Colour Schemes

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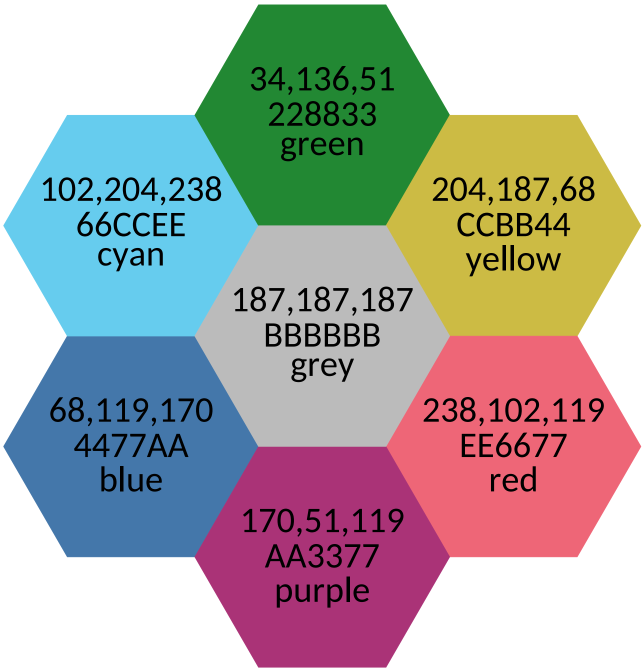


Document Change Record

Issue	Date	Changed Section	Description of Change
1.0	18 November 2009	All	Initial version
2.0	17 January 2010	All	Print-friendlier schemes
			Added commands to simulate colour blindness
2.1	17 August 2010	Fig. 4	Remark added on background grey
		p. 9	Remark added on NEN colour set
		Figs. 11, 16, 23	Added plots to check robustness
2.2	29 December 2012	Fig. 19	Added a discrete rainbow scheme
3.0	31 May 2018	All	Revised all schemes and text
3.1	23 September 2018	Section 2	Added high-contrast scheme
		Section 4	Added iridescent scheme
		Section 5	Added text on monochrome vision
		Section 6	Revised and extended text and figures
3.2	18 August 2021	Sections 2, 5, 6	Added medium-contrast scheme

Table of Contents

Reference Documents

[RD1] Cynthia A. Brewer. *ColorBrewer, a web tool for selecting colors for maps*. http://colorbrewer2.org. 2009.

[RD2] Gaurav Sharma, Wencheng Wu, and Edul N. Dalal. "The CIEDE2000 color-difference formula: implementation notes, supplementary test data, and mathematical observations". In: *Color Research and Application* 30 (2005). http://www.ece.rochester.edu/~gsharma/ciede2000/ciede2000noteCRNA.pdf, pp. 21–30.

[RD3] Olaf Drümmer. *ECI Offset Profiles*. http://www.eci.org/doku.php?id=en:colorstandards:offset#which_profile_should_i_use. 2009.

[RD4] Normcommissie 'Ergonomie van de fysische werkomgeving' with Buro Blind Color. *Functional use of colour—Accommodating colour vision disorders*. Code of practice NPR 7022. Delft: Netherlands Standardization Institute, Apr. 2006.

[RD5] Françoise Viénot, Hans Brettel, and John D. Mollon. "Digital video colourmaps for checking the legibility of displays by dichromats". In: *Color Research and Application* 24 (1999), pp. 243–252.

[RD6] Hans Brettel, Françoise Viénot, and John D. Mollon. "Computerized simulation of color appearance for dichromats". In: *Journal of the Optical Society of America A* 14 (1997), pp. 2647–2655.

[RD7] Andrew Kirkpatrick et al. *Web Content Accessibility Guidelines*. Issue 2.1, https://www.w3.org/TR/WCAG21/. Contrast ratio calculation: https://www.w3.org/WAI/WCAG21/Techniques/general/G18#procedure. World Wide Web Consortium, 2018.

[RD8] M. Hansen et al. *UMD Global Land Cover Classification, 1 Kilometer*. Issue 1.0. http://iridl.ldeo.columbia.edu/SOURCES/.UMD/.GLCF/.GLCDS/.lc. Department of Geography, University of Maryland, 1998.

1 Introduction

Graphics with scientific data become clearer when the colours are chosen carefully. It is convenient to have good default schemes ready for each type of data, with colours that are:

- distinct for all people, including colour-blind readers;
- distinct from black and white;
- distinct on screen and paper;
- matching well together.

This document shows such schemes, developed with the help of mathematical descriptions of colour differences and the two main types of colour-blind vision.

A colour scheme should reflect the type of data shown. There are three basic types of data:

- Qualitative data – nominal or categorical data, where magnitude differences are not relevant. This includes lines in plots and text in presentations. See Section 2.
- Diverging data – data ordered between two extremes where the midpoint is important, e.g. positive and negative deviations from zero or a mean. See Section 3.
- Sequential data – data ordered from low to high. See Section 4.

Section 5 gives more info on simulating approximately how any colour is seen if you are colour-blind. The schemes that work well in a monochrome display or printout are highlighted in Section 6, with tips on how to use them best. In Section 7, a very specific colour scheme is given for the AVHRR global land cover classification.

2 Qualitative Colour Schemes

My default colour scheme for qualitative data is the *bright* scheme in Fig. 1. Colour coordinates (R, G, B) are given in the RGB colour system (red R, green G and blue B), decimal at the top and hexadecimal below. An alternative when fewer colours are enough is the *high-contrast* scheme in Fig. 2, which also works when converted to greyscale. A second alternative is the *vibrant* scheme in Fig. 3, designed for data visualization framework TensorBoard. A third alternative is the *muted* scheme in Fig. 4, which has more colours, but lacks a clear red or medium blue. A fourth alternative is the *medium-contrast* scheme in Fig. 5 with three colour pairs that can work in greyscale, but not as well as the high-contrast scheme.

The bright, high-contrast, vibrant, muted and medium-contrast schemes work well for plot lines and map regions, but the colours are too strong to use for backgrounds to mark (black) text, typically in a table. For that purpose, the *pale* scheme is designed (Fig. 6, top). The colours are inherently not very distinct from each other, but they are clear in a white area. The *dark* scheme (Fig. 6, bottom) is meant for text itself on a white background, for example to mark a large block of text. The idea is to use one dark colour for support, not all combined and not for just one word.

There are situations where a scheme is needed between the bright and pale schemes, for example (Fig. 10, right) for backgrounds in a table where more colours are needed than available in the pale scheme and where the coloured areas are small. For this purpose, the *light* scheme of Fig. 7 is designed.

Colour names have been added to the scheme definitions as mnemonics for the maker of a figure, not necessarily for use in text: a reader should not have to guess what olive looks like. Colours are identified uniquely by their names within the collective of the bright, pale, dark and light schemes, whereas the high-contrast, vibrant, muted and medium-contrast schemes reuse some names for different colours.

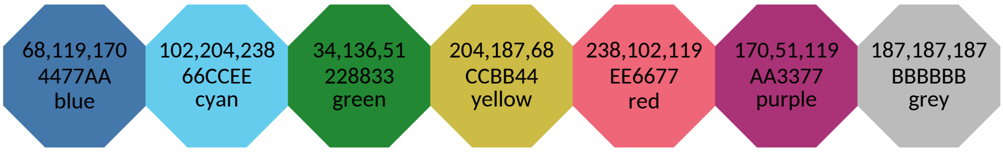


Figure 1: *Bright* qualitative colour scheme that is colour-blind safe. The main scheme for lines and their labels.

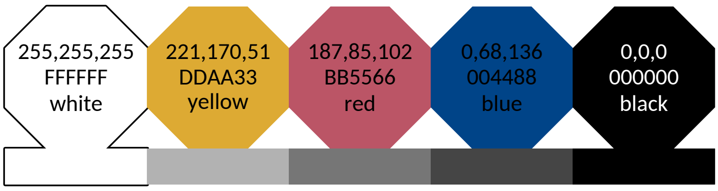


Figure 2: *High-contrast* qualitative colour scheme, an alternative to the bright scheme of Fig. 1 that is colour-blind safe and optimized for contrast. The samples underneath are shades of grey with the same luminance; this scheme also works well for people with monochrome vision and in a monochrome printout.

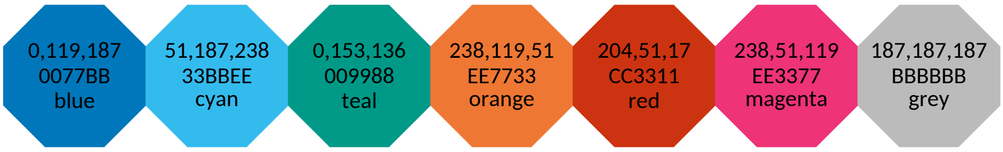


Figure 3: *Vibrant* qualitative colour scheme, an alternative to the bright scheme of Fig. 1 that is equally colour-blind safe. It has been designed for data visualization framework TensorBoard, built around their signature orange FF7043. That colour has been replaced here to make it print-friendly.

