

HPC - 1.4.2

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In this exercise, we explore the concept of illuminant metamerism, which occurs when colors that match under one light source (illuminant) appear different under another. Specifically, we examine three object colors (0, 1, and 2) that are metameric with respect to the standard illuminant D65 in the CIE 1931 colorimetric system. This means they have the same tristimulus values ($X = 42.5$, $Y = 33.0$, $Z = 15.1$) under D65. We aim to compute the illuminant metamerism index when these objects are illuminated by standard illuminants A, F1, F2, and F3. We use the CIELAB color difference formula to assess pairs (0,1) and (0,2) and plot the respective color signals to discuss the results.

First, we confirm that the given tristimulus values match under illuminant D65.

Object	X under D65	Y under D65	Z under D65
0	42.46	33.08	15.08
1	42.42	33.06	15.08
2	42.40	33.03	15.06

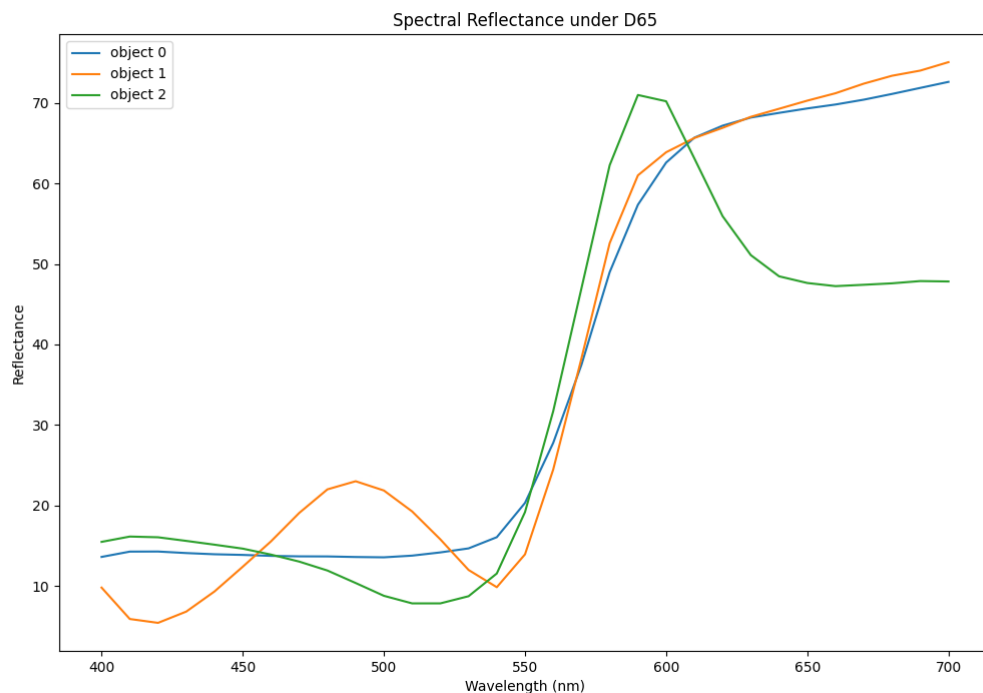
The metamerism indices provide insights into how differently the colors are perceived under different illuminants. A higher metamerism index (MI) indicates a greater difference in color appearance under the specified illuminant compared to D65. MI is the ratio of ΔE_{ab} of the illuminant and ΔE_{ab} of pairs under D65. Here is the result for two pairs of (0,1) and (0,2) for each illuminant:

