

The Concept of Diversity

# Diversity Index as Business KPI The Concept of Diversity

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bpmsg.com

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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

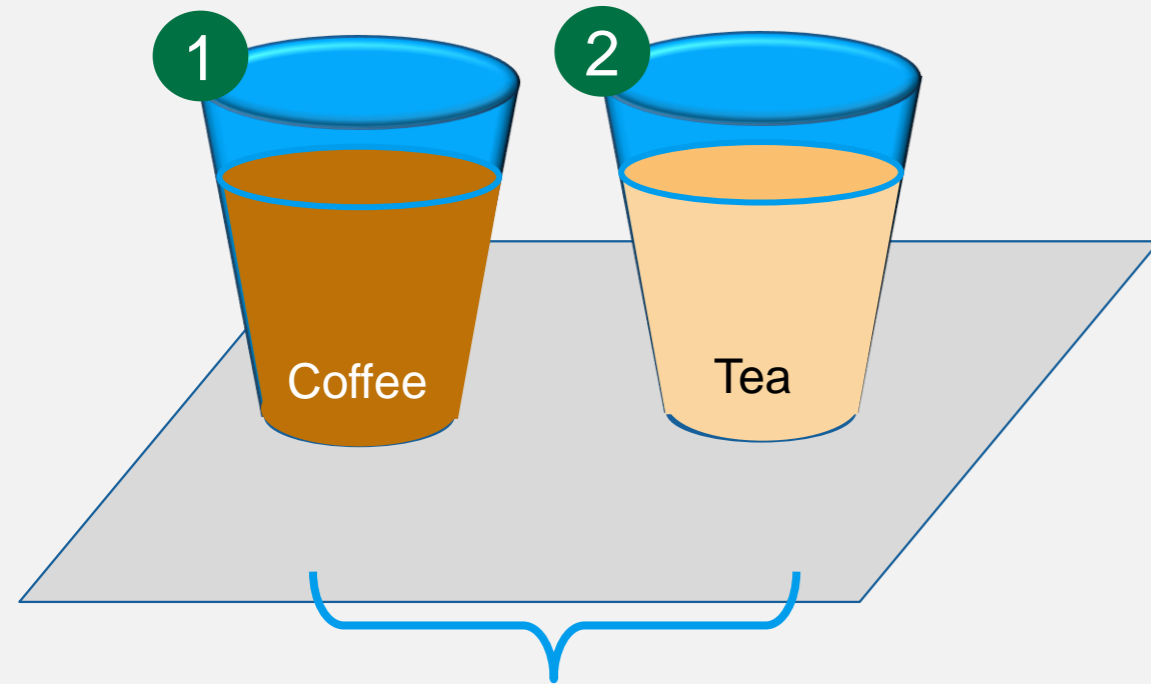


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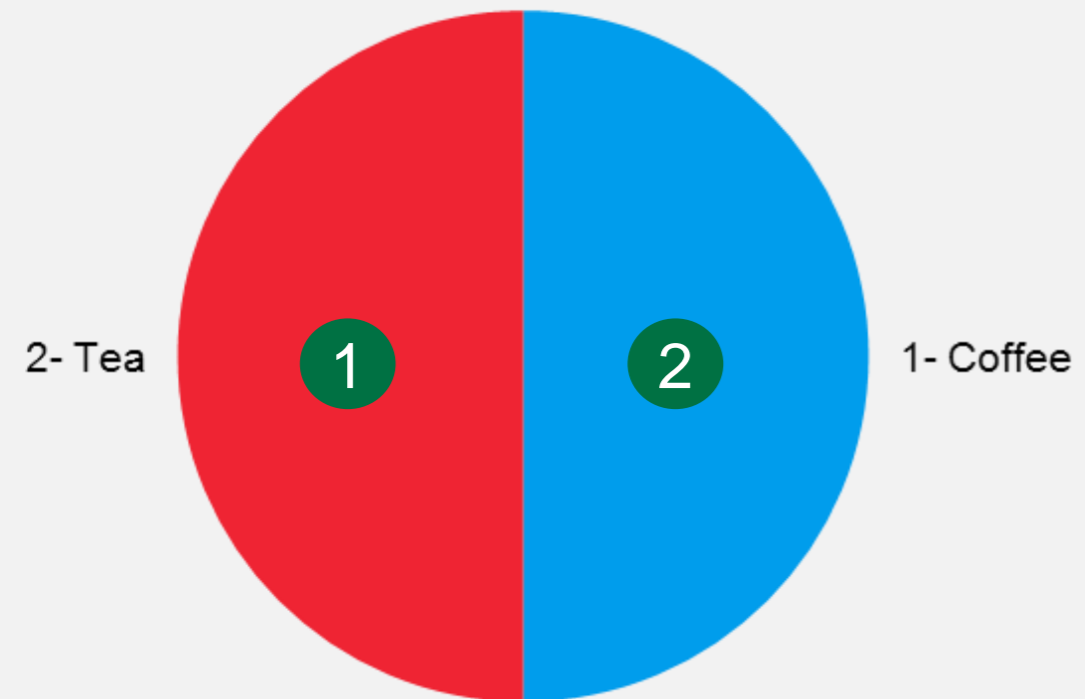
#### Diversity

- Richness
- Abundance
- Evenness

# Richness



Richness: Tea or Coffee  $R = 2$

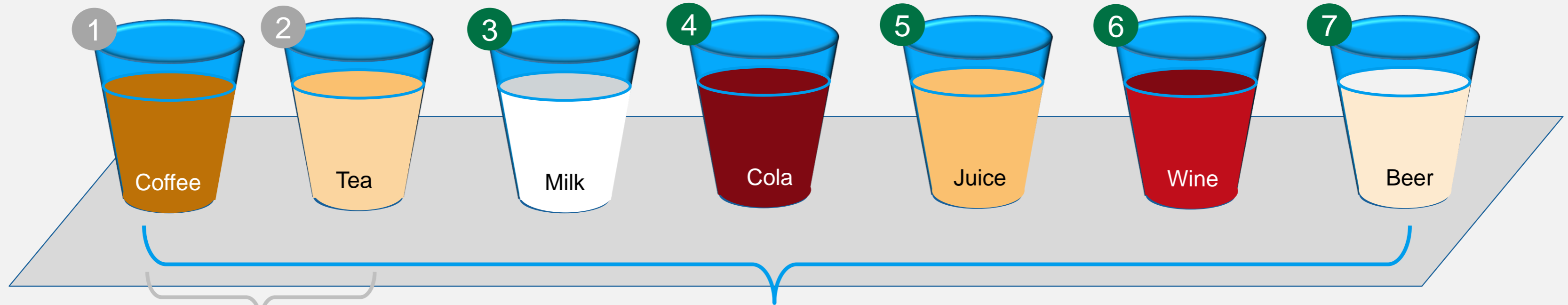


## Diversity Index as KPI The Simpson Index



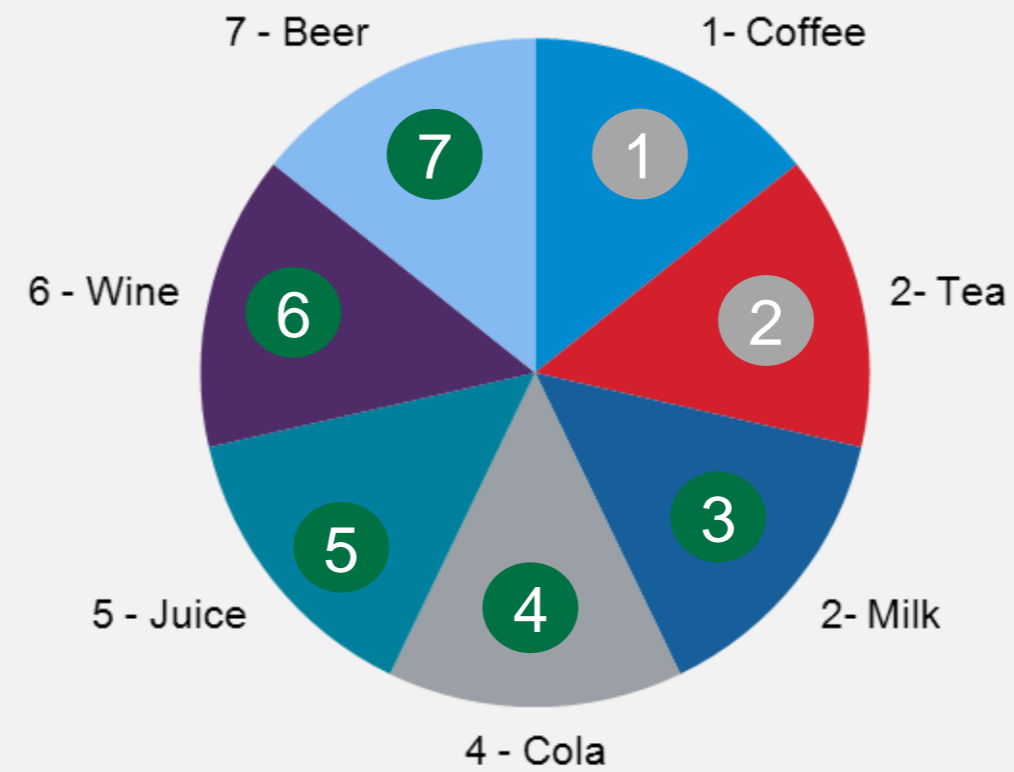
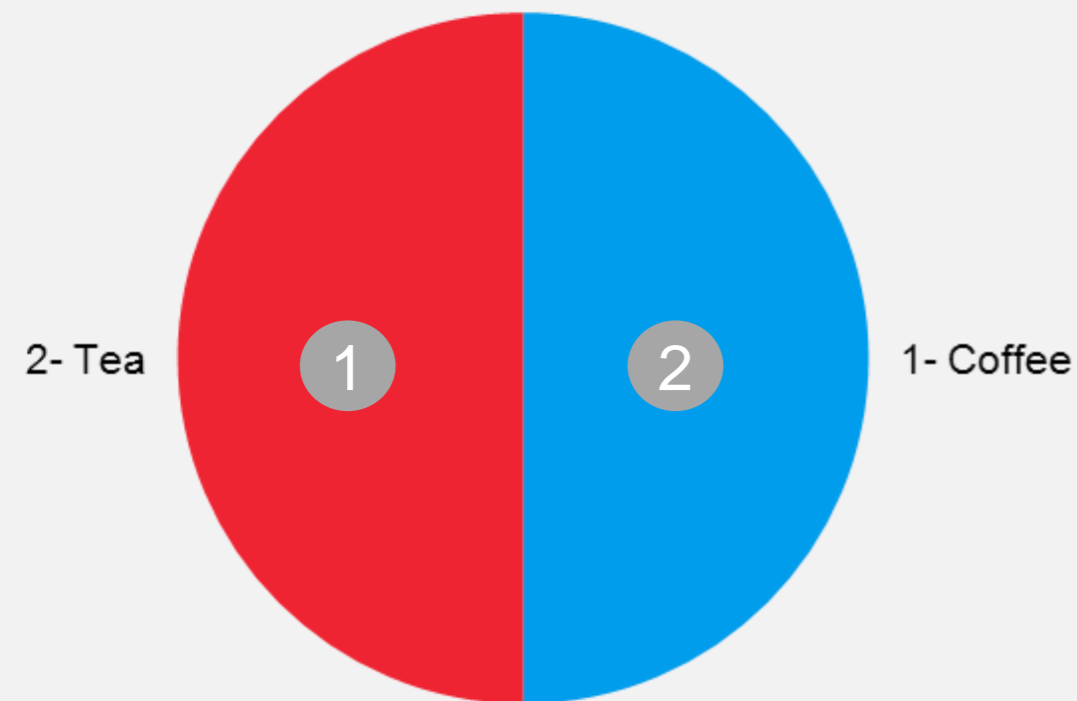
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# Richness

