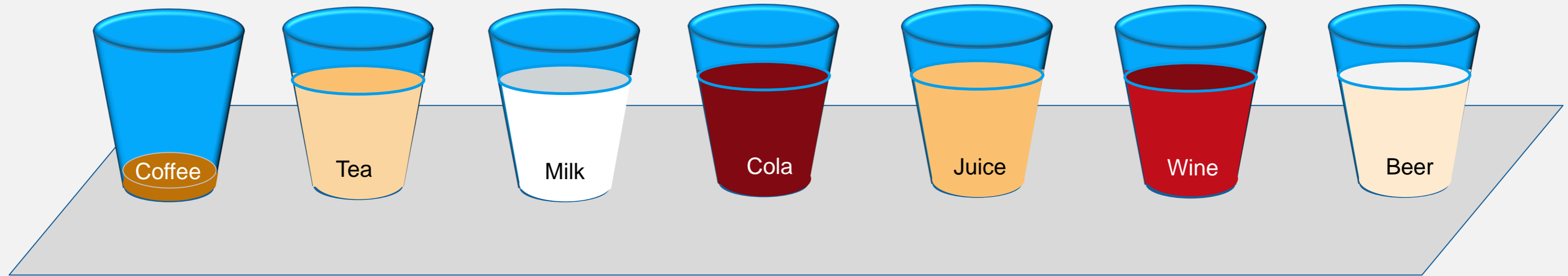
Proportional Abundances



Proportional Abundances



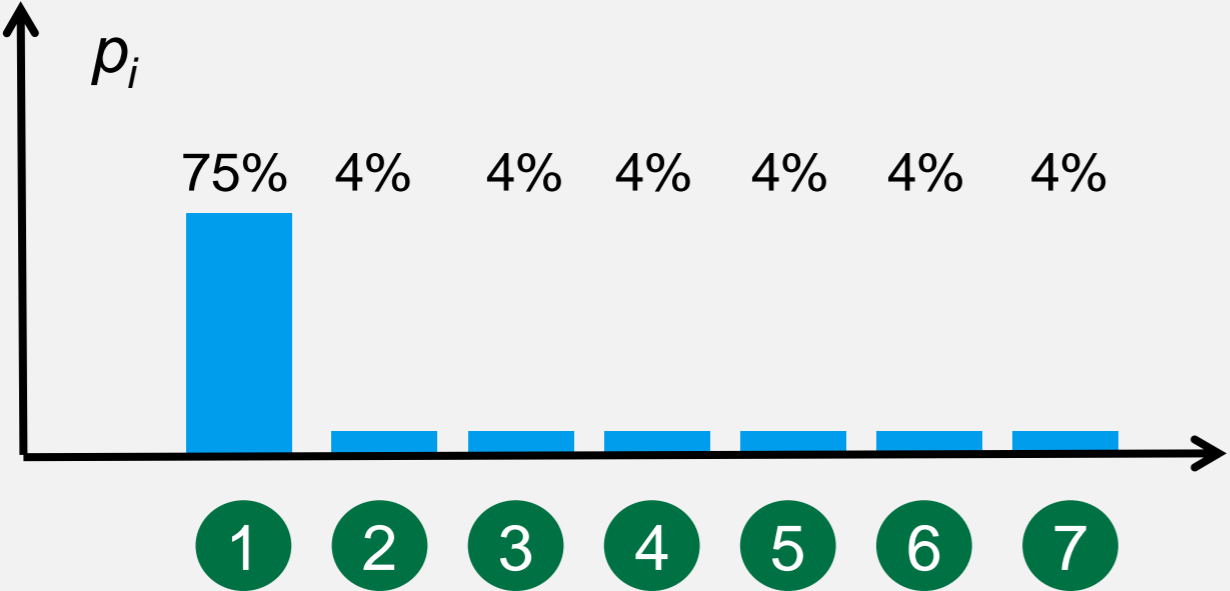
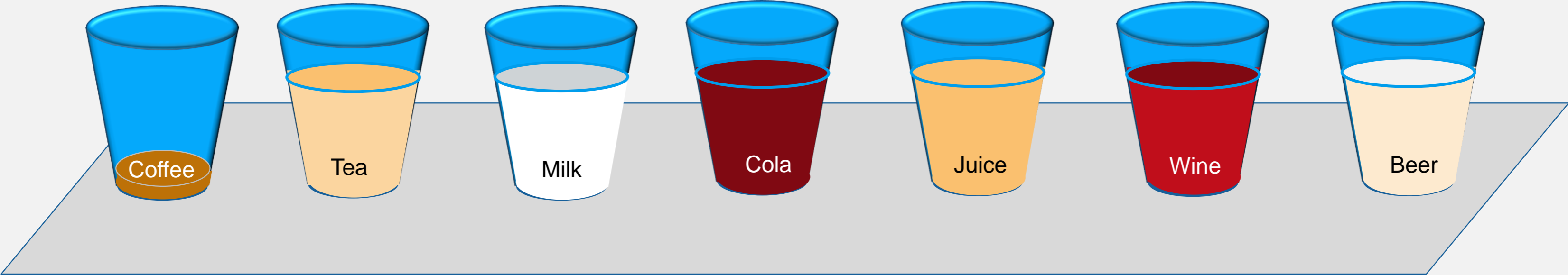
Proportional Abundances



Type	Sales	Proportional
Coffee	90	75%
Tea	5	4%
Milk	5	4%
Cola	5	4%
Juice	5	4%
Wine	5	4%
Beer	5	4%
Total	120	100%

