Explaining Color Evolution, Color Blindness, and Color Recognition by the Decoding Model of Color Vision

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用色觉译码模型解释色觉进化，色盲，和颜色识别

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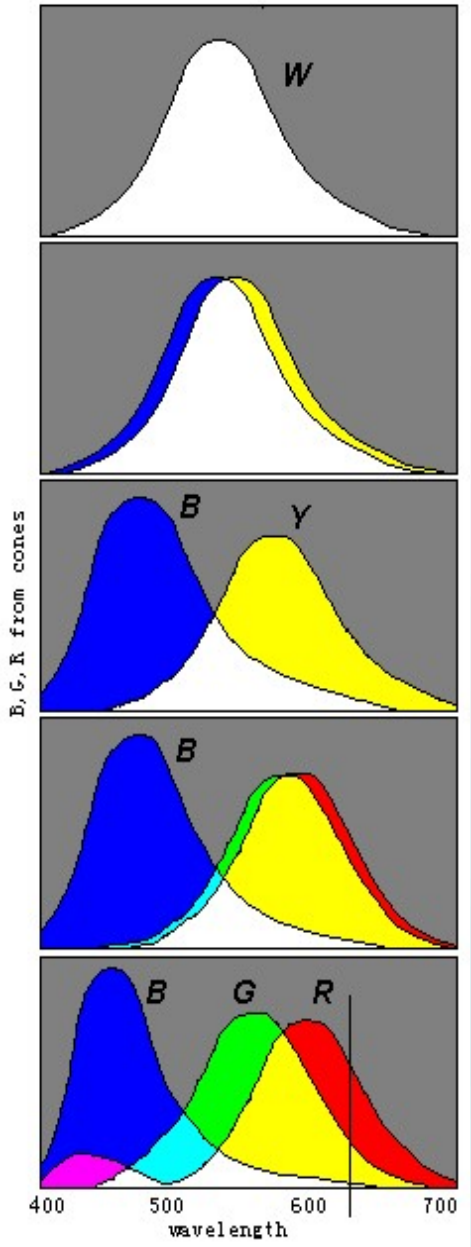
长沙学院退休教师，辽宁工程技术大学客座教授



