Assignment 2 Due 10/7 at Midnight

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Part 1: Math

In class, we have worked with "Signal plus noise Model" (equation 1.5)

$$\text{Model: } x_t = 2\cos(2\pi\frac{t+15}{50}) + w_t$$
$$\text{Mean function: } \mathbb{E}(x_t) = 2\cos(2\pi\frac{t+15}{50})$$

1. [5 points] The mean function is derived in Example 2.4. Describe what happens in each step of the computation [3 points], and provide a "math stress" rating (1 = effortless, 100 = nightmare) and 3 emojis[2 points]. This is personal and there is no right answer.
2. [5 points] Is the signal plus noise model stationary in the mean?
3. [5 points] Write down $\gamma_x(s,t)$, the autocovariance function of x_t [3 points]. You may accomplish this in any way, including asking me personally in office hours or asking a classmate. Just make sure you cite the source![2 points]
4. [6 points] Consider the model:

   $$y_t = x_t - 2\cos(2\pi\frac{t+15}{50})$$

   Compute the mean function of y_t [3 points]. Is y_t stationary in the mean?[1 point] How do you know?[2 points]

Part 2: Code

Note: I have set the code chunks here to have `eval: false` in the code chunk. Change that to `true` so that I can run your code easily.

0. [5 points] All your code runs without errors (unless that's the point), and if there is a message, explain what it means.
1. [5 points] Simulate from an AR(1) process with coefficient 0.7 and 10 data points.

```
library(astsa)

# your code here
```

2. [6 points] Look at the documentation for the `stats::lag` function (run `?lag` in the console). State what package the function is in and what the function does[4 points]. Using `k = 1` compute a lag(1) version of `x_t` that you simulated above[2 points].

```
x_t_lag1 <- # your code here
```

3. [3 points] Run the following code and compare `x_t` and `x_t_lag1`.

```
cbind(x_t, x_t_lag1)
```

4. Make a time series plot of `x_t` and `x_t_1`. Do you notice the same features as when in the previous question?

```
# your code here
```

5. Run the below code. Why are the plots different? Are either particularly useful?

```
plot(x_t, x_t_lag1)
plot(as.vector(x_t), as.vector(x_t_lag1))
```

6. Instead of using `stats::lag`, use `dplyr::lag` to create a new version of `x_t_lag`. Repeat the code from steps 2-5. Describe how the output has changed.

```
x_t_lag1 <- dplyr::lag(# your code here)
```

7. Fit an intercept-free regression model between `x_t` and `x_t_lag`. Provide the value of the slope estimate and interpret the value in the context of this simulation.

```r
linear_model <- # your code here
```

8. [11 points] Plot the `acf` of `x_t`[2 points] and the `acf` of the residuals from the regression model[4 points]. Which looks more like white noise?[2 points] What does this tell you about the temporal structure in `x_t` and its residuals?[3 points]

```r
# your code here
```

Part 3: Reading

[9 points] Read sections 2.8 and 2.9 from Forecasting Principles and Practice. Make 3 connections [3 points each] to content from the course textbook (equations or similar examples.).