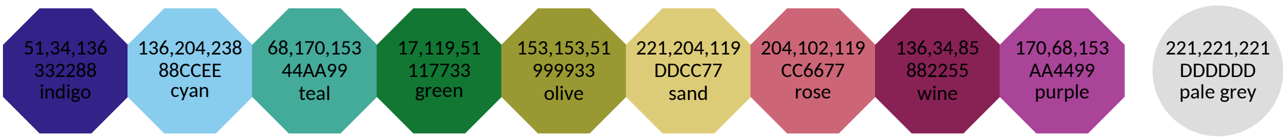


Figure 4: *Muted* qualitative colour scheme, an alternative to the bright scheme of Fig. 1 that is equally colour-blind safe with more colours, but lacking a clear red or medium blue. Pale grey is meant for bad data in maps.

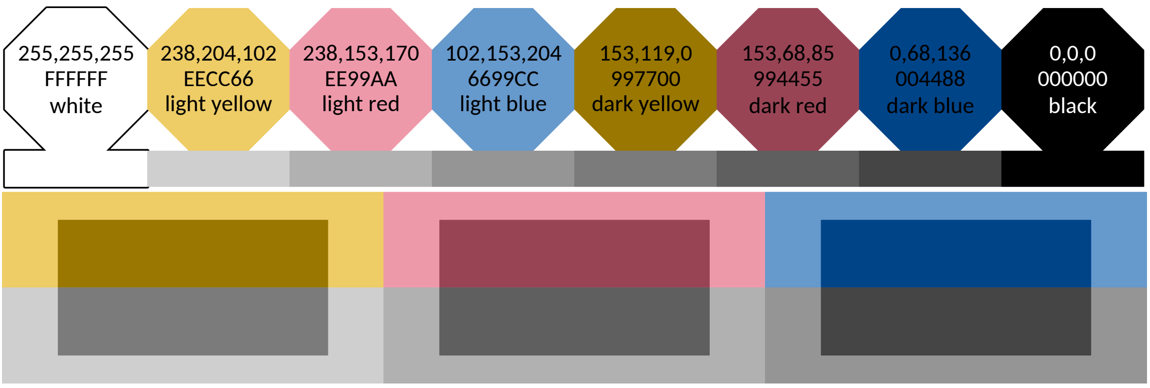


Figure 5: *Medium-contrast* qualitative colour scheme, an alternative to the high-contrast scheme of Fig. 2 that is colour-blind safe with more colours. It is also optimized for contrast to work in a monochrome printout, but the differences are inevitably smaller. It is designed for situations needing colour pairs, shown by the three rectangles, with the lower half in the greyscale equivalent.

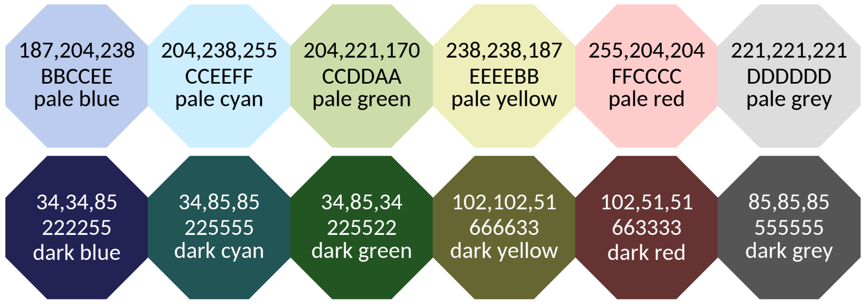


Figure 6: *Pale* and *dark* qualitative colour schemes where the colours are not very distinct in either normal or colour-blind vision; they are not meant for lines or maps, but for marking text. Use the pale colours for the background of black text, for example to highlight cells in a table. One of the dark colours can be chosen for text itself on a white background, for example when a large block of text has to be marked. In both cases, the text remains easily readable (see Fig. 10).

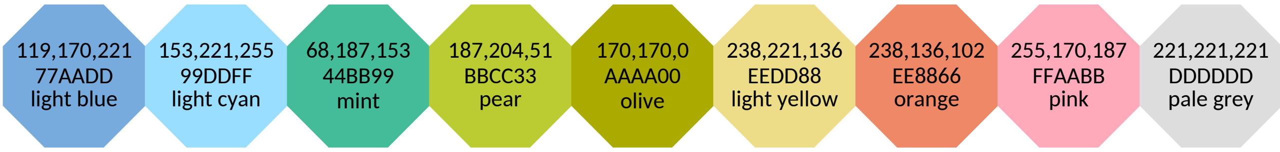


Figure 7: *Light* qualitative colour scheme that is reasonably distinct in both normal and colour-blind vision. It was designed to fill labelled cells with more and lighter colours than contained in the bright scheme of Fig. 1, using more distinct colours than that in the pale scheme of Fig. 6 (top), but keeping black labels clearly readable (see Fig. 10). However, it can also be used for general qualitative maps.

The colours within a qualitative scheme are given in order of changing hue (or luminance in the case of the high- and medium-contrast schemes), but the colours can be picked at random. Often, a data type suggests an appropriate choice or similar data types can be grouped by giving them similar colours. If the colours have to be picked in a fixed sequence, a good order for each scheme is as follows.

bright: blue red green yellow cyan purple grey
high-contrast: blue yellow red
vibrant: orange blue cyan magenta red teal grey
muted: rose indigo sand green cyan wine teal olive purple
medium-contrast: light blue dark blue light yellow dark red dark yellow light red
light: light blue orange light yellow pink light cyan mint pear olive pale grey

Examples of the use of the qualitative schemes are given in Figs. 8–9 for lines of the Tokyo metro and in Fig. 10 for cell backgrounds and text blocks. The application to maps is shown in Fig. 11. It is a stylized variation of the diagnostic map used by the ColorBrewer website [RD1]. In one area, all colours are shown in a random pattern. In other areas, basically one colour is shown, but with one small area of each other colour included. This indicates how well the colours within a scheme are identifiable when all of them are used.

The design of the qualitative schemes involved four types of calculations:

- for the distance between colours the CIEDE2000 colour difference ΔE_{00} is used [RD2];
- red-blind and green-blind vision is simulated by the method described in Section 5;
- colours with the same product of saturation S and value V in the HSV colour system (same ‘vividness’) match well together;
- colours are called ‘print-friendly’ if they are within the CMYK gamut provided by colour profile ‘ISO Coated v2 300 %’ (discussed below).

To reduce the number of calculations without much loss of choice, only websmart colours were considered, meaning the hexadecimal RGB coordinates are only 00, 11, . . . , FF.

All colours in this document are defined in sRGB colour space, the default used by most software and displays. Printers work in a different colour space that also varies from model to model. When they conform to international standard ISO 12647-2 and the exact printing conditions are not known beforehand, it is recommended to assume the CMYK colour space provided by colour profile ‘ISO Coated v2 300 %’ [RD3]. All

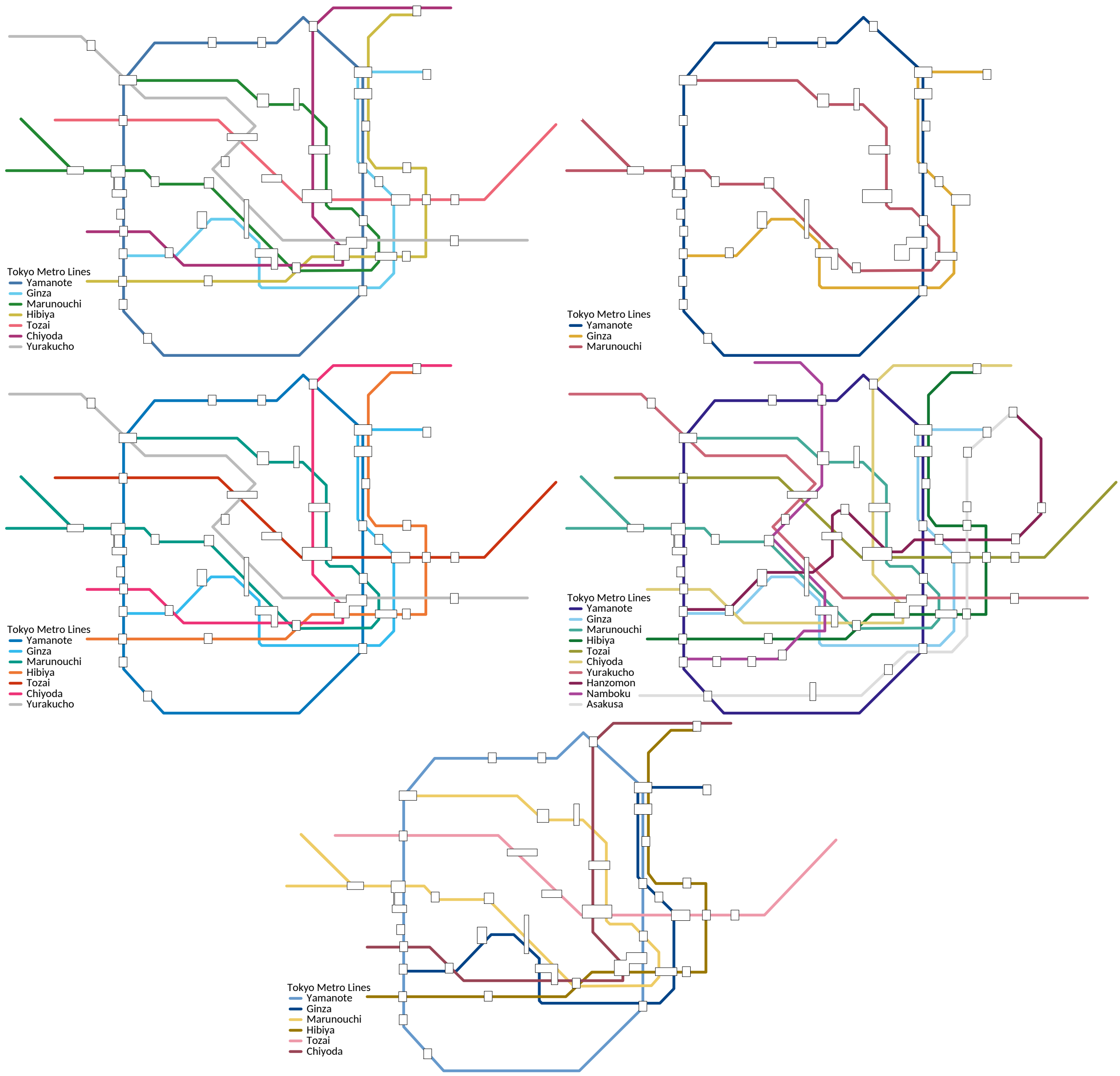


Figure 8: Metro lines in Tokyo coloured using the bright (top left), high-contrast (top right), vibrant (middle left), muted (middle right) and medium-contrast (bottom) scheme.