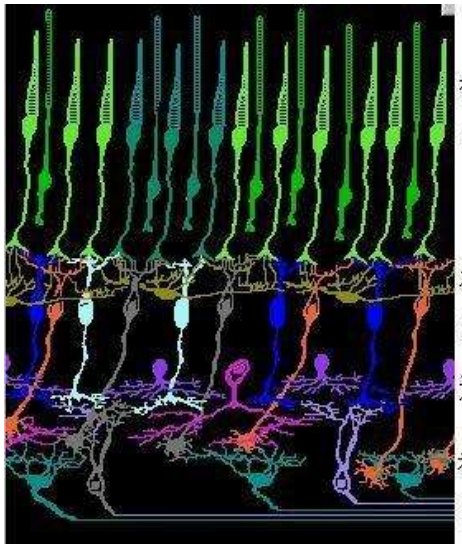
研究经历 Research Experience

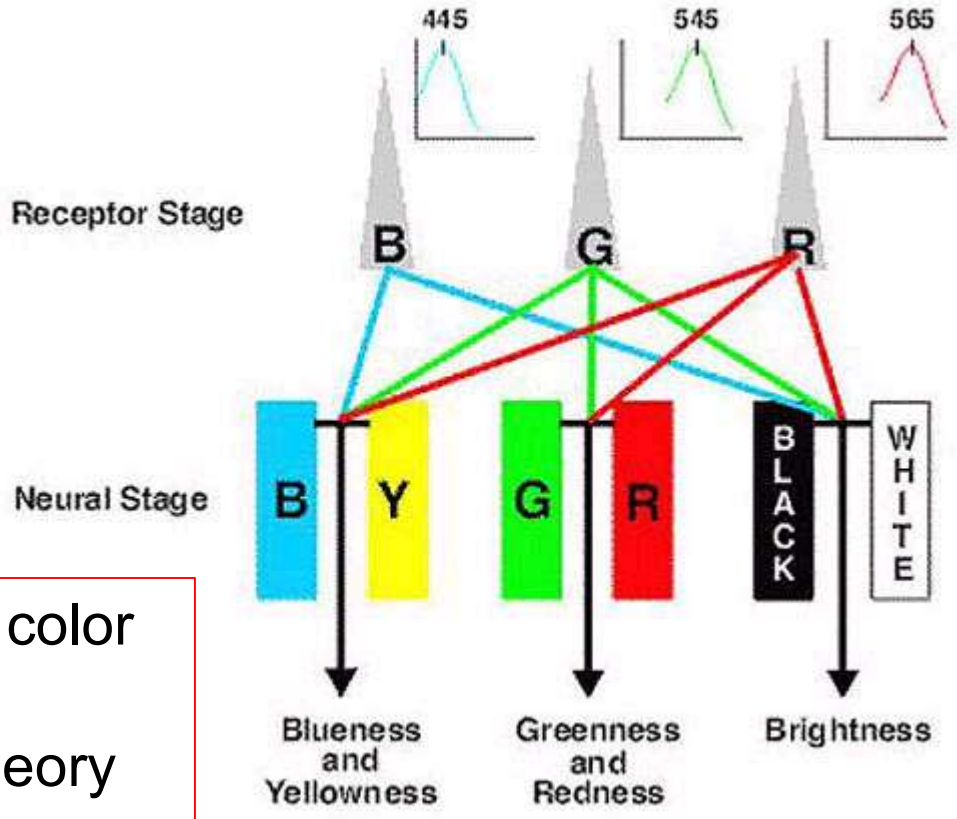
- In 1980s，studied color vision, philosophy, aesthetics
- In 1990s, studied semantic information theory, color vision, portfolio
- Recently combined semantic information method and likelihood method for machine learning.
- Wrote several books about color, beauty, semantic information, and Portfolio.
- 南航77级，最早研究色觉和美感等
- 哲学问题，因色觉模型涉及模糊数
- 学，当了汪培庄教授的访问学者，
- 完成《广义信息论》。后来研究投
- 资组合理论，下海搞投资。
  最近在汪老师鼓励下重新搞研究，
- 结合语义信息方法和似然度方法
  研究机器学习.

Recent Studies 最近几年研究

- **Conference Papers（大多在史教授主编的文集中）：**
- Channels‘ Matching Algorithm for Mixture Models 混合模型,改进EM算法
- Semantic Channel and Shannon’s Channel Mutually Match for Multi-label Classification 多标签分类
- From Bayesian Inference to Logical Bayesian Inference: A New Mathematical Frame for Semantic Communication and Machine Learning 逻辑贝叶斯推理
- **Journal Papers:**
- Semantic Information G Theory with Formulas for Falsification and Confirmation, Information, 1999,8 上面文章总结
- Channels’ Confirmation and Predictions’ Confirmation:from the Medical Test to the Raven Paradox, Entropy, 2020,4关于归纳，确证和乌鸦悖论
- Current Study（当前研究，写一篇科学哲学文章）
  The P-T Probability Framework for Semantic Communication, Falsification, Confirmation, and Bayesian Reasoning

Zone Models of Color Vision色觉阶段模型





Young-Helmholtz 3 primary color Theory

Herring：Opponent color theory

Problems：

1) Too many parameters; 不美

2) Logical confusion;

