Assignment code:

https://github.com/GeertHuissen/dms_assignment_1/blob/main/assignment.R

Question 1.1

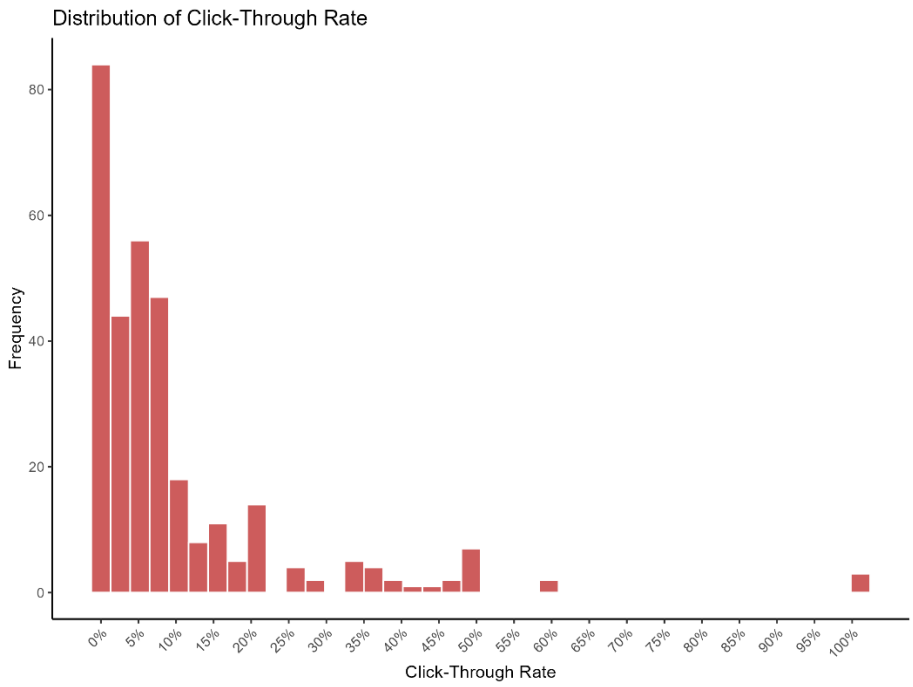
Formula for click-through rate:

$$CTR = \frac{Clicks}{Impressions}$$

Formula for conversion rate:

