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Data Privacy and Security

Homework 2

1. October 2025
2. Laplace Mechanism
   1. discussion of the global sensitivity and corresponding noise amount

* Global Sensitivity: I use an average-over-S sensitivity Δ = (range) / m (where range = max\_age − min\_age and m = |{age>25}|). This is a dataset-independent sensitivity Δ = R / min\_m (where [min\_m](vscode-file://vscode-app/c:/Users/seamu/AppData/Local/Programs/Microsoft%20VS%20Code/resources/app/out/vs/code/electron-browser/workbench/workbench.html" \o ") is the minimum m across the original + three neighbor datasets) so the same GS is used for datasets, This is done so that the range of our noise sampling does not leak information about the dataset used.) Choosing a realistic static range of ages to bound our sampling range is incredibly important for maintaining utility as a very large range which includes many values not in the dataset will cause a greater amount of noise to be injected to the noisy response and thus make the response less accurate (though very private). The global range to be used is set in my program using a cli argument, for all of my tests I use a range of 100.
* if (g\_global\_range > 0.0) {
* int m\_orig=0, m\_o=0, m\_a=0, m\_y=0;
* double avg; int min\_age, max\_age;
* bool ok=true;
* ok &= get\_stats(input\_path, m\_orig, avg, min\_age, max\_age);
* ok &= get\_stats(data\_dir + "/adult\_minus\_oldest.data", m\_o, avg, min\_age, max\_age);
* ok &= get\_stats(data\_dir + "/adult\_minus\_age26.data", m\_a, avg, min\_age, max\_age);
* ok &= get\_stats(data\_dir + "/adult\_minus\_youngest.data", m\_y, avg, min\_age, max\_age);
* if (!ok) {
* cerr << "Warning: failed to compute stats for one or more datasets; falling back to per-file sensitivity." << endl;
* } else {
* int min\_m = max(1, min(min(m\_orig, m\_o), min(m\_a, m\_y)));
* fixed\_sensitivity = double(g\_global\_range) / double(min\_m);
* cout << "Using fixed sensitivity = global\_range / min\_m = " << fixed\_sensitivity << " (global\_range=" << g\_global\_range << ", min\_m=" << min\_m << ")\n";
* }
* }
* Noise sampling: the Laplace mechanism is used with scale b = Δ / ε; noise is drawn from Laplace(0,b) via the inverse-CDF
* double sensitivity;
* if (sensitivity\_override > 0.0) {
* sensitivity = sensitivity\_override;
* } else if (g\_global\_range > 0.0) {
* sensitivity = double(g\_global\_range) / double(max(1, m));
* } else {
* sensitivity = double(max\_age - min\_age) / double(max(1, m));
* }
* double scale = sensitivity / epsilon;