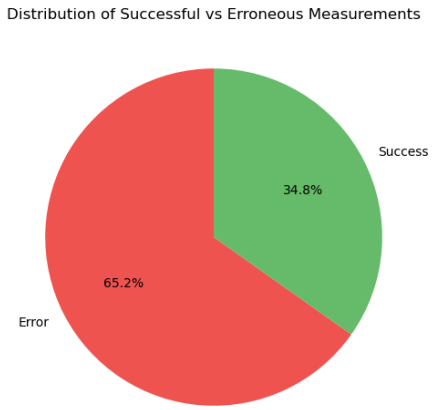
Jhannes Ernesto Reimann

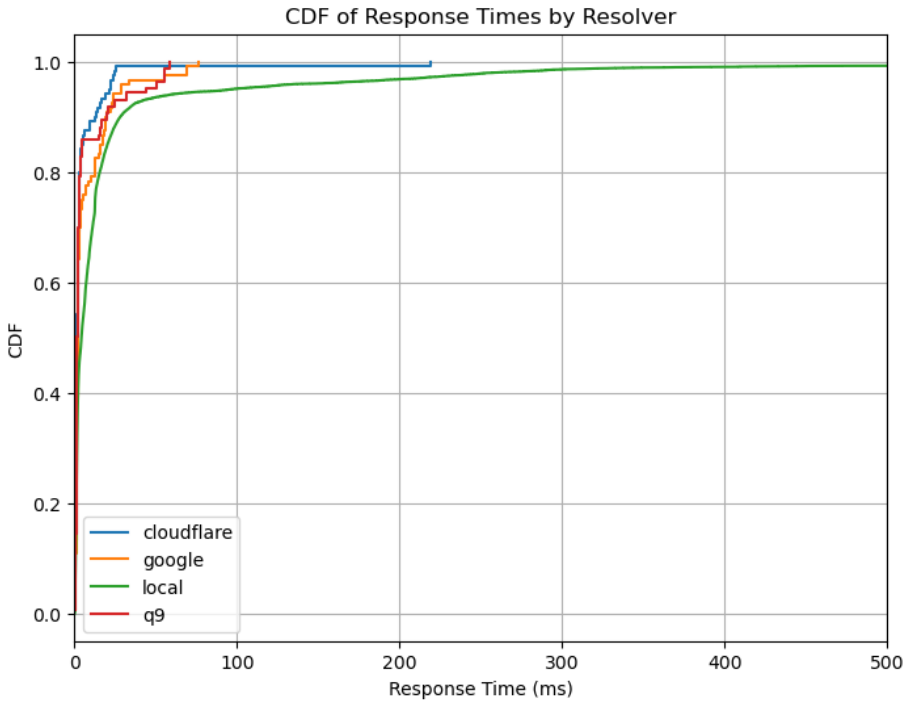
Task 1: DNS over UDP (15 points)

Interpret the plots you just created. What can you infer from the distributions? What differences between distributions in a figure can you spot?