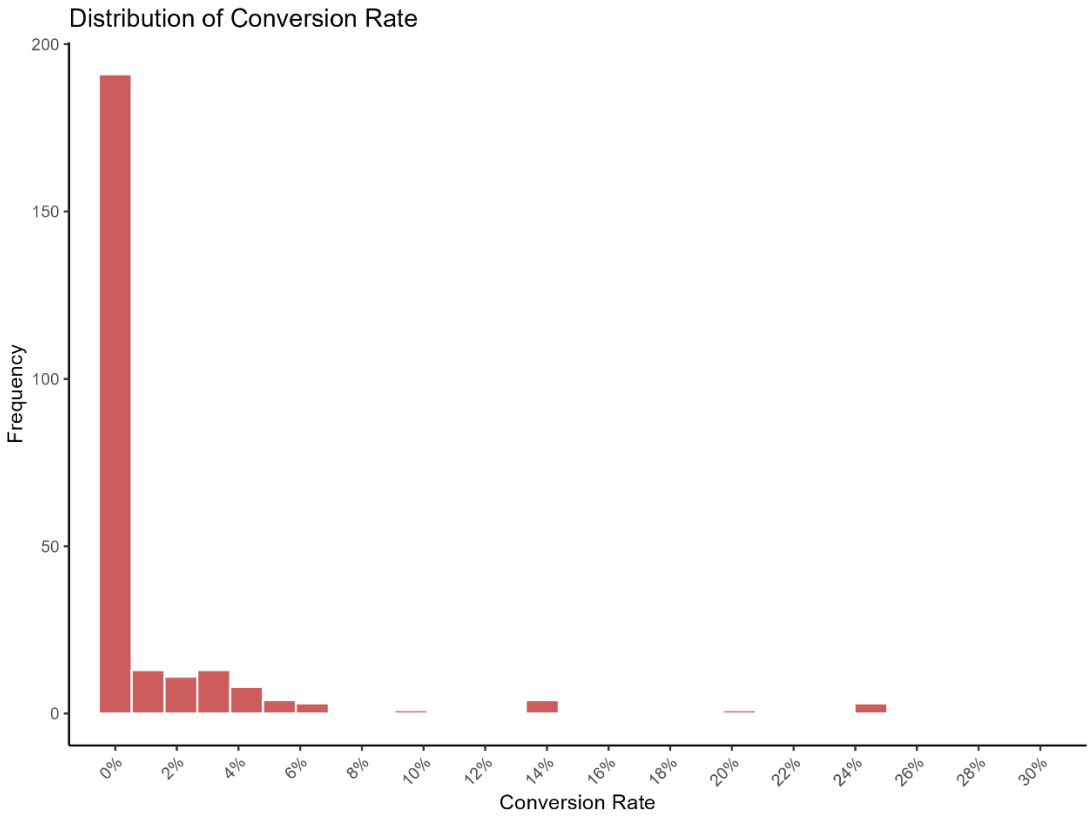
$$CR = \frac{Conversions}{Clicks}$$

Histogram for click-through rate:



Note: *This histogram includes only observations with impressions > 0. Additionally, one observation with a click-through rate greater than 1 (3 clicks and 2 impressions) was excluded, as CTR cannot exceed 100% and likely reflects a data recording error.*

Histogram for conversion rate:



Note: *Only observations with clicks > 0 are included, as conversion rate is conditional on there being clicks. The x-axis is limited to 30% to improve readability. A small number of observations show conversion rates of 100%. These occur because the data are recorded at the campaign-day level, and some campaign-day combinations have only one or two clicks. If one of those few clicks results in a conversion, the conversion rate equals 100%, which reflects sparse data rather than consistently high performance.*

The weighted CTR (7.9%) is lower than the simple average (9.7%) because observations with very few impressions can generate relatively high CTR values due to randomness. Since the unweighted mean gives these sparse observations equal weight, it overstates overall performance. The weighted CTR corrects for this by accounting for exposure. In 2025, the average Google Ads click-through rate was 6.66% (Marino, 2025). Even the weighted CTR is significantly higher than the 2025 average CTR.

The average conversion rate (CR) is 3.3%, while the weighted CR equals 1.5%. Similar to the CTR results, the unweighted average is inflated by campaign-day observations with very few clicks, but a high conversion rate. The weighted CR corrects for this by accounting for total click volume. The average Google Ads conversion rate in 2025, was 7.52%, which is significantly higher than even the inflated CR (Marino, 2025).

Question 1.2

There is a strong negative Spearman correlation between ad position and click-through rate, $\rho = -0.57$, $p = 2.2e\text{-}16 < 0.05$. Since a lower ad position corresponds to a higher placement in the search results, this result indicates that higher placed ads are associated with substantially higher click-through rates. This result makes a lot of sense. A lower rank (high up in the search results) means better exposure, resulting in a higher click-through rate.

The Spearman correlation between ad position and conversion rate is small and not statistically significant ($\rho = -0.07$, $p = 0.26 > 0.05$). This result is very intuitive from a funnel perspective. While ad position directly influences visibility and thus click-through rates, conversion occurs way further downstream in the sales funnel and thus depends on a lot of additional factors (e.g. pricing, quality of the products, website quality). These results suggest that ad position strongly impacts engagement, but not necessarily purchase behavior.

