# Package ‘CVD’

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**Type** Package

**Title** Color Vision Deficiencies

**Version** 1.0.2

**Encoding** UTF-8

**Description** Methods for color vision deficiencies (CVD), to help understanding and mitigating issues with CVDs and to generate tests for diagnosis and interpretation.

**License** GPL (>= 3)

**Depends** R (>= 2.10)

**Enhances** png, gWidgets2, RGtk2

**LazyData** yes

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# Contents

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`approx.scotopic.luminance.LarsonEtAl.RGB`
*Approximation of the scotopic luminance*

---

## Description

`approx.scotopic.luminance.LarsonEtAl.RGB` approximates the scotopic luminance from RGB values. `approx.scotopic.luminance.LarsonEtAl.XYZ` approximates the scotopic luminance from XYZ values.

## Usage

```
approx.scotopic.luminance.LarsonEtAl.XYZ(XYZmatrix)
approx.scotopic.luminance.LarsonEtAl.RGB(RGBmatrix)
```

## Arguments

| | |
|---|---|
| `XYZmatrix` | matrix with XYZ values |
| `RGBmatrix` | matrix with RGB values |

## Value

approximated scotopic luminance

## Author(s)

Jose Gama

## Source

Larson, G. W., H. Rushmeier, and C. Piatko (1997, October - December). A visibility matching tone reproduction operator for high dynamic range scenes. IEEE Transactions on Visualization and Computer Graphics 3 (4), 291–306.

## References

Larson, G. W., H. Rushmeier, and C. Piatko (1997, October - December). A visibility matching tone reproduction operator for high dynamic range scenes. IEEE Transactions on Visualization and Computer Graphics 3 (4), 291–306.

## Examples

```
## Not run:
samplePics <- c('fruits', 'pastel_color', 'sample1', 'TurnColorsGrayImage1', 'TurnColorsGrayImage2')
for (pics in samplePics)
{
fname<-paste(system.file(package='CVD'),'/extdata/',pics,'.png',sep='')
imgTest<-loadPNG(fname)
imgTest.array<-approx.scotopic.luminance.LarsonEtAl.RGB.array(imgTest)
png::writePNG(imgTest.array, paste(pics, '.approx.scotopic.luminance.LarsonEtAl.RGB.png',sep=''))
}

## End(Not run)
```

---

# attenuationNumberOfEyes

*Attenuation as a function of number of eyes*

---

## Description

`attenuationNumberOfEyes` computes the attenuation as a function M(e) of number of eyes e (1 or 2), from Watson A. B., Yellott J. I. (2012).

## Usage

```
attenuationNumberOfEyes(e)
```

## Arguments

| | |
|---|---|
| `e` | number of eyes (1 or 2) |

## Value

| | |
|---|---|
| `PupilSize` | attenuation |

## Author(s)

Jose Gama

## References

Watson A. B., Yellott J. I. (2012). A unified formula for light-adapted pupil size. Journal of Vision, 12(10):12, 1–16. http://journalofvision.org/12/10/12/, doi:10.1167/5.9.6.

## Examples

```
## Not run:
attenuationNumberOfEyes(1)
attenuationNumberOfEyes(2)

## End(Not run)
```

B20 *Farnsworth B-20 cap colors*

## Description

B20 contains the cap colors for the Farnsworth B-20 test, in XYZ coordinates. The Farnsworth B-20 is a short test for detecting congenital color vision deficiencies.

## Usage

```
B20
```

## Format

This data frame contains the following columns:

**CapNo** Cap Number

**Munsell** Munsell color

**X** CIE X cap color

**Y** CIE Y cap color

**Z** CIE Z cap color

## Author(s)

Jose Gama

## Source

Judd, D.B. and MacAdam, D.L., 1979 Contributions to Color Science University of Rochester. Institute of Optics and Center for Building Technology Department of Commerce, National Bureau of Standards

## References

Judd, D.B. and MacAdam, D.L., 1979 Contributions to Color Science University of Rochester. Institute of Optics and Center for Building Technology Department of Commerce, National Bureau of Standards

## Examples

```
data(B20)
B20
```

BowmanTCDS — *Table of color distance scores for quantitative scoring of the Farnsworth panel D-15 test*

## Description

BowmanTCDS contains the color distance scores for quantitative scoring of the Farnsworth panel D-15 test, from Bowman KJ (1982) The Farnsworth Dichotomous test (D-15) is a short test for detecting congenital color vision deficiencies. Bowman KJ (1982) created a table based on the Commission Internationale de l'Eclairage (International Commission on Illumination, CIE) Space and Color Difference formula, CIE 1976 (L*a*b*) with perceptual distances between pairs of caps. The table is used for the calculation of the Total Color Distance Score (TCDS) which is the sum of the CIELAB space distances between colored caps.

## Usage

```
BowmanTCDS
```

## Format

This data frame contains the following columns:

**Pilot** Distances between colored caps for the pilot cap

**Cap1** Distances between colored caps for the 1st cap

**Cap2** Distances between colored caps for the 2nd cap

**Cap3** Distances between colored caps for the 3rd cap

**Cap4** Distances between colored caps for the 4th cap

**Cap5** Distances between colored caps for the 5th cap

**Cap6** Distances between colored caps for the 6th cap

**Cap7** Distances between colored caps for the 7th cap

**Cap8** Distances between colored caps for the 8th cap

**Cap9** Distances between colored caps for the 9th cap

**Cap10** Distances between colored caps for the 10th cap

**Cap11** Distances between colored caps for the 11th cap

**Cap12** Distances between colored caps for the 12th cap

**Cap13** Distances between colored caps for the 13th cap

**Cap14** Distances between colored caps for the 14th cap

**Cap15** Distances between colored caps for the 15th cap

## Author(s)

Jose Gama

### Source

Bowman KJ: A method for quantitative scoring of the Farnsworth panel D-15. Acta Ophthalmol 60:907, 1982.

### References

Bowman KJ: A method for quantitative scoring of the Farnsworth panel D-15. Acta Ophthalmol 60:907, 1982.

### Examples

```
data(BowmanTCDS)
BowmanTCDS
```

---

`calculateCircle` *Generate points from a circle*

---

### Description

`calculateCircle` generates points from a circle with many options, equally spaced, randomly spaced, with noise added to the radius or limited to a segment of angle alpha.

### Usage

```
calculateCircle(x, y, r, steps=50,sector=c(0,360),randomDist=FALSE,
randomFun=runif,...)
```

### Arguments

| | |
|---|---|
| `x` | center point x |
| `y` | center point y |
| `r` | radius |
| `steps` | number of points |
| `sector` | limited circular sector |
| `randomDist` | logical, TRUE = randomly spaced |
| `randomFun` | random function |
| `...` | optiomal parameters to pass to randomFun |

### Value

| | |
|---|---|
| `points` | array n x 2 of point coordinates. |

### Author(s)

Jose Gama

### Examples

```
## Not run:
# 100 points from a circle at c(0,0) with radius=200
a<-calculateCircle(0,0,200,100)
plot(a[,1],a[,2],xlim=c(-200,200),ylim=c(-200,200))
par(new=TRUE)
# 12 points from a circle at c(0,0) with radius=190, points between 0 and 90
# degrees
a<-calculateCircle(0,0,190,12,c(0,90))
plot(a[,1],a[,2],xlim=c(-200,200),ylim=c(-200,200),col='red')
par(new=TRUE)
# 12 points from a circle at c(0,0) with radius=180, points between 0 and 180
# degrees, uniform random distribution
a<-calculateCircle(0,0,180,12,c(0,180),TRUE)
plot(a[,1],a[,2],xlim=c(-200,200),ylim=c(-200,200),col='green')
par(new=TRUE)
# 12 points from a circle at c(0,0) with radius=170, points between 0 and 180
# degrees, normal random distribution
a<-calculateCircle(0,0,170,12,c(0,180),TRUE,rnorm)
plot(a[,1],a[,2],xlim=c(-200,200),ylim=c(-200,200),col='blue')

## End(Not run)
```

---

## calculateTES *total error score (TES) using Farnsworth's or Kinnear's method*

---

### Description

calculateTES computes the total error score (TES) using Farnsworth's or Kinnear's method for the FM-100, D-15, Roth-28 and so forth. The input is a vector of cap positions.