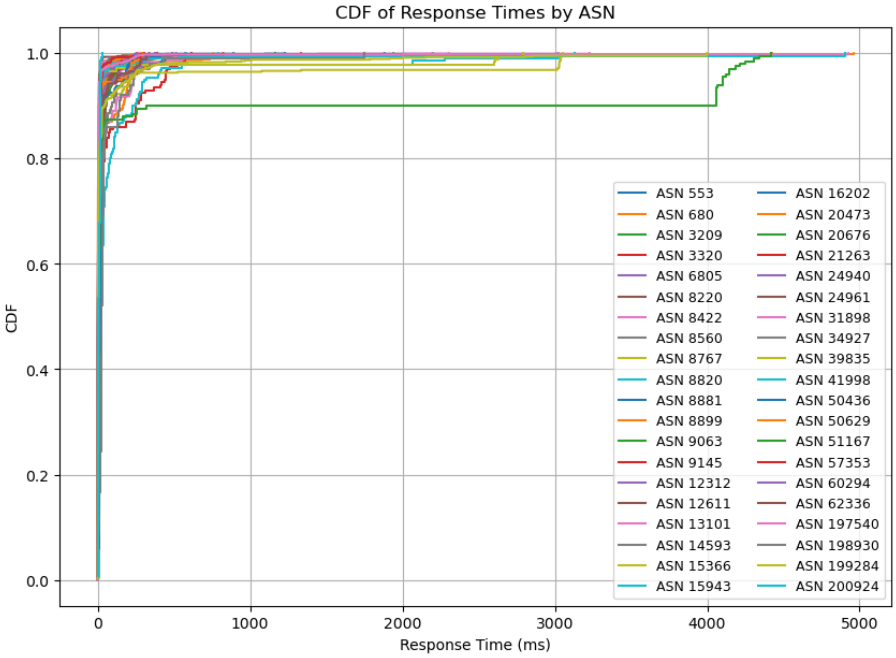


Only about one third (34.8%) of measurements were successful, while 65.2% resulted in errors. Despite the generally fast response times (see CDF), the majority of measurements fail, indicating systematic issues, such as reachability problems with certain resolvers or restrictive firewalls.

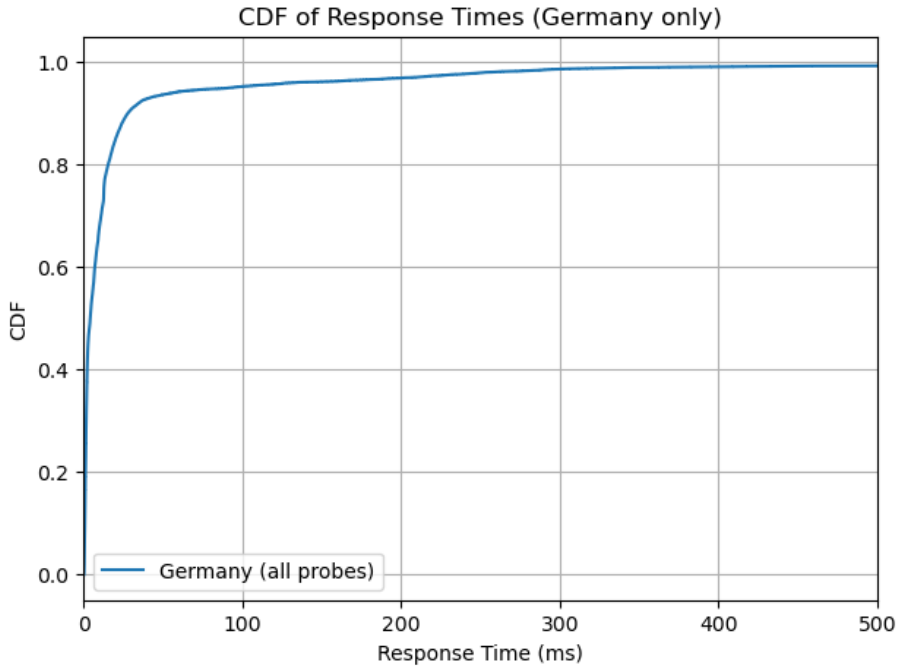
The majority of errors (60.6%) are due to timeouts (timeout: 5000). A significant portion (39.2%) is classified as “Unknown,” indicating unspecified or unhandled errors. Only a very small fraction (0.3%) falls under “Other” errors, such as “Network unreachable” or “Permission denied”. The frequent timeouts suggest network instability or congestion, especially for DNS queries from Germany. The “Unknown” category likely points to measurement artifacts or unhandled error cases in the script.



Cloudflare and Google generally provide the fastest DNS responses (steep curves, low latencies). Local resolvers and “q9” show greater variance and higher response times. Public resolvers like Cloudflare and Google tend to be more performant for German probes than local resolvers, reflecting their robust global infrastructure. However, many measurements still fail, likely due to network restrictions or specific probe issues.