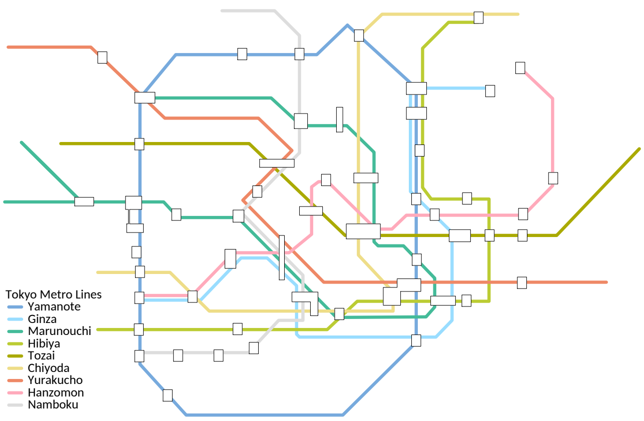


Figure 9: Metro lines in Tokyo coloured using the light scheme, showing that the light scheme is not meant for lines on a white background (see Fig. 10).

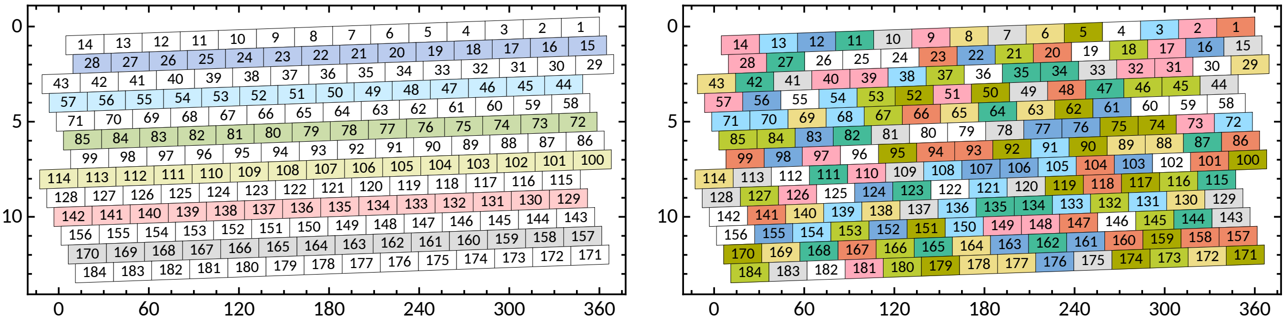


Figure 10: Examples of filling labelled cells. The pale colour scheme (left) can be used for most cases: large patterns with few colours. The highlighting works while the text remains easily readable. The light colour scheme (right) is better when more colours are needed or the colours need to be more distinct, for example when the areas with one colour are small. Note that if the colours were darker, the small print would become difficult to read, while this scheme is much lighter than the schemes for lines (see Fig. 9). This caption is set in dark green, which is distinct from black but still easily readable.

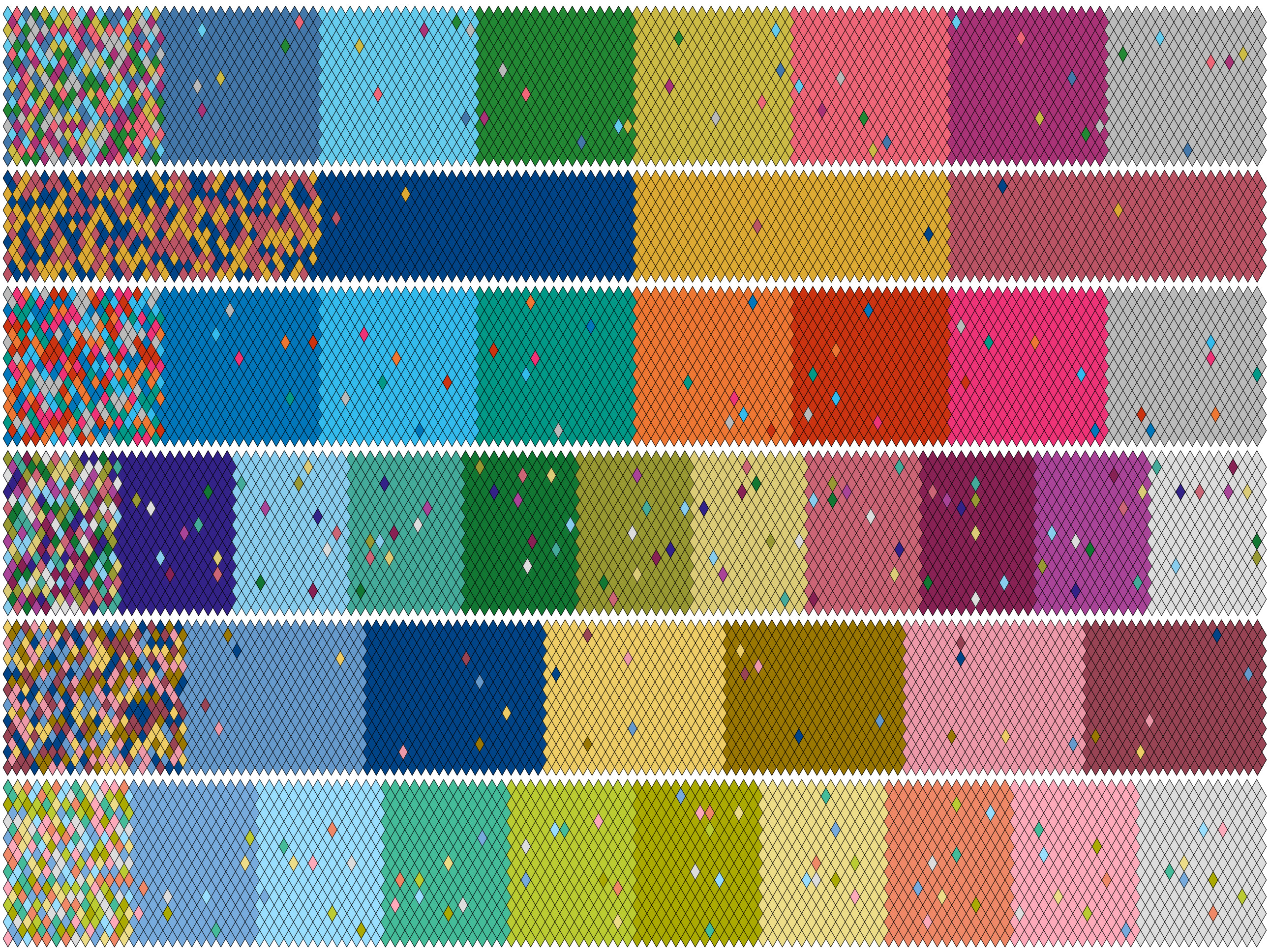


Figure 11: From top to bottom, diagnostic maps for the bright, high-contrast, vibrant, muted, medium-contrast and light qualitative schemes, given in Figs. 1, 2, 3, 4, 5 and 7, respectively. For each scheme, the section at the left contains all colours, while each of the other sections contains one colour with one diamond of each other colour. This tests how well the colours are identifiable.

scheme colours are taken from the overlap between this and the sRGB colour spaces. Individual printers may deviate, probably not so much that colours become unrecognizable, but enough to push some colours closer together. However, it is not possible to take individual printers into account.

The Netherlands Standardization Institute NEN has issued a code of practice which includes a recommended scheme with eight colours, three greys and white [RD4]. The colours are bright, but differences between them in colour-blind vision are often much smaller than the smallest difference in the bright, vibrant or muted schemes, two colours are not print-friendly and they cannot be quoted without infringing copyright.

3 Diverging Colour Schemes

Diverging schemes are for ordered data between two extremes where the midpoint is important. Such schemes could be constructed simply by scaling the colour coordinates linearly, e.g. from blue to white to red. However, by including subtle hue changes, the colours are more distinct and the schemes more attractive. Figures 12–14 show the *sunset*, *BuRd* and *PRGn* schemes, which are tweaked versions of schemes on the ColorBrewer website [RD1]. The darkest shades of the original versions have been removed, because they are too dark and similar to be used in practice. The circled colour is meant for bad data, without drawing attention away from good data with a large deviation from zero. The sunset scheme was designed for situations where bad data have to be shown white. The three schemes look similar in colour-blind vision, so if more than one is used, do not reverse the direction in one of them. If more colours than shown are needed from a given scheme, use a continuous version of the scheme instead of the discrete colours, by linearly interpolating the colour coordinates. If fewer colours are needed, pick colours at equidistant points in the continuous version. Examples of the use of the diverging schemes for maps are given in Figs. 15 and 16.