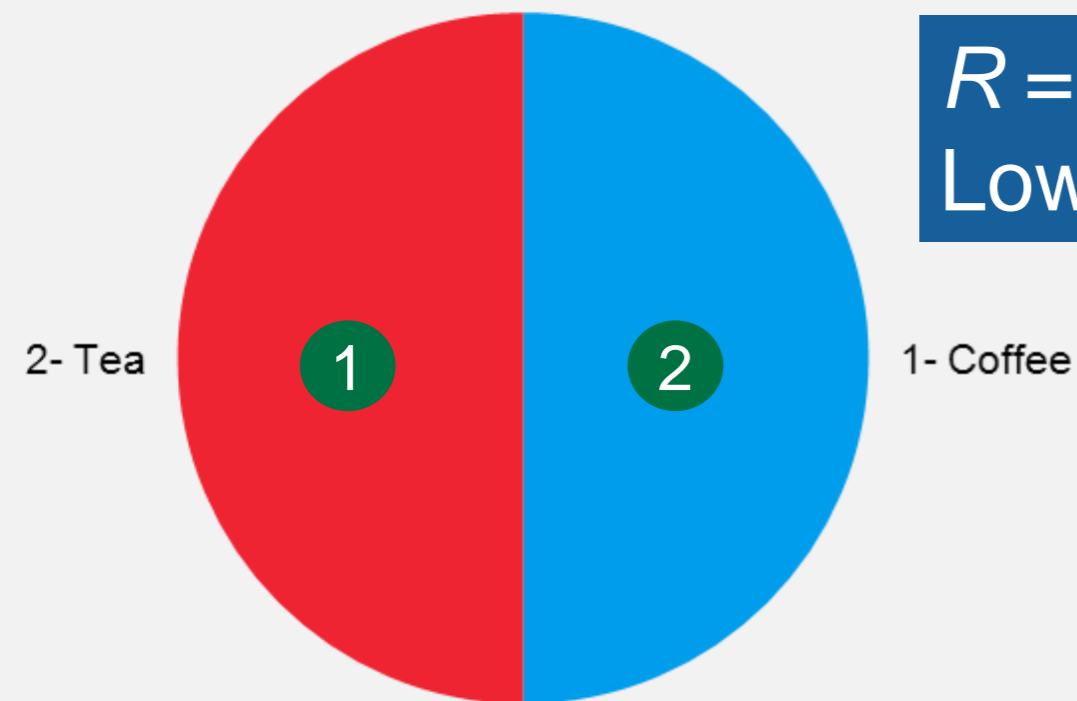
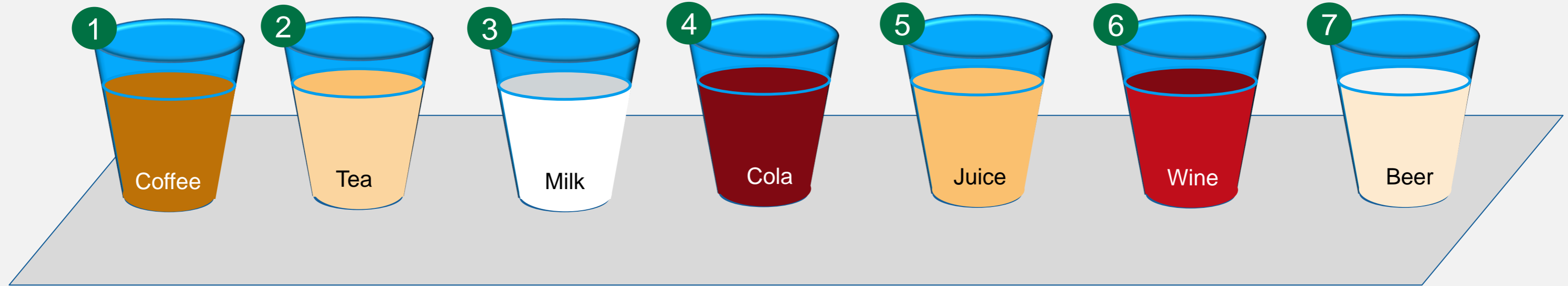


Richness: Tea or Coffee = 2

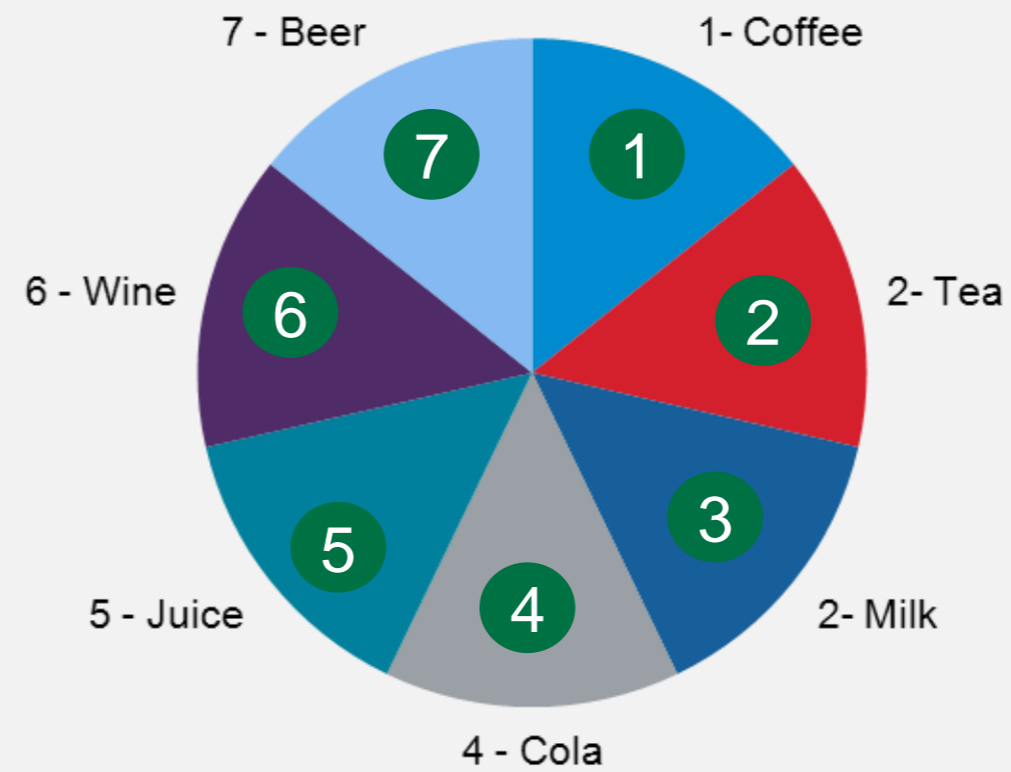
**Richness:** Tea, Coffee, Cola, Milk Juice, Wine Beer  $R = 7$