3) Transform from BGR system to HSL system is not convenient

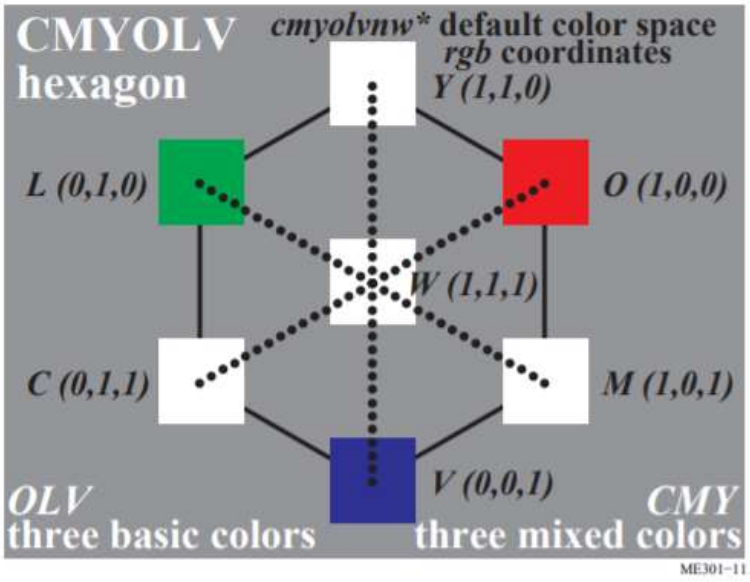
CIELAB Symmetrical Color Model 2006

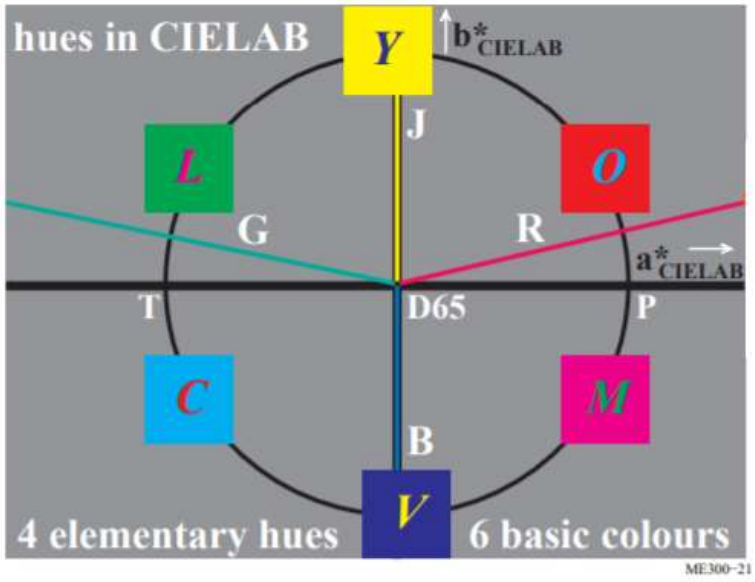
http://130.149.60.45/~farbmetrik/A/FI06E.PDF

国际照明协会推出对称色觉模型， 弥补Zone Model缺陷，符合屏幕显示需要

Symmetric Colour Vision Model, CIELAB and Colour Information Technology

3. Device and elementary colours in the CIELAB chroma diagram *(a*, b*)*





I Proposed the Decoding Model of Color Vision in 1986
我30多年前提出的对称色觉模型——译码模型

- 色觉新说及机制模拟, 心理学动态, No.2(1986),36—45
- 色觉的译码模型及其验证，1989 光学学报，网上有全文：http://opticswww.opticsjournal.net/ViewFull0.htm?aid=OJ110920000369IeLhNk

第9卷 第2期 光 学 学 报 Vol. 9, No. 2
1989年2月 ACTA OPTICA SINICA February 1989

色觉的译码模型及其验证

鲁 晨 光
(长沙大学计算机中心)

提 要

文中简要介绍了色觉机制的译码模型，提出了一个基于译码模型的 θ-r-s 色坐标制。这一色坐标制既具有孟塞尔色坐标制的特点，又具有 xyz 色坐标制的特点。同时，文中给出了一个通过对 R、G、B 作非线性变换得出 θ^m-r_c^*-s^m 色坐标制，并通过 s 和 s^m 对明度的反映孟塞尔色样品在 θ^m-r_c^*-s^m 制中的分布，验证了模型的合理性。