Proportional Abundances p_i

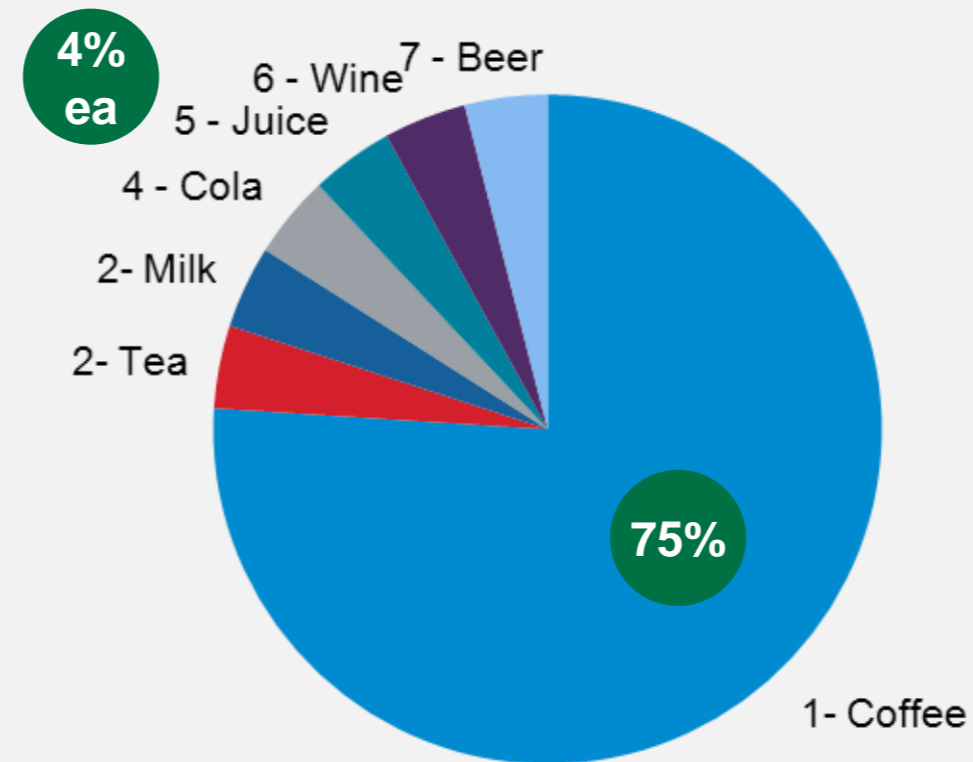
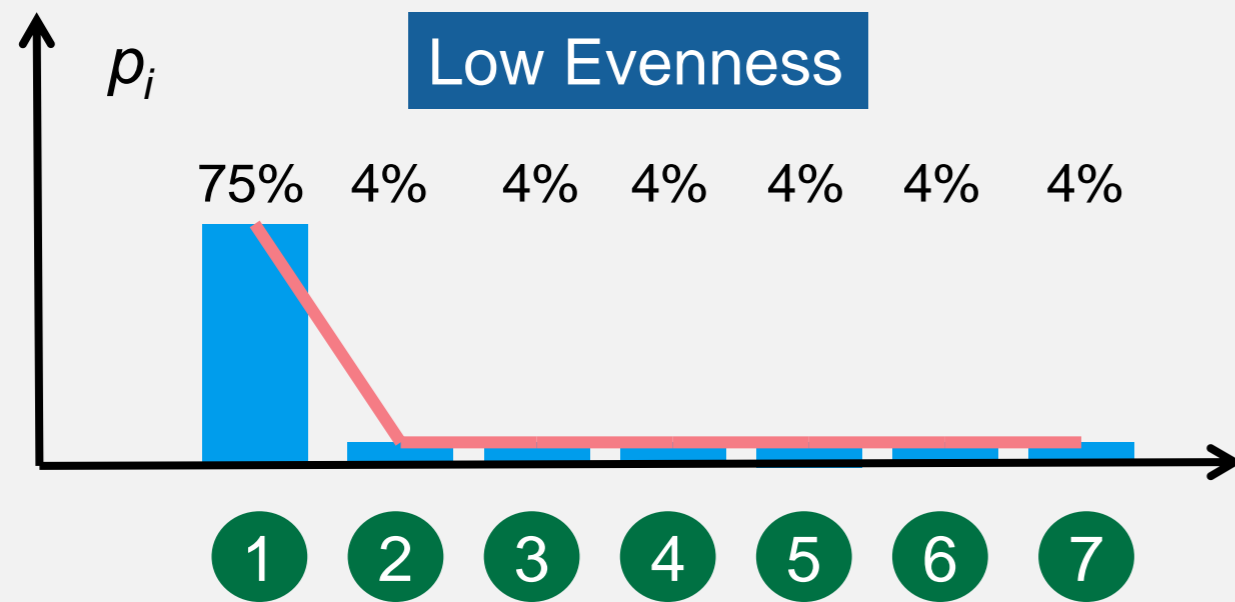
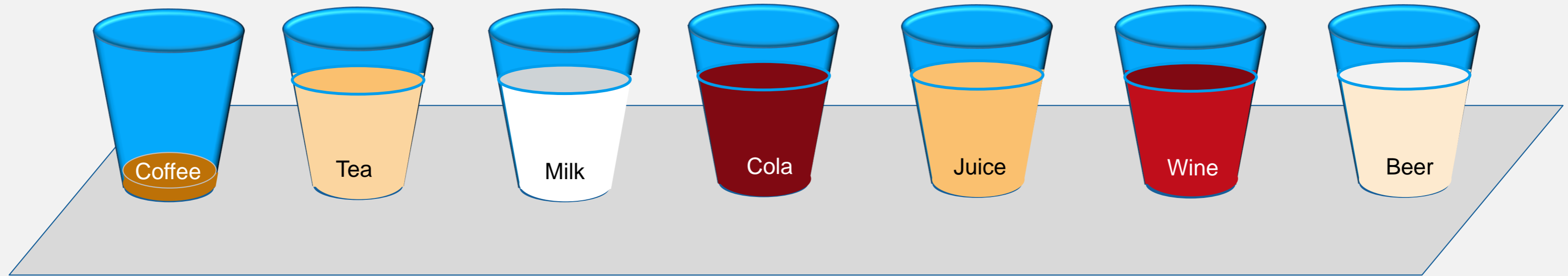
Proportional Abundances