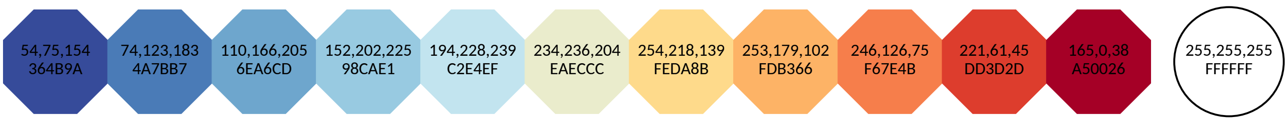


Figure 12: *Sunset* diverging colour scheme that also works in colour-blind vision. The colours can be used as given or linearly interpolated. The circled colour is meant for bad data. The scheme is related to the ColorBrewer RdYlBu scheme, but with darker central colours and made more symmetric.

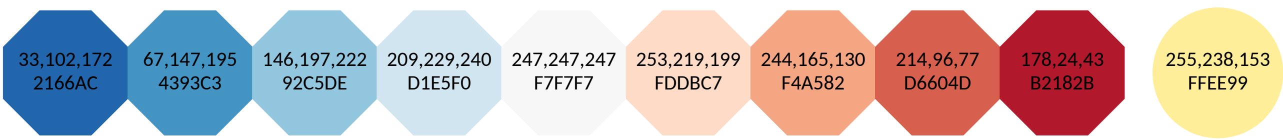


Figure 13: *BuRd* diverging colour scheme that also works in colour-blind vision. The colours can be used as given or linearly interpolated. The circled colour is meant for bad data. This is the reversed ColorBrewer RdBu scheme.

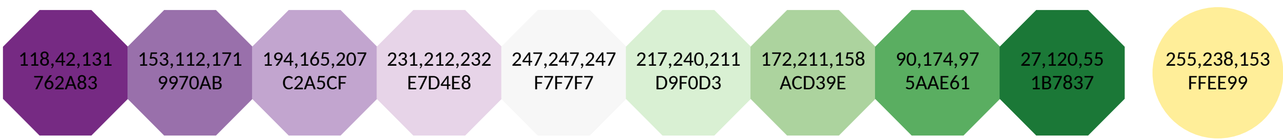


Figure 14: *PRGn* diverging colour scheme that also works in colour-blind vision. The colours can be used as given or linearly interpolated. The circled colour is meant for bad data. This is the ColorBrewer PRGn scheme, with green A6DBA0 shifted to ACD39E to make it print-friendly.

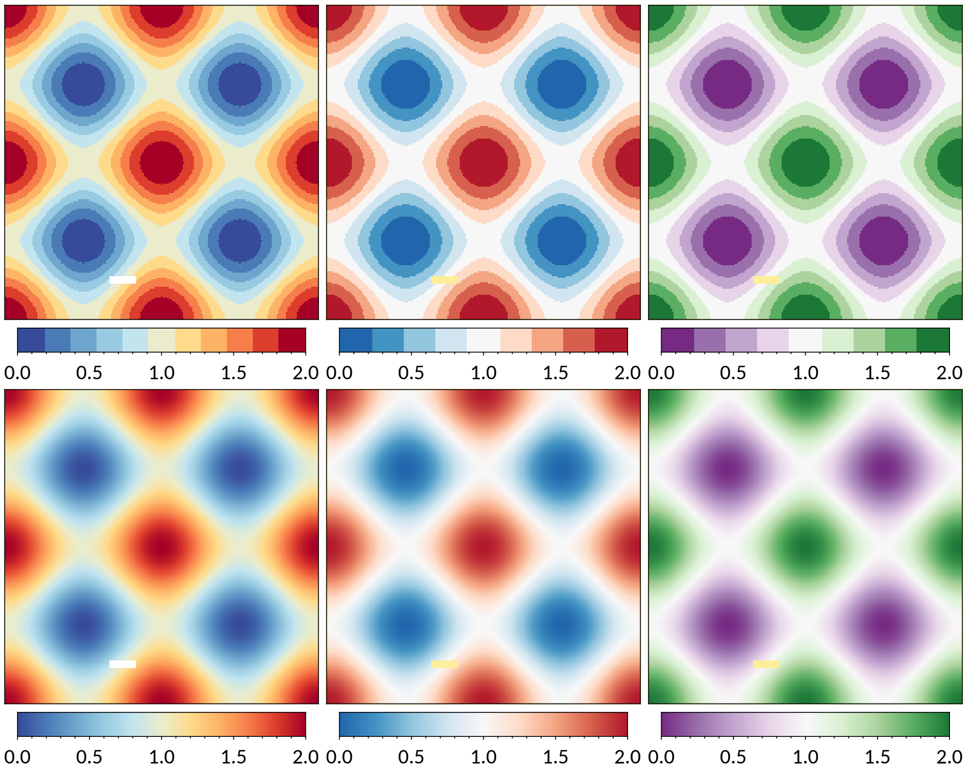


Figure 15: Examples of maps using the diverging colour schemes of Figs. 12–14, each discrete (top) and interpolated (bottom).

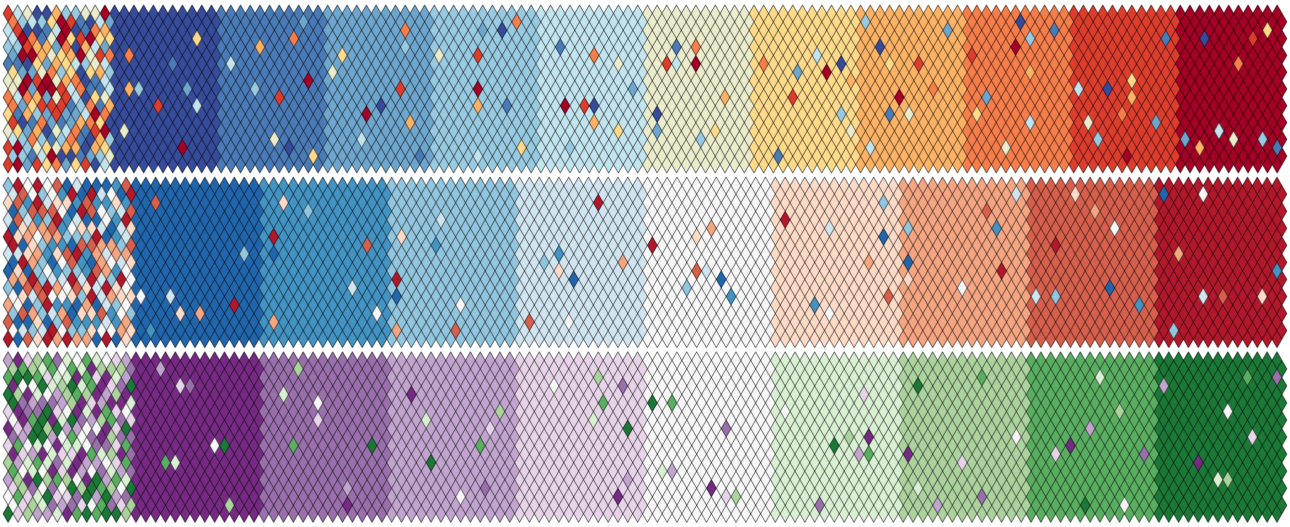


Figure 16: Diagnostic maps for the three diverging schemes given in Figs. 12–14. For each scheme, the section at the left contains all colours, while each of the other sections contains one colour with one diamond of each other colour. This tests how well the colours are identifiable when kept discrete.

4 Sequential Colour Schemes

Sequential schemes are for ordered data from low to high. The *YlOrBr* scheme given in Fig. 17 is a tweaked version of the ColorBrewer YlOrBr scheme. The most distinct grey is also given, useful for data gaps; it is not meant for extreme values. If more colours than shown are needed from this scheme, use a continuous version of the scheme instead of the discrete colours, by linearly interpolating the colour coordinates. If fewer colours are needed, pick colours at equidistant points in the continuous version. An alternative continuous scale is provided by the *iridescent* scheme, which is the linear interpolation of the colours specified in Fig. 18. The luminance varies linearly, so this scheme also works well for people with monochrome vision and in a monochrome printout.

There are many warnings that ordered data should not be shown with a rainbow scheme. The arguments are:

- The spectral order of visible light carries no inherent magnitude message. However, a rainbow provides a scheme with many colours, showing subtle effects in the data clearer or making it easier to read the value in a map. There are also cases where a scheme is preferred that does not have pale colours at the low end or middle of the range.
- Most rainbow schemes contain bands of almost constant hue with sharp transitions between them, which are perceived as jumps in the data. This can be avoided with careful design.
- Colour-blind people have difficulty distinguishing some colours of the rainbow. This can be taken into account in the design.

Here are given a *discrete rainbow* scheme (Fig. 19) and a *smooth rainbow* scheme (Fig. 20) that are reasonably clear in colour-blind vision. To remain colour-blind safe, the discrete rainbow scheme should not be interpolated. The smooth rainbow scheme does not have to be used over the full range (see caption of Fig. 20). Examples of the use of all sequential schemes for maps are given in Figs. 21 and 23.

