Humanized 4th qs

% WLS Simulation: Compare full vs reduced model

% Author: Your Name

% Date: March 25, 2025

n = 20;

x = 3 \* (1:n)'; % simulate x-values from 3 to 60

% True parameters for full model (includes 3 terms)

true\_beta = [100; 100; 100];

n\_sim = 100;

% Design matrices

X\_full = [ones(n,1), exp(-0.1\*x), exp(-0.01\*x)];

X\_reduced = [ones(n,1), exp(-0.1\*x)]; % drop last term

% Storage for estimates

b\_full\_all = zeros(3, n\_sim);

b\_reduced\_all = zeros(2, n\_sim);

% Plot one example of the data + fits

figure; hold on;

for rep = 1:n\_sim

eta = X\_full \* true\_beta;

noise\_std = 0.1 \* eta; % noise scales with signal

y = eta + noise\_std .\* randn(n, 1);

% weight matrix based on known noise std

W = diag(1 ./ noise\_std.^2);

% WLS estimation: full model

b\_full = (X\_full' \* W \* X\_full) \ (X\_full' \* W \* y);

b\_full\_all(:, rep) = b\_full;

% WLS estimation: reduced model (no beta\_3)

b\_reduced = (X\_reduced' \* W \* X\_reduced) \ (X\_reduced' \* W \* y);

b\_reduced\_all(:, rep) = b\_reduced;

% Plot only the first replicate for visual sanity check

if rep == 1

plot(x, y, 'ko', 'DisplayName', 'Sample data');

y\_fit\_full = X\_full \* b\_full;

y\_fit\_red = X\_reduced \* b\_reduced;

plot(x, y\_fit\_full, 'b-', 'LineWidth', 2, 'DisplayName', 'Full model');

plot(x, y\_fit\_red, 'r--', 'LineWidth', 2, 'DisplayName', 'Reduced model');

end

end

xlabel('x'); ylabel('y');

title('WLS Fit Comparison (1st run) — March 25, 2025');

legend('Location', 'best'); grid on;

% --- Summary Stats ---

mean\_full = mean(b\_full\_all, 2);

std\_full = std(b\_full\_all, 0, 2);

mean\_reduced = mean(b\_reduced\_all, 2);

std\_reduced = std(b\_reduced\_all, 0, 2);

% --- Print results ---

fprintf('\n===== FULL MODEL (3 parameters) =====\n');

fprintf('True beta: [%.1f, %.1f, %.1f]\n', true\_beta);

fprintf('Mean estimates: %.2f %.2f %.2f\n', mean\_full);

fprintf('Std deviations: %.2f %.2f %.2f\n', std\_full);

fprintf('\n===== REDUCED MODEL (2 parameters) =====\n');

fprintf('True beta (partial): [%.1f, %.1f]\n', true\_beta(1:2));

fprintf('Mean estimates: %.2f %.2f\n', mean\_reduced);

fprintf('Std deviations: %.2f %.2f\n', std\_reduced);

% (Optional) Check estimation bias

% bias\_full = mean\_full - true\_beta;

% disp('Bias (full):'); disp(bias\_full);