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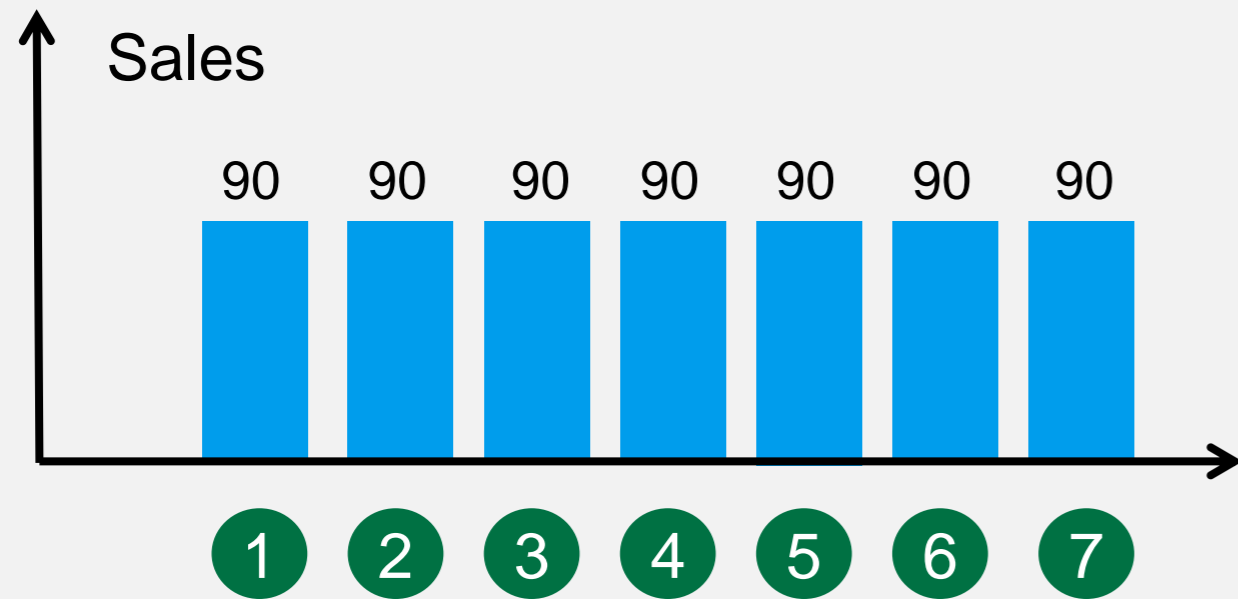
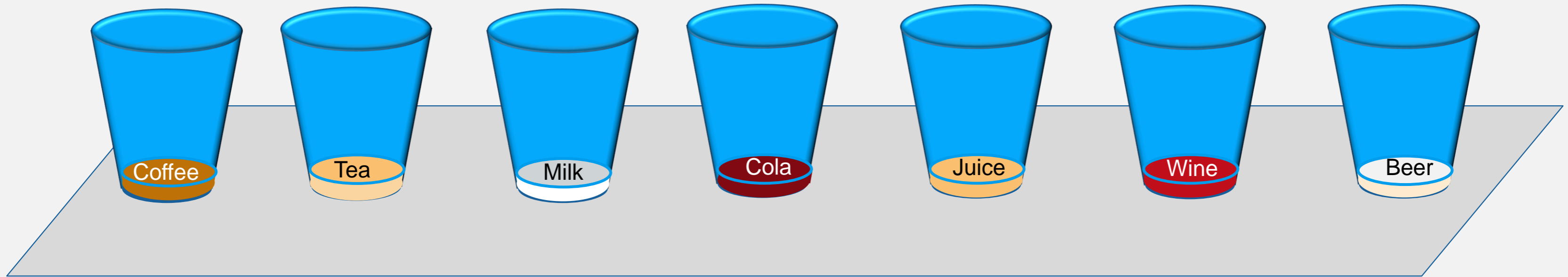
Proportional Abundances p_i

Proportional Abundances

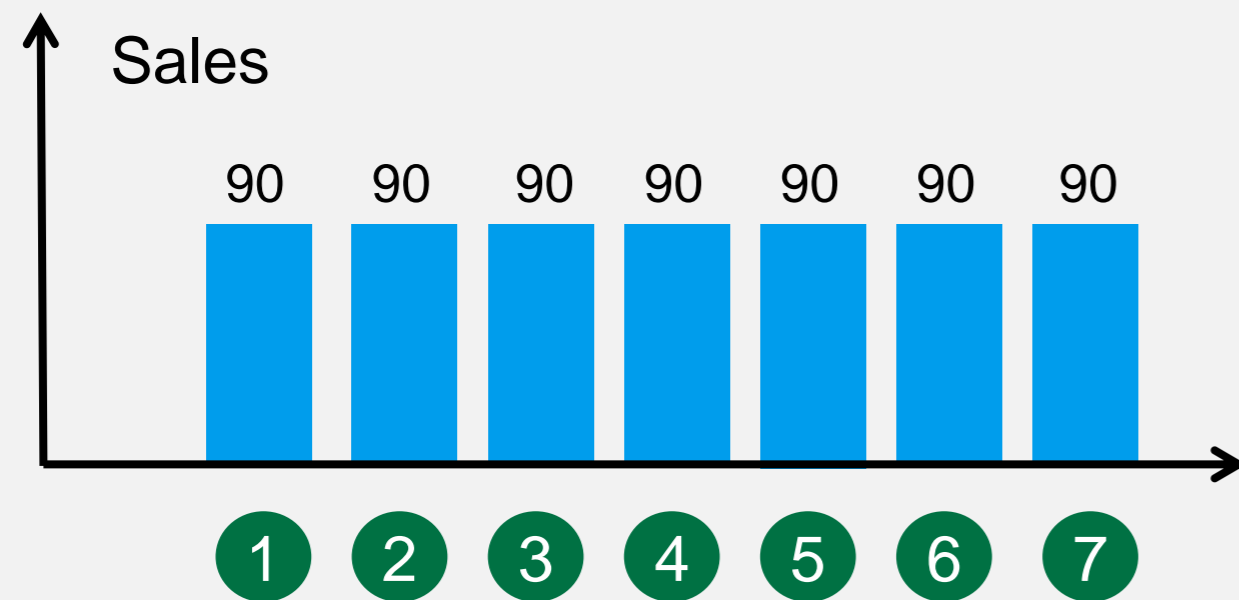
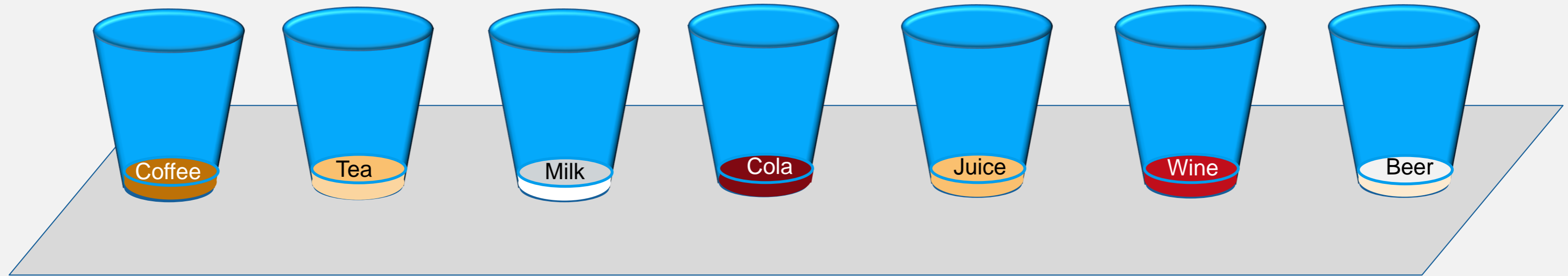