### Usage

```
calculateTES(fmData, Kinnear=FALSE)
```

### Arguments

| | |
|---|---|
| fmData | vector of cap positions |
| Kinnear | position values chosen by tester |

### Value

| | |
|---|---|
| TCDS | Total Color Difference Score (TCDS) |

### Author(s)

Jose Gama

### References

Farnsworth D. The Farnsworth-Munsell 100-Hue Test. Baltimore: Munsell Color Company, 1957.

### Examples

```
# a "perfect" score
## Not run:
calculateTES(userD15values=1:15)
## End(Not run)
```

---

## Color.Vision.c2g    *Decolorize an image using the c2g algorithm*

---

### Description

`Color.Vision.c2g` decolorizes an image using the c2g algorithm from Martin Faust (2008). `RGBtoHSL` converts from RGB to HSL, used by `Color.Vision.c2g`

### Usage

```
Color.Vision.c2g(fileIN=NULL, fileOUT=NULL, CorrectBrightness=FALSE)
```

### Arguments

| | |
|---|---|
| `fileIN` | PNG input file |
| `fileOUT` | PNG output file |
| `CorrectBrightness` | automatic brightness correction |

### Value

none

### Author(s)

Jose Gama

### References

Martin Faust 2008 http://www.e56.de/c2g.php

### Examples

```
## Not run:
fname<-paste(system.file(package='CVD'),'/extdata/fruits.png',sep='')
Color.Vision.c2g(fname, 'fruits.c2g.png')

## End(Not run)
```

`Color.Vision.Daltonize` *Daltonize images*

## Description

`Color.Vision.Daltonize` converts images so that the most problematic colors are more visible to people with CVD.

## Usage

```
Color.Vision.Daltonize(fileIN=NULL, fileOUT=NULL, myoptions=NULL, amount=1.0)
```

## Arguments

| | |
|---|---|
| `fileIN` | PNG input file |
| `fileOUT` | PNG output file |
| `myoptions` | CVD from "Protanope","Deuteranope" or "Tritanope" |
| `amount` | UNUSED - level from 0.0 to 1.0 for "Achromat" |

## Value

none

## Author(s)

Jose Gama

## References

Michael Deal Daltonize.org http://mudcu.be/labs/Color/Vision http://www.daltonize.org/p/about.html "Analysis of Color Blindness" by Onur Fidaner, Poliang Lin and Nevran Ozguven. "Digital Video Colourmaps for Checking the Legibility of Displays by Dichromats" by Francoise Vienot, Hans Brettel and John D. Mollon http://vision.psychol.cam.ac.uk/jdmollon/papers/colourmaps.pdf

## Examples

```
# a "perfect" score
## Not run:
fname<-paste(system.file(package='CVD'),'/extdata/fruits.png',sep='')
Color.Vision.Daltonize(fname, 'fruits.Daltonize.Protanope.png','Protanope')
Color.Vision.Daltonize(fname, 'fruits.Daltonize.Deuteranope.png','Deuteranope')
Color.Vision.Daltonize(fname, 'fruits.Daltonize.Tritanope.png','Tritanope')

## End(Not run)
```

## Color.Vision.Simulate *Simulate CVDs on images*

### Description

`Color.Vision.Simulate` converts images so that the colors look similar to how they are seen by people with CVD.

### Usage

```
Color.Vision.Simulate(fileIN=NULL, fileOUT=NULL, myoptions=NULL, amount=1.0)
```

### Arguments

| | |
|---|---|
| `fileIN` | PNG input file |
| `fileOUT` | PNG output file |
| `myoptions` | CVD from "Protanope","Deuteranope" or "Tritanope" |
| `amount` | level from 0.0 to 1.0 for "Achromat" |

### Value

none

### Author(s)

Jose Gama

### References

Michael Deal Daltonize.org http://mudcu.be/labs/Color/Vision http://www.daltonize.org/p/about.html "Analysis of Color Blindness" by Onur Fidaner, Poliang Lin and Nevran Ozguven. "Digital Video Colourmaps for Checking the Legibility of Displays by Dichromats" by Francoise Vienot, Hans Brettel and John D. Mollon http://vision.psychol.cam.ac.uk/jdmollon/papers/colourmaps.pdf

### Examples

```
# a "perfect" score
## Not run:
fname<-paste(system.file(package='CVD'),'/extdata/fruits.png',sep='')
Color.Vision.Simulate(fname, 'fruits.Simulate.Protanope.png','Protanope')
Color.Vision.Simulate(fname, 'fruits.Simulate.Deuteranope.png','Deuteranope')
Color.Vision.Simulate(fname, 'fruits.Simulate.Tritanope.png','Tritanope')

## End(Not run)
```

`Color.Vision.VingrysAndKingSmith` *Scoring the results of the "D-15", "D-15DS" or "FM1OO-Hue" tests*

## Description

`Color.Vision.VingrysAndKingSmith` takes a vector with cap numbers from the "D-15", "D-15DS" or "FM1OO-Hue" tests and outputs the score by the method from Vingrys and King-Smith.

## Usage

```
Color.Vision.VingrysAndKingSmith(capnumbers=NULL,testType='D-15',silent=TRUE)
```

## Arguments

| | |
|---|---|
| `capnumbers` | vector with cap numbers |
| `testType` | test type, one of "D-15", "D-15DS" or "FM1OO-Hue" |
| `silent` | logical, if TRUE then the function will send output to the screen, similarly to the original version |

## Value

| | |
|---|---|
| `Angle` | confusion angle which identifies the type of color defect |
| `MajRad` | major moment of inertia |
| `MinRad` | minor moment of inertia |
| `TotErr` | error score or estimate of the severity of color defect |
| `Sindex` | Selectivity-Index which quantifies the amount of polarity or lack of randomness in a cap arrangement |
| `Cindex` | Confusion-Index which quantifies the degree of color loss relative to a perfect arrangement of caps |

## Author(s)

Jose Gama

## References

Vingrys, A.J. and King-Smith, P.E. (1988). A quantitative scoring technique for panel tests of color vision. Investigative Ophthalmology and Visual Science, 29, 50-63.

### Examples

```
Color.Vision.VingrysAndKingSmith(1:15,silent=FALSE)
#result from the original GW Basic version:
#SUMS OF U AND V              41.25999     -4.92
# ANGLE MAJ RAD MIN RAD TOT ERR S-INDEX C-INDEX
#    61.98     9.23     6.71    11.42     1.38     1.00
Color.Vision.VingrysAndKingSmith(1:15,'D-15DS',silent=FALSE)
#result from the original GW Basic version:
#SUMS OF U AND V              26.86001     -38.69
# ANGLE MAJ RAD MIN RAD TOT ERR S-INDEX C-INDEX
#    61.44     5.12     3.60     6.26     1.42     1.00
Color.Vision.VingrysAndKingSmith(1:85, 'FM1OO-Hue',silent=FALSE)
#result from the original GW Basic version:
#SUMS OF U AND V              423.7896      203.7294
# ANGLE MAJ RAD MIN RAD TOT ERR S-INDEX C-INDEX
#    54.15     2.53     1.97     3.20     1.28     1.00
```

---

## createPNGbuttons *Creates PNG files to be used as colored caps (buttons)*

---

### Description

createPNGbuttons creates PNG files from a data.frame with RGB values.

### Usage

```
createPNGbuttons(capsData = get("FarnsworthD15", envir = environment()),
 imgLength = 44, imgWidth = 78)
```

### Arguments

| | |
|---|---|
| capsData | Input file name. |
| imgLength | Input file name. |
| imgWidth | Input file name. |

### Value

png file object.

### Author(s)

Jose Gama

### Examples

```
## Not run:
createPNGbuttons(data.frame(R=0,G=0,B=0))
data(FarnsworthD15)
createPNGbuttons(FarnsworthD15)

## End(Not run)
```

---

## D15Foutch *Quantitatively analyzes of D15 color panel tests*

---

### Description

`D15Foutch` Calculates angle, magnitude and scatter for VK-S 88 and VK-S 93 (Vingrys, A.J. and King-Smith, P.E. (1988, 1993)), LSA 05 (Foutch/Bassi '05), and JMO 11 (Foutch/Stringham/Vengu '11).