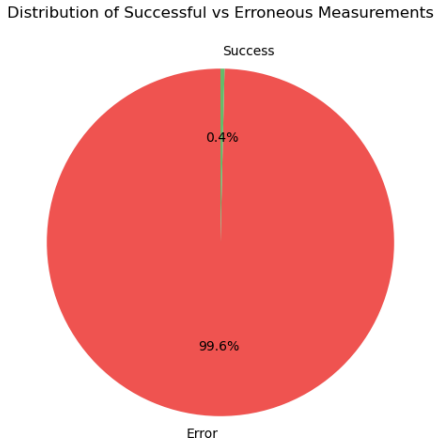
The CDFs for different ASNs show a wide spread: some networks deliver very fast responses (steep curves), while others have noticeably slower or more variable response times (flatter curves, outliers up to 5000ms). The network affiliation of the probes (as seen in probe_asn_mapping.csv) has a strong impact on DNS performance. Some ASNs are clearly better connected or optimized than others.



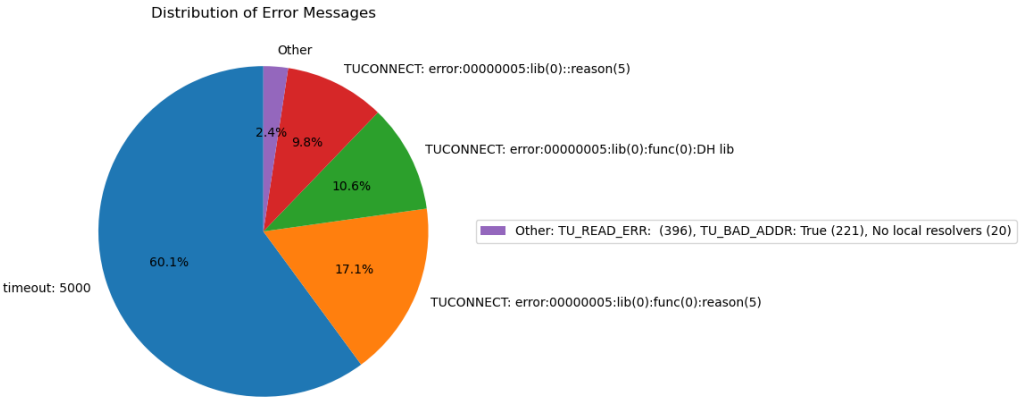
The cumulative distribution function (CDF) shows that most DNS response times for German probes are very low: over 90% of queries are answered in less than 100ms. Only a few outliers have higher response times. DNS resolvers in Germany generally provide very fast responses. The few slower queries may be due to individual poorly connected probes or temporary network issues.

Task 2: DNS over TLS (5 points)

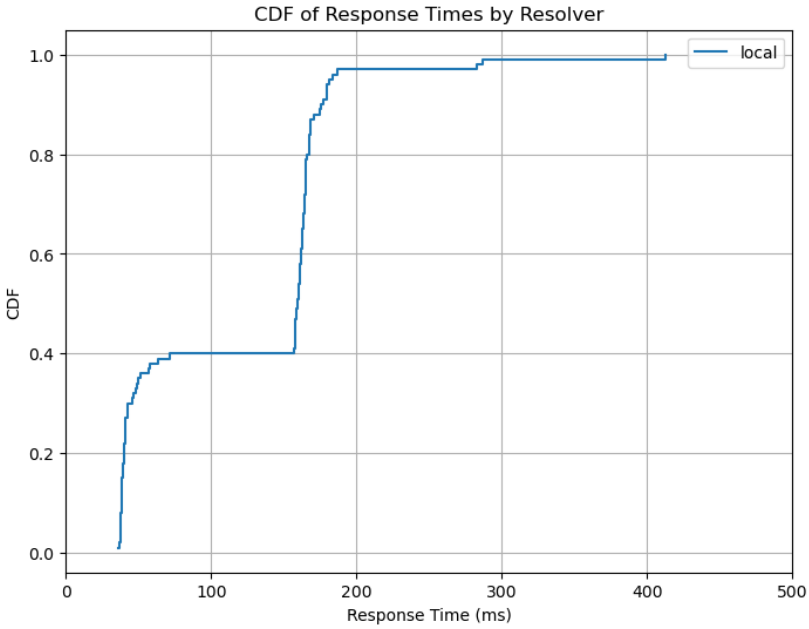
Interpret the plots you just created. What can you infer from the distributions? What differences between distributions in a figure can you spot?



