

CIEBasedABC—color space  
transformation  $ABC^* \rightarrow XYZ$   
CIELAB part 1:  $ABC^* \rightarrow LMN^*$

$A = \text{Decode}A^* = \{16 \text{ add } 116 \text{ div}\}$   
 $B = \text{Decode}B^* = \{500 \text{ div}\}$   
 $C = \text{Decode}C^* = \{200 \text{ div}\}$

$$\begin{pmatrix} L^* \\ M^* \\ N^* \end{pmatrix} = \begin{pmatrix} 1 & 1 & 0 \\ 1 & 0 & 0 \\ 1 & 0 & -1 \end{pmatrix} \times \begin{pmatrix} A \\ B \\ C \end{pmatrix}$$

ME360-1, B8\_36\_1

CIELAB  $L^*a^*b^*$ —color space

```
[/CIEBasedABC<< %Dict PostScript Level 2
/MatrixABC [1 0 0 1 0 0 1] %default
/DecodeABC [{16 add 116 div} bind
{500 div} bind {200 div} bind ]
/RangeABC [0 100 -128 127 -128 127] %Lab*
/MatrixLMN [0.9505 0 0 1 0 0 1.0890]
/DecodeLMN [{3 exp} {3 exp} {3 exp}]
/RangeLMN [0 0.9505 0 1 0 1.0890] %D65
/WhitePoint [0.9505 1 1.0890] %D65
/BlackPoint [0 0 0] % default
>>]setcolorspace
```

ME360-3, B8\_36\_3

least square fit for color rendering

$$Lab_{i,aim}^* - Lab_{i,gopt}^* = \text{Min.}$$

color-differences  $\Delta(Lab^*)$  for  
CIE-test colors  $i = 1, 2, \dots, 17$

$$\begin{aligned} \Delta L_i^* &= L_{i,aim}^* - L_{i,gopt}^* \\ \Delta a_i^* &= a_{i,aim}^* - a_{i,gopt}^* \\ \Delta b_i^* &= b_{i,aim}^* - b_{i,gopt}^* \\ \Sigma [(\Delta L_i^*)^2 + (\Delta a_i^*)^2 + (\Delta b_i^*)^2]^{1/2} &= \text{Min.} \\ i &= 1, 17 \end{aligned}$$

ME360-5, B8\_37\_2

CIEBasedABC—color space  
transformation  $ABC^* \rightarrow XYZ$   
CIELAB part 2:  $LMN^* \rightarrow XYZ$

$L = \text{Decode}L^* = \{3 \text{ exp}\}$   
 $M = \text{Decode}M^* = \{3 \text{ exp}\}$   
 $N = \text{Decode}N^* = \{3 \text{ exp}\}$

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \times \begin{pmatrix} X_n & L \\ Y_n & M \\ Z_n & N \end{pmatrix}$$

ME360-2, B8\_36\_2

CIEBasedABC—optimization of  
color rendering  $Lab_{soll}^* - Lab_{eopt}^*$

PSL2-program output measure  
 $L_{aim}^* \quad L \rightarrow L^* \rightarrow L \quad L_{real}^*$   
 $a_{aim}^* \rightarrow M \rightarrow M^* \rightarrow M \rightarrow a_{real}^*$   
 $b_{aim}^* \quad N \rightarrow N^* \rightarrow N \quad b_{real}^*$   
 $L_{aimc} = L_{aim}^* + (L_{aim}^* - L_{real}^*) \quad L_{eopt}^*$   
 $a_{aimc} = a_{aim}^* + (a_{aim}^* - a_{real}^*) \rightarrow a_{eopt}^*$   
 $b_{aimc} = b_{aim}^* + (b_{aim}^* - b_{real}^*) \quad b_{eopt}^*$

ME360-4, B8\_37\_1

least square fit for color rendering

$$Lab_{i,aim}^* - Lab_{i,gopt}^* = \text{Min.}$$

color-differences  $\Delta(Lab^*)$  for  
CIE-test colors  $i = 1$  to 17  $\rightarrow$  min.

$$\begin{pmatrix} L_{i,gopt}^* \\ a_{i,gopt}^* \\ b_{i,gopt}^* \end{pmatrix} = \begin{pmatrix} a_{11} & a_{21} & a_{31} \\ a_{12} & a_{22} & a_{32} \\ a_{13} & a_{23} & a_{33} \end{pmatrix} \times \begin{pmatrix} L_{i,aim}^* \\ a_{i,aim}^* \\ b_{i,aim}^* \end{pmatrix}$$
$$\Sigma [(\Delta L_i^*)^2 + (\Delta a_i^*)^2 + (\Delta b_i^*)^2]^{1/2} = \text{Min.}$$
$$i = 1, 17$$