关键词：颜色视觉；色坐标制；互补色处理；明度；模糊逻辑；模糊译码。

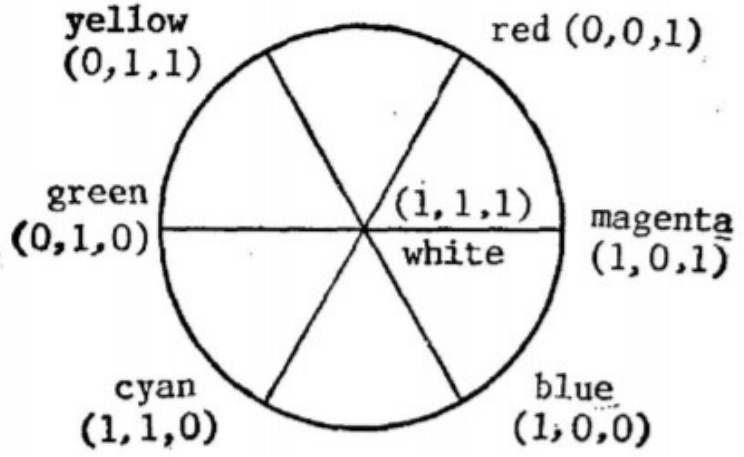
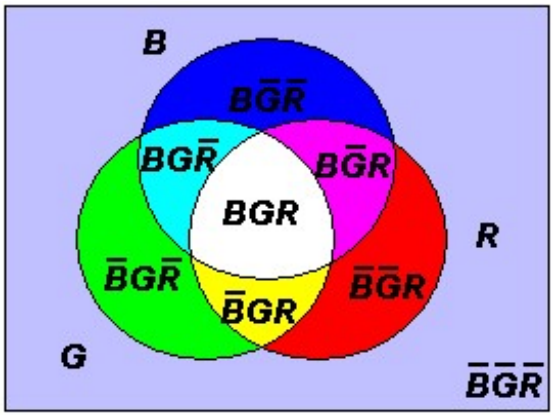


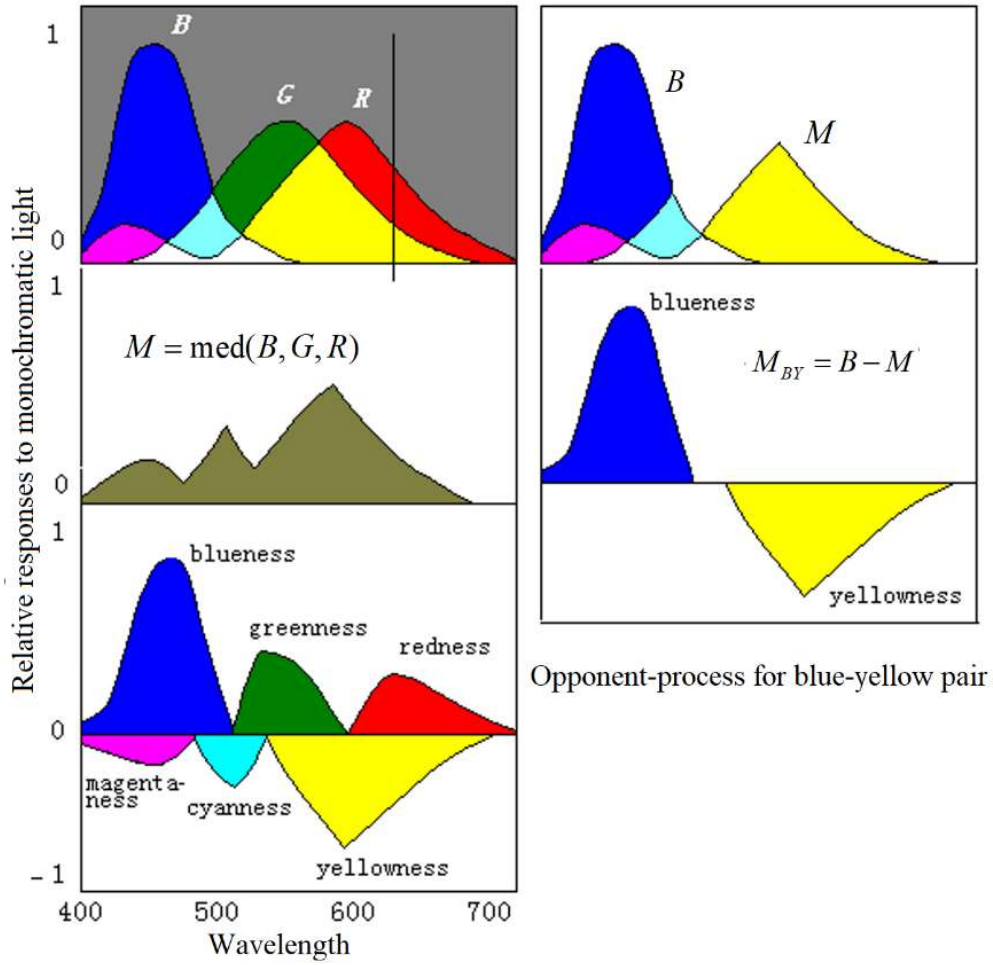
Fig. 1 The resolution pattern of a color vector