Proportional Abundances p_i

Proportional Abundances



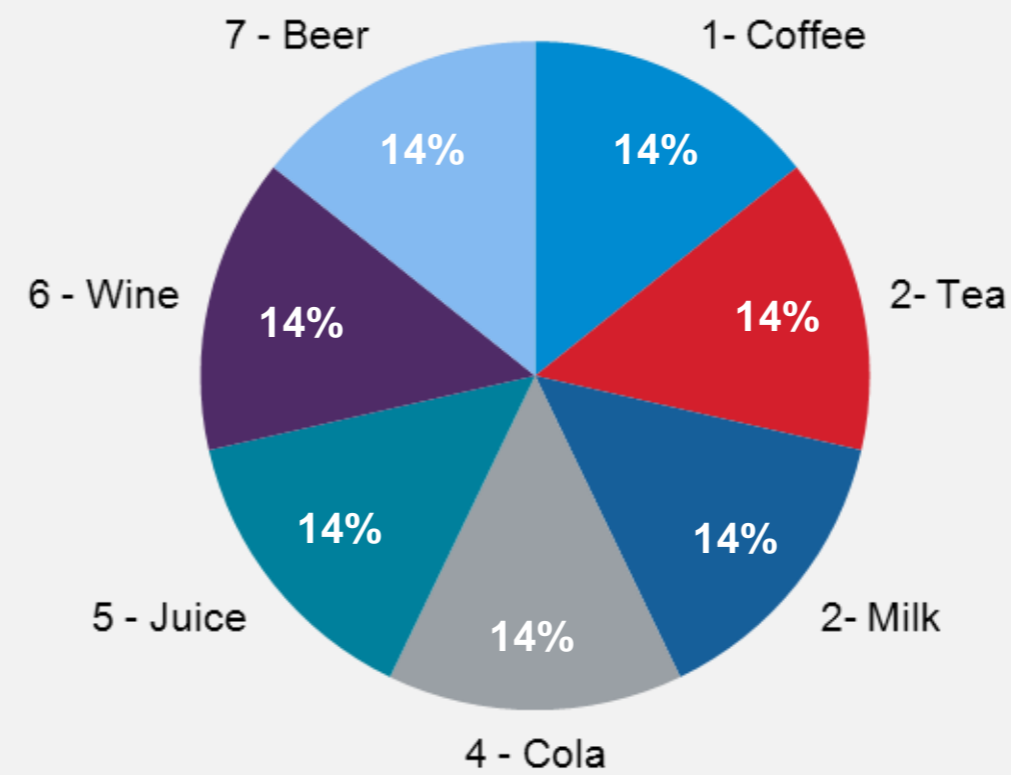
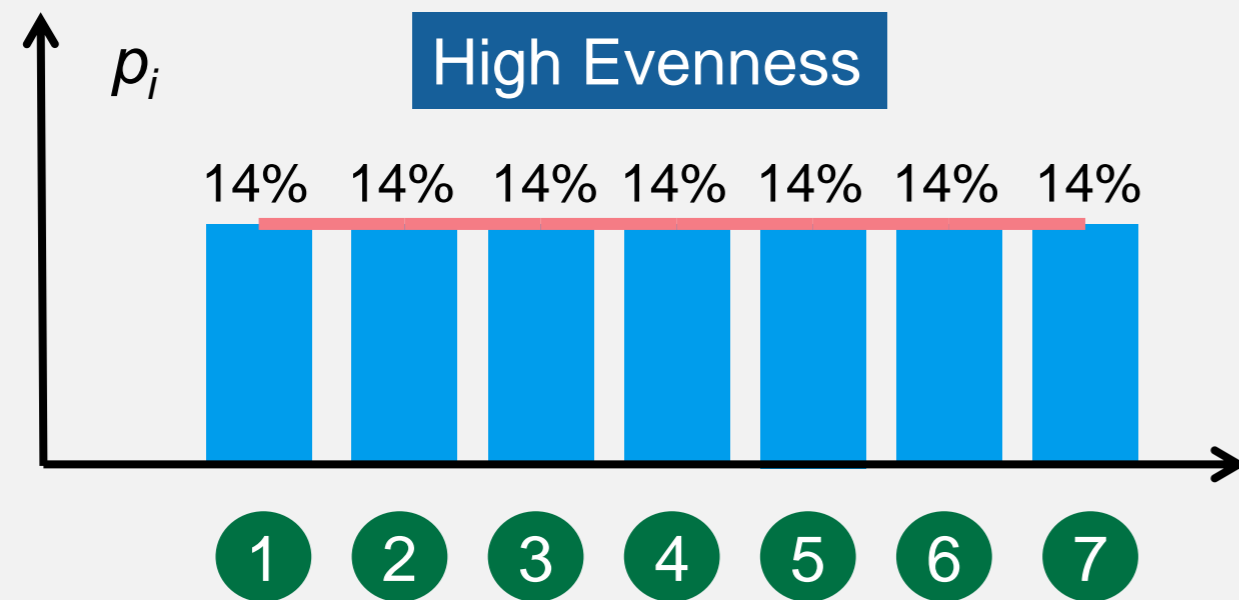
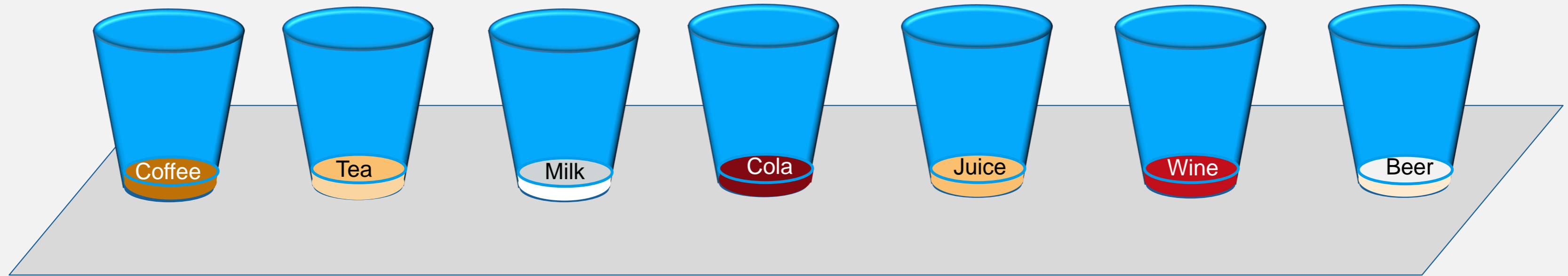
Proportional Abundances