The discrete rainbow colour scheme is inspired by the temperature map of the weather forecast in newspaper *de Volkskrant*: unconnected curves in CIELAB colour space for purples, blues, greens and oranges, each sampled three times but the last one twice extra for yellow and red, in total 14 colours. The curves were straightened, shifted and sampled equidistantly to make the colours more distinct, reasonably colour-blind safe and print-friendly. Later, the lines were resampled with smaller distances and the scheme was extended towards white and black, to get 23 colours. Figure 22 shows how the two sets can be combined to make a scheme with any number of colours up to 23.

Figure 17: *YlOrBr* sequential colour scheme that also works in colour-blind vision. The colours can be used as given or linearly interpolated. The grey is meant for bad data. This is the ColorBrewer YlOrBr scheme, with orange FE9929 shifted to FB9A29 to make it print-friendly. Pale yellow FFFFE5 can be set to completely white FFFFFF, for example in density histograms.

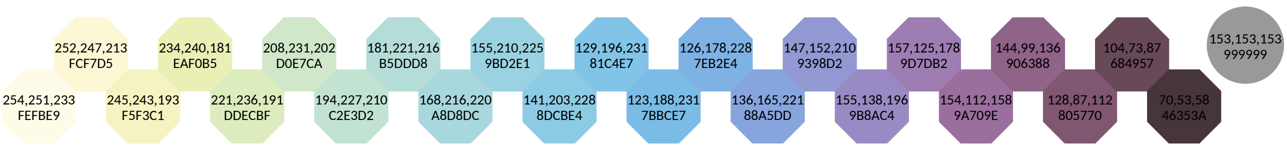


Figure 18: *Iridescent* sequential colour scheme with a linearly varying luminance that also works in colour-blind vision. The colours should be linearly interpolated, optionally extended towards white and black. The grey is meant for bad data.

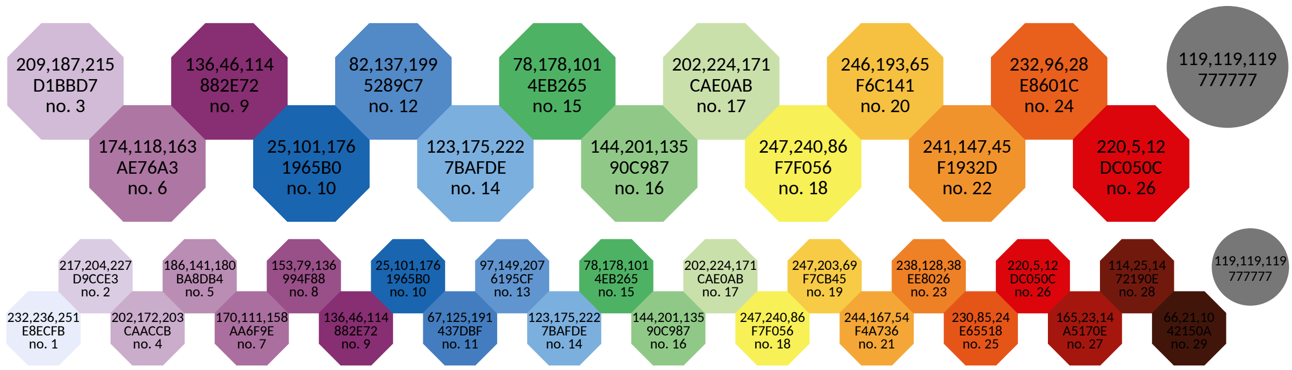


Figure 19: *Discrete rainbow* colour scheme with 14 or 23 colours for maps. See Fig. 22 for the best subset if a different number of colours is needed. The colours have to be used as given: do not interpolate. For a smooth rainbow scheme, see Fig. 20. The grey is meant for bad data, but white can also be used, except in the case of exactly 23 colours. The colours have been numbered for easy referencing in Fig. 22.

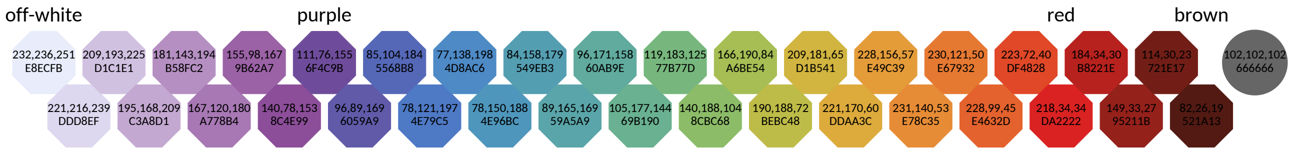


Figure 20: *Smooth rainbow* colour scheme. The colours are meant to be linearly interpolated: for a discrete rainbow scheme, see Fig. 19. Often it is better to use only a limited range of these colours. Starting at purple, bad data can be shown white, whereas starting at off-white, the most distinct grey is given in the circle. If the lowest data value occurs often, start at off-white instead of purple. If the highest data value occurs often, end at red instead of brown. For colour-blind people, the light purples and light blues should not be mixed much.

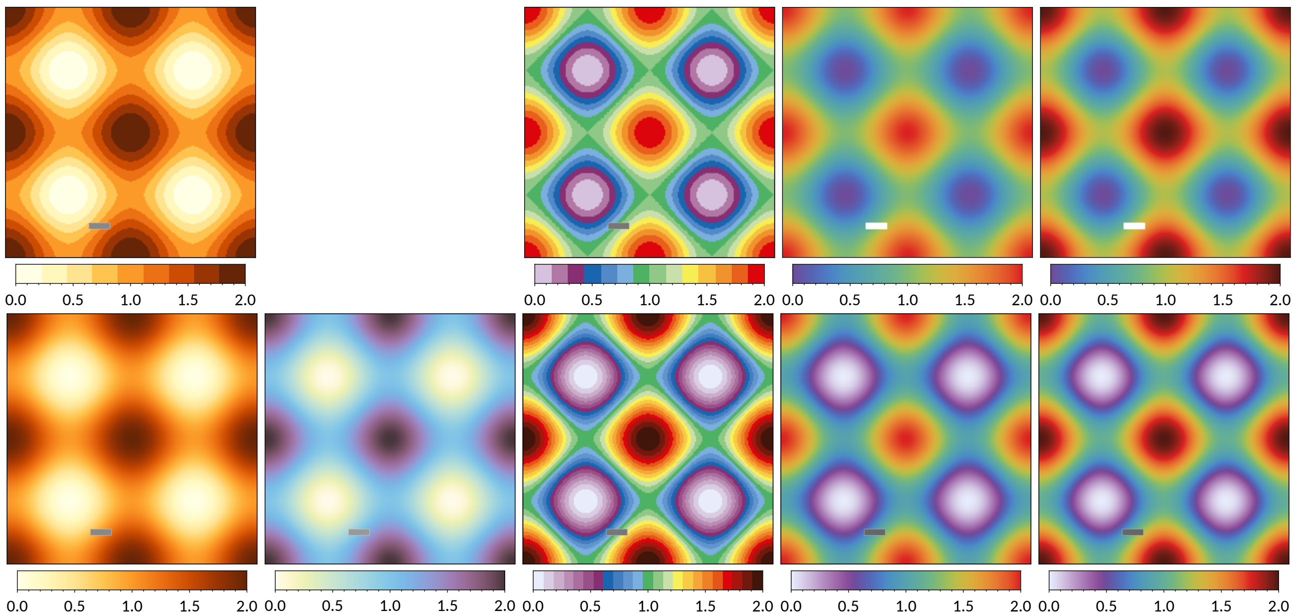


Figure 21: Examples of maps using the sequential colour schemes. From left to right: discrete and smooth YlOrBr of Fig. 17, iridescent of Fig. 18, short and long discrete rainbow of Fig. 19, and four versions of the smooth rainbow scheme of Fig. 20 with all combinations of two start colours (off-white or purple) and two end colours (red or brown).