Decoding and Opponent Process 译码和互补处理

- Extend 3-8 decoder to fuzzy 3-8 decoder 数字电路中选址用的
- 8 outputs: $[\bar{B}\bar{G}R], [\bar{B}G\bar{R}], [\bar{B}GR], [B\bar{G}\bar{R}], [BG\bar{R}], [B\bar{G}R]$, and $[BGR]$



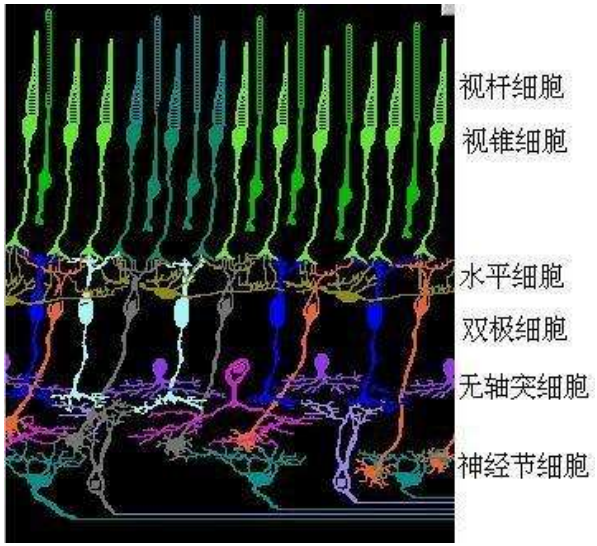
- Opponent process：
- First to obtain
- M=med(B,G,R)=[BGVBRVGR]
- Then
- R-M, G-M, B-M for six unique
- Colors
- 数学方法是独创的