### Usage

```
D15Foutch(userD15values=NULL, testType = 'D-15', dataVKS = NA)
```

### Arguments

| | |
|---|---|
| `userD15values` | position values chosen by tester |
| `testType` | the CVD test to be scored: "D-15", "D-15DS", "Roth28-Hue" or "FM1OO-Hue" |
| `dataVKS` | by default, the original 1976 CIE Luv data from Vingrys and King-Smith |

### Value

| | |
|---|---|
| `outmat` | data.frame with columns "angle", "magnitude" and "scatter" and rows "LSA05","JMO11","VKS88","VKS |

### Author(s)

Brian K. Foutch

### References


A new quantitative technique for grading Farnsworth D-15 color panel tests Foutch, Brian K.; Stringham, James M.; Lakshminarayanan, Vasuvedan Journal of Modern Optics, vol. 58, issue 19-20, pp. 1755-1763

Evaluation of the new web-based" Colour Assessment and Diagnosis" test J Seshadri, J Christensen, V Lakshminarayanan, CJ BASSI Optometry & Vision Science 82 (10), 882-885

Vingrys, A.J. and King-Smith, P.E. (1988). A quantitative scoring technique for panel tests of color vision. Investigative Ophthalmology and Visual Science, 29, 50-63.

### Examples

```
# 2 examples from VK-S
## Not run:
D15Foutch(userD15values=c(1:7,9,8,10:15))
D15Foutch(userD15values=c(1:7,9,8,10:13,15,14))
## End(Not run)
```

---

## decolorize — *Decolorize algorithm from Mark Grundland and Neil A. Dodgson*

---

### Description

`decolorize` converts a color image to contrast enhanced greyscale algorithm from Mark Grundland and Neil A. Dodgson. The input is an array of RGB values and the output is an array with the greyscale values. `decolorizeFile` sends the output to a file instead of returning an array

### Usage

```
decolorize(fileIN=NULL,effect=0.5,scale=NULL,noise=0.001,recolor=FALSE)
```

### Arguments

| | |
|---|---|
| `fileIN` | PNG file |
| `effect` | how much the picture's achromatic content should be altered to accommodate the chromatic contrasts |
| `scale` | in pixels is the typical size of relevant color contrast features |
| `noise` | noise quantile indicates the amount of noise in the picture enabling the dynamic range of the tones to be appropriately scaled |
| `recolor` | return also the chromatic content of the picture |

### Value

| | |
|---|---|
| `colorArray` | array of RGB colors converted to contrast enhanced greyscale. |

### Author(s)

Jose Gama

### References

Mark Grundland and Neil A. Dodgson, "Decolorize: Fast, Contrast Enhancing, Color to Grayscale Conversion", Pattern Recognition, vol. 40, no. 11, pp. 2891-2896, (2007). http://www.Eyemaginary.com/Portfolio/Publicatio

### Examples

```
## Not run:
samplePics <- c('fruits', 'pastel_color', 'sample1', 'TurnColorsGrayImage1', 'TurnColorsGrayImage2')
for (pics in samplePics)
{
fname<-paste(system.file(package='CVD'),'/extdata/fruits.png',sep='')
g1<-decolorize(fname)
png::writePNG(g1$tones, paste(pics, '.decolorize.png',sep=''))
}

## End(Not run)
```

---

## dichromaticCopunctalPoint

*Copunctal points derived by Smith and Pokorny (1975)*

---

### Description

`dichromaticCopunctalPoint` contains the copunctal points derived by Smith and Pokorny (1975)

### Usage

```
dichromaticCopunctalPoint
```

### Format

This data frame contains the following columns:

**P** copunctal points - protanope

**D** copunctal points - deuteranope

**T** copunctal points - tritanope

### Author(s)

Jose Gama

### Source

Smith, V. C. & Pokorny, J. Spectral sensitivity of the foveal cone photopigments between 400 and 500 nm. Vision Research, 15, 1975. 161-171.

### References

Smith, V. C. & Pokorny, J. Spectral sensitivity of the foveal cone photopigments between 400 and 500 nm. Vision Research, 15, 1975. 161-171.

### Examples

```
data(dichromaticCopunctalPoint)
dichromaticCopunctalPoint
```

`effectiveCornealFluxDensity` *Effective Corneal Flux Density*

## Description

`effectiveCornealFluxDensity` computes the effective Corneal Flux Density = product of luminance, area, and the monocular effect, F = Lae, from Watson A. B., Yellott J. I. (2012).

## Usage

```
effectiveCornealFluxDensity(L=NULL,a=NULL,e=NULL)
```

## Arguments

| | |
|---|---|
| `L` | luminance in cd m^-2 |
| `a` | field area in deg^2 |
| `e` | number of eyes (1 or 2) |

## Value

| | |
|---|---|
| `PupilSize` | effective Corneal Flux Density |

## Author(s)

Jose Gama

## References

Watson A. B., Yellott J. I. (2012). A unified formula for light-adapted pupil size. Journal of Vision, 12(10):12, 1–16.

## Examples

```
# effective Corneal Flux Density, luminance in cd m^-2 = 1, field area in
# deg^2 = 30, number of eyes = 2
## Not run: effectiveCornealFluxDensity(1,30^2,2)
```

## effectivePupilArea — *Effective area of the illuminated pupil*

### Description

`effectivePupilArea` computes the effective area of the illuminated pupil from its diameter.

### Usage

```
effectivePupilArea(d)
```

### Arguments

| | |
|---|---|
| `d` | diameter in mm |

### Value

| | |
|---|---|
| `PupilSize` | Pupil effective area in mm^2 |

### Author(s)

Jose Gama

### References

#Smith, VC, Pokorny, J, and Yeh, T: The Farnsworth-Munsell 100-hue test in cone excitation space. Documenta Ophthalmologica Proceedings Series 56:281-291, 1993.

### Examples

```
# Pupil area in mm^2 for diameter = 2 mm
## Not run: effectivePupilArea(2)
```

## example1Lanthony1978 — *Example of cap arrangements for the D-15d test, Simple/Extreme Anomalous Trichromacy*

### Description

`example1Lanthony1978` contains an example of cap arrangements for the D-15d test, Simple/Extreme Anomalous Trichromacy, from Lanthony (1978)

### Usage

```
example1Lanthony1978
```

## Format

This data frame contains the following columns:

**SimpleAnomalousTrichromacyD15** example cap arrangements D15 - Simple Anomalous Trichromacy

**SimpleAnomalousTrichromacyD15d** example cap arrangements D15d - Simple Anomalous Trichromacy

**ExtremeAnomalousTrichromacyD15** example cap arrangements D15 - Extreme Anomalous Trichromacy

**ExtremeAnomalousTrichromacyD15d** example cap arrangements D15d - Extreme Anomalous Trichromacy

## Author(s)

Jose Gama

## Source

The Desaturated Panel D-15 P. Lanthony Documenta Ophthalmologica 46,1: 185-189, 1978

## References

The Desaturated Panel D-15 P. Lanthony Documenta Ophthalmologica 46,1: 185-189, 1978

## Examples

```
data(example1Lanthony1978)
example1Lanthony1978
```

---

`example2Lanthony1978` *Example of cap arrangements for the D-15d test, Central Serous Choroidopathy/Optic Neuritis/Autosomal Dominant OpticAtrophy*

---

## Description

`example2Lanthony1978` contains an example of cap arrangements for the D-15d test, Central Serous Choroidopathy/Optic Neuritis/Autosomal Dominant OpticAtrophy, from Lanthony (1978)

## Usage

```
example2Lanthony1978
```

## Format

This data frame contains the following columns:

**CentralSerousChoroidopathyD15** example cap arrangements D15 - Central Serous Choroidopathy

**CentralSerousChoroidopathyD15d** example cap arrangements D15d - Central Serous Choroidopathy

**OpticNeuritisD15** example cap arrangements D15 - Optic Neuritis

**OpticNeuritisD15d** example cap arrangements D15d - Optic Neuritis

**AutosomalDominantOpticAtrophyD15** example cap arrangements D15 - Autosomal Dominant OpticAtrophy

**AutosomalDominantOpticAtrophyD15d** example cap arrangements D15d - Autosomal Dominant OpticAtrophy

## Author(s)

Jose Gama

## Source

THE DESATURATED PANEL D-15 P. LANTHONY Documenta Ophthalmologica 46,1: 185-189, 1978

