Workshop Homework: OOP, Shiny & Rcpp

Homework Assignment

Please complete the following tasks within one week and submit as a GitHub repository named **knn_workshop_hw**.

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1. Extend the k-NN S3 Class (30 pts)

- **Inverse-Distance Weights**: Modify your `knn_s3` implementation to support a `weight = c("uniform", "inverse")` argument. When `inverse`, use weights proportional to 1/distance, normalized to sum to 1.
- **Unit Tests**: Write **testthat** tests verifying both weighting schemes, and that uniform results match when distances are equal.
- **Documentation**: Add roxygen comments for the new argument and regenerate help files with `devtools::document()`.

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2. Shiny App Enhancement (30 pts)

- **Dynamic Predictors**: In the k-NN app, add a multi-select input to choose predictor variables at runtime.
- **Nearest-Neighbor Table**: Display the indices and distances of the k nearest neighbors for the first test observation in a table.
- **Download Button**: Enable downloading the test-set predictions as a CSV file.
- **Input Validation**: Disable or warn if no predictors are selected.

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3. Rcpp Performance Study (30 pts)

- **Benchmark Script**: Create `benchmark_knn_dims.R` to measure runtimes for pure-R vs Rcpp across combinations of sample size $n \in \{500, 1000, 2000\}$ and feature count $p \in \{3, 5, 10\}$. Plot a heatmap of speed-up ratios.
- **C++ Optimization**: Modify `knn_pred.cpp` to use `std::partial_sort` instead of `std::nth_element`, re-benchmark, and report any differences.
- **Summary Report**: Produce a one-page PDF summarizing your benchmarks, code changes, and recommendations.

Deliverables

Your GitHub repository **knn_workshop_hw** should include:

```
knn_workshop_hw/
  R/           # R scripts and tests
  app/         # Shiny app files
  src/         # C++ source for Rcpp
  benchmark_knn_dims.R
  report.pdf   # summary of benchmarks and findings
  README.md    # overview and instructions
```

Include a **README** with setup instructions and a sample run of each component.

Good luck, and feel free to reach out with questions!