Diversity Index as Business KPI
The Concept of Diversity

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bpmsg.com

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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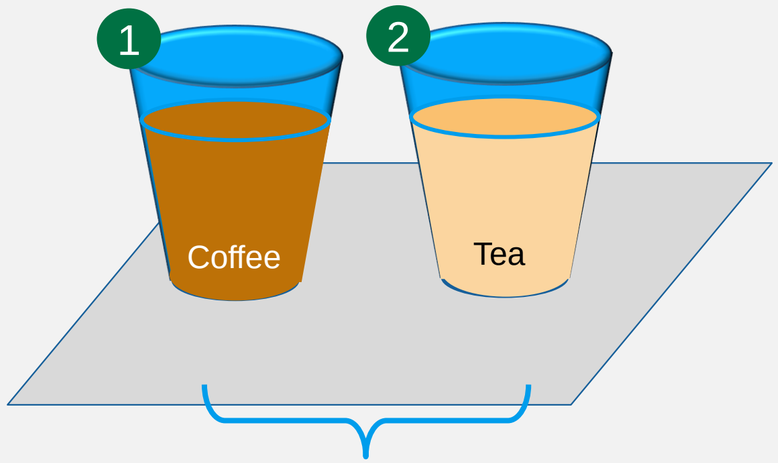
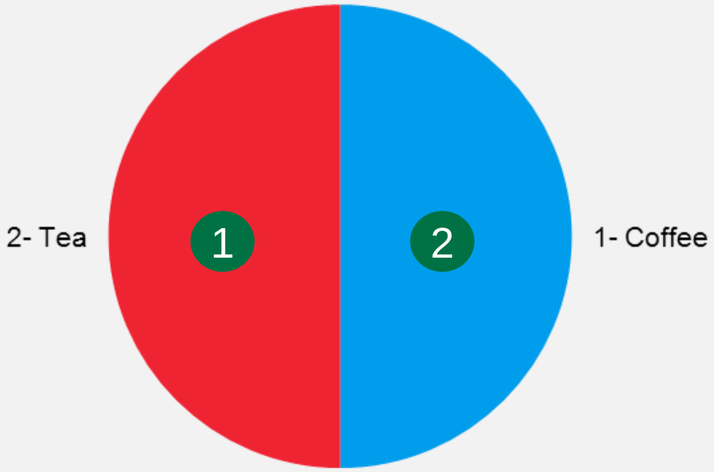
Diversity

- Richness
- Abundance
- Evenness

Richness



Richness: Tea or Coffee $R = 2$



Diversity Index as KPI
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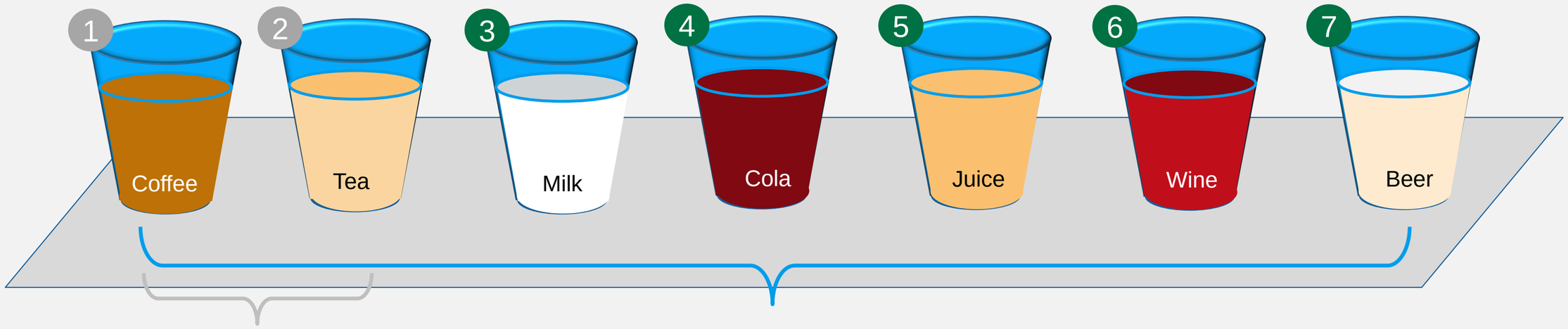
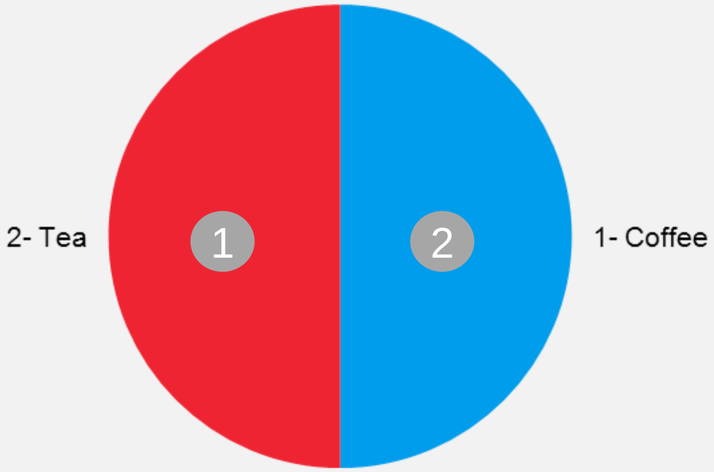
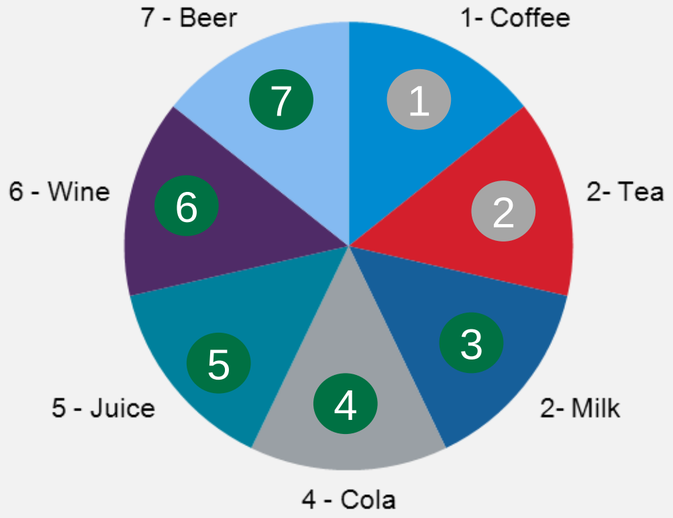
Richness