# Richness

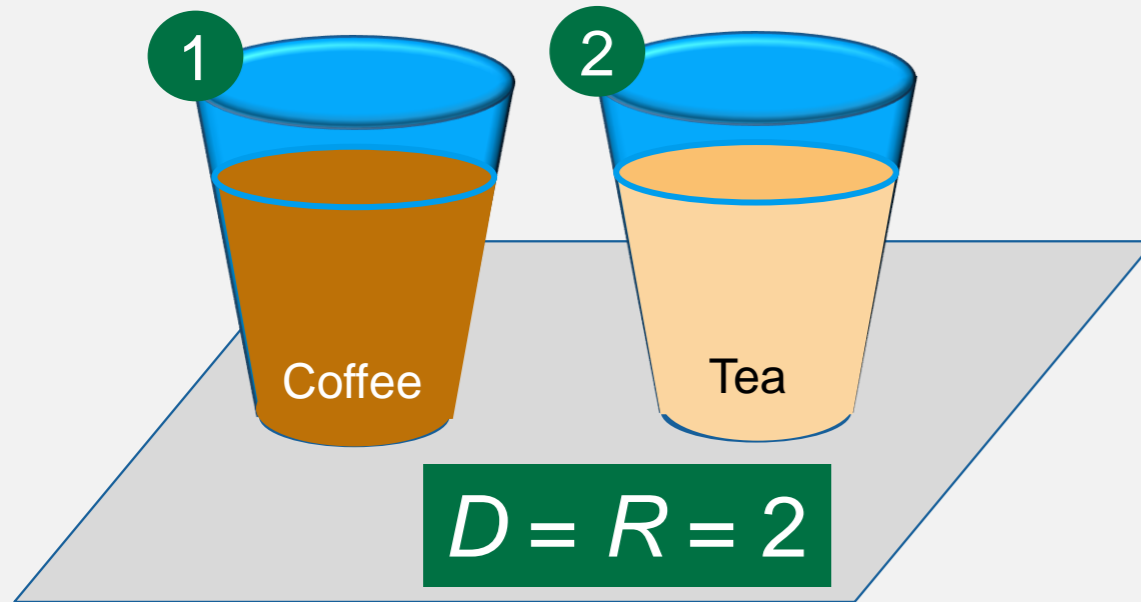


$R = 2$   
Low Richness



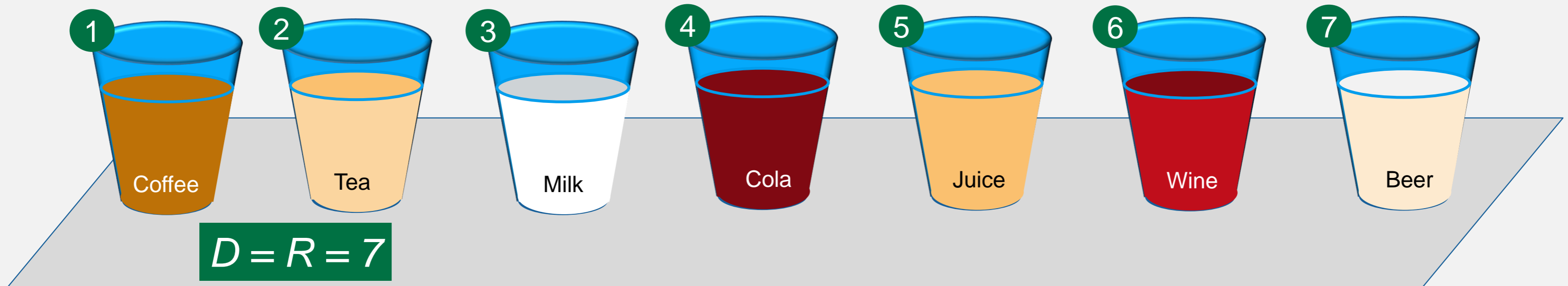
$R = 7$   
Higher Richness

# Diversity $D =$ Richness $R$

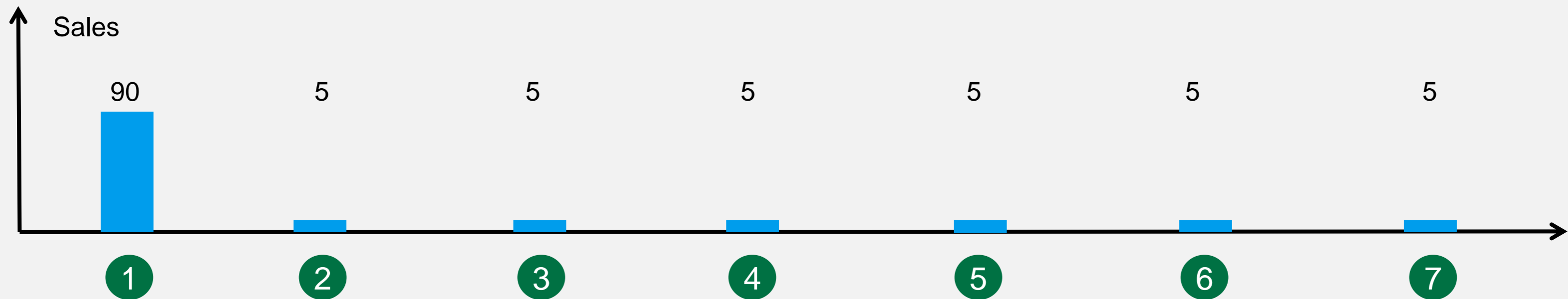
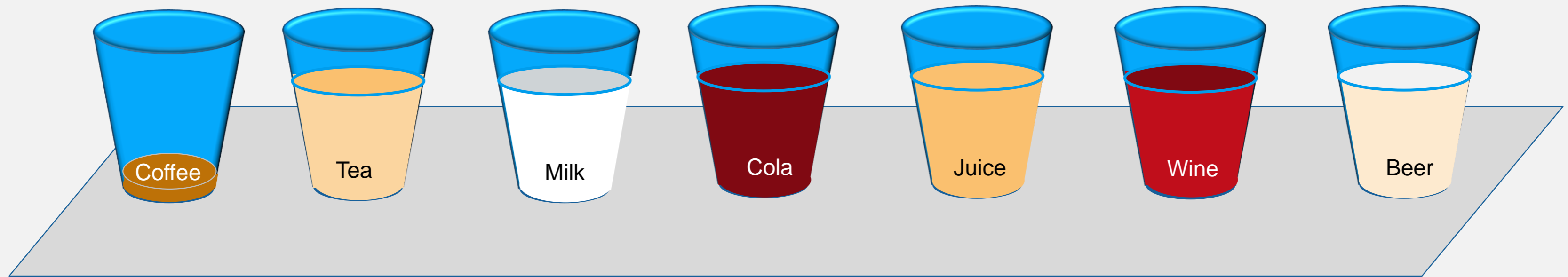


We could measure Diversity by simply **counting the number of types** or categories

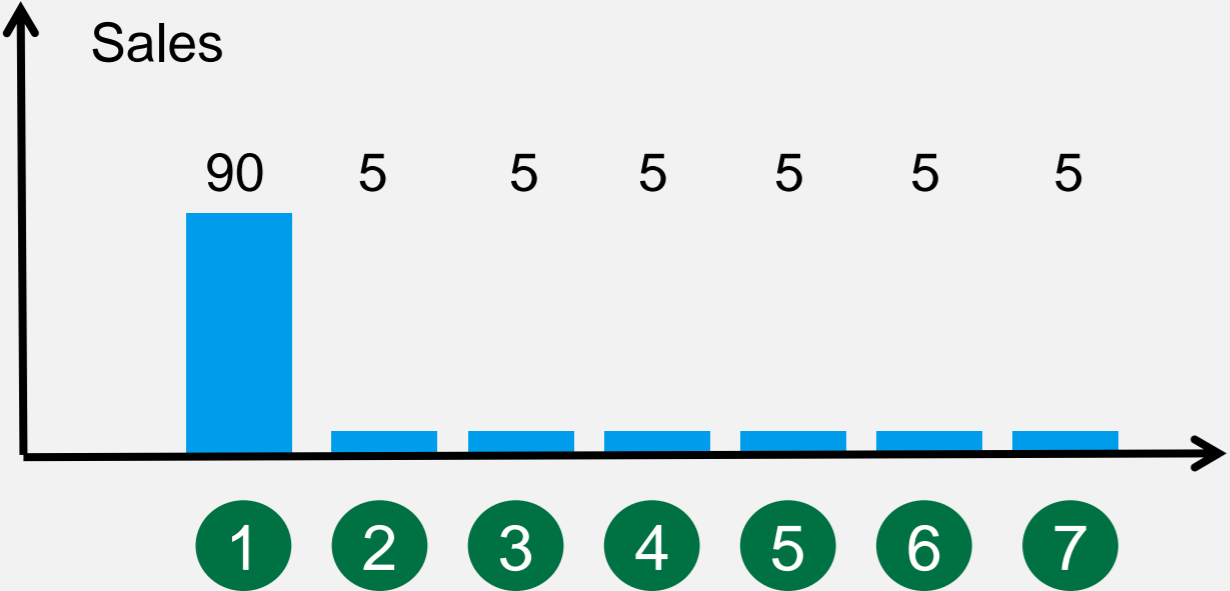
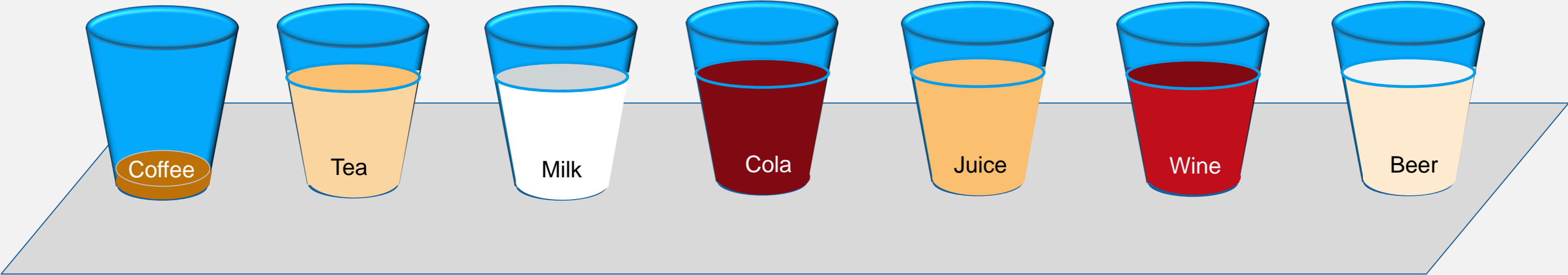
Richness has been a popular diversity index in ecology. It simply quantifies how many different types the dataset of interest contain