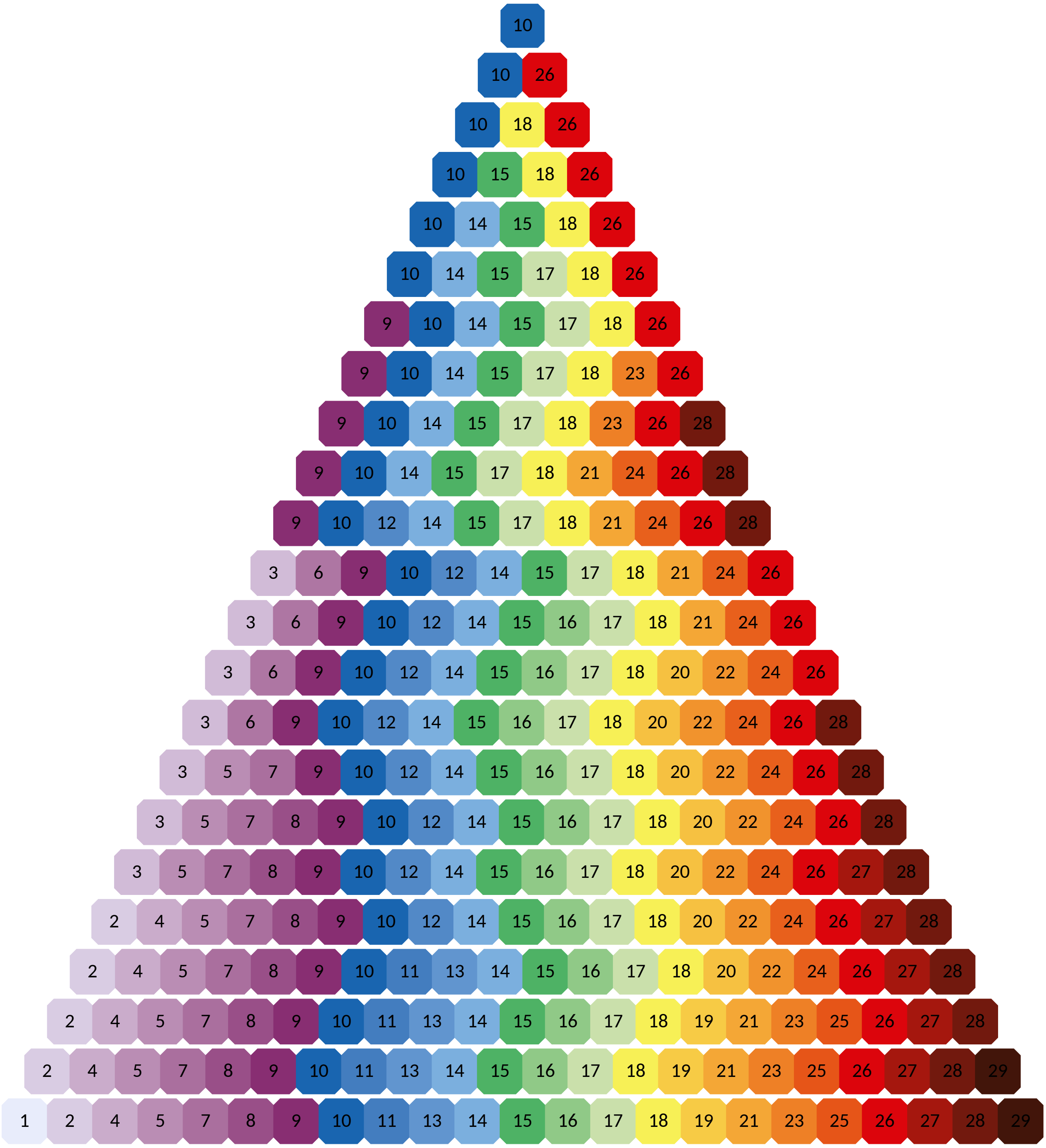


Figure 22: Discrete rainbow colour scheme for maps, with 1 to 23 colours. The numbers refer to the colour definitions in Fig. 19.

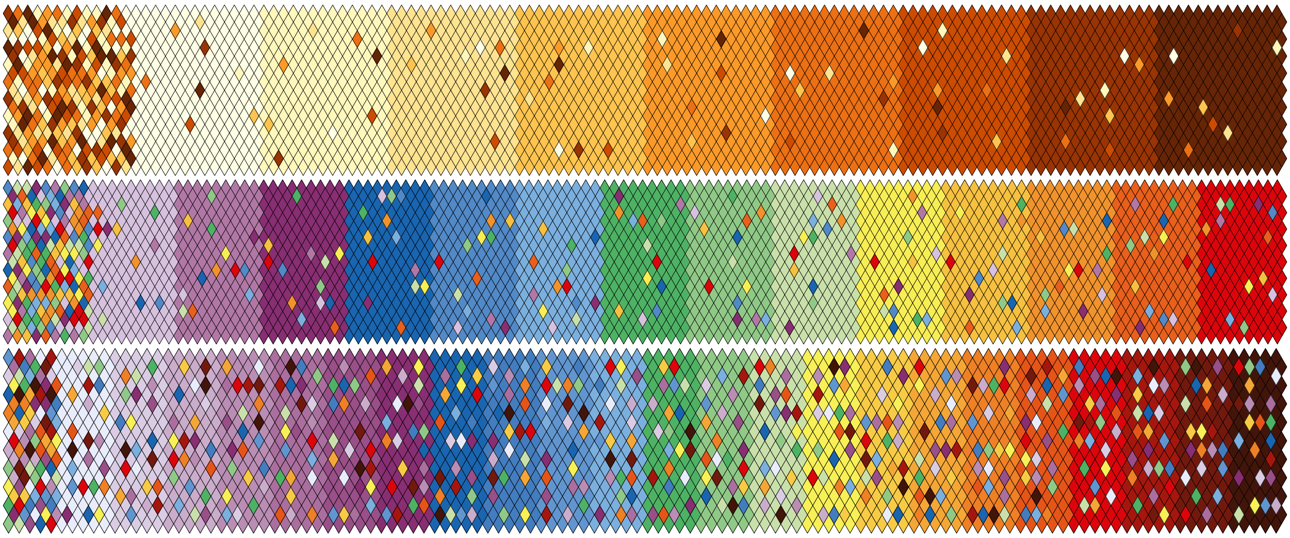


Figure 23: Diagnostic maps for the discrete sequential schemes given in Figs. 17 and 19. For each scheme, the section at the left contains all colours, while each of the other sections contains one colour with one diamond of each other colour. This tests how well the colours are identifiable.

5 Colour Blindness

People usually find out at an early age whether they are colour-blind. However, there are subtle variants of colour-vision deficiency. The two main types are:

- Green-blindness – the cone cells in the retina that are sensitive to medium wavelengths are absent or have their response shifted to the red (6 % of men, 0.4 % of women);
- Red-blindness – the cone cells in the retina that are sensitive to long wavelengths are absent or have their response shifted to the green (2.5 % of men).

Effectively, one (and only one) of the three types of colour receptors is missing. In the much rarer monochrome vision, all working colour receptors are the same or missing and only brightness variations are seen. Figure 24 is a test on green-blindness and red-blindness. It works on a computer screen (when looking straight at it), projected with a beamer and sometimes even in unfaded print, although this will depend on the quality of the equipment.

To simulate green-blindness [RD5, RD6], all RGB colours in an image are converted to R'G'B' colours with

$$R' = \left(4211 + 0.677\,G^{2.2} + 0.2802\,R^{2.2}\right)^{1/2.2}\,, \tag{1a}$$

$$G' = \left(4211 + 0.677\,G^{2.2} + 0.2802\,R^{2.2}\right)^{1/2.2}\,, \tag{1b}$$

$$B' = \left(4211 + 0.95724\,B^{2.2} + 0.02138\,G^{2.2} - 0.02138\,R^{2.2}\right)^{1/2.2}\,, \tag{1c}$$

with parameters R, G and B in the range 0–255 and the output values rounded. To simulate red-blindness, colours are shifted as follows:

$$R' = \left(782.7 + 0.8806\,G^{2.2} + 0.1115\,R^{2.2}\right)^{1/2.2}\,, \tag{2a}$$

$$G' = \left(782.7 + 0.8806\,G^{2.2} + 0.1115\,R^{2.2}\right)^{1/2.2}\,, \tag{2b}$$

$$B' = \left(782.7 + 0.992052\,B^{2.2} - 0.003974\,G^{2.2} + 0.003974\,R^{2.2}\right)^{1/2.2}\,. \tag{2c}$$

These conversions should be applied in sRGB colour space, i.e. they work on a standard video display, but not necessarily on paper. The conversion can be performed with the free software suite *ImageMagick*. The following two commands make green-blind and red-blind versions of original image `original.png`, respectively:[1]

```
convert original.png \( +clone -channel RG -fx "(0.02138+0.6770*G^2.2+0.2802*R^2.2)^(1/2.2)" \) \
+swap -channel B -fx "(0.02138(1+v.G^2.2-v.R^2.2)+0.9572*v.B^2.2)^(1/2.2)" greenblind.png
```

[1] These are Unix-style commands, for Windows replace \(and \) by (and), and use a caret (^) instead of a backslash to end the first line.

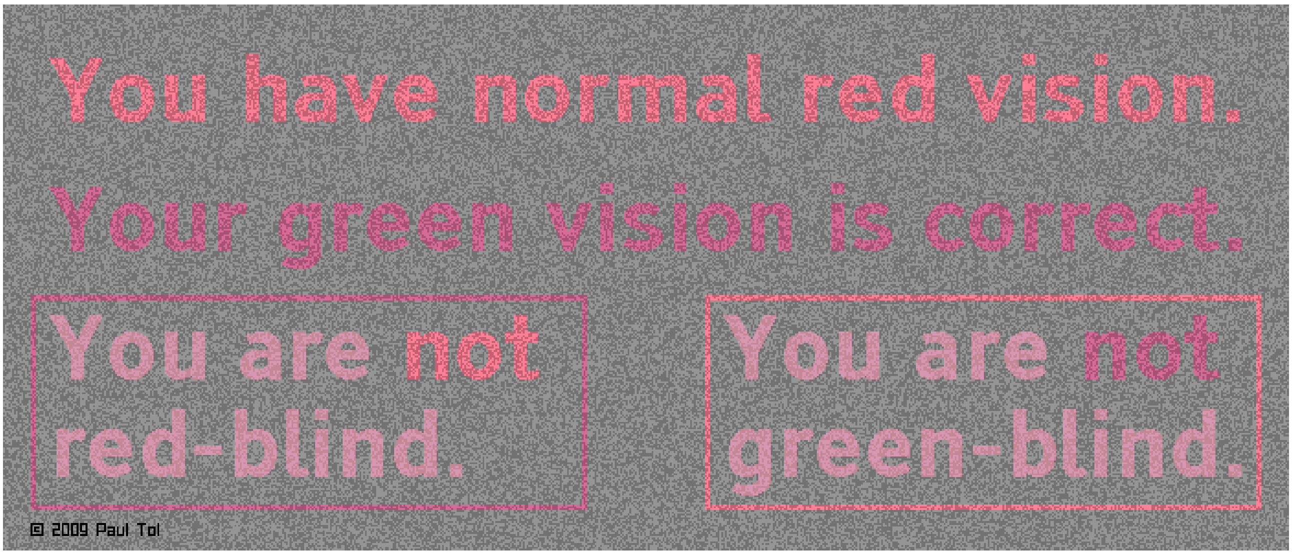


Figure 24: The readable text in this image is the colour-vision diagnosis of the reader. It is not a puzzle: there is no hidden message that requires much effort to see. The clarity of the text is not important, only whether it is readable at all; in normal vision one text is clearer than the other. This test only works for standard, red-blind and green-blind vision, not monochrome vision. Please do not make life-changing decisions based only on this test.