## References

THE DESATURATED PANEL D-15 P. LANTHONY Documenta Ophthalmologica 46,1: 185-189, 1978

## Examples

```
data(example2Lanthony1978)
example2Lanthony1978
```

---

`exampleBowman1982` *Example of cap arrangements for the D-15d test*

---

## Description

`exampleBowman1982` contains an example of cap arrangements for the D-15d test, from Bowman (1982)

## Usage

```
exampleBowman1982
```

## Format

This data frame contains the following columns:

**A** example cap arrangements A

**B** example cap arrangements B

**C** example cap arrangements C

**D** example cap arrangements D

**E** example cap arrangements E

**F** example cap arrangements F

## Author(s)

Jose Gama

## Source

A Method For Quantitative Scoring Of The Farnsworth Panel D-15 K.J. Bowman 1982

## References

A Method For Quantitative Scoring Of The Farnsworth Panel D-15 K.J. Bowman 1982

## Examples

```
data(exampleBowman1982)
exampleBowman1982
```

---

# `exampleFarnsworth1974` *Example of cap arrangements for the D-15 test, deuteranope/protanope/tritanope*

---

## Description

`exampleFarnsworth1974` contains an example of cap arrangements for the D-15 test, deuteranope/protanope/tritanope, from Farnsworth (1974)

## Usage

```
exampleFarnsworth1974
```

## Format

This data frame contains the following columns:

**deuteranope** example cap arrangements D15 - deuteranope

**protanope** example cap arrangements D15 - protanope

**tritanope** example cap arrangements D15 - tritanope

### Author(s)

Jose Gama

### Source

Farnsworth D. The Farnsworth Dichotomous Test for Color Blindness. Panel D-15. New York, Psychological Testing, 1974

### References

Farnsworth D. The Farnsworth Dichotomous Test for Color Blindness. Panel D-15. New York, Psychological Testing, 1974

### Examples

```
data(exampleFarnsworth1974)
exampleFarnsworth1974
```

---

## exampleFM100 *Example of cap arrangements for the FM-100 test*

---

### Description

`exampleFM100` contains an example of cap arrangements for the FM-100, from Hidayat (2008)

### Usage

```
exampleFM100
```

### Format

This table contains one example of cap arrangements for the FM-100

### Author(s)

Jose Gama

### Source

proceedings of the New Zealand Generating fast automated reports for the Farnsworth-Munsell 100-hue colour vision test Ray Hidayat, Computer Science Research Student Conference 2008

### References

proceedings of the New Zealand Generating fast automated reports for the Farnsworth-Munsell 100-hue colour vision test Ray Hidayat, Computer Science Research Student Conference 2008

## Examples

```
data(exampleFM100)
exampleFM100
```

---

`exampleNRC1981` *Example of cap arrangements for the D-15 test, protanope/deuteranope/monochromat*

---

## Description

`exampleNRC1981` contains an example of cap arrangements for the D-15d test, protanope/deuteranope/monochromat, from National Research Council (1981)

## Usage

```
exampleNRC1981
```

## Format

This data frame contains the following columns:

**protanope** example cap arrangements D15 - protanope

**deuteranope** example cap arrangements D15 - deuteranope

**monochromat** example cap arrangements D15 - monochromat

## Author(s)

Jose Gama

## Source

Procedures for Testing Color Vision: Report of Working Group 41, 1981, Committee on Vision, National Research Council, pp. 107

## References

Procedures for Testing Color Vision: Report of Working Group 41, 1981, Committee on Vision, National Research Council, pp. 107

## Examples

```
data(exampleNRC1981)
exampleNRC1981
```

`exampleSimunovic2004` *Example of cap arrangements for the D-15 test, rodMonochromat/blueConeMonochromat*

## Description

`exampleSimunovic2004` contains an example of cap arrangements for the D-15d test, rodMonochromat/blueConeMonochromat, from Lanthony (1978)

## Usage

```
exampleSimunovic2004
```

## Format

This data frame contains the following columns:

**rodMonochromat** example cap arrangements D15 - rodMonochromat

**blueConeMonochromat** example cap arrangements D15 - blueConeMonochromat

## Author(s)

Jose Gama

## Source

Cone dystrophies Part 2 Cone dysfunction syndromes, Matthew P Simunovic

## References

Cone dystrophies Part 2 Cone dysfunction syndromes, Matthew P Simunovic

## Examples

```
data(exampleSimunovic2004)
exampleSimunovic2004
```

## FarnsworthD15 — *Farnsworth D-15 cap colors*

### Description

`FarnsworthD15` contains the cap colors for the D-15 tests, in CIELab and RGB from Farnsworth D (1947) The Farnsworth Dichotomous test (D-15) is a short test for detecting congenital color vision deficiencies.

### Usage

```
FarnsworthD15
```

### Format

This data frame contains the following columns:

**CapNo** Cap Number

**Munsell** Munsell color

**x.C** CIE x cap color

**y.C** CIE y cap color

**R** R channel cap color

**G** G channel cap color

**B** B channel cap color

### Author(s)

Jose Gama

### Source

Farnsworth D. The Farnsworth Dichotomous Test for Color Blindness Panel D-15 Manual. New York, The Psychological Corp., 1947, pp. 1-8.

### References

Farnsworth D. The Farnsworth Dichotomous Test for Color Blindness Panel D-15 Manual. New York, The Psychological Corp., 1947, pp. 1-8.

### Examples

```
data(FarnsworthD15)
FarnsworthD15
```

`FarnsworthMunsell100Hue` *Farnsworth D-15 cap colors*

## Description

`FarnsworthMunsell100Hue` contains the cap colors for the Farnsworth Munsell 100-Hue tests, in CIELab and RGB from Farnsworth D (1957) The Farnsworth Munsell 100-Hue is a test for detecting congenital and acquired color vision deficiencies.

## Usage

```
FarnsworthMunsell100Hue
```

## Format

This data frame contains the following columns:

**CapNo** Cap Number

**Munsell** Munsell color

**x.C** CIE x cap color

**y.C** CIE y cap color

**R** R channel cap color

**G** G channel cap color

**B** B channel cap color

## Author(s)

Jose Gama

## Source

Farnsworth D: The Farnsworth-Munsell 100-Hue Test for the Examination of Color Discrimination Manual. Baltimore, Munsell Color Co., 1957, pp. 1-7.

## References

Farnsworth D: The Farnsworth-Munsell 100-Hue Test for the Examination of Color Discrimination Manual. Baltimore, Munsell Color Co., 1957, pp. 1-7.

## Examples

```
data(FarnsworthMunsell100Hue)
FarnsworthMunsell100Hue
```

`GellerTCDS` *Table of color distance scores for quantitative scoring of the Lanthony desaturate D-15s test*

## Description

`GellerTCDS` contains the color distance scores for quantitative scoring of the Lanthony desaturate D-15s test, from Geller AM. (2001). The Lanthony desaturate test (D-15s) is a short test for detecting acquired color vision deficiencies. Geller AM (2001) created a table based on the Commission Internationale de l'Eclairage (International Commission on Illumination, CIE) Space and Color Difference formula, CIE 1976 (L*a*b*) with perceptual distances between pairs of caps. The table is used for the calculation of the Total Color Distance Score (TCDS) which is the sum of the CIELAB space distances between colored caps.

## Usage

```
GellerTCDS
```

## Format

This data frame contains the following columns:

**Pilot** Distances between colored caps for the pilot cap

**Cap1** Distances between colored caps for the 1st cap

**Cap2** Distances between colored caps for the 2nd cap

**Cap3** Distances between colored caps for the 3rd cap

**Cap4** Distances between colored caps for the 4th cap

**Cap5** Distances between colored caps for the 5th cap

**Cap6** Distances between colored caps for the 6th cap

**Cap7** Distances between colored caps for the 7th cap

**Cap8** Distances between colored caps for the 8th cap

**Cap9** Distances between colored caps for the 9th cap

**Cap10** Distances between colored caps for the 10th cap

**Cap11** Distances between colored caps for the 11th cap

**Cap12** Distances between colored caps for the 12th cap

**Cap13** Distances between colored caps for the 13th cap

**Cap14** Distances between colored caps for the 14th cap

**Cap15** Distances between colored caps for the 15th cap

## Author(s)

Jose Gama

## Source

Geller AM. A table of color distance scores for quantitative scoring of the Lanthony desaturate color vision test. Neurotoxicol Teratol 2001; 23: 265-267.

