

# **The Colors of the Germany Crown and Eagle Series**

**Objectifying Their Classification by Color**

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# The Stamps of the Series



# The Color Varieties

Stamp	Michel	Gibbons	Scott	Number Stamps
2pf	1	1	1	19
3pf	8	4	6	2499
5pf	5	2	3	285
10pf	11	2	5	1193
20pf	7	2	4	791
25pf	4	2	2	53
50pf	8	2	5	86

# Goal of the Study

- For each denomination, using scanned images, break up the set of stamps into (relatively few) smaller groups of similar colors (i.e., all of the stamps in a group should have very similar colors)
- So that:
  - Each such group can be identified with exactly one of the color varieties.
- Then, given an unknown stamp, match its color with the color of one of the groups and we will know its color variety.

## And – Allow the Collector to Use It ...

- **Cheaply:** In other words, be able to use a scanner that the average stamp collector could afford rather than use expensive equipment.
- **Objectively:** In other words, the process should not involve the user having to make judgments as to the similarity of two colors.

# Process

- Break up the stamps (images) into groups of similar color using some procedure.
- If the color varieties are properly broken up we are done.
- Otherwise, try again with smaller groups.
- If this does not work, try a different way of breaking up the set of stamps.

# Clustering methods we used

- Maximal Cliques
- K-Means
- Split/Merge
- Stamps matched to a specific color in Color Guide
- Create an anti-clique and match stamps to the nearest member of the anti-clique.

# Groups Look Good !

- When we collect together the images in one of the groups, the sets “look homogeneous”.
- We objectified the “look homogeneous” idea by defining the homogeneity of the group to be the diameter of the set. That is, it is the maximum distance between any two images in the set. The smaller the homogeneity, the better.



# The 3pf Stamps

- Michel Catalog Color Varieties:
  - a yellowish-brown [brown] (1889 – 1892)
  - aa dark (yellowish) brown [dark brown] (1889 - 1890)
  - b medium brown [grey-brown] (1891 – 1897)
  - c pale ochre-brown [yellow-brown] (1897 – 1900)
  - ca pale ochre (1898 – 1900)
  - cb bright orange-brown [ochre-brown] (1899 – 1900)
  - d bright brown-ochre [reddish-ochre] (1897 – 1900)
  - e dark olive-brown (shades) [olive-brown] (uv: brownish-black) (1899 – 1900)

# K-Means (with $K = 8$ )

- We will show 2 (or fewer) stamps from each of the clusters.



# Brick Wall

- Although the groups look good and give the appearance of breaking the set of stamps (images) into groups of stamps with similar colors, I was unable to make the groups small enough so that each only contained stamps of a single cataloged color variety.

# The 50pf Stamps

- Michel Catalog Color Varieties:

- a (bright) brownish-red (uv: dark rose-red)(1889-1890)
- aa brownish-carmine (uv: brown-carmine)(1889-1890)
- ab dark brownish-red (uv: carmine-red)(1889-1890)
- b (bright) brown-red [reddish-brown](1889-1891)
- ba (bright) lilac-brown [reddish lilac-brown](1889-1891)
- c medium brown-red [dull rose-brown](1893-1894)
- d bright reddish-brown [lilac-brown](shades)(1890-1900)
- da bright red-brown[dark lilac-brown](1897-1899)

- All the shades other than the a-types seem to have a uv of brown.

# Stamps 2 and 12



# Are these the Same Color?

- The DeltaE76 distance between these stamps is 0.
- The colors of these stamps are:
  - Stamp 2: R,G,B = 145, 92, 89
  - H,S,L = 0.0089, 0.2393, 0.4588
  - Stamp 12: RGB = 145, 92, 89
  - HSL = 0.0087, 0.2378, 0.4599
- Thus, we cannot distinguish between them at the RGB (or Lab) level, but we can see a slight difference in the measured HSL values. The HSL distance between them is 0.04 (on a scale of 0-150). Stamp 12 is definitely brown under uv whereas stamp 2 is dark red.

# But ...

- Stamp 2 is an a-type which means that its color is one of:
  - a (bright) brownish-red
  - aa brownish-carmine
  - ab dark brownish-red
- Stamp 12 is cancelled 1890 and is brown under uv. So, its color is one of:
  - b (bright) brown-red
  - ba (bright) lilac-brown
  - d bright reddish-brown
- The only varieties with a color in common between the two groups are:
  - a (bright) brownish-red
  - b (bright) brown-red
  - d bright reddish-brown
- We thus conclude that stamps 2 is of type a and stamp12 is of type b or d. This is consistent with the perceived uv color of dark red for stamp 2.
- Stamp 12 is signed as type b, (bright) brown-red.