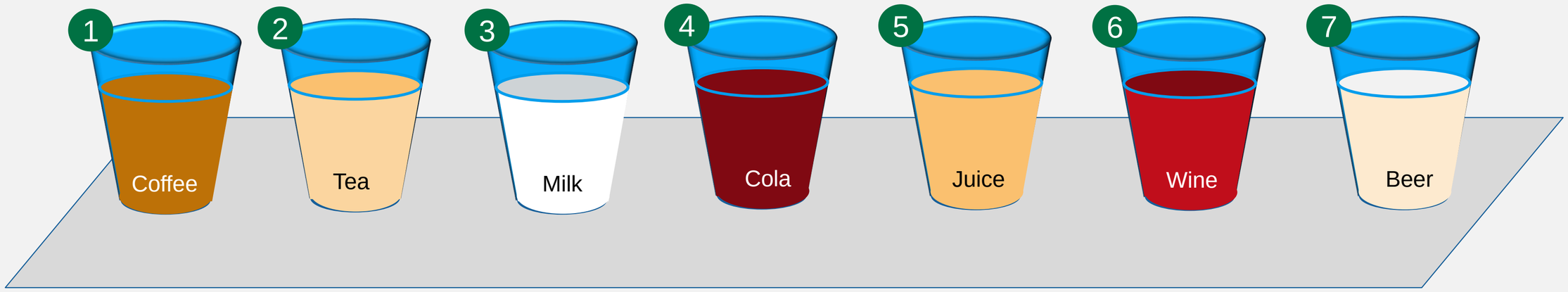
Richness: Tea or Coffee =2

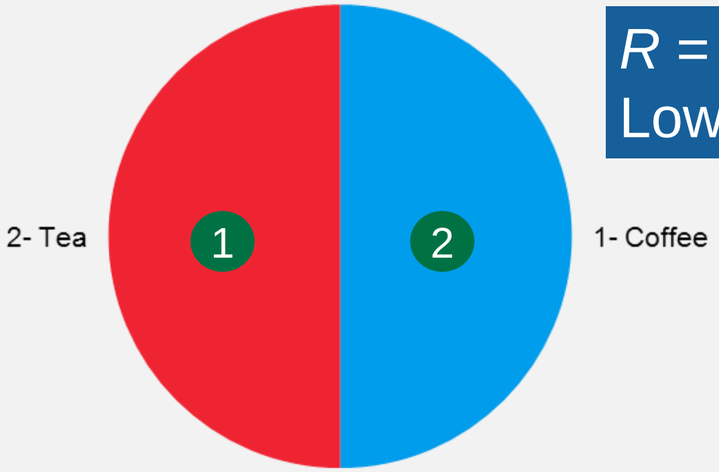
Richness: Tea, Coffee, Cola, Milk Juice, Wine Beer *R* = 7