## References

Geller AM. A table of color distance scores for quantitative scoring of the Lanthony desaturate color vision test. Neurotoxicol Teratol 2001; 23: 265-267.

## Examples

```
data(GellerTCDS)
GellerTCDS
```

---

# greyscale.avg *Greyscale algorithms*

---

## Description

Common algorithms to convert color images to greyscale. The input is an array of RGB values and the output is an array with the greyscale values. `greyscale.avg` Greyscale algorithm, convert to average RGB values. `greyscale.Y` Greyscale algorithm YIQ/NTSC - RGB colors in a gamma 2.2 color space. `greyscale.linear` Greyscale algorithm linear RGB colors `greyscale.RMY` Greyscale algorithm RMY `greyscale.BT709` Greyscale algorithm BT709 `greyscale.luminosity` Greyscale algorithm using luminosity

## Usage

```
greyscale.avg(colorArray)
```

## Arguments

| | |
|---|---|
| `colorArray` | array of RGB colors. |

## Value

| | |
|---|---|
| `colorArray` | array of RGB colors converted to greyscale. |

## Author(s)

Jose Gama

## Examples

```
## Not run:
samplePics <- c('fruits', 'pastel_color', 'sample1', 'TurnColorsGrayImage1', 'TurnColorsGrayImage2')
for (pics in samplePics)
{
fname<-paste(system.file(package='CVD'),'/extdata/',pics,'.png',sep='')
imgTest<-loadPNG(fname)
g1<-greyscale.avg(imgTest)
png::writePNG(g1, paste(pics, '.greyscale.avg.png',sep=''))
}

imgTest<-loadPNG(fname)
g1<-greyscale.avg(imgTest)
png::writePNG(g1, paste(pics, '.greyscale.avg.png',sep=''))
g1<-greyscale.BT709(imgTest)
png::writePNG(g1, paste(pics, '.BT709.png',sep=''))
g1<-greyscale.Linear(imgTest)
png::writePNG(g1, paste(pics, '.Linear.png',sep=''))
g1<-greyscale.Luminosity(imgTest)
png::writePNG(g1, paste(pics, '.Luminosity.png',sep=''))
g1<-greyscale.RMY(imgTest)
png::writePNG(g1, paste(pics, '.RMY.png',sep=''))
g1<-greyscale.Y(imgTest)
png::writePNG(g1, paste(pics, '.Y.png',sep=''))


## End(Not run)
```

---

H16 *Farnsworth H-16 cap colors*

---

## Description

H16 contains the cap colors for the Farnsworth H-16 test, in Yxy coordinates. The Farnsworth H-16 is a short test for detecting congenital color vision deficiencies.

## Usage

```
H16
```

## Format

This data frame contains the following columns:

**CapNo** Cap Number

**x.C** CIE x cap color

**y.C** CIE y cap color

**Munsell** Munsell color

**ProductionNo** Munsell Production Number

## Author(s)

Jose Gama

## Source

Judd, D.B. and MacAdam, D.L., 1979 Contributions to Color Science University of Rochester. Institute of Optics and Center for Building Technology Department of Commerce, National Bureau of Standards

## References

Judd, D.B. and MacAdam, D.L., 1979 Contributions to Color Science University of Rochester. Institute of Optics and Center for Building Technology Department of Commerce, National Bureau of Standards

## Examples

```
data(H16)
H16
```

---

`illuminance2troland` *Convert from luminance to troland and effective troland*

---

## Description

`illuminance2troland` convert from illuminance (lux) to conventional retinal illuminance (troland) and effective troland (trolands per effective area). `luminance2troland` convert from luminance (cd/m^2) to troland and effective troland.

## Usage

```
luminance2troland(Lv, d=NA)
illuminance2troland(Ev, lumFactor, d=NA)
```

## Arguments

| | |
|---|---|
| `d` | diameter in mm |
| `Lv` | luminance (cd/m^2) |
| `Ev` | illuminance (lux) |
| `lumFactor` | luminance factor |

## Value

| | |
|---|---|
| `troland` | conventional retinal illuminance (troland) |
| `effectivetroland` | effective troland (trolands per effective area) |

### Author(s)

Jose Gama

### References

#Smith, VC, Pokorny, J, and Yeh, T: The Farnsworth-Munsell 100-hue test in cone excitation space. Documenta Ophthalmologica Proceedings Series 56:281-291, 1993.

### Examples

```
# Pupil area in mm^2 for diameter = 2 mm
## Not run: illuminance2troland(2)
```

---

## `interpretation.VingrysAndKingSmith` *Automatic interpretation of test scores*

---

### Description

`interpretation.VingrysAndKingSmith` and `interpretation.Foutch` perform an interpretation of the test results based on the classification ranges from the authors of the tests.

### Usage

```
interpretation.VingrysAndKingSmith(VKS,optMethod=88)
```

### Arguments

| | |
|---|---|
| `VKS` | data to be interpreted |
| `optMethod` | CVD test method |

### Value

| | |
|---|---|
| `TCDS` | Total Color Difference Score (TCDS) |

### Author(s)

Jose Gama

### References

Vingrys, A.J. and King-Smith, P.E. (1988). A quantitative scoring technique for panel tests of color vision. Investigative Ophthalmology and Visual Science, 29, 50-63.

A new quantitative technique for grading Farnsworth D-15 color panel tests Foutch, Brian K.; Stringham, James M.; Lakshminarayanan, Vasuvedan Journal of Modern Optics, vol. 58, issue 19-20, pp. 1755-1763

Evaluation of the new web-based" Colour Assessment and Diagnosis" test J Seshadri, J Christensen, V Lakshminarayanan, CJ BASSI Optometry & Vision Science 82 (10), 882-885

## Examples

```
# a "perfect" score
## Not run:
interpretation.VingrysAndKingSmith(D15Foutch(1:15))
## End(Not run)
```

---

LanthonyD15 *Farnsworth H-16 cap colors*

---

## Description

LanthonyD15 contains the cap colors for Lanthony D-15 test, in Yxy coordinates. The Lanthony D-15 (desaturated D-15) is a short test for detecting congenital color vision deficiencies.

## Usage

```
LanthonyD15
```

## Format

This data frame contains the following columns:

**CapNo** Cap Number

**Munsell** Munsell color

**x.C** CIE x cap color

**y.C** CIE y cap color

**R** R channel cap color

**G** G channel cap color

**B** B channel cap color

## Author(s)

Jose Gama

## Source

Judd, D.B. and MacAdam, D.L., 1979 Contributions to Color Science University of Rochester. Institute of Optics and Center for Building Technology Department of Commerce, National Bureau of Standards

## References

Judd, D.B. and MacAdam, D.L., 1979 Contributions to Color Science University of Rochester. Institute of Optics and Center for Building Technology Department of Commerce, National Bureau of Standards

## Examples

```
data(LanthonyD15)
LanthonyD15
```

---

`lightAdaptedPupilSize.Barten`
*pupil diameter ranges from Barten, L. (1999)*

---

## Description

`lightAdaptedPupilSize.Barten` computes the pupil diameter ranges from Barten, L. (1999).

## Usage

```
lightAdaptedPupilSize.Barten(L=NULL, a=NULL)
```

## Arguments

| | |
|---|---|
| `L` | luminance in cd m^-2 |
| `a` | area in deg^2 |

## Value

| | |
|---|---|
| `PupilSize` | Pupil size in mm |

## Author(s)

Jose Gama

## References

Watson A. B., Yellott J. I. (2012). A unified formula for light-adapted pupil size. Journal of Vision, 12(10):12, 1–16. http://journalofvision.org/12/10/12/, doi:10.1167/5.9.6. Barten, P. G. J. (1999). Contrast sensitivity of the human eye and its effects on image quality. Bellingham, WA: SPIE Optical Engineering Press.

## Examples

```
# Pupil diameter in mm for luminance = 1 cd m^-2, field diameter = 30 degrees
## Not run: lightAdaptedPupilSize.Barten(1,30^2)
```

`lightAdaptedPupilSize.BlackieAndHowland`
*pupil diameter ranges from Blackie, C. A., & Howland, H. C. (1999)*

## Description

`lightAdaptedPupilSize.BlackieAndHowland` computes the pupil diameter ranges from Blackie, C. A., & Howland, H. C., (1999).

