Congratulations! You passed!

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1. The derivative (expressed as a column vector) with respect to X of $AX + b$, where A is an $k \times p$ matrix, X is a $p \times 1$ vector and b is a $k \times 1$ vector is? (Use a superscript t for transpose if needed). **1 / 1 point**

- ○ X
- ○ b
- ◉ A^t

Correct
The transpose is just taken because of convention on the desired dimensional organization of the gradient.

2. The derivative (expressed as a column vector) with respect to X of $(X - b)^t A(X - b)$ where X and b are $p \times 1$ vectors and A is a $p \times p$ symmetric matrix is? **1 / 1 point**

- ○ A
- ◉ $2A(X - b)$
- ○ $2(X - b)$

Correct
Look back to matrix derivatives lecture. Recall A is symmetric.

3. Let X be an $n \times p$ matrix. The matrix $(I - \frac{1}{n}J_{n,n})X(I - \frac{1}{p}J_{p,p})$ has all row and column means equal to zero. **1 / 1 point**

- (●) True
- ( ) False

✓ **Correct**
Look back at the lecture on centering.

4. Let X be an $n \times p$ matrix. The elements of $\frac{1}{n-1} X^t (I - \frac{1}{n} J_{n,n}) X$ are what? ($J_{n,n}$ is an $n \times n$ matrix of ones.) **1 / 1 point**

- ( ) The empirical variances and covariances of the rows of X.
- (●) The empirical variances and covariances of the columns of X.
- ( ) The empirical means of the rows of X.
- ( ) The empirical means of the columns of X.

✓ **Correct**
Look back at the lecture on variance via matrix multiplication.

5. Let X be an $n \times p$ matrix with $p \times p$ variance/covariance matrix S. Let D be the $p \times p$ diagonal matrix of the square root of the diagonal entries of S. The matrix $X D^{-1}$ has what property? **0 / 1 point**

- ( ) All of its column variances are 1.
- (●) All of its column means are 0.
- ( ) All of its row means are 0.
- ( ) All of its row variances are 1.

✗ **Incorrect**
This is irrelevant to the problem.

6. Let X be an $n \times p$ matrix with $p \times p$ variance/covariance matrix S. Let $\tilde{X} = (1 - \frac{1}{n} J_{n,n}) X$. Let D be the $p \times p$ diagonal matrix of the square root of the diagonal entries of S. The matrix $\frac{1}{n-1} D^{-1} \tilde{X}^t \tilde{X} D^{-1}$ has what properties? **1 / 1 point**

- [ ] Entries have the units of the columns of the X matrix squared.
- [x] Has empirical correlations in the off diagonals.

Correct
$\frac{1}{n-1} D^{-1} \tilde{X}^t \tilde{X} D^{-1} = D^{-1} S D^{-1}$. The purpose of this problem is to show how to convert a variance/covariance matrix into a correlation matrix via matrix multiplication.

- [ ] Entries have the units of the columns of the X matrix.
- [x] Has ones on its diagonals.

Correct
$\frac{1}{n-1} D^{-1} \tilde{X}^t \tilde{X} D^{-1} = D^{-1} S D^{-1}$. The purpose of this problem is to show how to convert a variance/covariance matrix into a correlation matrix via matrix multiplication.