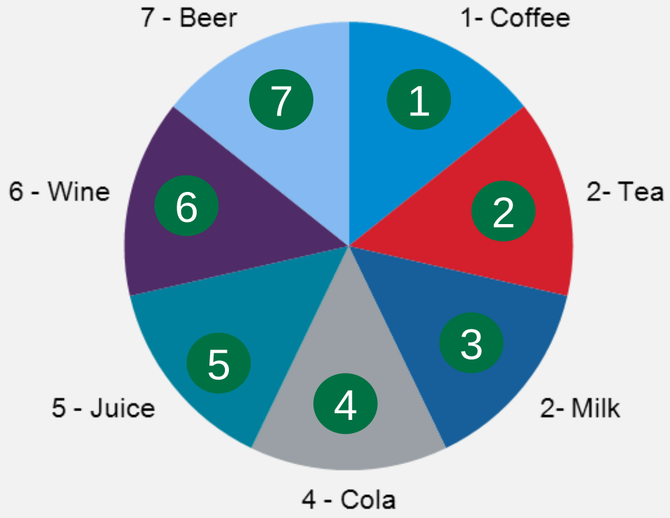


Richness



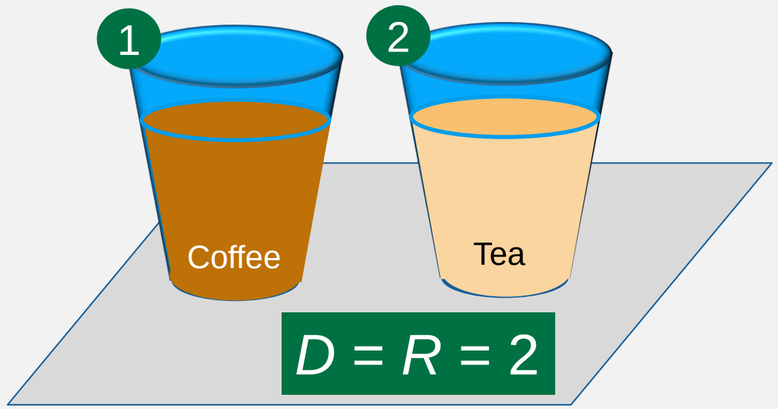


R = 2
Low Richness



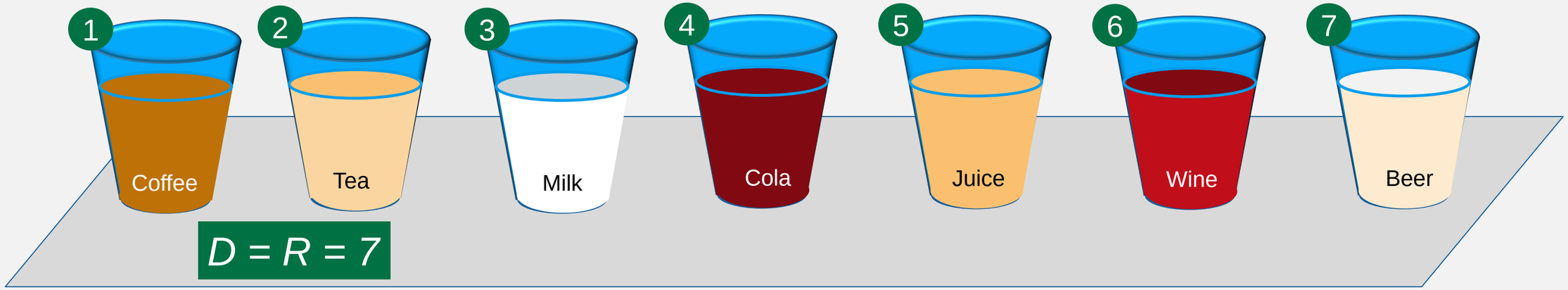
R = 7
Higher Richness

Diversity *D* = Richness *R*

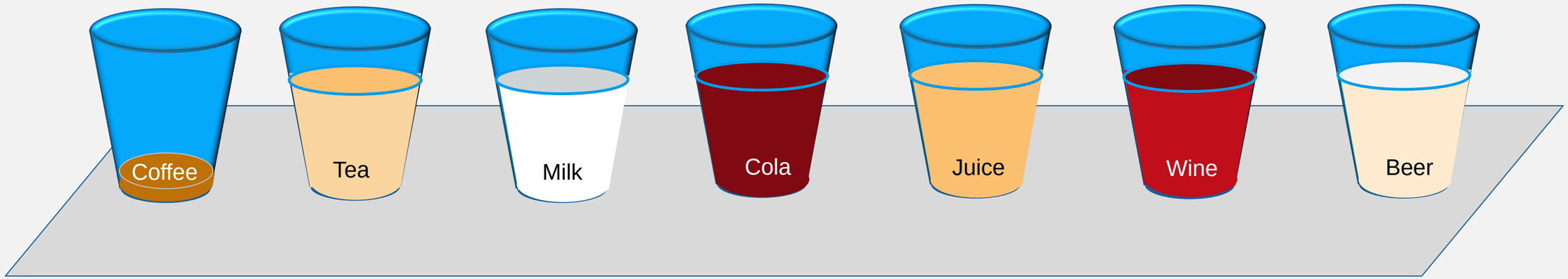


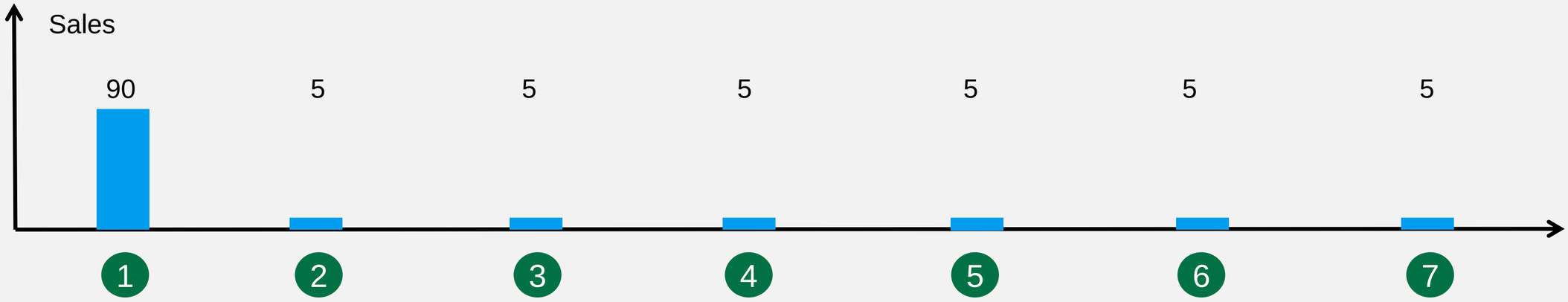
We could measure Diversity by simply **counting the number of types** or categories

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



Proportional Abundances





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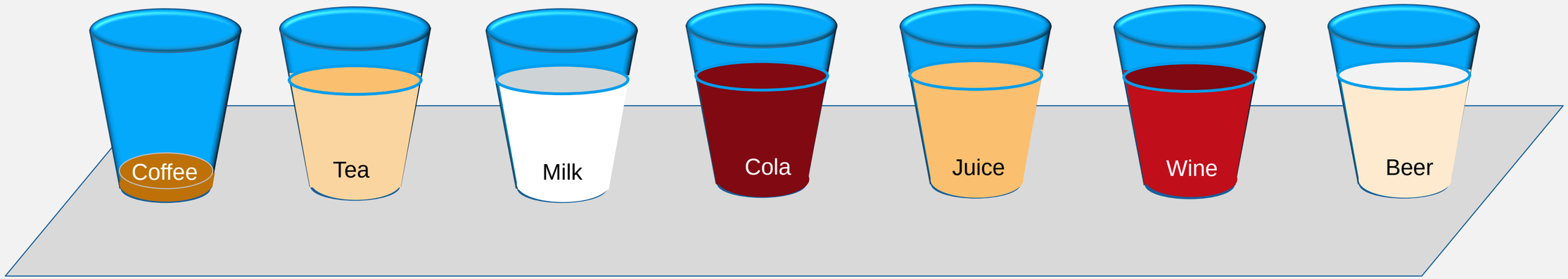