Type	Sales	Proportional
Coffee	90	14%
Tea	90	14%
Milk	90	14%
Cola	90	14%
Juice	90	14%
Wine	90	14%
Beer	90	14%
Total	630	100%

Proportional Abundances p_i

Proportional Abundances



Proportional Abundances p_i

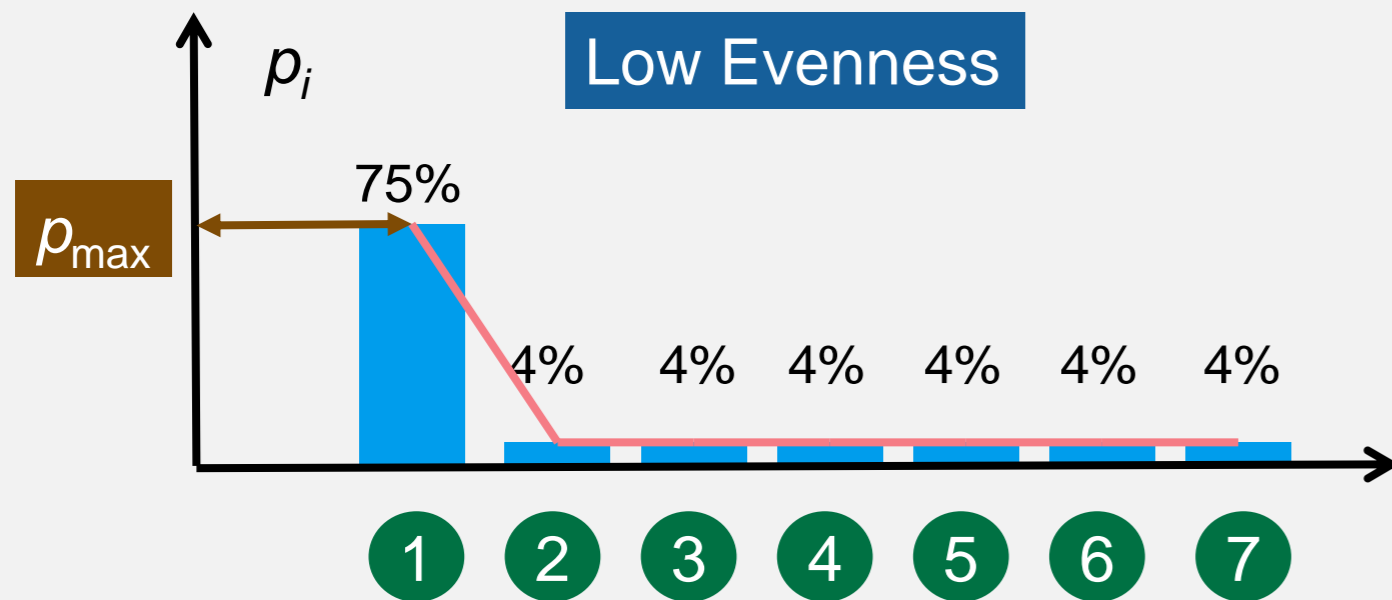
Diversity $D = 1/p_{\max}$

We could measure Diversity by simply calculating the inverse of the maximum proportional abundance:

$p_{\max} = 75\%$

$D = 1/75\% = 1.3$

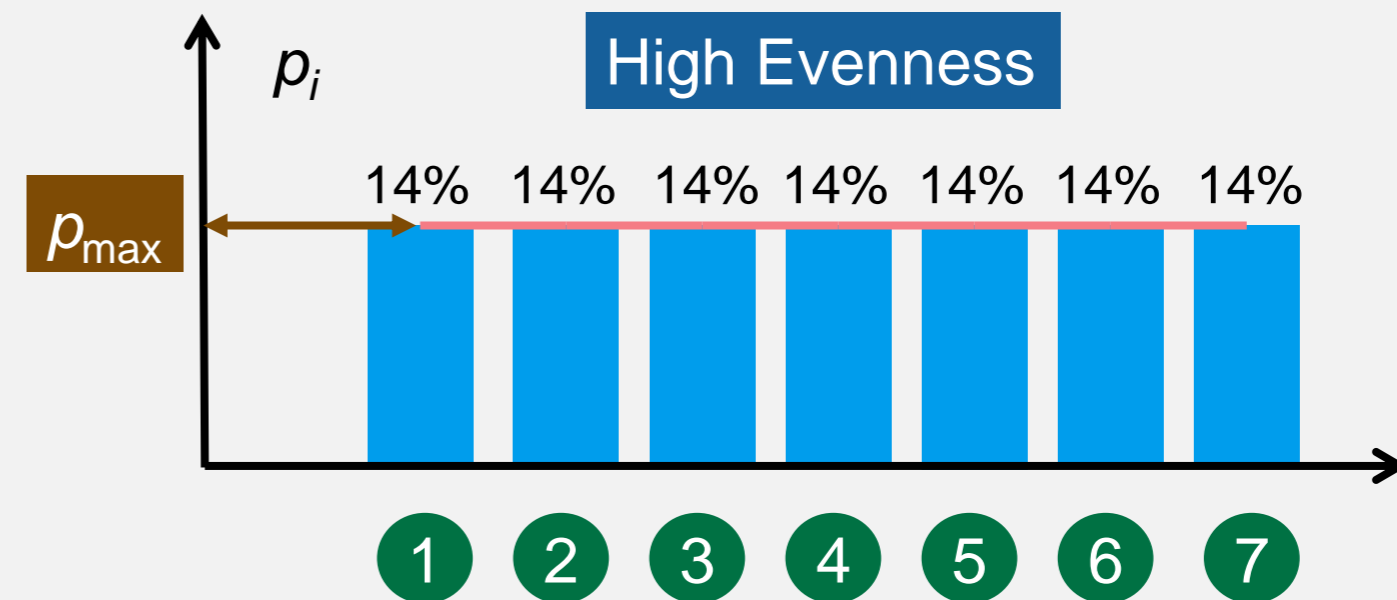
We are effectively selling in 1.3 categories