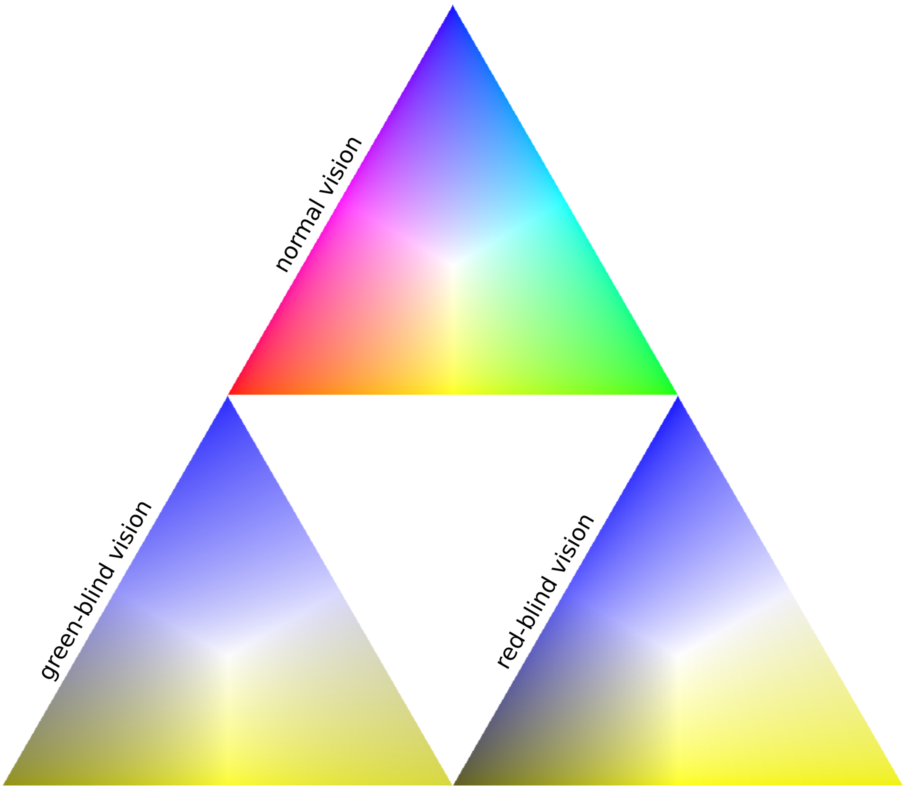


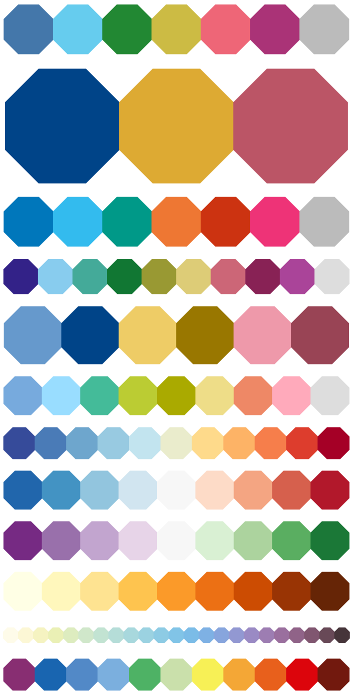
Figure 25: Colour scale in normal vision (top), green-blind vision (bottom left) and red-blind vision (bottom right). These conversions are only approximate and are designed for a computer screen.

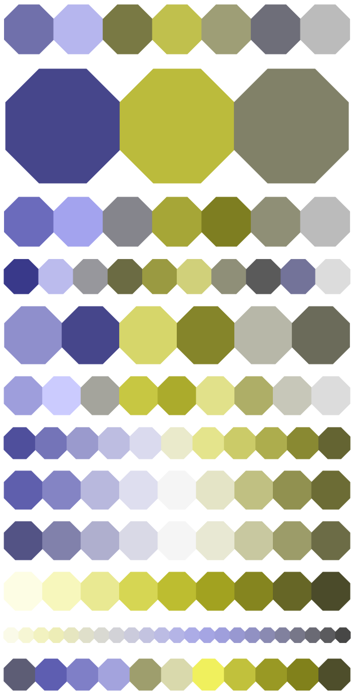
```
convert original.png \( +clone -channel RG -fx "(0.003974+0.8806*G^2.2+0.1115*R^2.2)^(1/2.2)" \) \
+swap -channel B -fx "(0.003974(1-v.G^2.2+v.R^2.2)+0.9921*v.B^2.2)^(1/2.2)" redblind.png
```

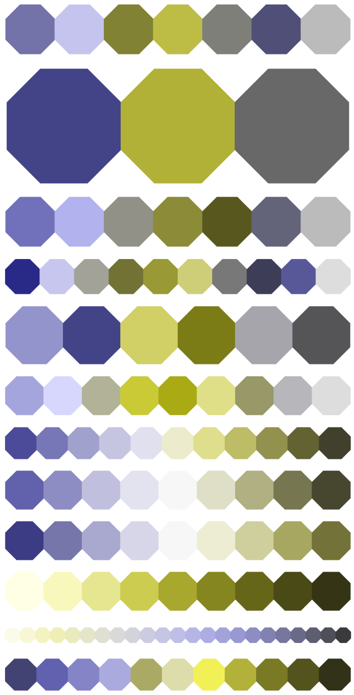
Figure 25 shows the result when they are applied to a triangle of normal colours (top): the green-blind simulation is at bottom left, the red-blind simulation at bottom right. Contrary to popular belief, pure red and green can be distinguished. Instead, yellow/green and purple/blue combinations are problematic. However, there are more unexpected pairs of colours that look the same, as used in Fig. 24. Table 1 shows colour-blind vision simu-

Table 1: Colour schemes as given earlier and approximate simulations of green-blind and red-blind vision.

scheme	normal vision	green-blind vision	red-blind vision
bright			
high-contrast			
vibrant			
muted			
medium-contrast			
light			
sunset			
BuRd			
PRGn			
YlOrBr			
iridescent			
rainbow			







lations of the colour schemes given in this document.

6 Greyscale Conversion

According to the Web Content Accessibility Guidelines [RD7], a contrast ratio between colours of at least 3 is recommended by ISO-9241-3 for standard text and vision, but the Guidelines define a stronger criterion of at least 4.5 to make the colours useful for people with moderately low vision. This includes people with monochrome vision, who only see brightness variations. The criterion actually only applies to body text, but “charts, graphs, diagrams, and other non-text-based information [. . .] should also have good contrast to ensure that more users can access the information.”

The criterion cannot be met using more than one print-friendly websmart colour plus white and black. The only blue shades are 4477BB and 5577AA, almost the same as the blue from the bright scheme. A websmart shade of grey is not available: only 757575 meets the criterion. The largest minimum contrast ratio in a set of two print-friendly websmart colours plus white and black is 2.8 and in a set with three such colours 2.1. One example with three colours is the high-contrast scheme. However, with some precautions it can still be applied to lines and symbols: use the colours in the order

- blue yellow red from the high-contrast scheme

on a white background and use black only for annotation (e.g. text or a grid) that is not on top of blue. When the first two colours are used, the contrast between yellow and white is just 2.1, but that is probably less important than the contrast between blue and yellow, which is large enough: 4.52. Only in the case of all three colours does the contrast between them decrease to 2.1, but that is the highest achievable value. Use different types of lines and symbols for better clarity.

The largest minimum contrast ratio with six colours is 1.5. The medium-contrast scheme uses print-friendly websmart colours not darker than the blue in the high-contrast scheme (from light to dark):

- light yellow light red light blue dark yellow dark red dark blue from the medium-contrast scheme

with the contrast ratio decreasing slightly to 1.4 between the lighter colours.

All other schemes fail the contrast-ratio criterion completely, as they contain too many colours and were designed for standard, red-blind and green-blind vision, relying not only on brightness differences, but also on hue differences. If one of the other qualitative schemes is used, the best subsets for greyscale conversion are (from light to dark):

- yellow red blue from the bright scheme;
- cyan teal red from the vibrant scheme;
- cyan olive purple wine from the muted scheme.

These subsets are slightly clearer than the medium-contrast scheme (but with fewer colours) and less clear than the high-contrast scheme.