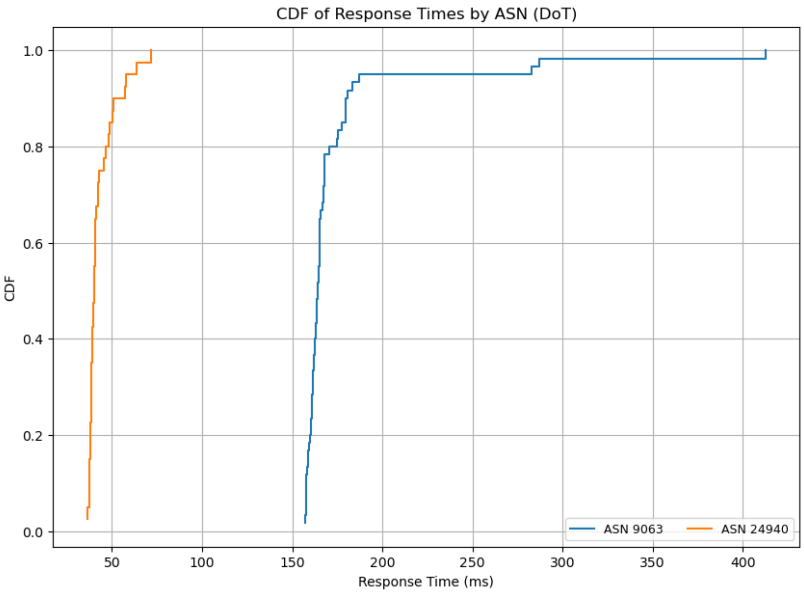
Only 0.4% of measurements were successful, with 99.6% resulting in errors. The extremely low success rate underlines that DNS-over-TLS is largely inaccessible for the tested German probes and resolvers, except for the local resolver in a few specific cases (3 resolvers overall). This highlights major deployment or reachability issues for DoT in this measurement context.



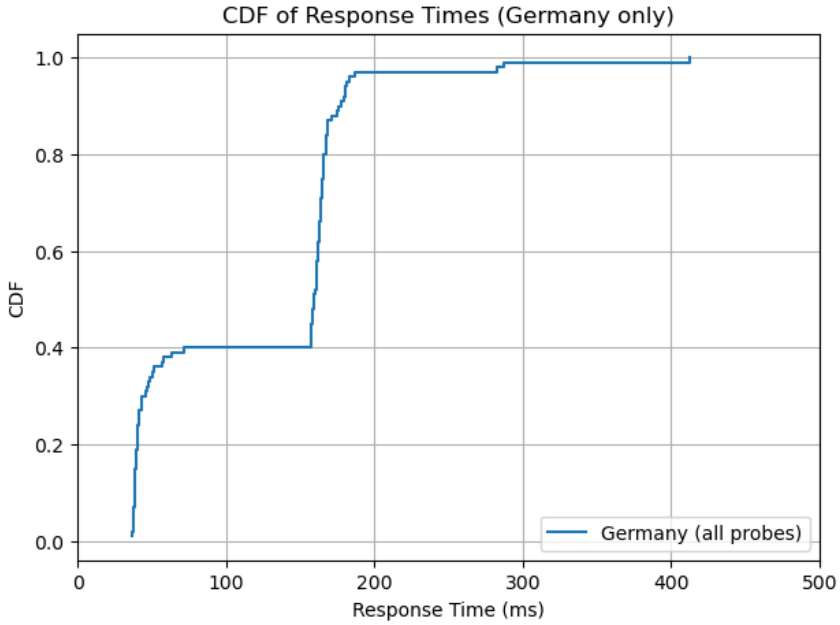
The majority of errors (60.1%) are timeouts (timeout: 5000). The rest are split among various TLS connection errors (e.g., TUC0NNECT, DH lib, and others), with a small fraction labeled as “Other” (including read errors and missing resolvers). The high rate of timeouts and TLS-specific errors strongly suggests that most DoT queries from German probes could not establish a secure connection to the resolver. This points to widespread blocking, misconfiguration, or lack of support for DoT on the tested resolvers.