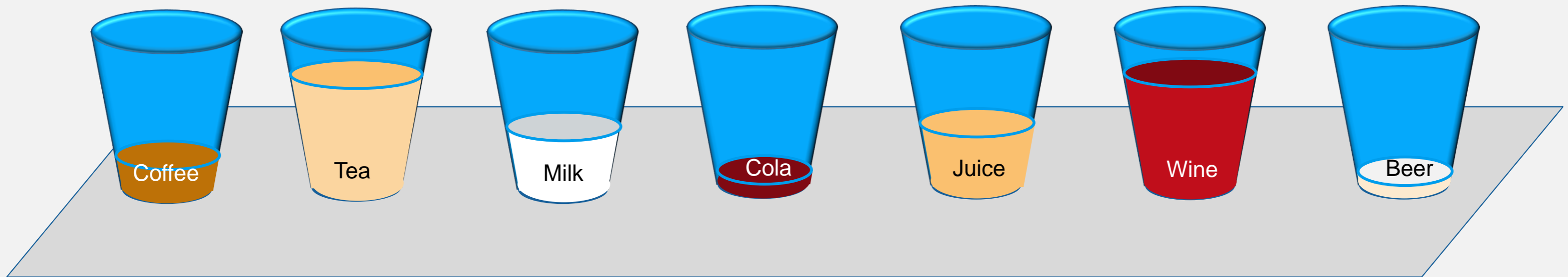
$p_{\max} = 14\%$

$D = 1/14.3\% = 7$

We are effectively selling in all 7 categories



Diversity

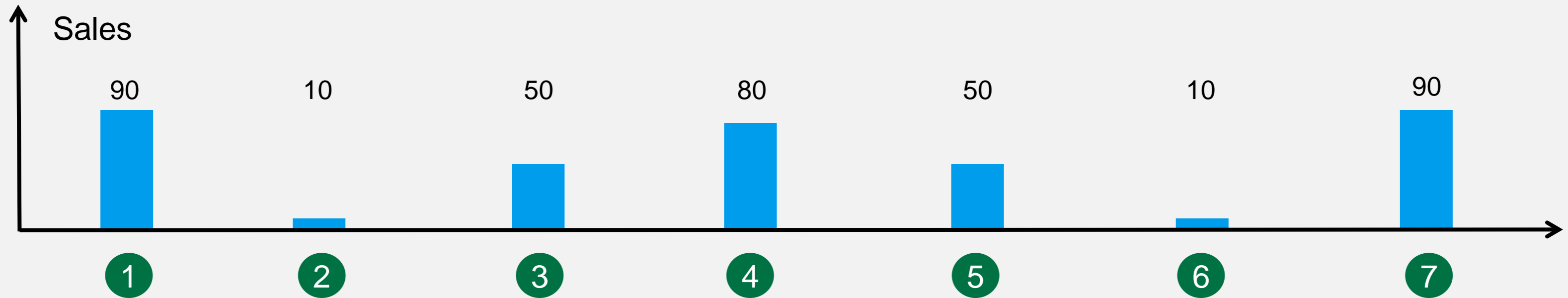
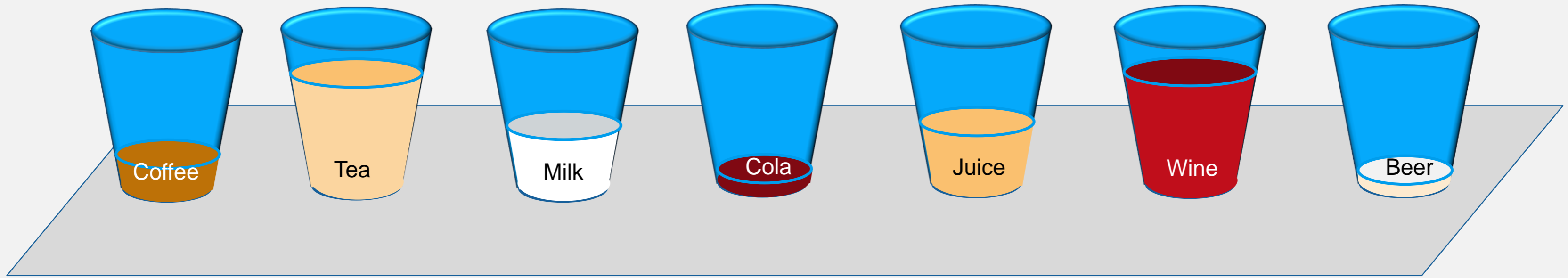


To measure True Diversity, *i.e.* the effective number of types, we need to take into account

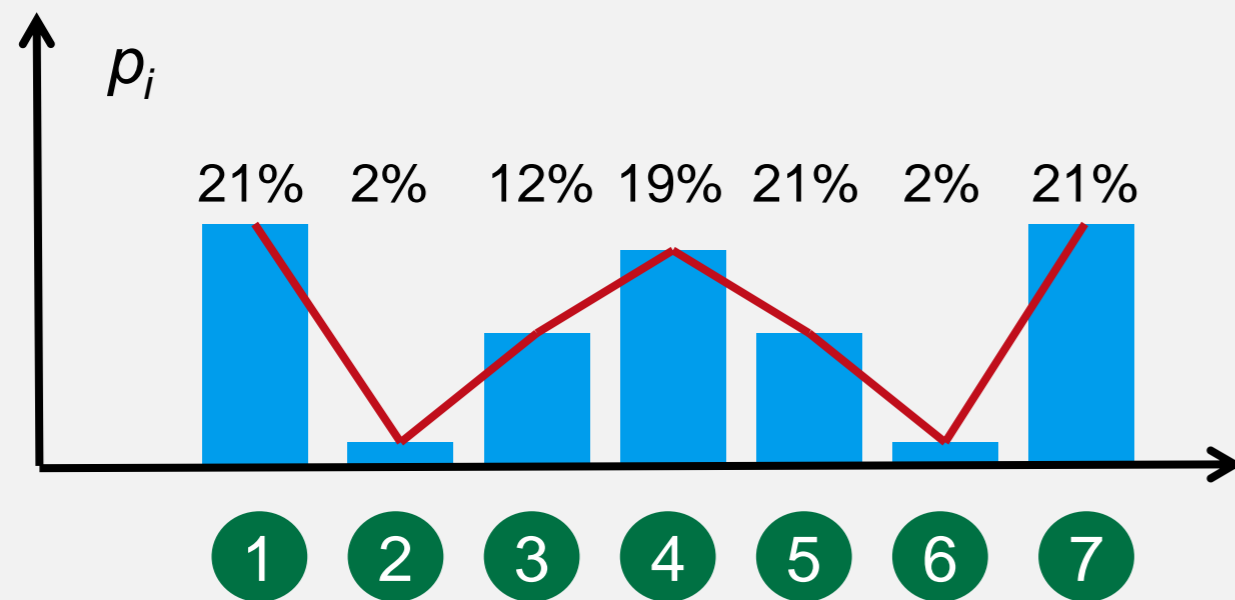
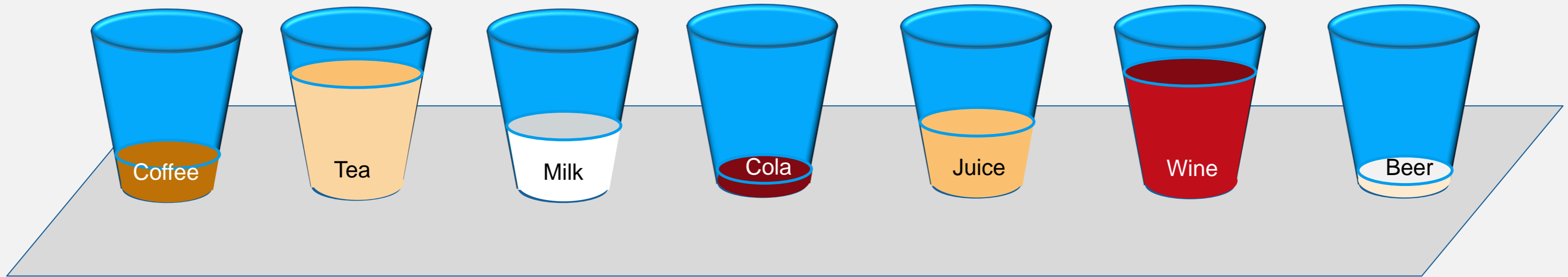
1 **Richness**
total number of types or categories