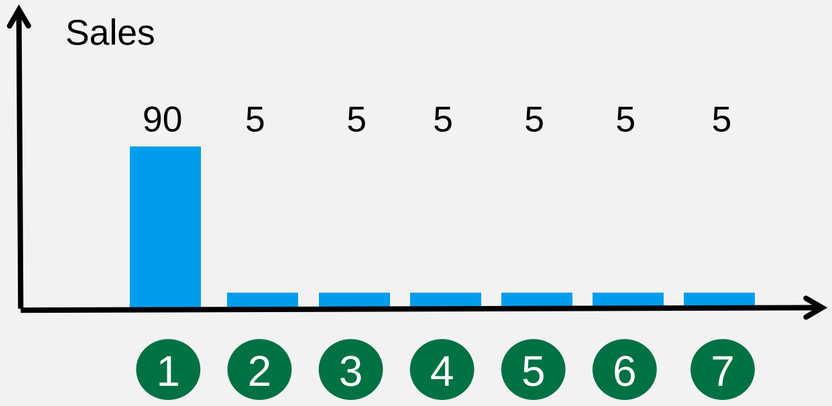

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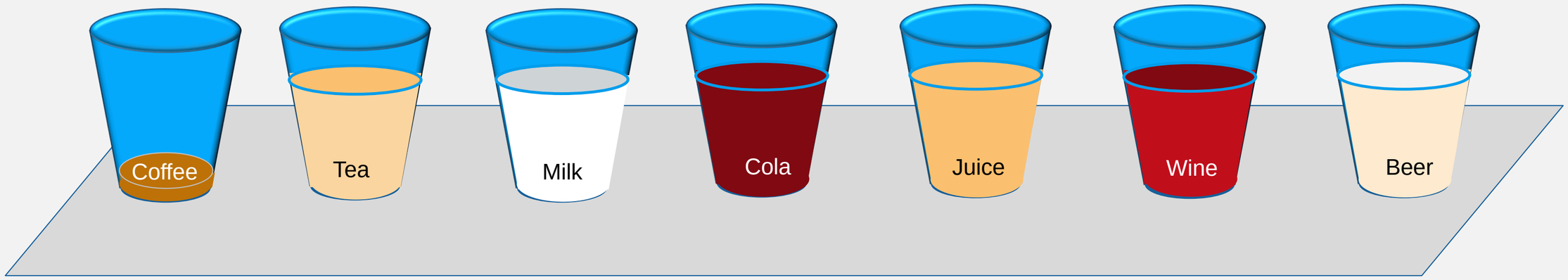
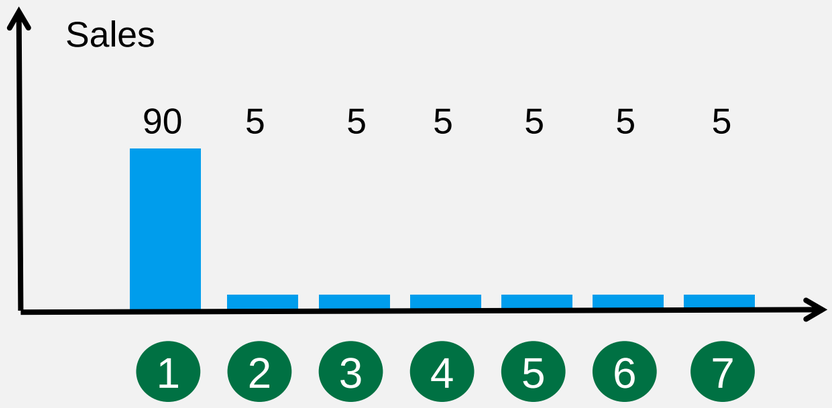
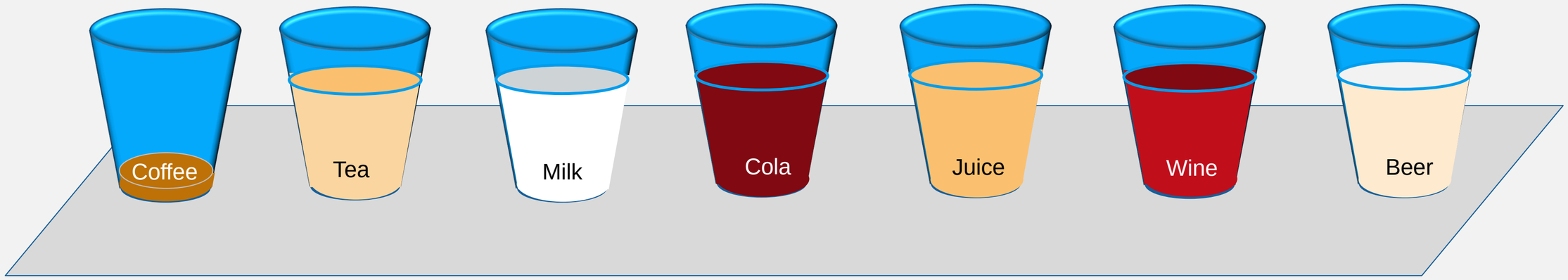


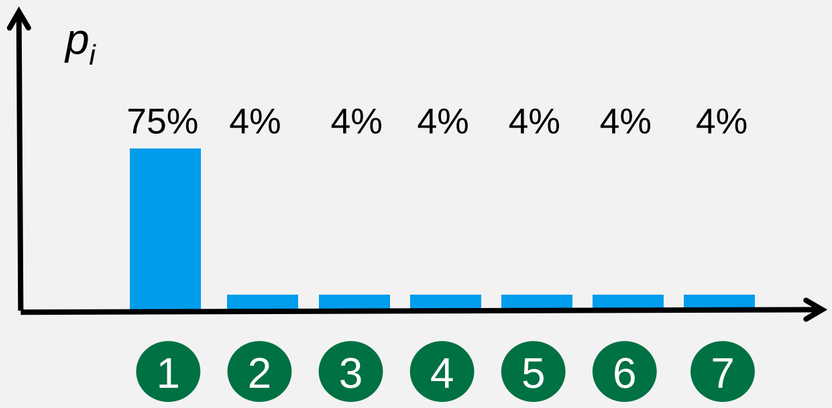


Type	Sales	Proportional
Coffee	90	75%
Tea	5	4%
Milk	5	4%
Cola	5	4%
Juice	5	4%
Wine	5	4%
Beer	5	4%
Total	120	100%

Proportional Abundances p_i

Proportional Abundances





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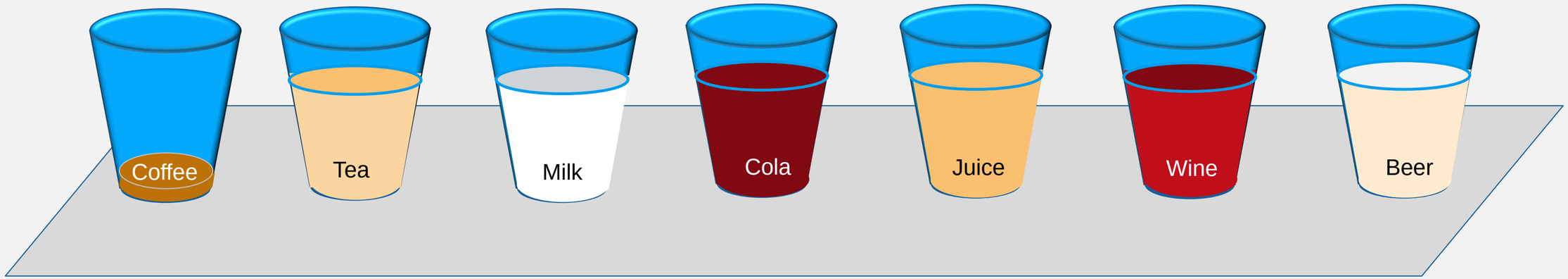