# Proportional Abundances

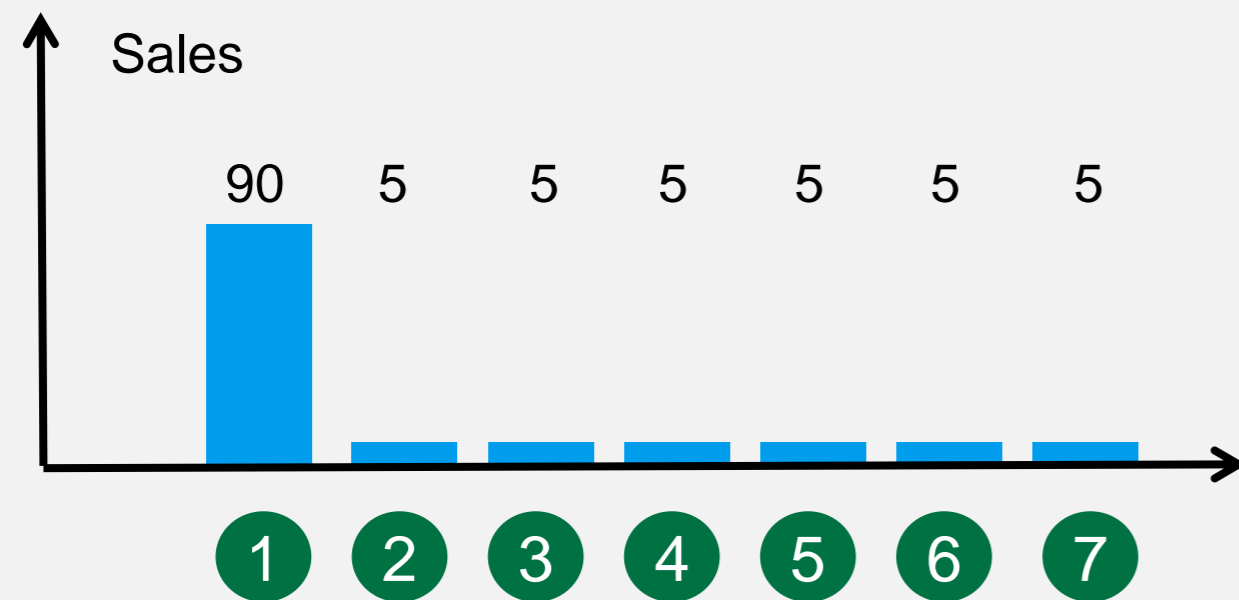
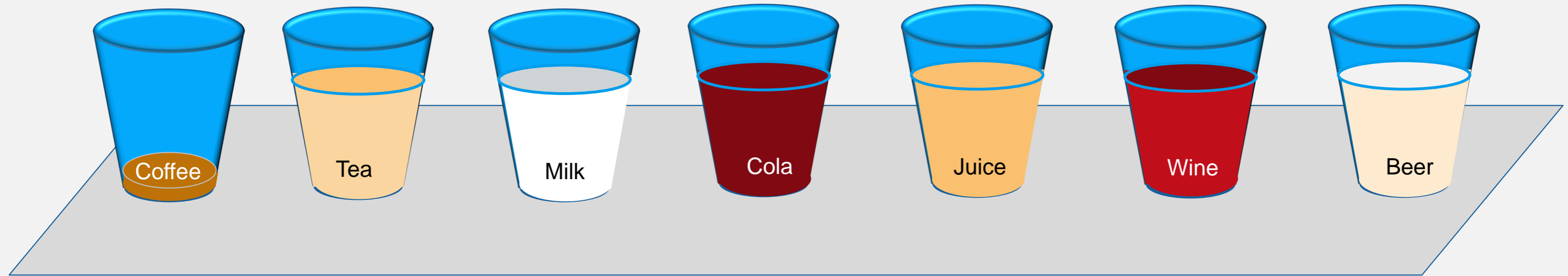


# Proportional Abundances





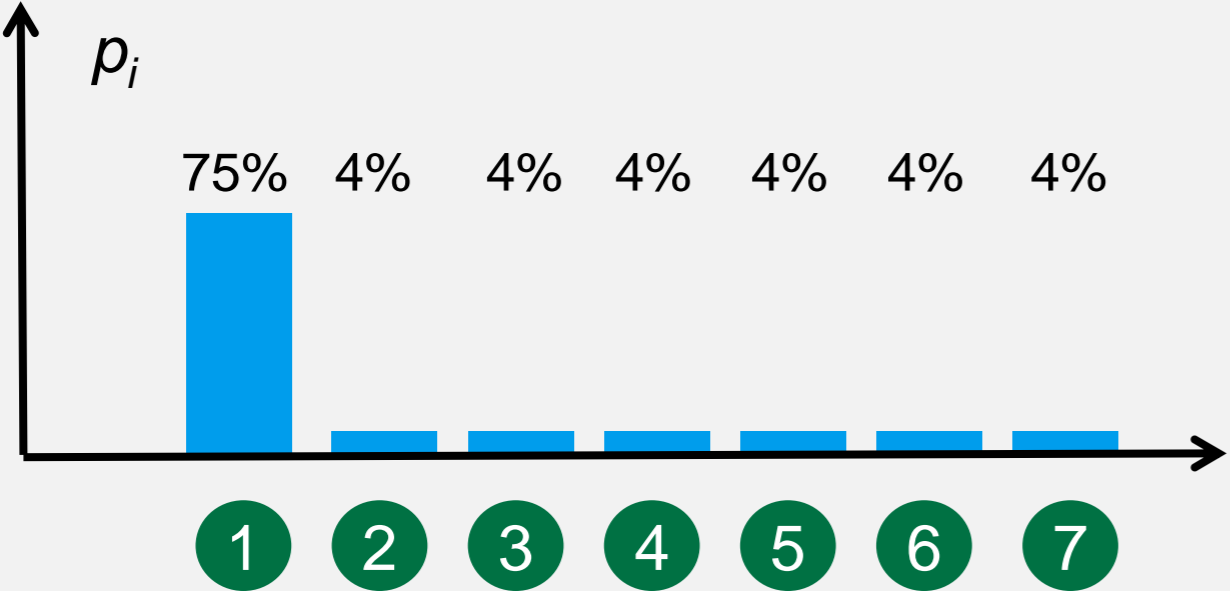
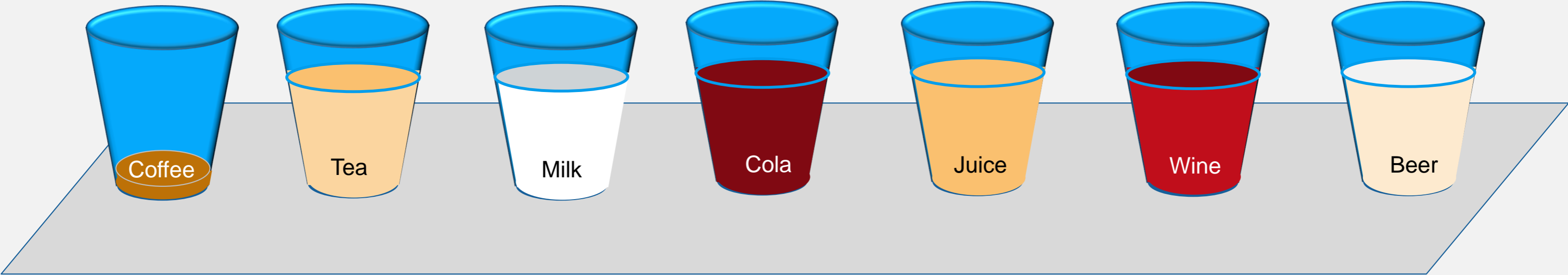
# Proportional Abundances