The YlOrBr and iridescent sequential schemes work well (Fig. 26). The latter was designed for this purpose, with a linearly varying luminance. Python's default sequential scheme viridis has a similar property, but it is not print-friendly and seems to have fewer discernible colours. The rainbow schemes do not work. By definition, all diverging schemes do not work either after greyscale conversion.

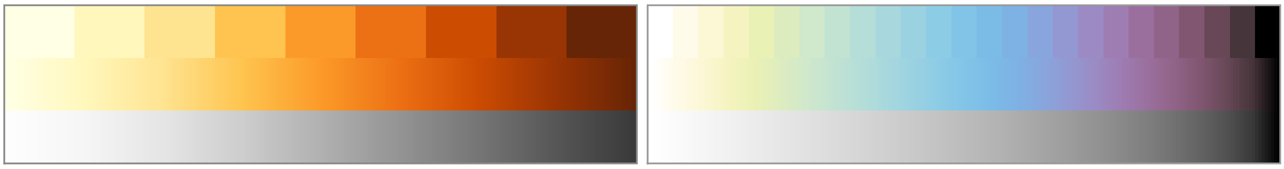


Figure 26: The YlOrBr (left) and iridescent (right) sequential colour schemes, with below the grey shades with the same luminance.

7 Colour Scheme for Ground Cover

Some data sets need a very specific colour scheme. An example is the global land cover classification, as generated by the University of Maryland Department of Geography from AVHRR data acquired between 1981 and 1994 [RD8], available at a resolution of 1 km. There is a recommended colour scheme, but the colours are not distinct, some not even in normal vision. Figure 27 gives a more subtle and logical scheme where all colours are distinct in all visions. Figure 28 shows the world with a reduced resolution of 20 km using this scheme. Figure 29 shows only North America at a resolution of 5 km, using almost all classes.

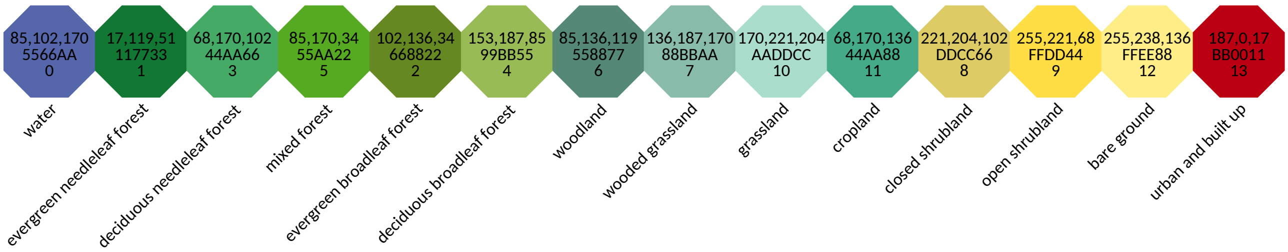


Figure 27: Colour-blind safe colour scheme for the AVHRR global land cover classification. The colours have been numbered with the data values. Note that value 13 is not used.

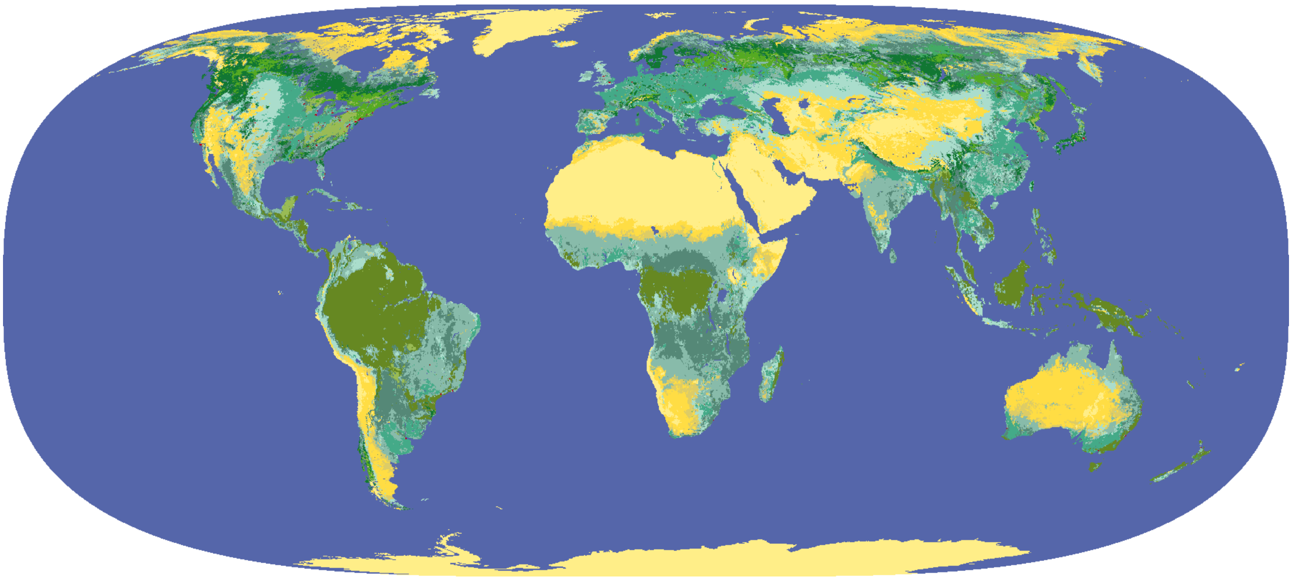


Figure 28: Global land cover classification using the scheme of Fig. 27. The most frequent value of blocks of 20 × 20 original pixels was used.

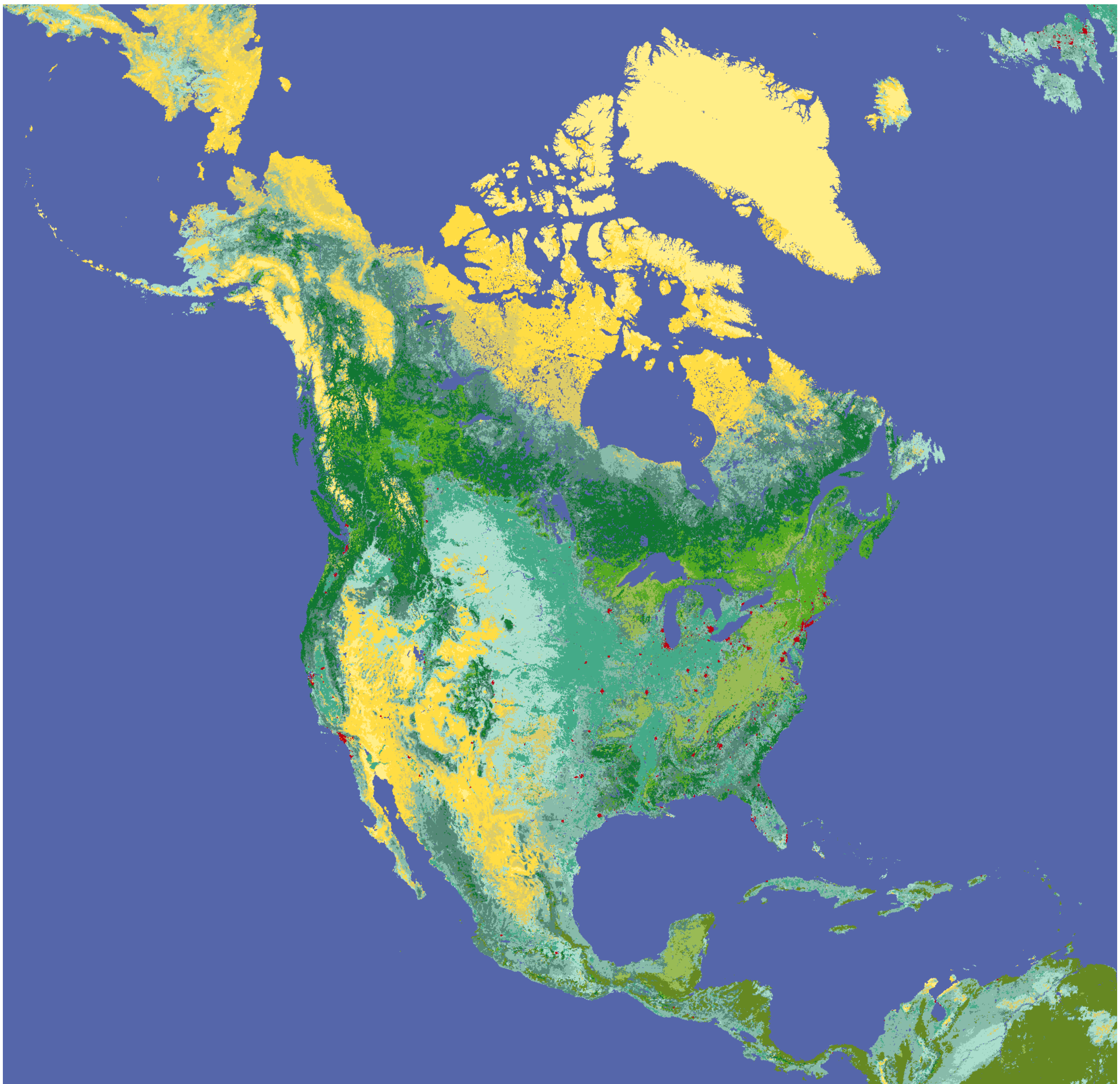


Figure 29: Land cover classification of North America at a resolution of 5 km. All possible classes except deciduous needleleaf forest are found.