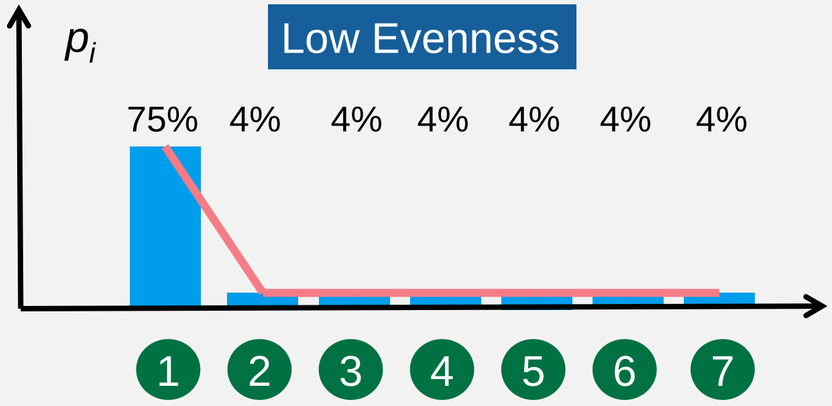

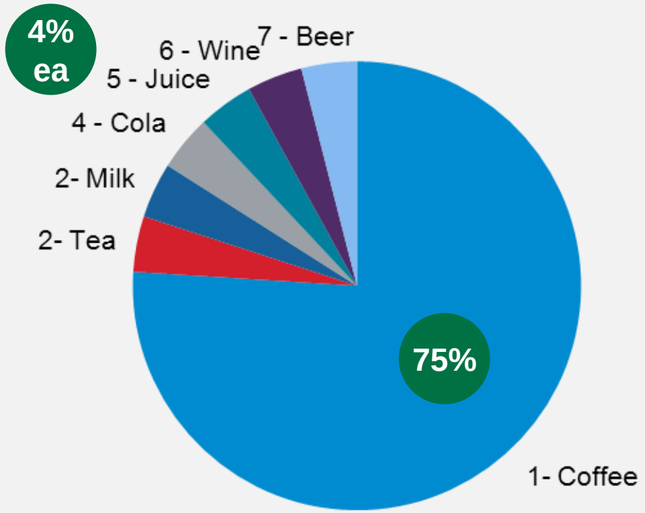

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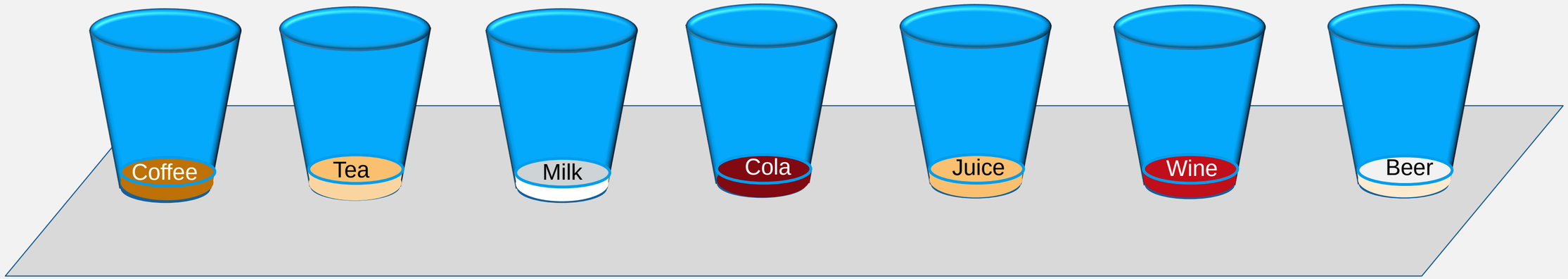

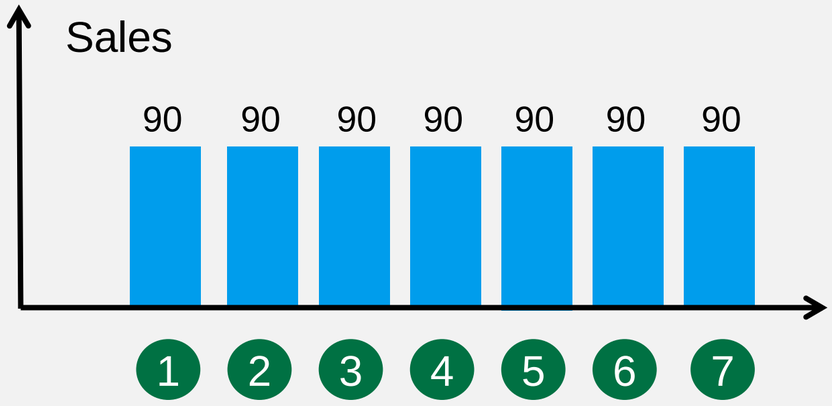

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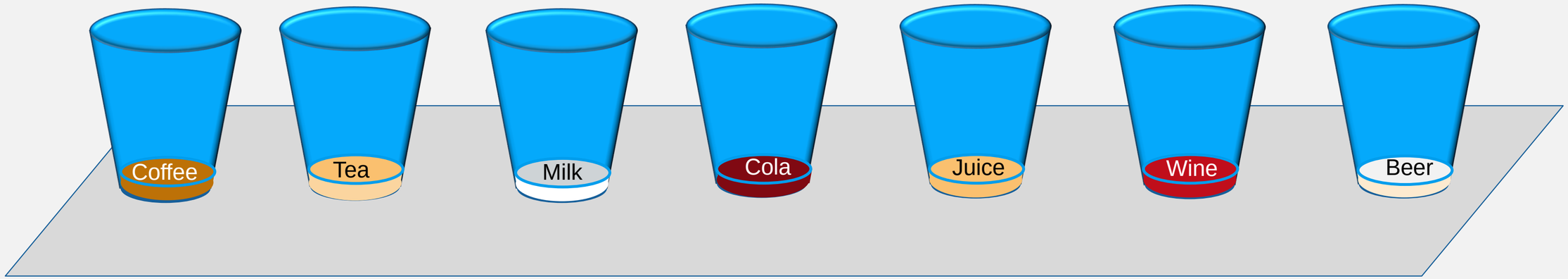
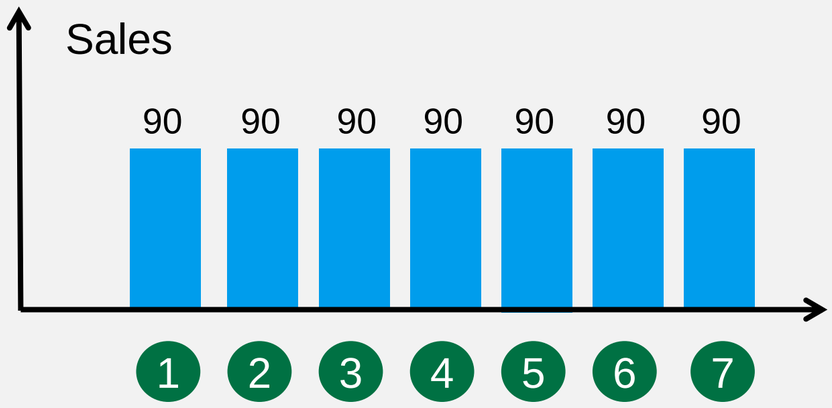
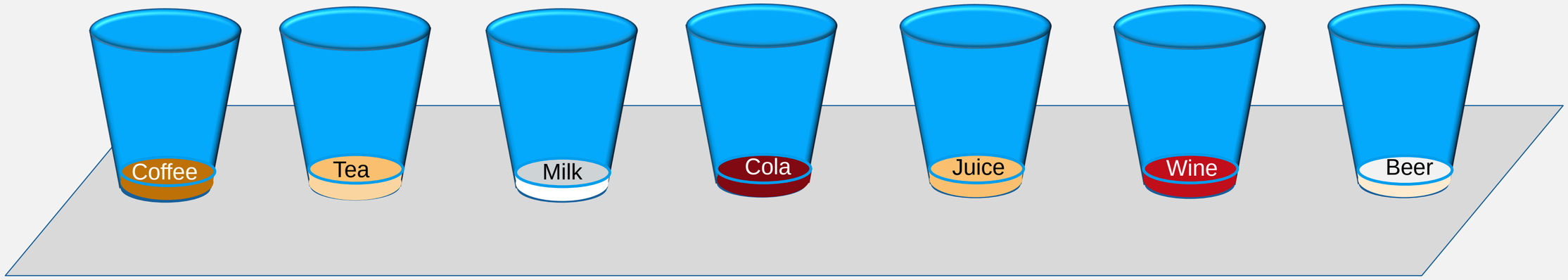