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  $p_i$

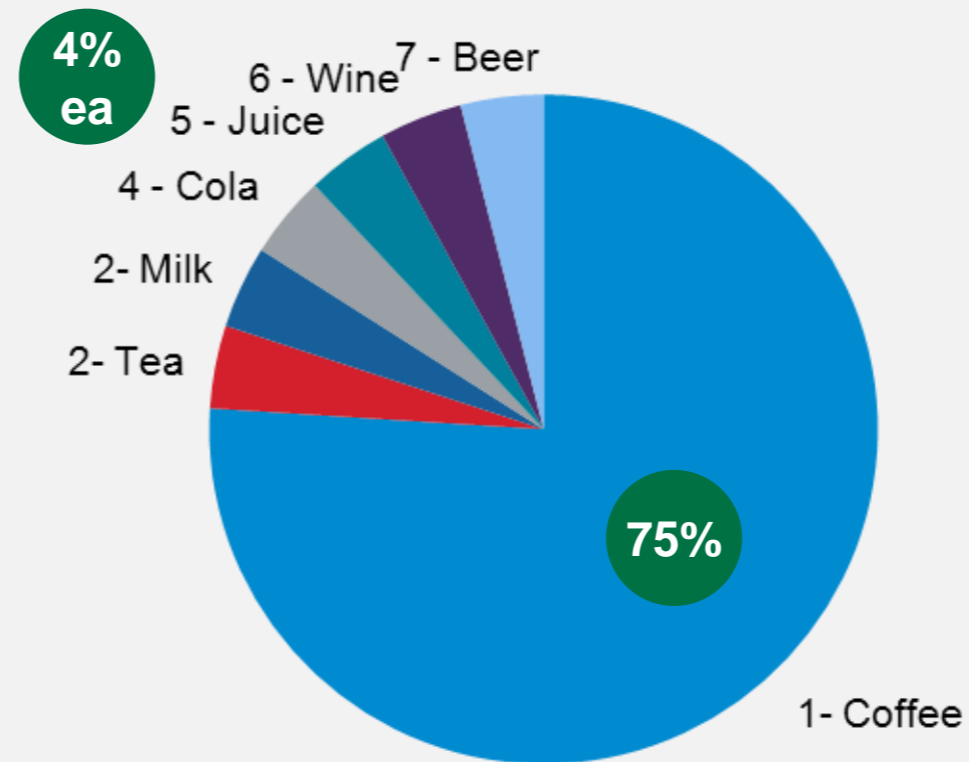
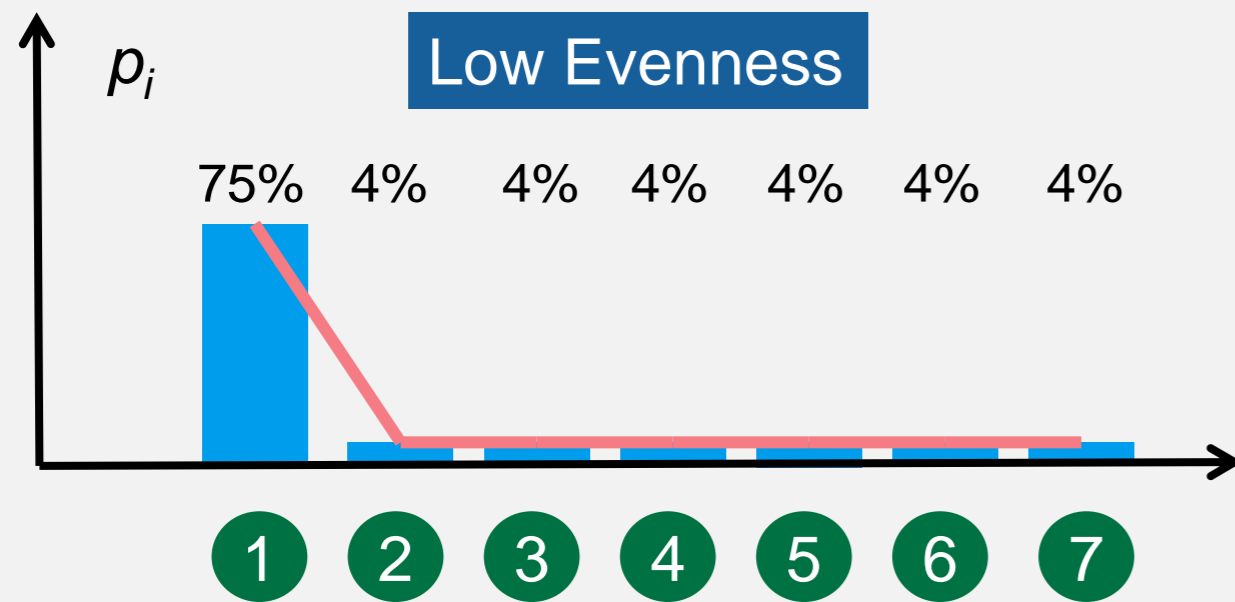
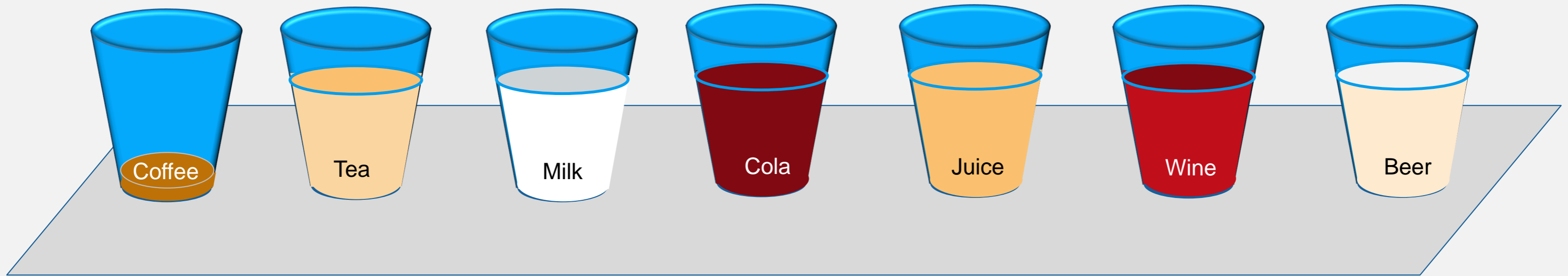
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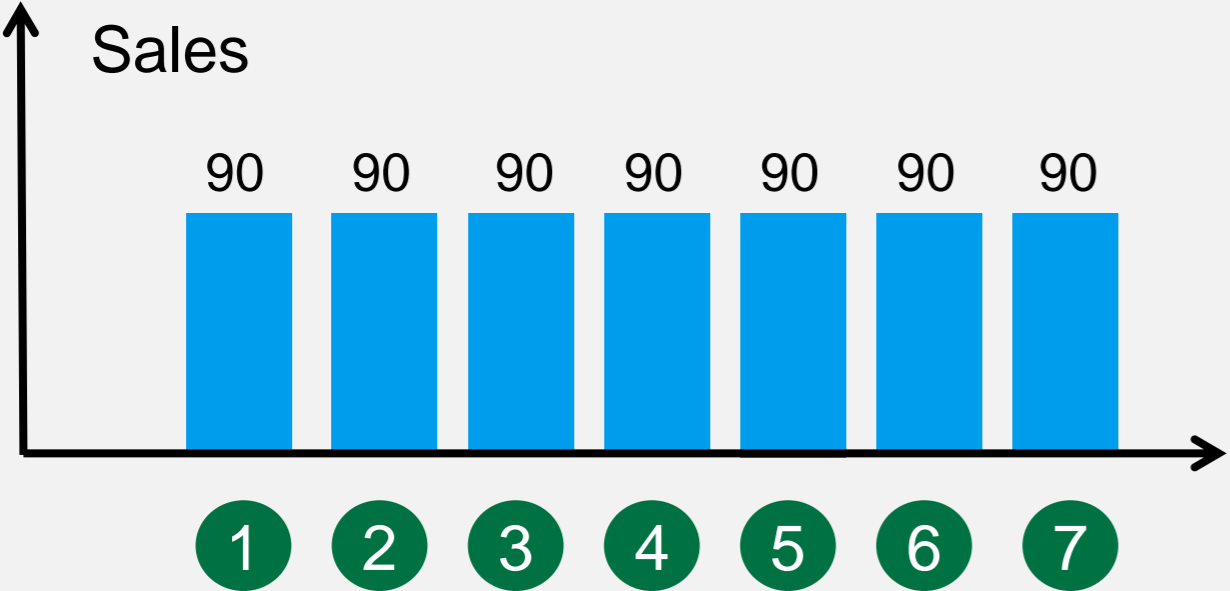
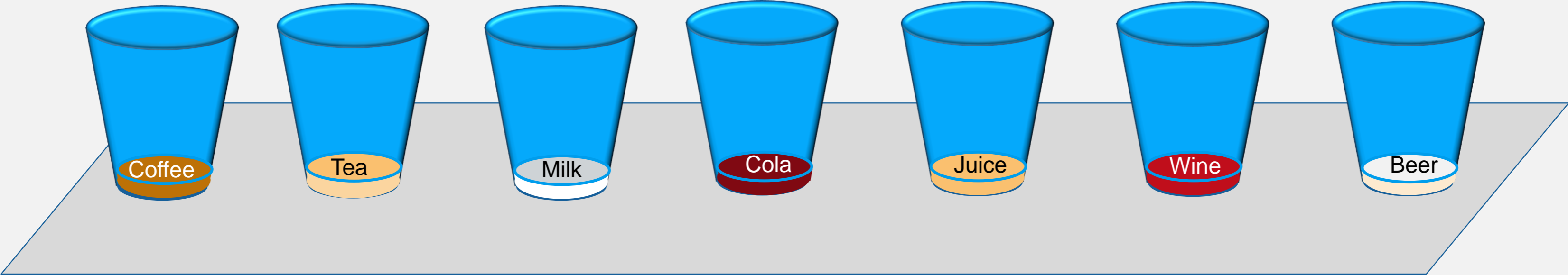
Proportional Abundances  $p_i$

# Proportional Abundances

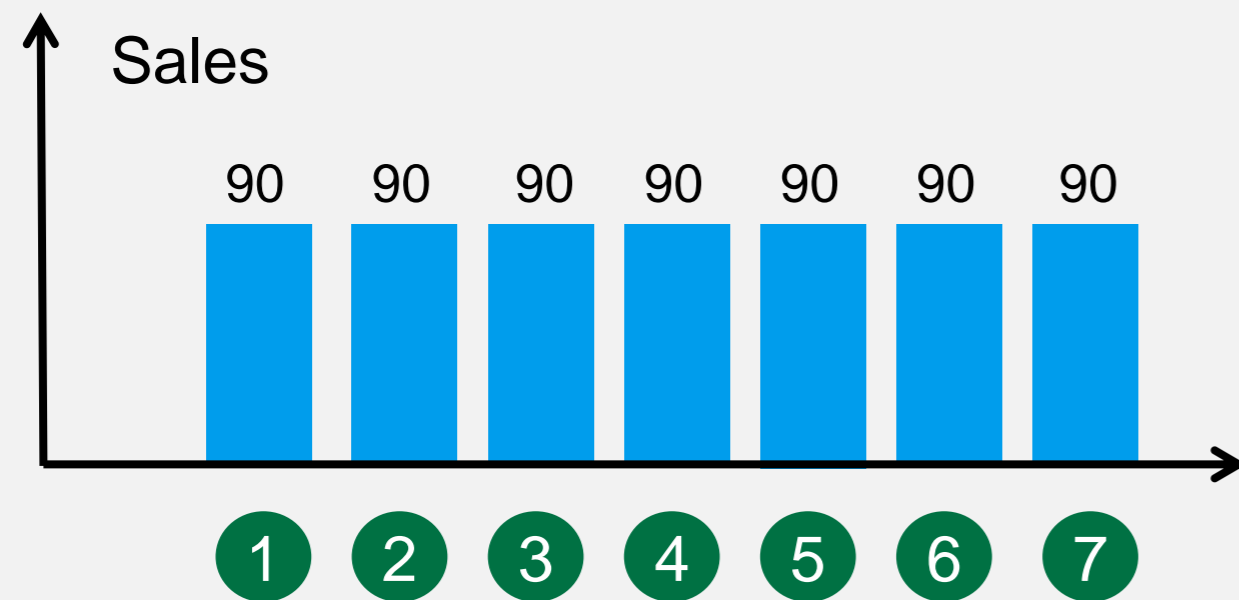
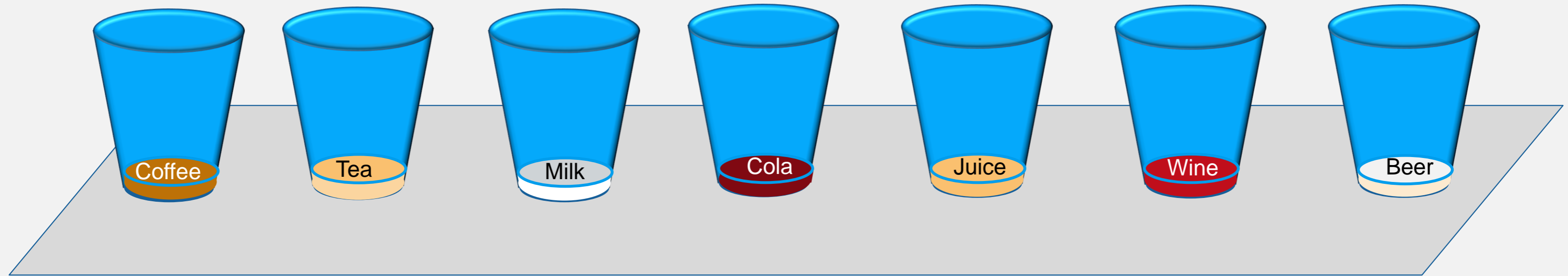