2 **Evenness**
how the actual numbers are distributed among the types or categories

Diversity



Diversity Index



Type	Sales	p_i	p_i^2
Coffee	90	21%	4.6%
Tea	10	2%	0.1%
Milk	50	12%	1.4%
Cola	80	19%	3.6%
Juice	90	21%	4.6%
Wine	10	2%	0.1%
Beer	90	21%	4.6%
Total	630	100%	18.9%

Simpson Diversity Index

We introduce the **Simpson index** λ as the square sum (SUMSQ) of proportional abundances p_i :

$$\lambda = \sum_{i=1}^R p_i \cdot p_i$$

$$\lambda = \text{SUMSQ}(p_i) = 18.9\%$$

The maximum of the **Simpson index** λ is reached for equal abundances, and it is the inverse of Richness R :

$$p_i = \frac{1}{R} \quad \lambda_{\max} = \sum_{i=1}^R \frac{1}{R^2} = \frac{1}{R}$$

$$\lambda_{\max} = 1/7 = 14.3\%$$

Type	Sales	p_i	p_i^2
Coffee	90	21%	4.6%
Tea	10	2%	0.1%
Milk	50	12%	1.4%
Cola	80	19%	3.6%
Juice	90	21%	4.6%
Wine	10	2%	0.1%
Beer	90	21%	4.6%
Total	630	100%	18.9%

Simpson Diversity Index

We use the **complement of the Simpson Index**
 $1 - \lambda$ as KPI to measure Market Diversity

