day_10_example_GP_1_template

September 26, 2025

[ ]:
```r
# Gaussian Process regression with mlegp (simple first example)

# install.packages("mlegp") [uncomment for first install]
```

[ ]:
```r
library(mlegp)
```

[ ]:
```r
set.seed(123) #ensures reproducibility
```

[ ]:
```r
#Training data
x_train <- # <-- put your points here
```

[ ]:
```r
# Generate noisy observations from f(x) = x * sin(x) (+noise), use values for␣
 ↪sd between 0.2 to 0.9
y_train <- #put your code here (y_train is your f(x))
```

[ ]:
```r
# Fit GP model (note: mlegp expects X as a matrix (n x d). Here d = 1, so n x 1.
 ↪)
# Z is the response vector (length n).

gp_model <- #put your code here
```

[ ]:
```r
# Prediction grid
x_pred <- # specify where you want predictions
pred   <- # put your code here to generate a prediction grid
```

[ ]:
```r
# Extract mean and standard deviation
mu  <- pred$fit # predictive mean at x_pred
sdv <- pred$se.fit # predictive standard deviation at x_pred
```

[ ]:
```r
# Plot: uncertainty ribbon, mean line, training points
# Draw in layers so the ribbon sits behind the line and points.
plot(x_pred, mu, type = "n",
     xlab = "x", ylab = "f(x) = x sin(x)",
     ylim = range(mu + 2 * sdv, mu - 2 * sdv, y_train))

# Plot the uncertainty band first (behind everything) (±2 sd) -> shows how␣
 ↪confident the GP is
polygon(
```

```r
  c(x_pred, rev(x_pred)),
  c(mu + 2 * sdv, rev(mu - 2 * sdv)),
  col = adjustcolor("orange", alpha.f = 0.30),
  border = NA
)

# Plot the Mean line (the posterior mean)
lines(x_pred, mu, col = "orange4", lwd = 2)

# True function on the prediction grid (just for comparison)
f_true <- x_pred * sin(x_pred)
lines(x_pred, f_true, col = "darkgreen", lwd = 2, lty = 3)

# Finally, plot the training points on top
points(x_train, y_train, pch = 19, col = "steelblue")

# Add a legend
legend("topleft",
       legend = c("GP mean", "±2 sd (uncertainty)", "observations", "sampled␣
 ↪functions"),
       lwd = c(2, 1, NA, 1),
       lty = c(1, 3, NA, 1),
       pch = c(NA, NA, 19, NA),
       col = c("orange4", "orange3", "steelblue", adjustcolor("gray30", 0.7)),
       pt.cex = 1, bty = "n")
```