Proportional Abundances  $p_i$

# Proportional Abundances



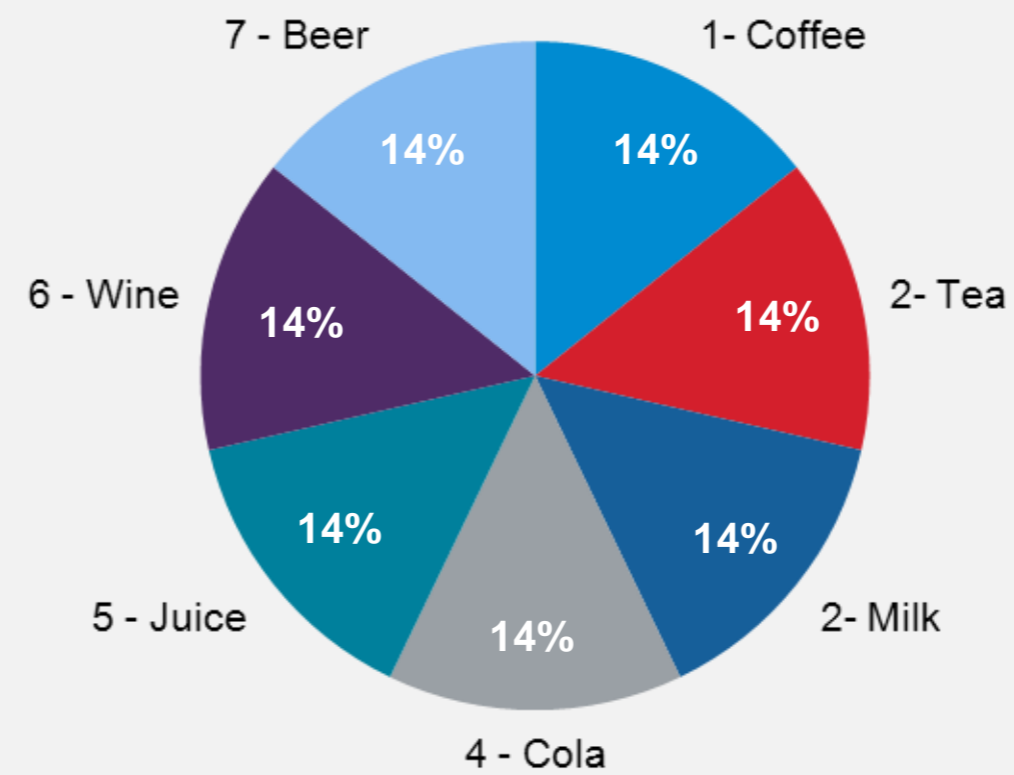
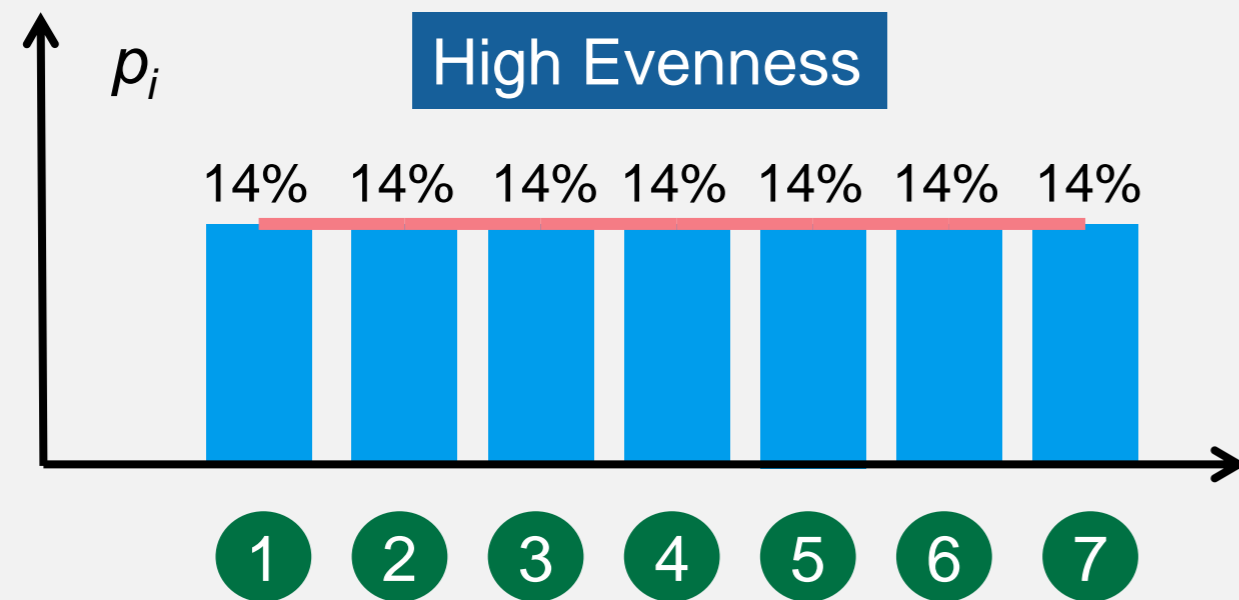
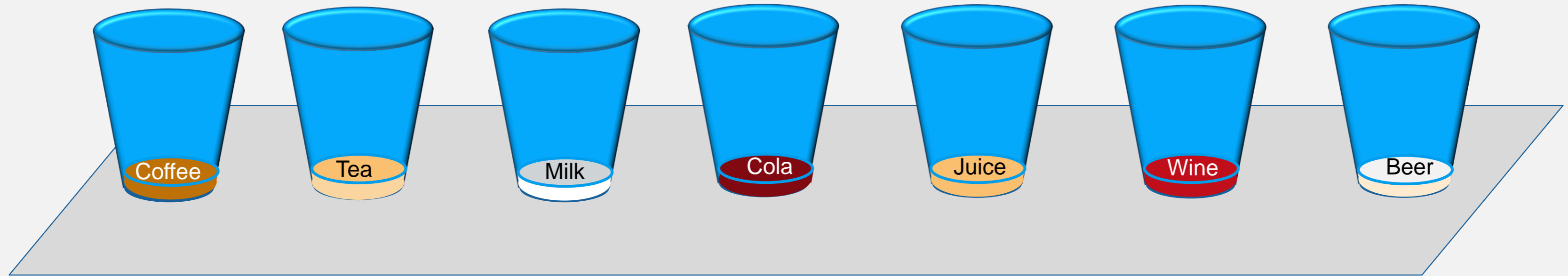
# Proportional Abundances