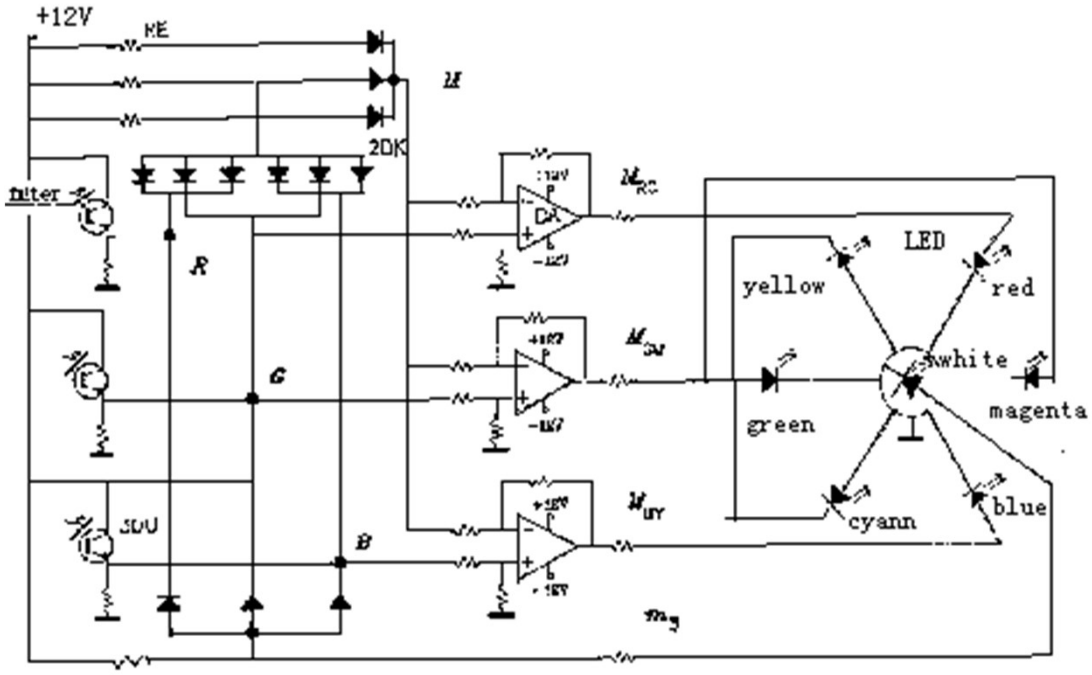


Opponent-process for blue-yellow pair

Physical Model 物理模型

- Extend 3-8 decoder to fuzzy 3-8 decoder

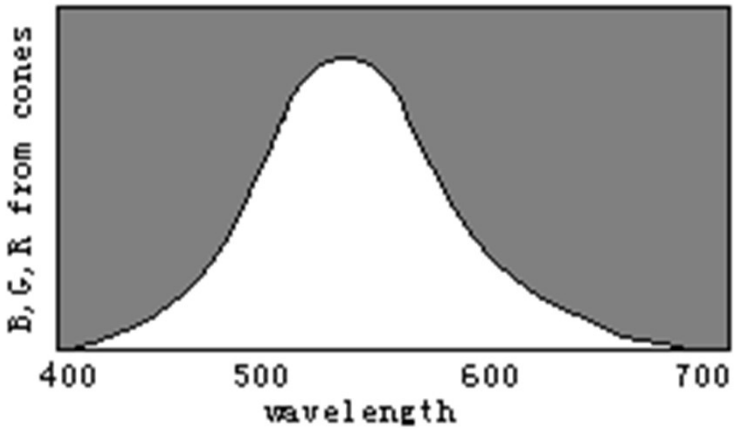


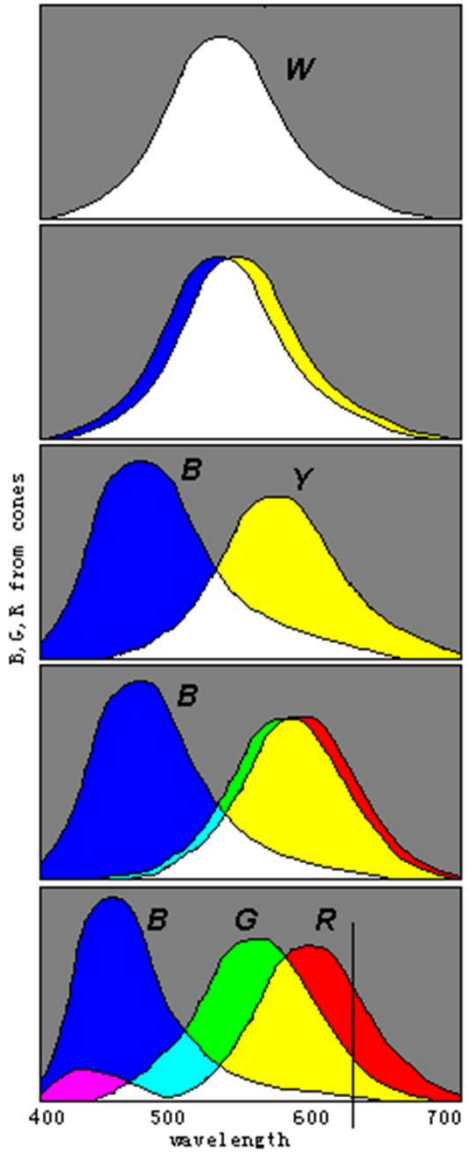


- 关于郭念锋，王雨田，汪培庄老师的支持

Illustrating the Evolution of Color Vision
图解色觉进化

http://survivor99.com/LCG/english/