# Stamps 2 and 12 on 3 Scanners

Canon



Epson



HP





# Colors of 2 and 12 from 3 Scanners

	R	G	B	H	S	L
Canon						
2	145	92	89	0.0085	0.2380	0.4600
12	145	92	89	0.0087	0.2378	0.4599
Epson						
2	127	94	86	0.0299	0.1923	0.4205
12	127	97	90	0.0354	0.1666	0.4146
HP						
2	139	91	90	0.0018	0.2145	0.4518
12	134	87	87	0.0000	0.2129	0.4361

## DeltaE76 Distances between Stamps 2 and 12

<b>Canon</b>	0.00
<b>Epson</b>	2.63
<b>HP</b>	1.83

# Where are we so-far?

- At this point we can definitely say that we cannot distinguish between the color varieties based entirely on the visible colors (produced by the scanner). We need to also rely upon the uv-colors.
- At least for this scanner !
- So, at this point I thought that I would need to re-scan all the 4926 stamps using one of my other scanners.

# Which Scanner?

- All three of my scanners exhibited pairs of stamps that could not be differentiated by color but which could be seen to be different colors on the other scanners.
- Thus, we would experience the same problem no matter which of the three scanners we used.
- So, we will continue to use the Canon scanner.

# Conclusion 1

- We cannot tell if two colors are the same with either of the three scanners. For each of the scanners we can find pairs of stamps having identical RGB colors but which are distinguishable on the other two scanners.
- Thus, we cannot hope to distinguish color varieties using any of these scanners.

## Conclusion 2

- Given any two of the scanners, we can find two colors on the first that pair with a single color on the second.
- Thus, there does not exist a perfect transformation of colors between any two of the three scanners.

# What Can We Do?

- We cannot definitively say that 2 stamps have the same color.
- But, we can positively assert that 2 stamps have different colors!
- If we can detect a difference, then they must be different.
- If we can't detect a difference, they may still be different.
- Unless the difference we see is due to noise.
- So, we need to remove the noise contributing factors.

## Continued ...

- Suppose we are using a distance  $d$  and a cutoff  $C > 0$ .
- If  $d(s,t) < C$ , it **would not** be justified in saying that the stamps  $s$  and  $t$  had the same color.
- If  $d(s,t) > C$ , it **would** make sense to say that they had different colors. (Unless the difference is due to noise.)
- Thus, we should shift our focus from trying to establish that 2 stamps “have the same color” to “have different colors”.



## Continued ...

- Assume that we have found a way to reduce the noise factor.
- Let us try to break up the sets into groups so that the stamps in one group have a different color from the stamps in any other group.
- Remember that almost every stamp has a slightly different color from any other.
- For example, for the 2499 copies of Mi 45 (3pf brown), we have 1218 distinct colors that we could conceivably use to define the groups. Of course, this is far too many!

# How Many Colors?

- Question: How many groups (colors) should we strive for?
- Answer: Examine the distances between the signed stamps that we have and try to choose a cutoff distance that will satisfy the following:
  - Separate the stamps of different varieties into different groups.
  - Keep the number of groups to a small number.
- Both goals are somewhat unreasonable (or even impossible) as well as being mutually contradictory.

# What is a “Small Number”?

- Remember that we are performing matches with the computer, not with our eyes.
- A small number of groups for the computer may seem like a large number for us.
- We should be guided, by hoping that we have chosen a reasonable  $\Delta E_{76}$  distance to distinguish between colors. The Just Noticeable Difference (JND) of 2.3 is too small. It gives too many groups.

# How Many Colors (Maximal Cliques)?

Catalog Number	Nmb. Of Stamps	Nmb. Diff. Colors	JND	4.5
Mi 45 (3pf)	2499	1218	129	41
Mi 46 (5pf)	285	199	43	19
Mi 47 (10pf)	1193	576	77	30
Mi 48 (20pf)	791	590	86	31
Mi 49 (25pf)	53	53	22	9
Mi 50 (50pf)	86	83	20	10

# How Many Colors (Maximal Anti-Cliques)?

Catalog Number	Nmb. Of Stamps	Nmb. Diff. Colors	JND	4.5
Mi 45 (3pf)	2499	1218	63	18
Mi 46 (5pf)	285	199	31	12
Mi 47 (10pf)	1193	576	47	15
Mi 48 (20pf)	791	590	48	12
Mi 49 (25pf)	53	53	14	4
Mi 50 (50pf)	86	83	16	6

# Maximal Anti-Cliques with Cutoff of 4.5

# Mi 45 (3pf)



**End of Talk  
Thank You for Your  
Attention !**



Optional Slides that can be Used to Answer  
Questions or Provide Supplementary  
Discussion

# Color Guides

- Michel            600 Colors
- Gibbons         200 Colors

# 5pf Color Shades

Gibbons	Hue	Saturation	Luminance
yellow-green	0.206	0.325	0.374
a blue-green	0.488	0.968	0.256

Michel	Hue	Sat.	Lum.
a green	0.430	0.301	0.448
aa dark gray green	0.290	0.129	0.374
b yellowish-green	0.296	0.345	0.520
ba dark yellowish-green	0.294	0.305	0.432
c bright opal-green	0.446	0.355	0.536

- Next to the 2pf, this is probably the simplest case.