This plot only shows the local resolver, as all other resolvers failed to return successful measurements. The distribution matches the national CDF, with most queries answered in under 200ms, but a non-negligible fraction experiencing higher delays. The fact that only the local resolver produced any successful DoT measurements is striking. This suggests that, for the German probes and the tested setup, DoT queries to public or external resolvers were systematically blocked, unreachable, or otherwise unsuccessful. Only the local resolver could be reached using DoT.

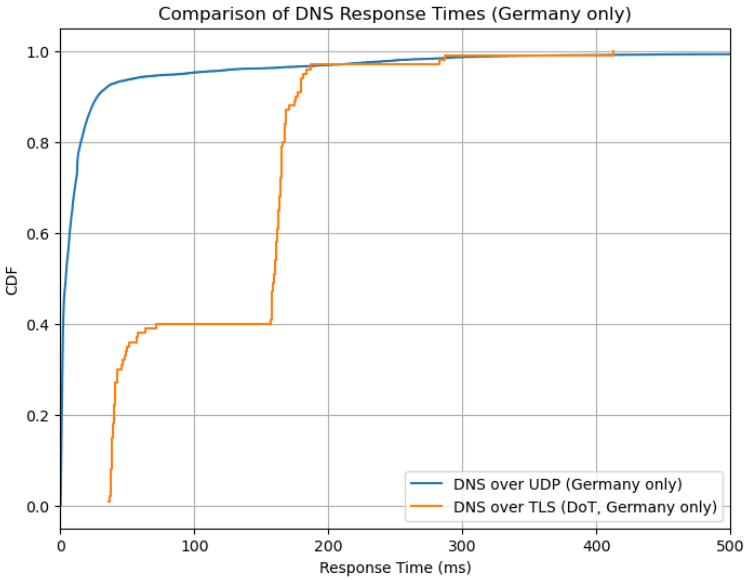


The CDF compares response times for two ASNs (9063 and 24940). ASN 24940 exhibits significantly lower response times, with almost all queries answered in under 80ms. In contrast, ASN 9063 shows much higher latencies, with most responses clustering between 150ms and 200ms, and some outliers reaching over 400ms. There are substantial differences in DoT performance between networks. ASN 24940 is much better optimized or connected for DoT queries than ASN 9063. This highlights the strong influence of network infrastructure on DNS-over-TLS latency.



The CDF shows the overall distribution of DoT response times for all successful measurements from German probes. Most queries are answered within 200ms, but there is a noticeable plateau, indicating that a significant fraction of queries experience higher latency. Special note: Since only the local resolver produced successful measurements, this CDF is effectively identical to the CDF for the local resolver. The overall DoT performance in Germany appears moderate, but this result is heavily biased: only queries to the local resolver succeeded, and all other resolvers failed. This limits the representativeness of the CDF for the broader DNS-over-TLS landscape in Germany.

Choose one CDF of your choice from Task 1 showing DNS over UDP and compare it to the corresponding CDF showing DoT. Describe similarities and differences you can see when comparing regular DNS and DoT.



Similarities:
Both CDFs show the cumulative distribution of response times for DNS queries from German probes. In both cases, the majority of successful queries are answered in under 500ms.

Differences:
The CDF for DNS over UDP rises very steeply, with over 90% of queries answered in less than 100ms. This indicates that regular DNS is both fast and consistent across a wide range of probes and resolvers. In contrast, the CDF for DoT shows a very pronounced step between 80ms and 160ms at the 0.4 mark. This means that about 40% of successful DoT queries have response times clustered in this range, and there are almost no faster responses. The curve is much less steep and shows more variability compared to UDP.

Explanation:
The main reason for this difference is that, in the DoT measurements, only three local resolvers actually returned successful results. This small and homogeneous sample leads to the step-like appearance in the CDF and the lack of very fast responses. In contrast, the UDP measurements include many more probes and resolvers, resulting in a smoother and steeper CDF that reflects the generally better performance and higher availability of regular DNS.

Conclusion:
Regular DNS over UDP provides much faster and more consistent response times for German probes than DNS-over-TLS, which in this measurement was only successful for a handful of local resolvers, leading to higher and more variable response times. The step in the DoT CDF is a direct result of the limited number of successful measurements and the lack of diversity in the responding resolvers.