Light Source	Pair	Metamerism Index
A	(0,1)	39.9084

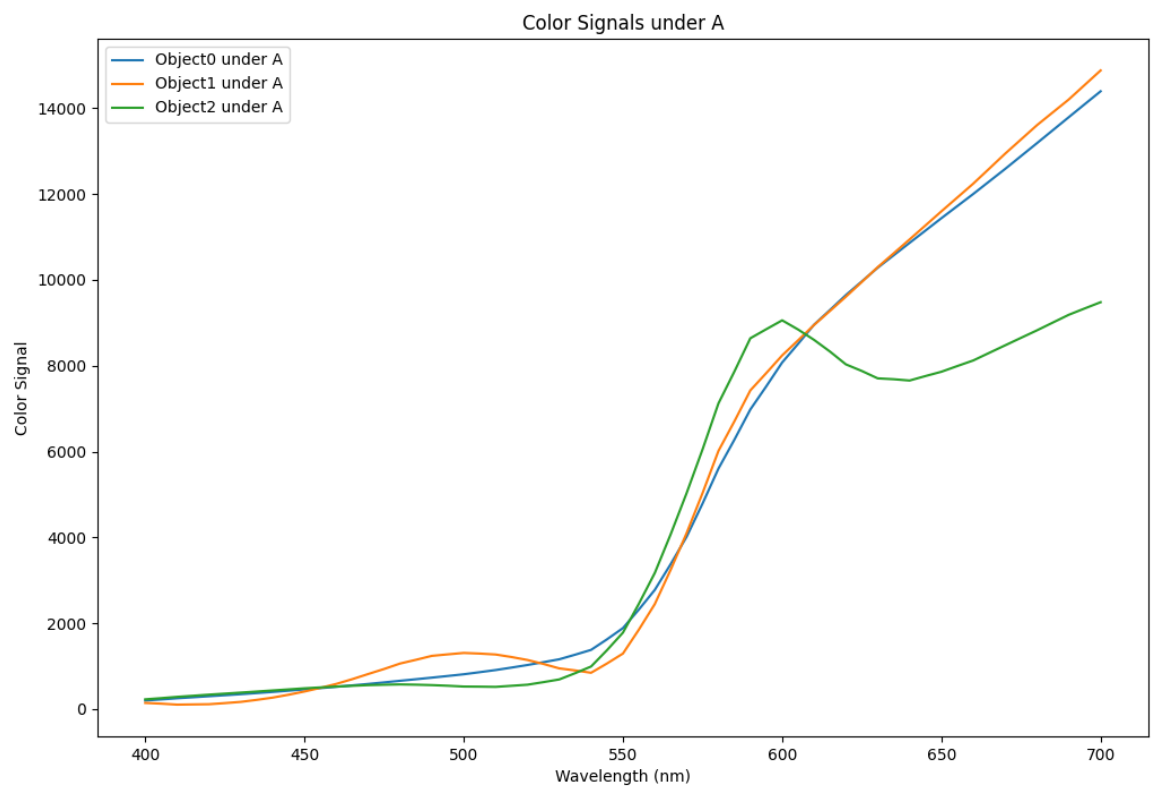
Light Source	Pair	Metamerism Index
A	(0,2)	103.9790
F1	(0,1)	35.2381
F1	(0,2)	132.1484
F2	(0,1)	23.9979
F2	(0,2)	61.4101
F3	(0,1)	14.4977
F3	(0,2)	1.2010

We see that in A, F1, and F2, the metamerism index is high which means the pairs do not maintain metamerism under these light sources. But under F3, the MI is low, specially for (0,2) pair and this pair remains metameric under F3 as well as D65.