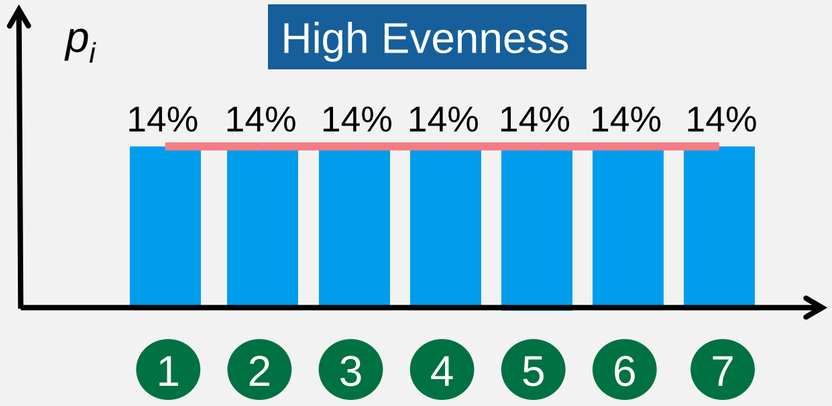


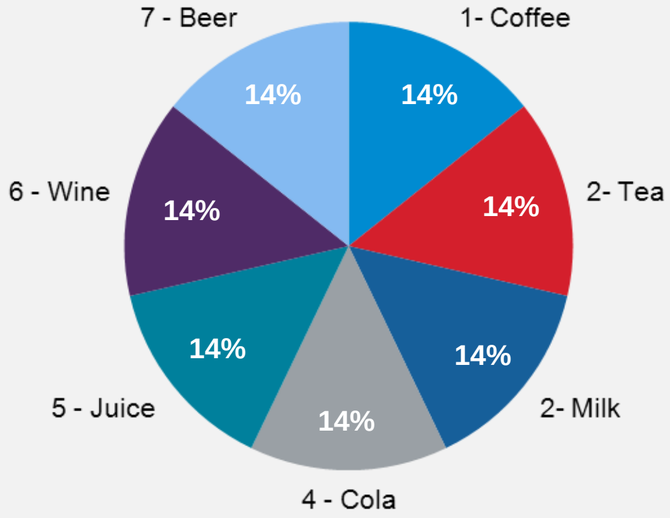
Type	Sales	Proportional
Coffee	90	14%
Tea	90	14%
Milk	90	14%
Cola	90	14%
Juice	90	14%
Wine	90	14%
Beer	90	14%
Total	630	100%

Proportional Abundances p_i

Proportional Abundances







Proportional Abundances p_i

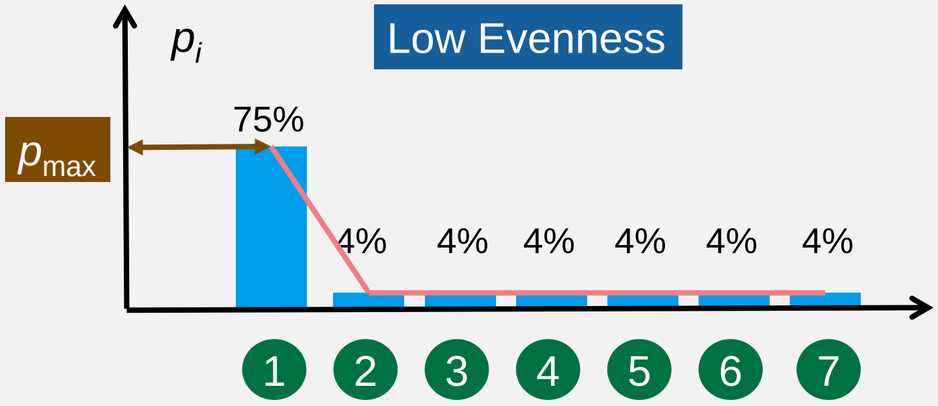
Diversity $D = 1/p_{max}$

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

$p_{max} = 75\%$

$D = 1/75\% = 1.3$

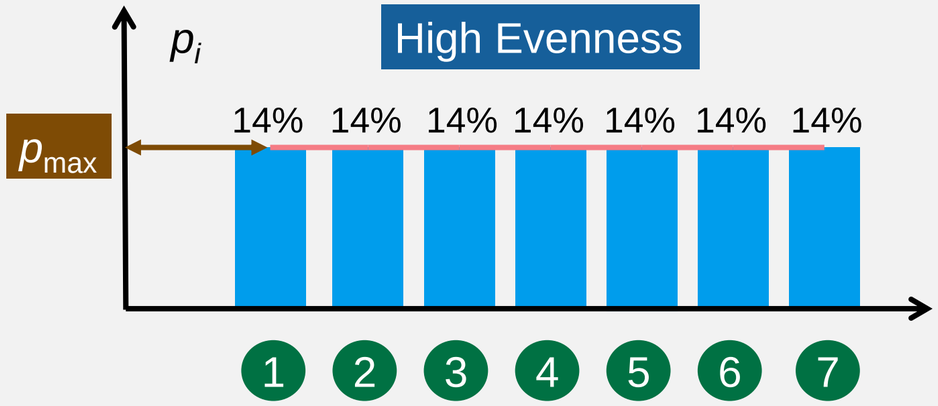
We are effectively selling in 1.3 categories