Question 1.3

The formula used to compute the average ROI:

$$ROI \quad avg = (1/n) \sum \big((Revenue * 0.035 - Clicks * BidPrice)/(Clicks * BidPrice)\big)$$

The average ROI equals -22.9%. The average ROI is computed across all campaign-day observations with finite ROI values, excluding cases with zero advertising costs (i.e., zero clicks) or missing values, for which ROI is undefined.

In addition to campaign-day ROI, we compute ROI at the campaign level by aggregating profits and costs per campaign and then averaging across campaigns. This ensures that each campaign contributes equally to the final estimate. The average ROI at campaign level equals -55.2%.

Question 2.1

	Average conversion rates in %	
	With retailer names	Without retailer names
Keyword Length 2	0.2% (7)	1.2% (131)
Keyword Length 3	10.7% (13)	4.4% (73)

Note: *The number between brackets is the size of the corresponding group*

For three-word keywords, including the retailer name leads to a substantially higher conversion rate (10.7% vs. 4.4%). This aligns with purchase-intent theory: consumers who include the retailer name in their query likely already intend to buy from that specific store. For two-word keywords, the opposite pattern appears (0.2% vs. 1.2%), but this result is based on a very small sample (n = 7) and is therefore likely driven by random variation rather than a structural effect. The table also shows that 3 keywords perform better than 2 keywords. This also seems correct. Longer keywords correspond to more specific user search queries and a higher purchase intent. It can for example indicate that a consumer already knows more specifically what they want to buy (e.g. gaming laptop vs. gaming laptop dell) and is already further down the sales funnel. This indicates that longer keyword lengths may be better for converting sales, but shorter keyword lengths could be better if the intention is just being seen higher up in the sales funnel.

Question 2.2

	Average CTR in %			
	With Retailer		Without Retailer	
	With Brand	Without Brand	With Brand	Without Brand
Keyword Length 2	37.0% (5)	4.7% (5)	8.3% (103)	3.2% (47)
Keyword Length 3	29.0% (9)	5.5% (14)	9.2% (62)	6.3% (39)

Note: *The number between brackets is the size of the corresponding group*

Using both the retailer and the brand in the keyword results in the highest click-through rate. In general, including the retailer name increases CTR when comparing groups that only differ in that dimension. The same holds for including the brand name: across comparable groups, adding the brand consistently leads to higher CTR.

Keyword length also seems to matter. In most cases, three-word keywords perform better than two-word keywords. The only exception is the group that includes both retailer and brand, but these cells are based on very few observations, so the result should be interpreted cautiously.

Overall, the pattern suggests that more specific keywords perform better. If the goal is to drive traffic, it therefore makes sense to use three-word keywords and include both the retailer and the brand name.

Question 2.3

Average ROI in %

	With Retailer		Without Retailer	
	With Brand	Without Brand	With Brand	Without Brand
Keyword Length 2	-80.0% (5)	-100% (5)	-73.3% (103)	-92.8% (47)
Keyword Length 3	630.6% (9)	-68.2% (14)	-20.2% (62)	96.2% (39)

Note: *The number between brackets is the size of the corresponding group*

The ROI results are less consistent across retailer and brand combinations. However, one clear pattern emerges: in all comparable groups, 3-word keywords generate a higher ROI than 2-word keywords. The effects of including the retailer or brand name are mixed and do not show a consistent direction. Given that several groups are very small, individual observations can strongly influence the average ROI, which likely explains the large variation across cells and the significantly higher ROI of 630.6% (Keyword Length 3, With Retailer, With Brand), since that group size is only 9.

Overall, the only consistent effect in this table is the positive impact of using three-word keywords. Therefore, if the goal is to improve ROI, the most reliable recommendation is to focus on three-word keywords rather than two-word keywords.

REFERENCES

. Marino, S. (2025, 29 september). *Google Ads Benchmarks 2025: Competitive Data & Insights for Every Industry*. WordStream. https://www.wordstream.com/blog/2025-google-ads-benchmarks