# Some Signed Copies



a



b



ba



c

# What led me to decide to study this set?

- Answer:
  - An accumulation of  
**4,926 stamps**

And:

It is **Notoriously Difficult** to sort the color varieties

Stamp	Number	With Years
2pf	19	12
3pf	2499	1762
5pf	285	179
10pf	1193	915
20pf	791	384
25pf	53	42
50pf	86	65

- With this many stamps and so many with cancel years, we should be able to tell what color varieties they are.

# Scanners Used in this Study

- Canon LiDE 120
  - This is the main scanner used in the study. It is cheap and reliable.
- HP Photosmart 6520 “All-in-one”
  - Used only for a few comparisons.
- Epson Perfection V600 Photo
  - Used only for a few comparisons.

# Scanning

- In order to obtain consistent results among the scanners, a single driver was used for all the scanners: the standard Twain driver which is provided as part of the Windows operating system.
- All stamps were scanned at 300 DPI with no adjustments of Brightness or Contrast.
- All stamps were scanned with a black background.

# The First Four

- Stamps 1, 2, 3 and 4 are all postmarked 1889 or 1890.





# What are their Color Varieties?

- The Michel catalog distinguishes the a-types (a, aa, ab) by their uv colors. They would all be reddish under uv.
- All the other varieties are brownish under uv.
- Stamps 1 and 2 are reddish under uv. Stamps 3 and 4 are brownish. Stamp 1 is bright red and stamp 2 is dark red.
- Thus, stamps 1 and 2 are either a, aa or ab and stamps 3 and 4 are either b, ba or d.
- You should notice that this is a very “non-objective” discussion.

## Color Varieties (Continued)

- According to the Michel catalog, the uv of variety a should be dark rose-red, variety aa should be brown-carmine and variety ab should be carmine-red.
- Based on these descriptions, I would be prone to say that stamp 1 was type ab and stamp 2 was type a. Of course, this goes contrary to the classification of Wiegand who has declared stamp 1 to be of type a.

# What are their Colors?

- Stamp 1: R,G,B = 149, 89, 87
- H,S,L = 0.0054, 0.2627, 0.4627
- L,a,b = 44.5503, 24.4659, 11.7317
- 
- Stamp 2: R,G,B = 145, 92, 89
- H,S,L = 0.0089, 0.2393, 0.4588
- L,a,b = 44.7946, 21.3551, 10.7822
- 
- Stamp 3: R,G,B = 147, 88, 84
- H,S,L = 0.0106, 0.2727, 0.4529
- L,a,b = 43.9774, 23.8651, 12.7159
- 
- Stamp 4: R,G,B = 149, 91, 87
- H,S,L = 0.0108, 0.2627, 0.4627
- L,a,b = 45.0254, 23.3228, 12.3907

# What are the Distances Between Them?

The DeltaE76 distances between these stamps are given in the following table:

	1	2	3	4
1	0	3.2611	1.2879	1.4024
2	3.2611	0	3.2722	2.5524
3	1.2879	3.2722	0	1.2245
4	1.4024	2.5524	1.2245	0

# Anomalies

- We see that stamps 1, 3 and 4 are very close to each other in color.
- But, because of their uv colors they cannot belong to the same color variety.
- Now let's muddy the picture some more.

# So What About Stamp 1?

- Its uv color is clearly bright red and is much different from the uv color of stamp 2. We thus must have stamp 1 being of type ab. Its typing as an a must be incorrect.
- Maybe ...

# Mi 46 (5pf)



# Mi 47 (10pf)





# Mi 48 (20pf)



# Mi 49 (25pf)



# Mi 50 (50pf)



# Comparison of Two Canon Scanners



## Comparison of Two Canon Scanners - 2

Stamp	Distance Between Scans
Mi 52 – 2 pf	0.0000
Mi 45 – 3 pf	0.6642
Mi 46 – 5 pf	1.9654
Mi 47 – 10 pf	2.0546
Mi 48 – 20 pf	0.4040
Mi 49 – 25 pf	1.2515
Mi 50 – 50 pf	0.6590

## Comparison of Two Canon Scanners - 3

Stamp	Scanner	H	S	L
Mi 52 – 2 pf	Old	0.6157	0.0541	0.5137
	New	0.6152	0.0535	0.5136
Mi 45 – 3 pf	Old	0.0771	0.2075	0.4598
	New	0.0766	0.2076	0.4560
Mi 46 – 5 pf	Old	0.3582	0.1484	0.4755
	New	0.3426	0.1493	0.4677
Mi 47 – 10 pf	Old	0.0007	0.4399	0.5176
	New	0.0010	0.4548	0.5136
Mi 48 – 20 pf	Old	0.6133	0.2126	0.4559
	New	0.6124	0.2126	0.4519
Mi 49 – 25 pf	Old	0.0604	0.5475	0.5676
	New	0.0614	0.5622	0.5676
Mi 50 – 50 pf	Old	0.0111	0.2476	0.4716
	New	0.0107	0.2478	0.4677