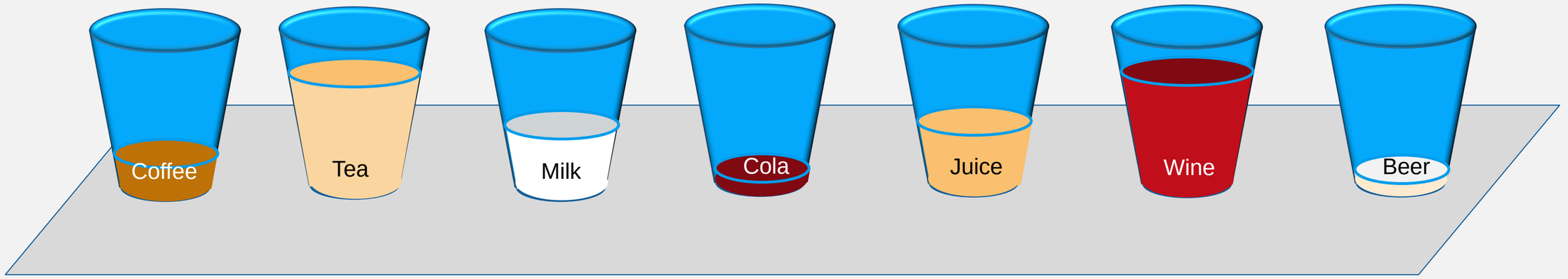
$p_{max} = 14\%$

$D = 1/14.3\% = 7$

We are effectively selling in all 7 categories



Diversity

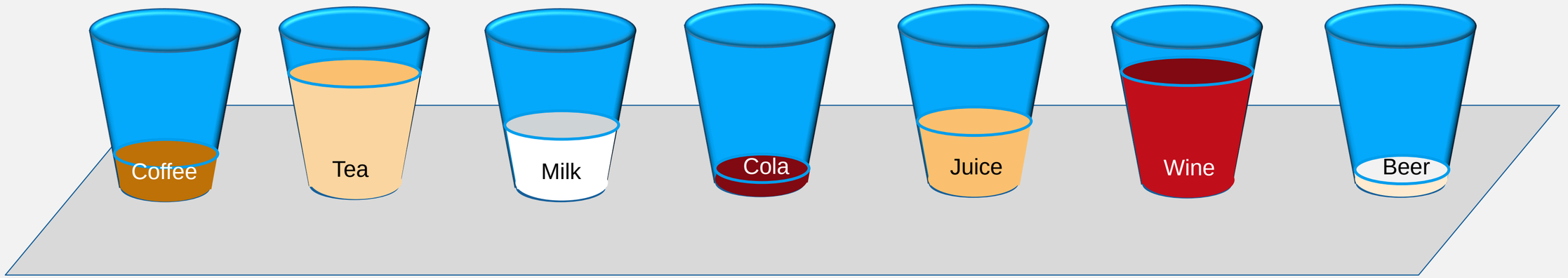


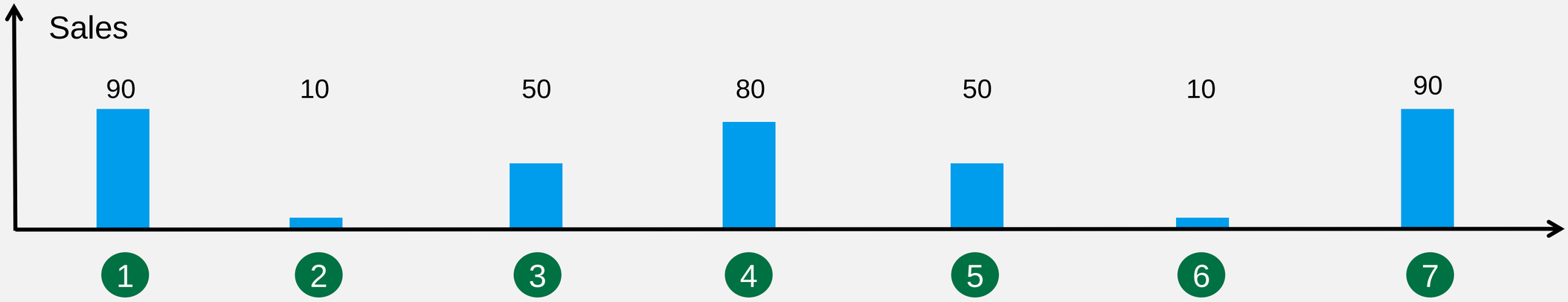
To measure True Diversity, *i.e.* the effective number of types, we need to take into account

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

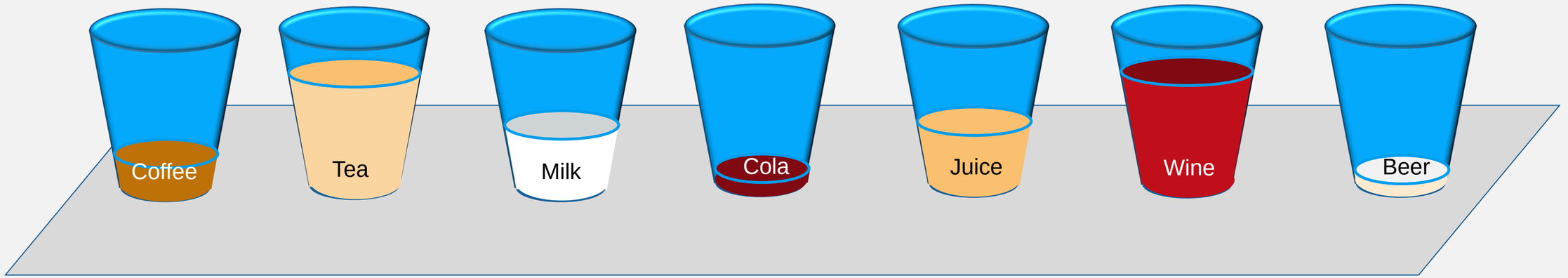
2. **Evenness**
   how the actual numbers are distributed among the types or categories

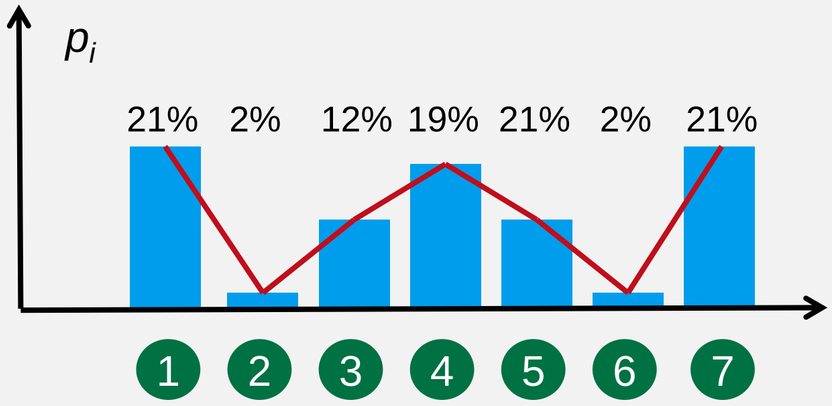
Diversity


Coffee
Tea
Milk
Cola
Juice
Wine
Beer


Sales
90
10
50
80
50
10
90
1
2
3
4
5
6
7

Diversity Index





Type	Sales	p_i	p^2_i
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 :

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

λ = 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:

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

λ_{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 - λ as KPI to measure Market Diversity