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  $p_i$

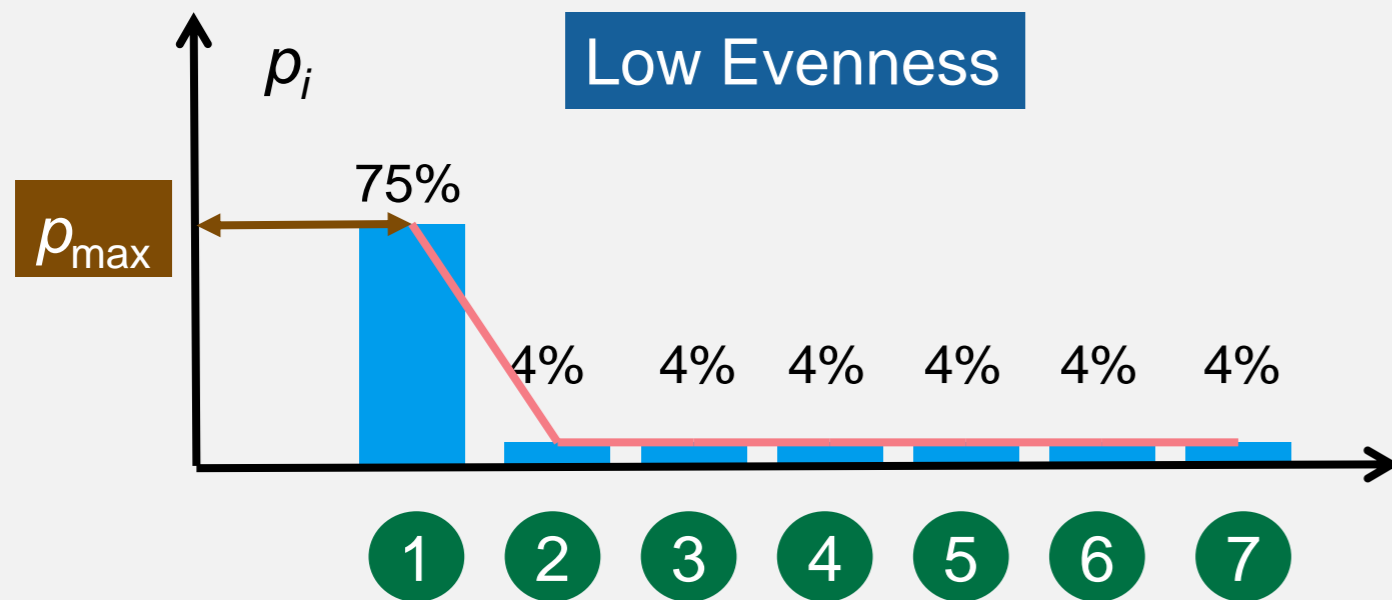
Diversity  $D = 1/p_{\max}$

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

$p_{\max} = 75\%$

$D = 1/75\% = 1.3$

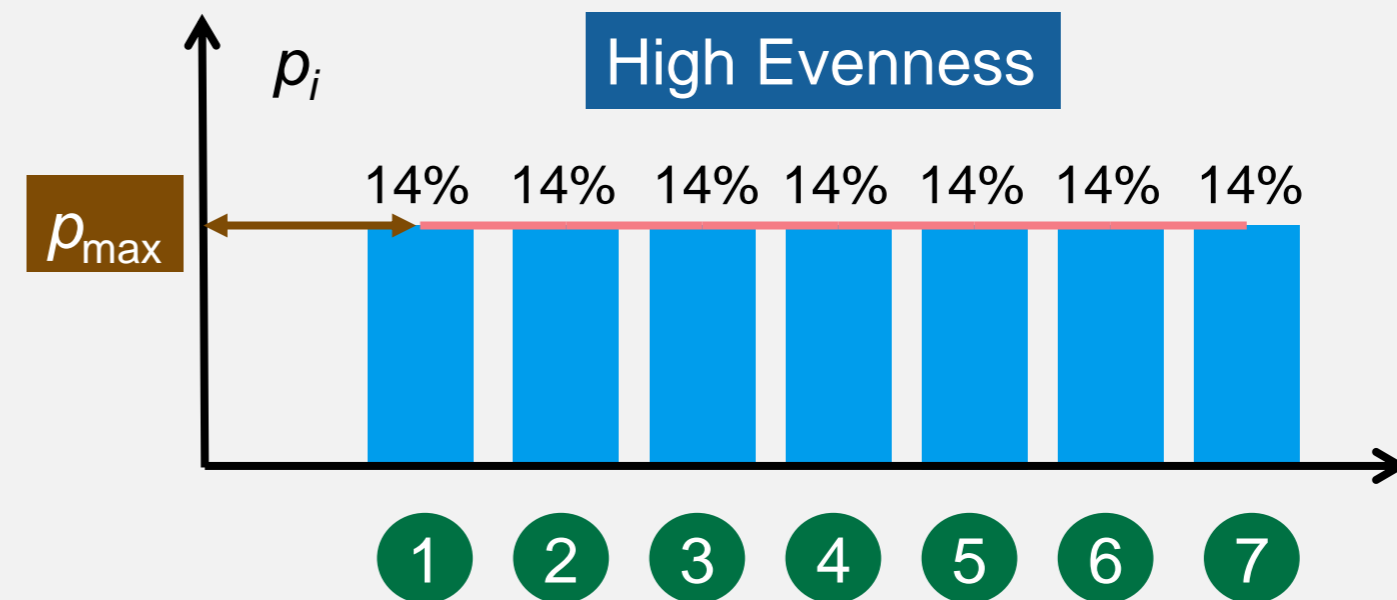
We are effectively selling in 1.3 categories



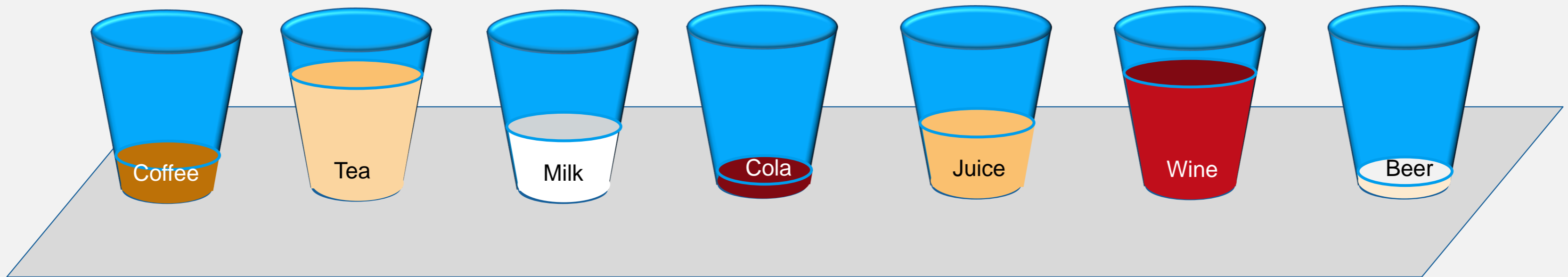
$p_{\max} = 14\%$

$D = 1/14.3\% = 7$

We are effectively selling in all 7 categories



# Diversity



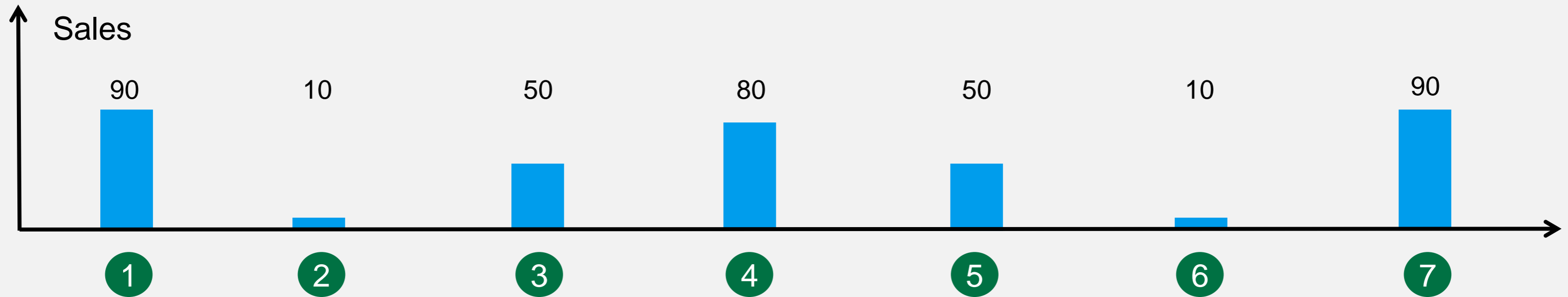
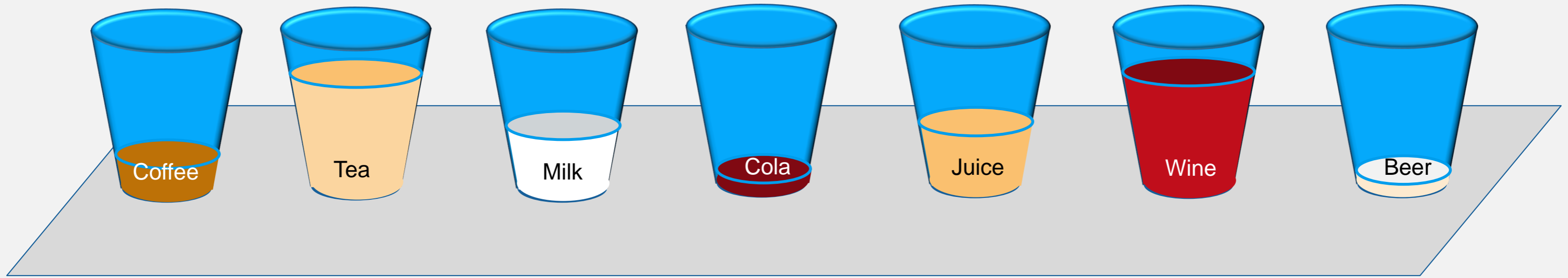
To measure True Diversity, *i.e.* the effective number of types, we need to take into account

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

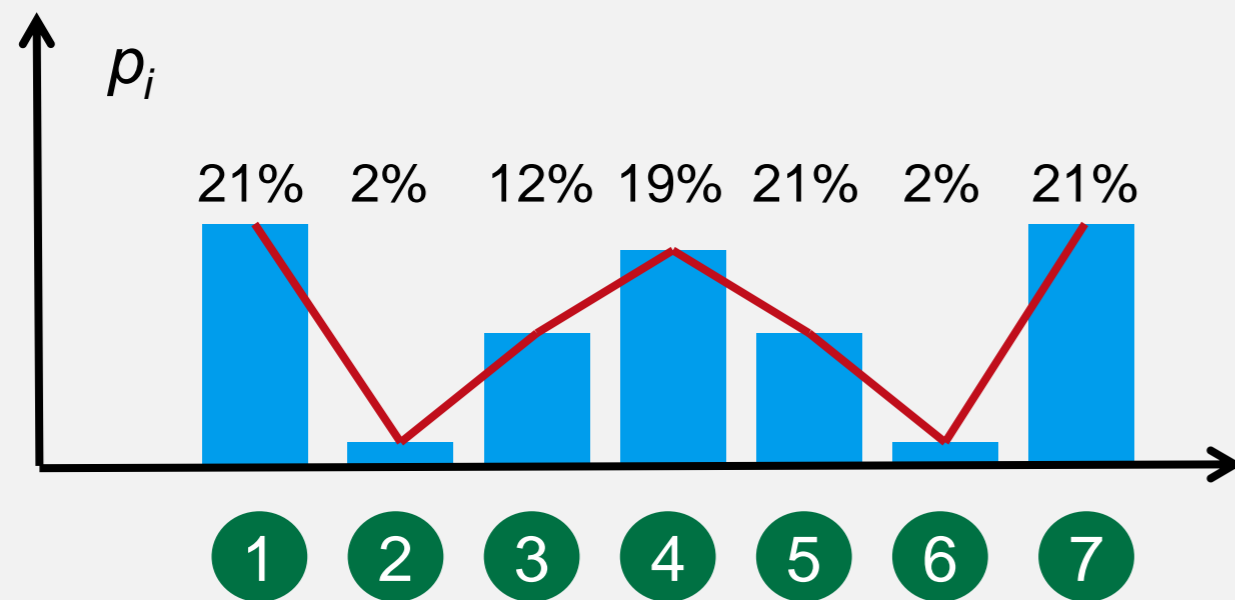
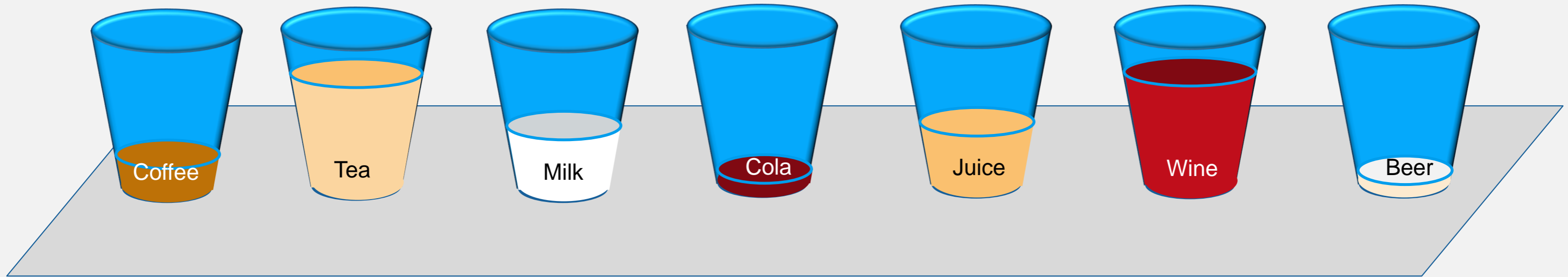
2 **Evenness**  
how the actual numbers are distributed among the types or categories