## Usage

```
lightAdaptedPupilSize.BlackieAndHowland(L=NULL)
```

## Arguments

| | |
|---|---|
| `L` | luminance in cd m^-2 |

## Value

| | |
|---|---|
| `PupilSize` | Pupil size in mm |

## Author(s)

Jose Gama

## References

Watson A. B., Yellott J. I. (2012). A unified formula for light-adapted pupil size. Journal of Vision, 12(10):12, 1–16. http://journalofvision.org/12/10/12/, doi:10.1167/5.9.6. Blackie, C. A., & Howland, H. C. (1999). An extension of an accommodation and convergence model of emmetropization to include the effects of illumination intensity. Ophthalmic and Physiological Optics, 19(2), 112–125.

## Examples

```
# Pupil diameter in mm for luminance = 1 cd m^-2
## Not run: lightAdaptedPupilSize.BlackieAndHowland(1)
```

---

`lightAdaptedPupilSize.Crawford`
*pupil diameter ranges from Crawford, L. (1936)*

---

### Description

`lightAdaptedPupilSize.Crawford` computes the pupil diameter ranges from Crawford, L. (1936).

### Usage

```
lightAdaptedPupilSize.Crawford(L=NULL)
```

### Arguments

| | |
|---|---|
| `L` | luminance in cd m^-2 |

### Value

| | |
|---|---|
| `PupilSize` | Pupil size in mm |

### Author(s)

Jose Gama

### References

Watson A. B., Yellott J. I. (2012). A unified formula for light-adapted pupil size. Journal of Vision, 12(10):12, 1–16. http://journalofvision.org/12/10/12/, doi:10.1167/5.9.6. Crawford, B. H. (1936). The dependence of pupil size upon external light stimulus under static and variable conditions. Proceedings of the Royal Society of London, Series B, Biological Sciences, 121(823), 376–395.

### Examples

```
# Pupil diameter in mm for luminance = 1 cd m^-2
## Not run: lightAdaptedPupilSize.Crawford(1)
```

---

`lightAdaptedPupilSize.DeGrootAndGebhard`
*pupil diameter ranges from DeGrootAndGebhard, L. (1952)*

---

### Description

`lightAdaptedPupilSize.DeGrootAndGebhard` computes the pupil diameter ranges from DeGrootAndGebhard, L. (1952).

## Usage

```
lightAdaptedPupilSize.DeGrootAndGebhard(L=NULL)
```

## Arguments

| | |
|---|---|
| L | luminance in cd m^-2 |

## Value

| | |
|---|---|
| PupilSize | Pupil size in mm |

## Author(s)

Jose Gama

## References

Watson A. B., Yellott J. I. (2012). A unified formula for light-adapted pupil size. Journal of Vision, 12(10):12, 1–16. http://journalofvision.org/12/10/12/, doi:10.1167/5.9.6. De Groot, S. G., & Gebhard, J. W. (1952). Pupil size as determined by adapting luminance. Journal of the Optical Society of America A, 42(7), 492–495.

## Examples

```
# Pupil diameter in mm for luminance = 1 cd m^-2
## Not run: lightAdaptedPupilSize.DeGrootAndGebhard(1)
```

---

# lightAdaptedPupilSize.Holladay

*pupil diameter ranges from Holladay, L. (1926)*

---

## Description

`lightAdaptedPupilSize.Holladay` computes the pupil diameter ranges from Holladay, L. (1926).

## Usage

```
lightAdaptedPupilSize.Holladay(L=NULL)
```

## Arguments

| | |
|---|---|
| L | luminance in cd m^-2 |

## Value

| | |
|---|---|
| PupilSize | Pupil size in mm |

## Author(s)

Jose Gama

## References

Watson A. B., Yellott J. I. (2012). A unified formula for light-adapted pupil size. Journal of Vision, 12(10):12, 1–16. http://journalofvision.org/12/10/12/, doi:10.1167/5.9.6. Holladay, L. (1926). The fundamentals of glare and visibility. Journal of the Optical Society of America, 12(4), 271–319.

## Examples

```
# Pupil diameter in mm for luminance = 1 cd m^-2
## Not run: lightAdaptedPupilSize.Holladay(1)
```

---

`lightAdaptedPupilSize.LeGrand` *pupil diameter ranges from Le Grand (1992)*

---

## Description

`lightAdaptedPupilSize.LeGrand` computes the pupil diameter ranges from Le Grand (1992).

## Usage

```
lightAdaptedPupilSize.LeGrand(L=NULL)
```

## Arguments

| | |
|---|---|
| `L` | luminance in cd m^-2 |

## Value

| | |
|---|---|
| `PupilSize` | Pupil size in mm |

## Author(s)

Jose Gama

## References

Vision, Pierre A. Buser, Michel Imbert, MIT Press, 1992

## Examples

```
# Pupil diameter in mm for luminance = 1 cd m^-2
## Not run: lightAdaptedPupilSize.LeGrand(1)
```

lightAdaptedPupilSize.MoonAndSpencer
*pupil diameter ranges from MoonAndSpencer, L. (1944)*

## Description

`lightAdaptedPupilSize.MoonAndSpencer` computes the pupil diameter ranges from MoonAndSpencer, L. (1944).

## Usage

```
lightAdaptedPupilSize.MoonAndSpencer(L=NULL)
```

## Arguments

| | |
|---|---|
| `L` | luminance in cd m^-2 |

## Value

| | |
|---|---|
| `PupilSize` | Pupil size in mm |

## Author(s)

Jose Gama

## References

Watson A. B., Yellott J. I. (2012). A unified formula for light-adapted pupil size. Journal of Vision, 12(10):12, 1–16. http://journalofvision.org/12/10/12/, doi:10.1167/5.9.6. Moon, P., & Spencer, D. E. (1944). On the Stiles-Crawford effect. Journal of the Optical Society of America, 34(6), 319–329, http://www.opticsinfobase. org/abstract.cfm?URI1⁄4josa-34-6-319.

## Examples

```
# Pupil diameter in mm for luminance = 1 cd m^-2
## Not run: lightAdaptedPupilSize.MoonAndSpencer(1)
```

`lightAdaptedPupilSize.StanleyAndDavies`
*pupil diameter ranges from StanleyAndDavies, L. (1995)*

## Description

`lightAdaptedPupilSize.StanleyAndDavies` computes the pupil diameter ranges from StanleyAndDavies, L. (1995).

## Usage

```
lightAdaptedPupilSize.StanleyAndDavies(L=NULL, a=NULL)
```

## Arguments

| | |
|---|---|
| `L` | luminance in cd m^-2 |
| `a` | area in deg^2 |

## Value

| | |
|---|---|
| `PupilSize` | Pupil size in mm |

## Author(s)

Jose Gama

## References

Watson A. B., Yellott J. I. (2012). A unified formula for light-adapted pupil size. Journal of Vision, 12(10):12, 1–16. http://journalofvision.org/12/10/12/, doi:10.1167/5.9.6. Stanley, P. A., & Davies, A. K. (1995). The effect of field of view size on steady-state pupil diameter. Ophthalmic & Physiological Optics, 15(6), 601–603.

## Examples

```
# Pupil diameter in mm for luminance = 1 cd m^-2, field diameter = 30 degrees
## Not run: lightAdaptedPupilSize.StanleyAndDavies(1,30^2)
```

## lightAdaptedPupilSize.WatsonAndYellott

*pupil diameter ranges from Watson A. B., Yellott J. I. (2012)*

### Description

`lightAdaptedPupilSize.WatsonAndYellott` computes the pupil diameter ranges from Watson A. B., Yellott J. I. (2012).