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

KPI

1 - λ = 1 -18.9% = 81.1%

1 - λ_{max} = 1 - 1/7 = 85.7%

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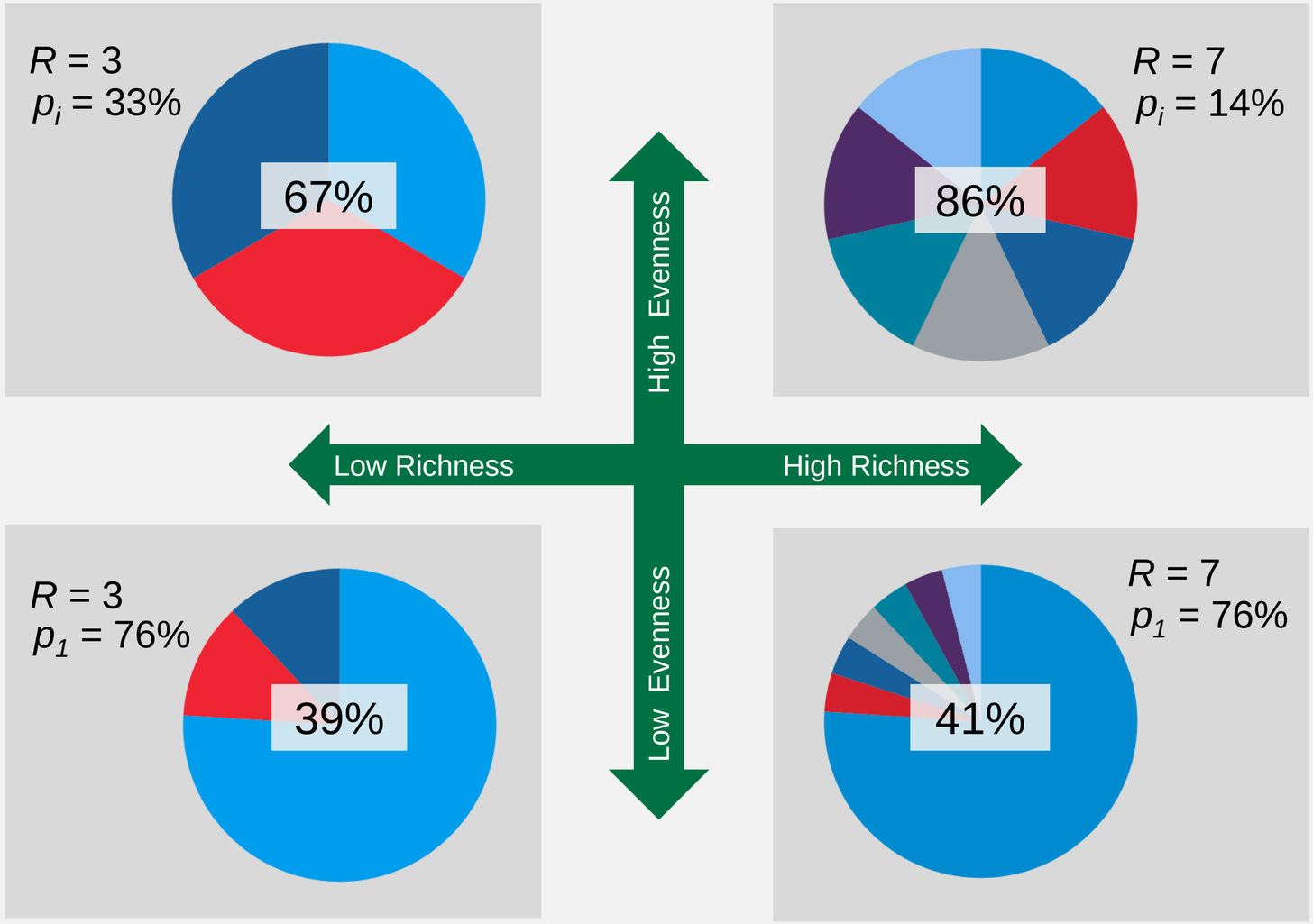
Simpson Diversity Index 1-λ



Diversity Index as KPI
The Simpson Index

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Simpson Index

We use the complement of the Simpson Index 1 - λ as KPI to measure Market Diversity

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

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General Formulation of True Diversity

for $q \neq 0$

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

for $q = 0$

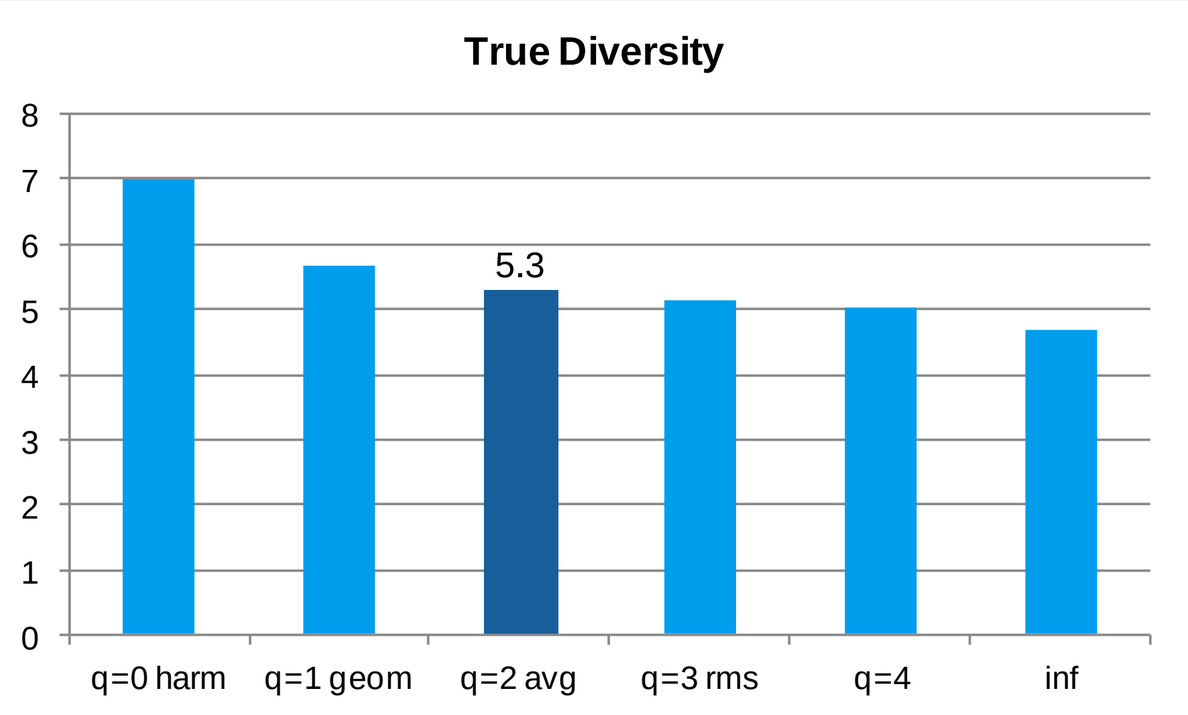
$$ {}^{1}D = \left(\prod_{i=1}^{R} p_i^{p_i} \right)^{-1} $$

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 - λ) 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 I and its complement (1 - λ) as a KPI to assess market diversity.

This index takes into account richness and evenness

Diversity Index as KPI
The Simpson Index

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