# 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**  $\lambda$  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**  $\lambda$  is reached for equal abundances, and it is the inverse of Richness  $R$ :

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

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

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Total	630	100%	18.9%

# Simpson Diversity Index

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

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

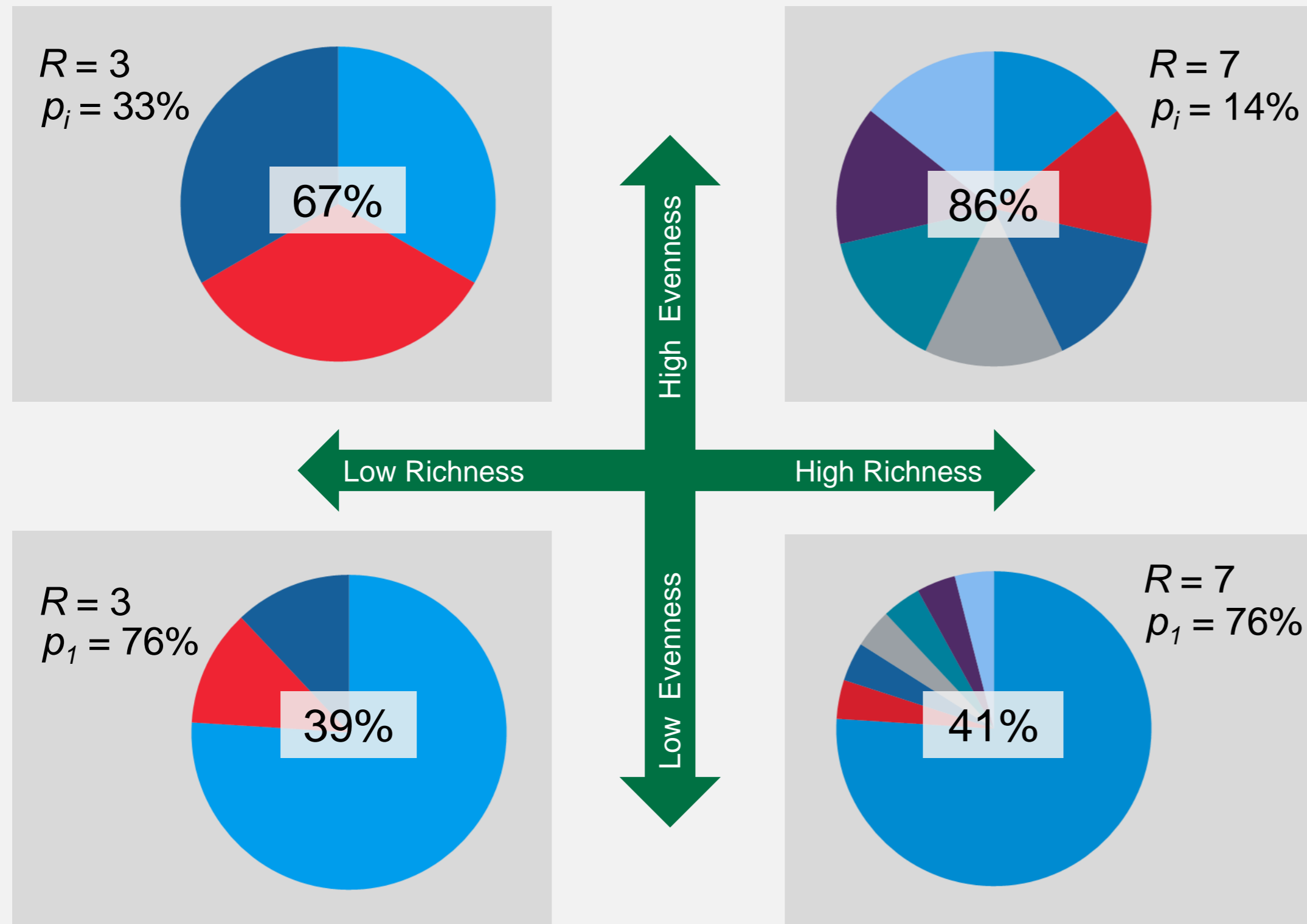
KPI

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

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

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Tea	10	2%	0.1%
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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  $q = 0$

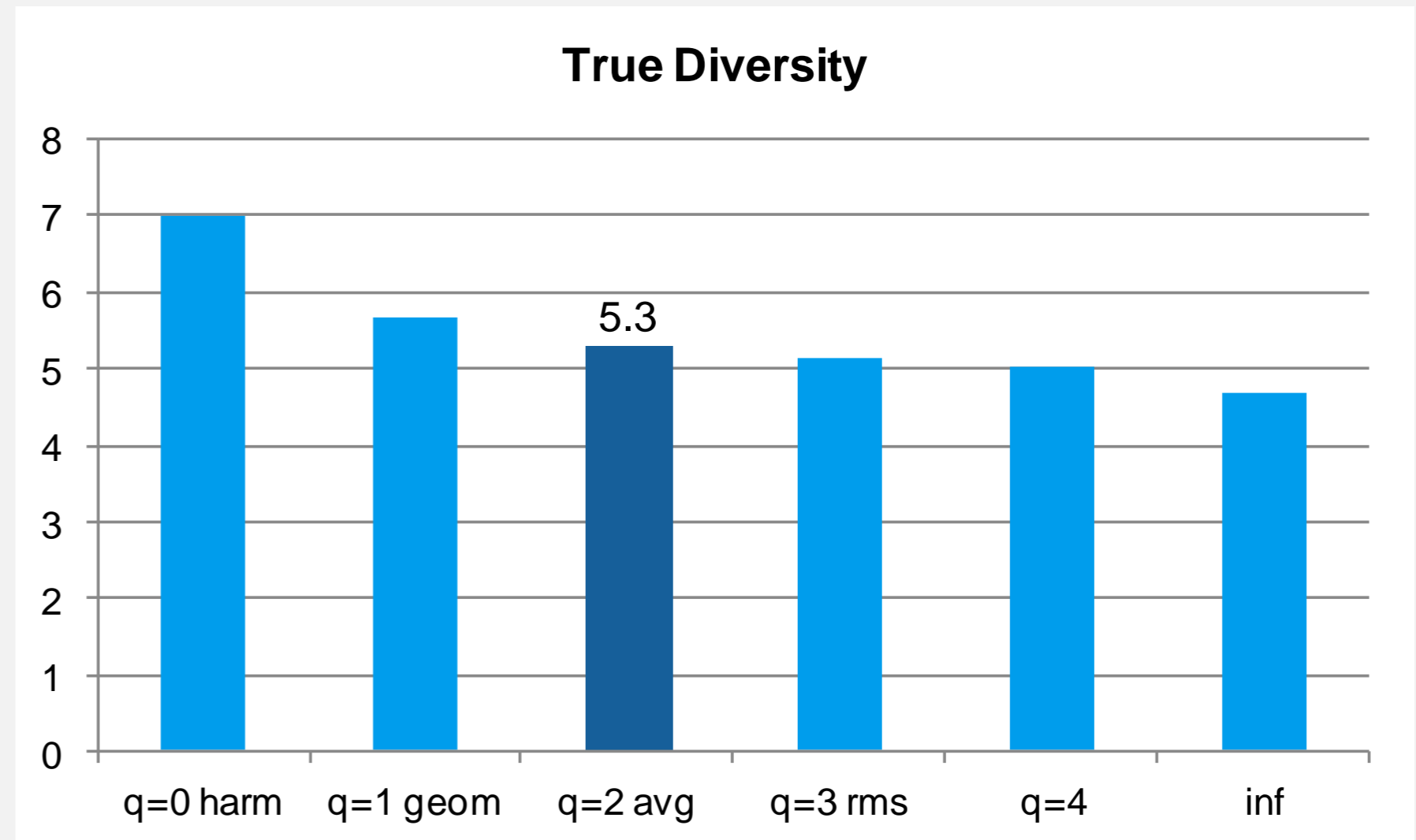
$${}^1D = \left( \prod_{i=1}^R p_i^{p_i} \right)^{-1}$$

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  $\lambda$  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  $\lambda$  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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