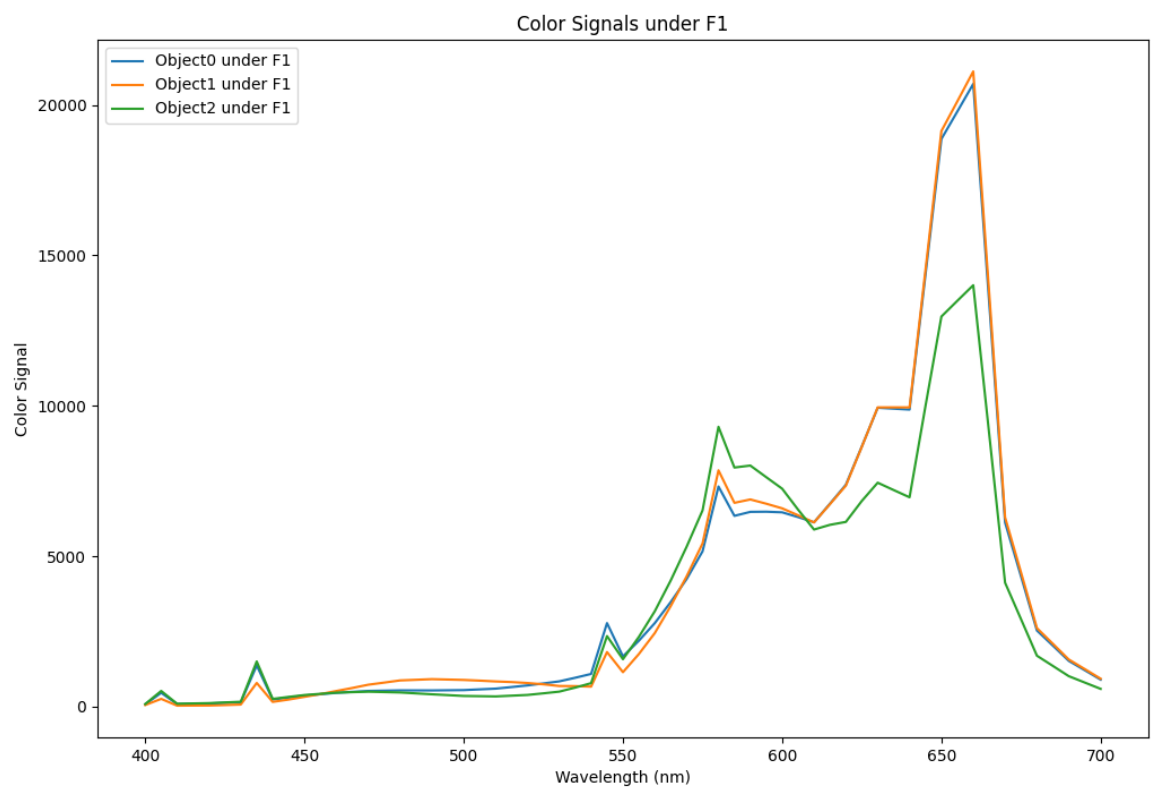
Here are the respective color signals under different illuminants:



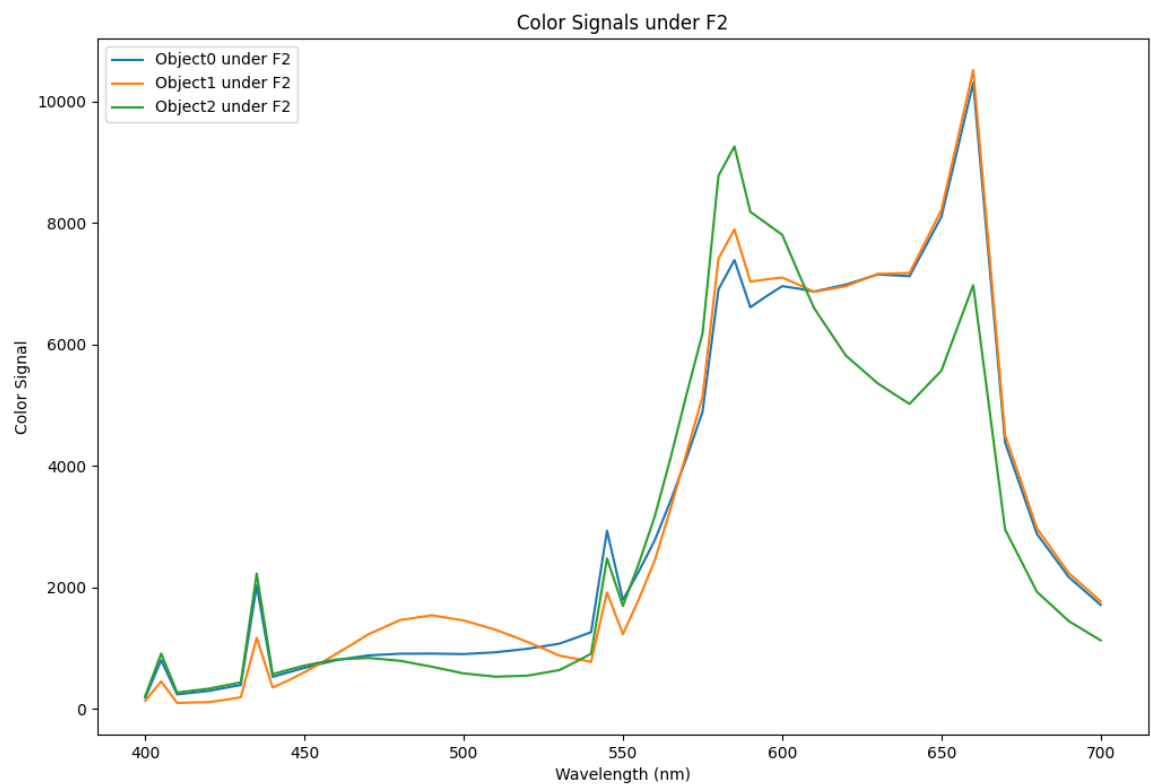
Illuminant D65: they are indeed metameric