### Usage

```
lightAdaptedPupilSize.WatsonAndYellott(L=NULL, a=NULL, y=NULL, y0=NULL, e=NULL)
```

### Arguments

| | |
|---|---|
| `L` | luminance in cd m^-2 |
| `a` | area in deg^2 |
| `y` | age in years |
| `y0` | reference age |
| `e` | number of eyes (1 or 2) |

### Value

| | |
|---|---|
| `PupilSize` | Pupil size in mm |

### Author(s)

Jose Gama

### References

Watson A. B., Yellott J. I. (2012). A unified formula for light-adapted pupil size. Journal of Vision, 12(10):12, 1–16. http://www.ncbi.nlm.nih.gov/pubmed/23012448

### Examples

```
# Pupil diameter in mm for luminance = 1 cd m^-2, field diameter = 30 degrees,
# age=45, estimated reference age = 28.58, eyes = 2
## Not run: lightAdaptedPupilSize.WatsonAndYellott(1,30^2,45,28.58,2)
```

---

`lightAdaptedPupilSize.WinnEtAl`
*pupil diameter ranges from Winn et al (1995)*

---

## Description

`lightAdaptedPupilSize.WinnEtAl` computes the pupil diameter ranges from Winn et al (1995).

## Usage

```
lightAdaptedPupilSize.WinnEtAl(L=NULL, y=NULL)
```

## Arguments

| | |
|---|---|
| `L` | luminance in cd m^-2 |
| `y` | age in years |

## Value

| | |
|---|---|
| `PupilSize` | Pupil size in mm |

## Author(s)

Jose Gama

## References

Watson A. B., Yellott J. I. (2012). A unified formula for light-adapted pupil size. Journal of Vision, 12(10):12, 1–16. http://journalofvision.org/12/10/12/, doi:10.1167/5.9.6. Winn, B., Whitaker, D., Elliott, D. B., & Phillips, N. J. (1994). Factors affecting light-adapted pupil size in normal human subjects. Investigative Ophthalmology & Visual Science, 35(3):1132–1137, http://www.iovs.org/content/35/3/1132.

## Examples

```
# Pupil diameter in mm for luminance = 1 cd m^-2, age = 45 years
## Not run: lightAdaptedPupilSize.WinnEtAl(1,45)
```

## loadPNG *Load a PNG file*

### Description

`loadPNG` loads a PNG file and displays the image dimensions.

### Usage

```
loadPNG(fileIN=NULL, silent=FALSE)
```

### Arguments

| | |
|---|---|
| `fileIN` | Input file name. |
| `silent` | Logic, TRUE=do not display image dimensions. |

### Value

png file object.

### Author(s)

Jose Gama

### Examples

```
## Not run:
loadPNG(paste(system.file(package='CVD'),'/inst/extdata/fruits.png',sep=''))

## End(Not run)
```

## neutralPoint *Neutral points for CIE 1976 uv, CIE 1931 xy and CIE 1960 uv*

### Description

`neutralPoint` contains the neutral points for CIE 1976 uv, CIE 1931 xy and CIE 1960 uv

### Usage

```
neutralPoint
```

### Format

This data frame contains the following columns:

**CIE1931xy** neutral point CIE 1931 xy

**CIE1960uv** neutral point CIE 1976 uv

**CIE1960uv** neutral point CIE 1960 uv

### Author(s)

Jose Gama

### Examples

```
data(neutralPoint)
neutralPoint
```

---

## plotConfusionVectors *Plot confusion vectors for CIE 1976 uv, CIE 1931 xy and CIE 1960 uv*

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### Description

`plotConfusionVectors` Plots the confusion vectors for CIE 1976 uv, CIE 1931 xy and CIE 1960 uv.

### Usage

```
plotConfusionVectors(colorSpace='CIE1931xy')
```

### Arguments

| | |
|---|---|
| `colorSpace` | chosen colorSpace, default='CIE1931xy' |

### Value

none

### Author(s)

Jose Gama

### Examples

```
# find duplicate values
## Not run: plotConfusionVectors()
```

Roth28 *Roth-28 cap colors*

## Description

Roth28 contains the cap colors for the Roth-28 tests, in CIELab and RGB from Roth A (1966) The Roth-28 is a short test for detecting congenital color vision deficiencies.

## Usage

```
Roth28
```

## Format

This data frame contains the following columns:

**CIEL** CIELab L channel cap color

**CIEa** CIELab a channel cap color

**CIEb** CIELab b channel cap color

**R** R channel cap color

**G** G channel cap color

**B** B channel cap color

## Author(s)

Jose Gama

## Source

Roth A. Test-28 hue de Roth selon Farnsworth–Munsell (Manual). Paris: Luneau, 1966.

## References

Roth A. Test-28 hue de Roth selon Farnsworth–Munsell (Manual). Paris: Luneau, 1966.

## Examples

```
data(Roth28)
Roth28
```

`scoreD15Graphic` *Graphical score for the D-15 tests*

## Description

`scoreD15Graphic` computes the graphical score for the D-15 test or similar. The input is either a vector of RGB colors or cap positions.

## Usage

```
scoreD15Graphic(userD15colors=NULL,userD15values=NULL, titleGraphic=
"Farnsworth dichotomous test (D-15) results", okD15colors=NULL)
```

## Arguments

| | |
|---|---|
| `userD15colors` | RGB colors chosen by tester |
| `userD15values` | position values chosen by tester |
| `titleGraphic` | title for the graphic |
| `okD15colors` | vector with RGB colors in the correct sequence |

## Value

none

## Author(s)

Jose Gama

## References

Farnsworth D. The Farnsworth Dichotomous Test for Color Blindness Panel D-15 Manual. New York, The Psychological Corp., 1947, pp. 1-8.

## Examples

```
# a "perfect" score
## Not run: scoreD15Graphic(userD15values=1:15)
```

scoreD15TCDS *Total Color Difference Score (TCDS) for the D-15 tests*

## Description

scoreD15TCDS computes the Total Color Difference Score (TCDS) for the D-15 test, from Bowman's (1982). The input is either a vector of RGB colors or cap positions.

## Usage

```
scoreD15TCDS(userD15colors=NULL,userD15values=NULL,
 distTable = get("BowmanTCDS", envir = environment()),
D15colors = get("FarnsworthD15", envir = environment()))
```

## Arguments

| | |
|---|---|
| userD15colors | RGB colors chosen by tester |
| userD15values | position values chosen by tester |
| distTable | distance table - matrix with the color distances |
| D15colors | RGB colors for the CVD test |

## Value

| | |
|---|---|
| TCDS | Total Color Difference Score (TCDS) |

## Author(s)

Jose Gama

## References

Bowman's (1982) Total Color Difference Score (TCDS) for congenitally defective observers on the D-15 with enlarged tests. K.J. Bowman, A method for quantitative scoring of the Farnsworth Panel D-15, Acta Ophthalmologica, 60 (1982), pp. 907–916

## Examples

```
# a "perfect" score
## Not run:
scoreD15TCDS(userD15values=1:15)
## End(Not run)
```

`scoreFM100Graphic` *Graphical score for the D-15 tests*

## Description

`scoreFM100Graphic` computes the graphical score for the FM-100 test or similar. The input is either a vector of RGB colors or cap positions.

## Usage

```
scoreFM100Graphic(userFM100colors=NULL,userFM100values=NULL, titleGraphic=
"Farnsworth Munsell 100-Hue test results", okFM100colors=NULL, Kinnear=FALSE)
```

## Arguments

| | |
|---|---|
| `userFM100colors` | RGB colors chosen by tester |
| `userFM100values` | position values chosen by tester |
| `titleGraphic` | title for the graphic |
| `okFM100colors` | vector with RGB colors in the correct sequence |
| `Kinnear` | logical, scoring method TRUE = Farnsworth, FALSE = Kinnear |

## Value

none

## Author(s)

Jose Gama

## References

Dean Farnsworth, 1943 The Farnsworth Munsell 100-hue dichotomous tests for colour vision Journal of the Optical Society of America, 33 (1943), pp. 568–576

## Examples

```
# an example score
## Not run:
FM100example<-exampleFM100
userFM100values=cbind(FM100example[1,], FM100example[4,-22],
 FM100example[7,-22], FM100example[10,-22])
userFM100values=as.vector(unlist(userFM100values))
scoreFM100Graphic(userFM100values)

## End(Not run)
```

## scoreRoth28Graphic *Graphical score for the D-15 tests*

### Description

`scoreRoth28Graphic` computes the graphical score for the Roth-28 test or similar. The input is either a vector of RGB colors or cap positions.