$$1 - \lambda = 1 - \sum_{i=1}^R p_i \cdot p_i$$

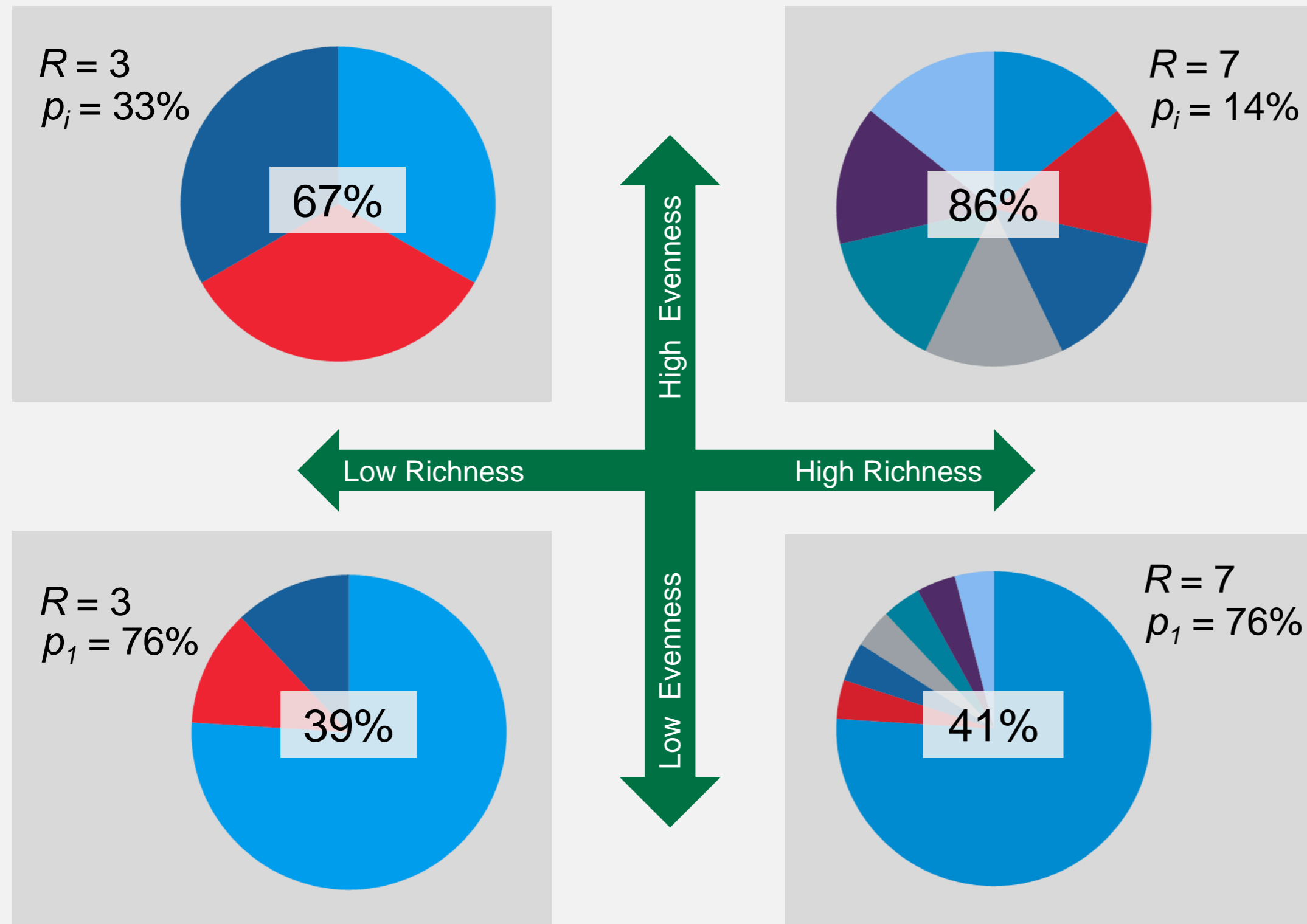
KPI

$$1 - \lambda = 1 - 18.9\% = 81.1\%$$

$$1 - \lambda_{\max} = 1 - 1/7 = 85.7\%$$

Type	Sales	p_i	p_i^2
Coffee	90	21%	4.6%
Tea	10	2%	0.1%
Milk	50	12%	1.4%
Cola	80	19%	3.6%
Juice	90	21%	4.6%
Wine	10	2%	0.1%
Beer	90	21%	4.6%
Total	630	100%	18.9%

Simpson Diversity Index $1-\lambda$



Diversity Index as KPI The Simpson Index



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Simpson Index

We use the complement of the Simpson Index $1 - \lambda$ as KPI to measure Market Diversity

$$1 - \lambda = 1 - \sum_{i=1}^R p_i \cdot p_i$$

General Formulation of True Diversity

for $q \neq 0$

$${}^qD = \left(\sum_{i=1}^R p_i^q \right)^{1/(1-q)}$$

for $q = 0$

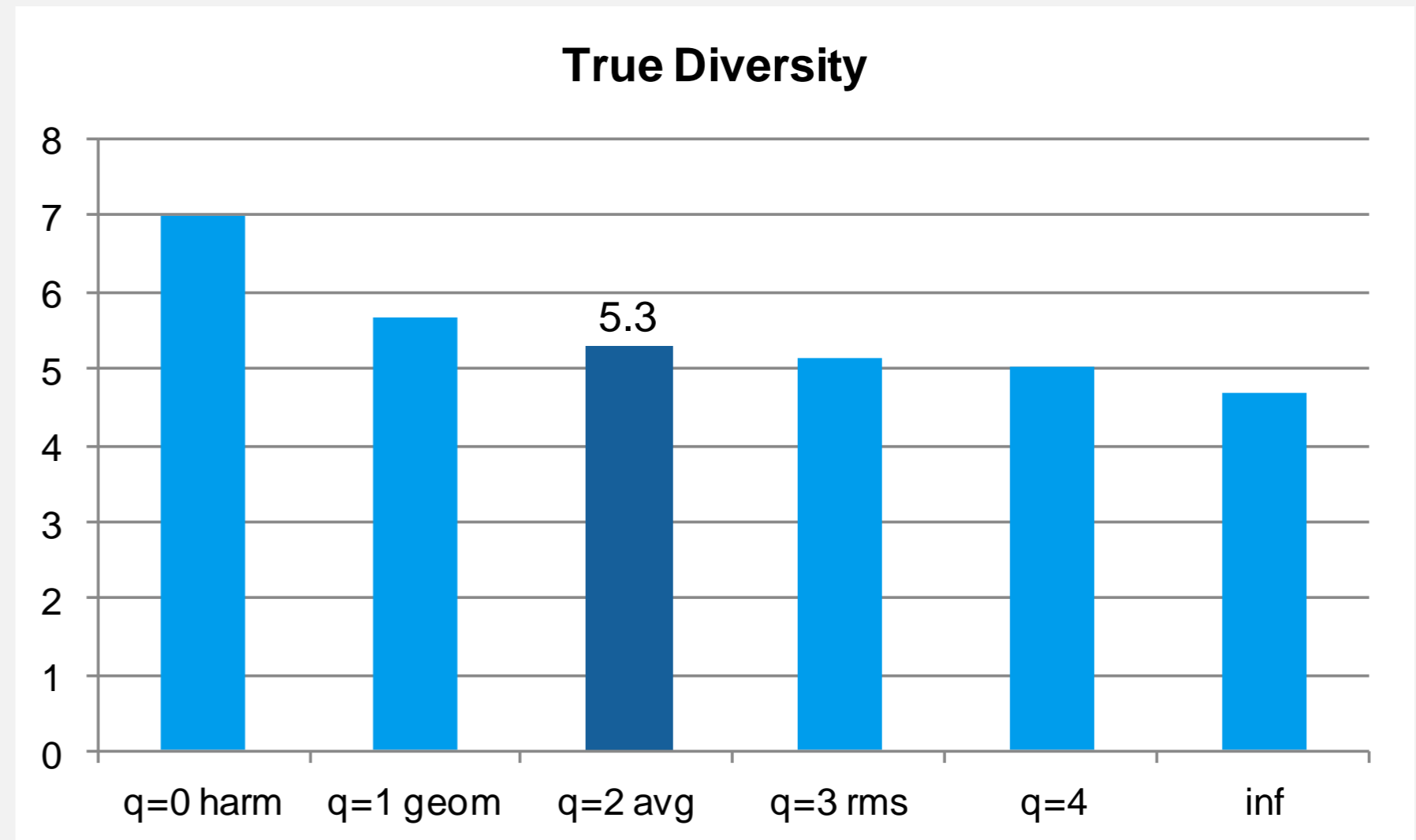
$${}^1D = \left(\prod_{i=1}^R p_i^{p_i} \right)^{-1}$$

The inverse of the **Simpson Index** $1/\lambda$ describes the true diversity of order 2

$${}^2D = 1/\lambda$$

$${}^2D = 1/\lambda = 5.3$$

We are effectively selling in 5.3 categories



$q = 0$

$q = 2$

$q = \infty$

$${}^0D = R$$

$${}^2D = 1/\lambda$$

$${}^\infty D = 1/p_{\max}$$

Richness only

Richness AND Abundance

Abundance only

Summary

Diversification is a possibility to spread and reduce potential business risks

Important terms to describe diversity are richness, abundance and evenness

We introduced the Simpson index λ and its complement $(1 - \lambda)$ as a KPI to assess market diversity.

This index takes into account richness – for example the number of product categories – and their evenness of distribution in the markets.

Diversity Index as KPI The Simpson Index



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Summary

Diversification is a possibility to spread and reduce potential business risks

Important terms to describe diversity are richness, abundance and evenness

We introduced the Simpson index λ and its complement $(1 - \lambda)$ as a KPI to assess market diversity.

This index takes into account richness and evenness

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The Simpson Index



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