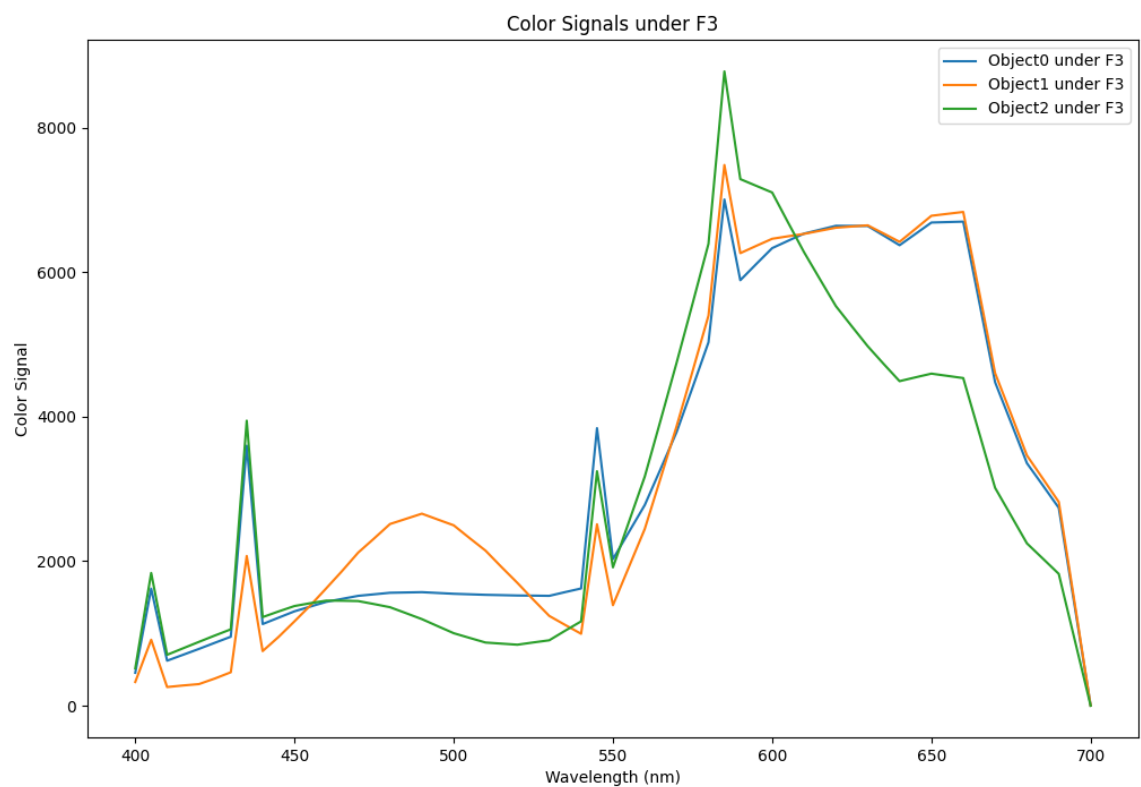
Illuminant A: All three objects had similar trends, but the difference between object 2 and the others was more noticeable.



Illuminant F1: Objects 0 and 1 had closer color signals, while object 2 differed more significantly.



Illuminant F2: The difference between objects 0 and 1 was smaller, and the divergence of object 2 was again evident.



Illuminant F3: Objects 0 and 1 remained close in their color signals with some noticeable peaks and troughs, but object 2 exhibited more variation, particularly around 550 nm and 600 nm. Despite this, the differences are less pronounced compared to other illuminants, indicating that F3 has a moderate effect on metamerism.