### Usage

```
scoreRoth28Graphic(userR28colors=NULL,userR28values=NULL, titleGraphic=
"Roth-28 test results", okR28colors=NULL)
```

### Arguments

| | |
|---|---|
| `userR28colors` | RGB colors chosen by tester |
| `userR28values` | position values chosen by tester |
| `titleGraphic` | title for the graphic |
| `okR28colors` | vector with RGB colors in the correct sequence |

### Value

none

### Author(s)

Jose Gama

### References

Carl Erb, Martin Adler, Nicole Stübiger, Michael Wohlrab, Eberhart Zrenner, Hans-Jürgen Thiel, Colour vision in normal subjects tested by the colour arrangement test ‘Roth 28-hue desaturated’, Vision Research, Volume 38, Issue 21, November 1998, Pages 3467-3471, ISSN 0042-6989, http://dx.doi.org/10.1016/S0042-6989(97)00433-1.

### Examples

```
# a "perfect" score
## Not run: scoreRoth28Graphic(userD15values=1:28)
```

## showDuplicated *Show missing and duplicated cap numbers*

### Description

showDuplicated shows missing and duplicated cap numbers from D-15, D15d, FM-100 and similar tests.

### Usage

```
showDuplicated(cnum)
```

### Arguments

| | |
|---|---|
| cnum | cap numbers |

### Value

none

### Author(s)

Jose Gama

### Examples

```
# find duplicate values
## Not run: showDuplicated(1:15)
showDuplicated(c(1:4,8,5:14))
# this is an example of a typo in data from a publication
#Procedures for Testing Color Vision: Report of Working Group 41, 1981,
Committee on Vision, National Research Council, pp. 107
#the "monochromat" data has "16" instead of "6"
data(exampleNRC1981)
showDuplicated(exampleNRC1981[,3])

## End(Not run)
```

## typicalD15 *Typical cap arrangements for the D-15 tests*

### Description

typicalD15 contains typical cap arrangements for the D-15 tests, from Farnsworth D (1947), Simunovic (1998) and NRC (1981)

### Usage

```
typicalD15
```

### Format

This data frame contains the following columns:

**protanope** typical cap arrangements - protanope

**deuteranope** typical cap arrangements - deuteranope

**tritanope** typical cap arrangements - tritanope

**monochromat** typical cap arrangements - monochromat

**rodMonochromat** typical cap arrangements - rodMonochromat

**blueConeMonochromat** typical cap arrangements - blueConeMonochromat

### Author(s)

Jose Gama

### Source

Farnsworth D. The Farnsworth Dichotomous Test for Color Blindness Panel D-15 Manual. New York, The Psychological Corp., 1947, pp. 1-8. Simunovic MP, Moore AT. The cone dystrophies. Eye 1998;12:553–65. National Research Council (US). Committee on Vision. Procedures for testing color vision: report of Working Group 41. National Academies Press, 1981.

### References

Farnsworth D. The Farnsworth Dichotomous Test for Color Blindness Panel D-15 Manual. New York, The Psychological Corp., 1947, pp. 1-8. Simunovic MP, Moore AT. The cone dystrophies. Eye 1998;12:553–65. National Research Council (US). Committee on Vision. Procedures for testing color vision: report of Working Group 41. National Academies Press, 1981.

### Examples

```
data(typicalD15)
typicalD15
```

---

## vectorPNGbuttons *Vector of PNG files representing colored caps (buttons)*

---

### Description

`vectorPNGbuttons` returns a vector with the filenames of the PNG files representing colored caps (buttons) from a data.frame.

## Usage

```
vectorPNGbuttons(capsData=get("FarnsworthD15", envir = environment()))
```

## Arguments

| | |
|---|---|
| capsData | data.frame with RGB values of colored caps (buttons). |

## Value

vector with path+filenames of PNG files.

## Author(s)

Jose Gama

## Examples

```
## Not run:
vectorPNGbuttons(FarnsworthD15)

## End(Not run)
```

---

VKSgraphic *Graphical score for the D-15 tests*

---

## Description

VKSgraphic computes a graphical score based on the Vingrys and King-Smith method (VKS) for the D-15 test or similar tests. VKSvariantGraphic shows the angles with double their value, for a continuous display of the confusion axis.

## Usage

```
VKSgraphic(VKSdata, xLimit=5, yLimit=4, VKStitle='', VKSxlabel='',
VKSylabel='')
```

## Arguments

| | |
|---|---|
| VKSdata | data.frame with color vision deficiency name, VKS angle and VKS index |
| xLimit | X-axis boundaries |
| yLimit | Y-axis boundaries |
| VKStitle | title for the plot |
| VKSxlabel | text for the x label |
| VKSylabel | text for the y label |

### Value

none

### Author(s)

Jose Gama

### Source

VKSvariantGraphic - original idea by David Bimler Atchison DA, Bowman KJ, Vingrys AJ Quantitave scoring methods for D15 panel tests in the diagnosis of congenital colour-vision deficiencies. Optometry and Vision Science 1991, 68:41-48.

### References

Atchison DA, Bowman KJ, Vingrys AJ Quantitave scoring methods for D15 panel tests in the diagnosis of congenital colour-vision deficiencies. Optometry and Vision Science 1991, 68:41-48.

### Examples

```
# Creating similar graphics to "A Quantitative Scoring Technique For Panel
#Tests of Color Vision" Algis J. Vingrys and P. Ewen King-Smith
## Not run:
VKSdata<-VKStable2[,c(1,3:5)]
VKSdata[1,1]<-'Normal no error'
VKSdata[2:9,1]<-'Normal'
VKSdata[10:13,1]<-'Acquired CVD'
# the graphics are similar but not identical because the data used in the
#plots is the average of the values instead of all the values
VKSgraphic(VKSdata[,1:3],5,4,'D-15 angle vs C-index (Average)','Angle',
'C-index') # Fig. 6
VKSgraphic(VKSdata[,c(1,2,4)],5,4,'D-15 angle vs S-index (Average)','Angle',
'S-index') # Fig. 7

## End(Not run)
```

---

## VKStable2 — *Table with results of D-15 tests scored with the Vingrys and King-Smith method*

---

### Description

VKStable2 contains tthe results of D-15 tests scored with the Vingrys and King-Smith method, from Vingrys and King-Smith (1988), table 2

### Usage

```
VKStable2
```

## Format

This data frame contains the following columns:

**typeCVD** Type of color vision

**sample** Number in sample

**Angle** Angle

**S.index** S-index

**C.index** C-index

**Major** Major radius

**Minor** Minor radius

**TES** TES

**TCDS** TCDS

## Author(s)

Jose Gama

## Source

Atchison DA, Bowman KJ, Vingrys AJ Quantitave scoring methods for D15 panel tests in the diagnosis of congenital colour-vision deficiencies. Optometry and Vision Science 1991, 68:41-48.

## References

Atchison DA, Bowman KJ, Vingrys AJ Quantitave scoring methods for D15 panel tests in the diagnosis of congenital colour-vision deficiencies. Optometry and Vision Science 1991, 68:41-48.

## Examples

```
data(VKStable2)
VKStable2
```

---

`XYZ2scotopic.Rawtran` *Approximation of the scotopic luminance*

---

## Description

`XYZ2scotopic.Rawtran` approximates the scotopic luminance from XYZ values, illuminant D65, from Filip Hroch (1998). Used in the astronomy software Rawtran.

`XYZ2scotopic.Rawtran.array` idem, however the data type used is array.

## Usage

```
XYZ2scotopic.Rawtran(XYZmatrix)
```

## Arguments

| | |
|---|---|
| `XYZmatrix` | matrix (or array) with XYZ values |

## Value

Matrix (or array) with approximated scotopic luminance.

## Author(s)

Jose Gama

## Source

Filip Hroch, 1998, Computer Programs for CCD Photometry, 20th Stellar Conference of the Czech and Slovak Astronomical Institutes, DusekJ., http://adsabs.harvard.edu/abs/1998stel.conf...30H Rawtran - integral.physics.muni.cz Masaryk University http://integral.physics.muni.cz/rawtran/

## References

Filip Hroch, 1998, Computer Programs for CCD Photometry, 20th Stellar Conference of the Czech and Slovak Astronomical Institutes, DusekJ., http://adsabs.harvard.edu/abs/1998stel.conf...30H Rawtran - integral.physics.muni.cz Masaryk University http://integral.physics.muni.cz/rawtran/

# Index