ME360-6, B8\_37\_3

### PSL2-program code: definition and reproduction of 17 CIE-test colors

```
!PS-Adobe-3.0 B7221-7n.eps 20.10.94
%%BoundingBox: 72 90 226 206
/FS {findfont exch scalefont setfont} bind def
/MM {72 25.4 div mul} def
/languagelevel where {pop languagelevel} {1} ifelse
/PSL2 exch def
/dictende {counttomark 2 idiv dup dict begin {def}
repeat pop currentdict end} bind def
%%EndProlog

72 90 translate 0.01 MM dup scale 20 setlinewidth

PSL2 2 eq {[/CIEBasedABC [ %color space and limits for D65
/WhitePoint [0.9505 1 1.089] %CIEXYZ for D65
/RangeABC [0 0.9505 0 1 0 1.0885] %CIEXYZ-limits N/W
/RangeLMN [0 0.9505 0 1 0 1.0885] dictende }
setcolorspace } if %end standard definition PSL2-CIEBasedA

PSL2 1 eq
{ {/setrgbcolor where %definition for PSL1-devices
%question for PSL1-color device
{pop setrgbcolor} %PSL1-color device
{pop 0.4 exp setgray pop} ifelse } %PSL1->NW-device
/setcolor exch def} if

/colRec {moveto s 0 rlineto 0 s rlineto s neg 0 rlineto %square
closepath setcolor} bind def

0.1885 0.1983 0.2157 setcolor %test color no. 16 (mean gray)

0 0 moveto 5400 0 rlineto 0 4000 rlineto %image size 54mm x 40mm
-5400 0 rlineto closepath fill

250 /Times-Bold FS 0.7239 0.7615 0.8289 setcolor %white
3200 3300 moveto (17 CIE-test colors) show

500 500 translate %zero point lower left test color

/s 600 def /xw 1000 def /yw 800 def %square width and distances

% X Y Z x,y-position fill color rectangle
0.3298 0.2976 0.2459 0 0 colRec fill %CIE-TF01
0.2749 0.2890 0.1501 xw 1 mul yw 0 mul colRec fill %CIE-TF02
0.2393 0.3043 0.0996 xw 2 mul yw 0 mul colRec fill %CIE-TF03
0.2045 0.2948 0.2127 xw 3 mul yw 0 mul colRec fill %CIE-TF04
0.2502 0.3087 0.4042 xw 4 mul yw 0 mul colRec fill %CIE-TF05
0.2826 0.2983 0.5791 0 yw 1 mul colRec fill %CIE-TF06
0.3333 0.2939 0.5322 xw 1 mul yw 1 mul colRec fill %CIE-TF07
0.3757 0.3131 0.4544 xw 2 mul yw 1 mul colRec fill %CIE-TF08
0.2048 0.1120 0.0436 xw 3 mul yw 1 mul colRec fill %CIE-TF09
0.5487 0.5894 0.1208 xw 4 mul yw 1 mul colRec fill %CIE-TF10
0.1212 0.2035 0.1533 0 yw 2 mul colRec fill %CIE-TF11
0.0628 0.0647 0.2773 xw 1 mul yw 2 mul colRec fill %CIE-TF12
0.5885 0.5709 0.4139 xw 2 mul yw 2 mul colRec fill %CIE-TF13
0.0935 0.1171 0.0543 xw 3 mul yw 2 mul colRec fill %CIE-TF14
0.0342 0.0359 0.0394 0 yw 3 mul colRec fill %CIE-TF15 N
0.1885 0.1983 0.2157 xw 1 mul yw 3 mul colRec fill %CIE-TF16 Z
0.7239 0.7615 0.8289 xw 2 mul yw 3 mul colRec fill %CIE-TF17 W
0.7239 0.7615 0.8289 xw 1 mul yw 3 mul colRec stroke %-TF17 W

1 1 17 {/nrl exch def %squares and text no. 1 to 17
nrl 9 gt {/xp 300 def}{/xp 200 def} ifelse
nrl 14 gt {/nr nrl 1 add def} {/nr nrl def} ifelse
nr 1 sub 5 idiv /i exch def
nr 1 sub 5 mod /j exch def
j xw mul xp sub i yw mul 20 add moveto
nrl 4 string cvs show } for
showpage
```

ME361-7, B8\_39