With cones' splitting from one to three,
we can perceive more colors

如果分裂成4根曲线，就可以看出16种—乌龟可以。有此可建立四原色机器人色觉模型。

用色敏感细胞分裂解释色觉进化

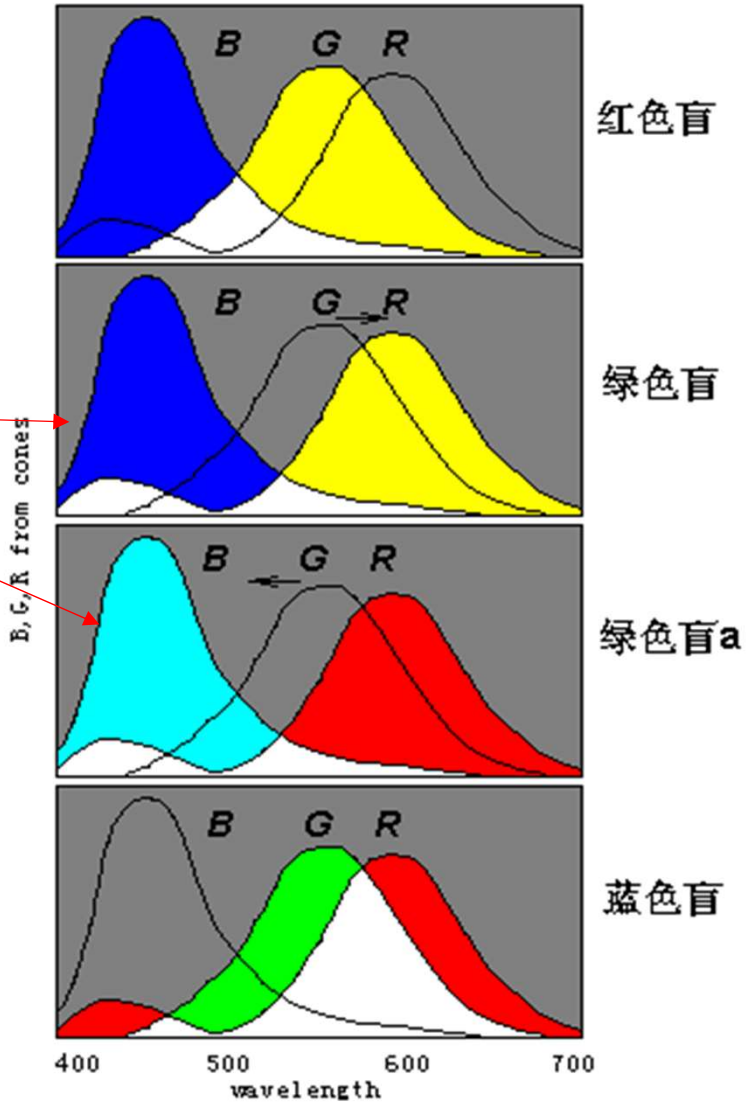
进化和设计的区别：

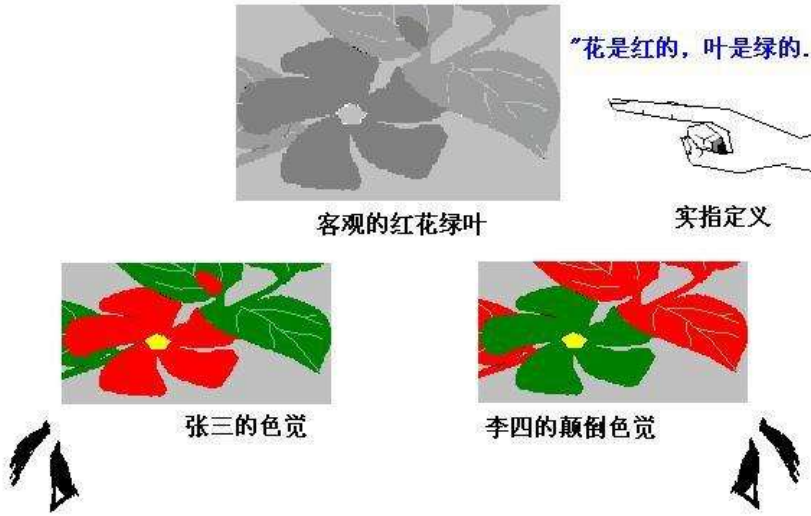
进化从简单到复杂， 中间类型都是改进

Illustrating Color Blindness
图解色盲

- Colorblindness
- because cones' sensitive
- curves have not split well

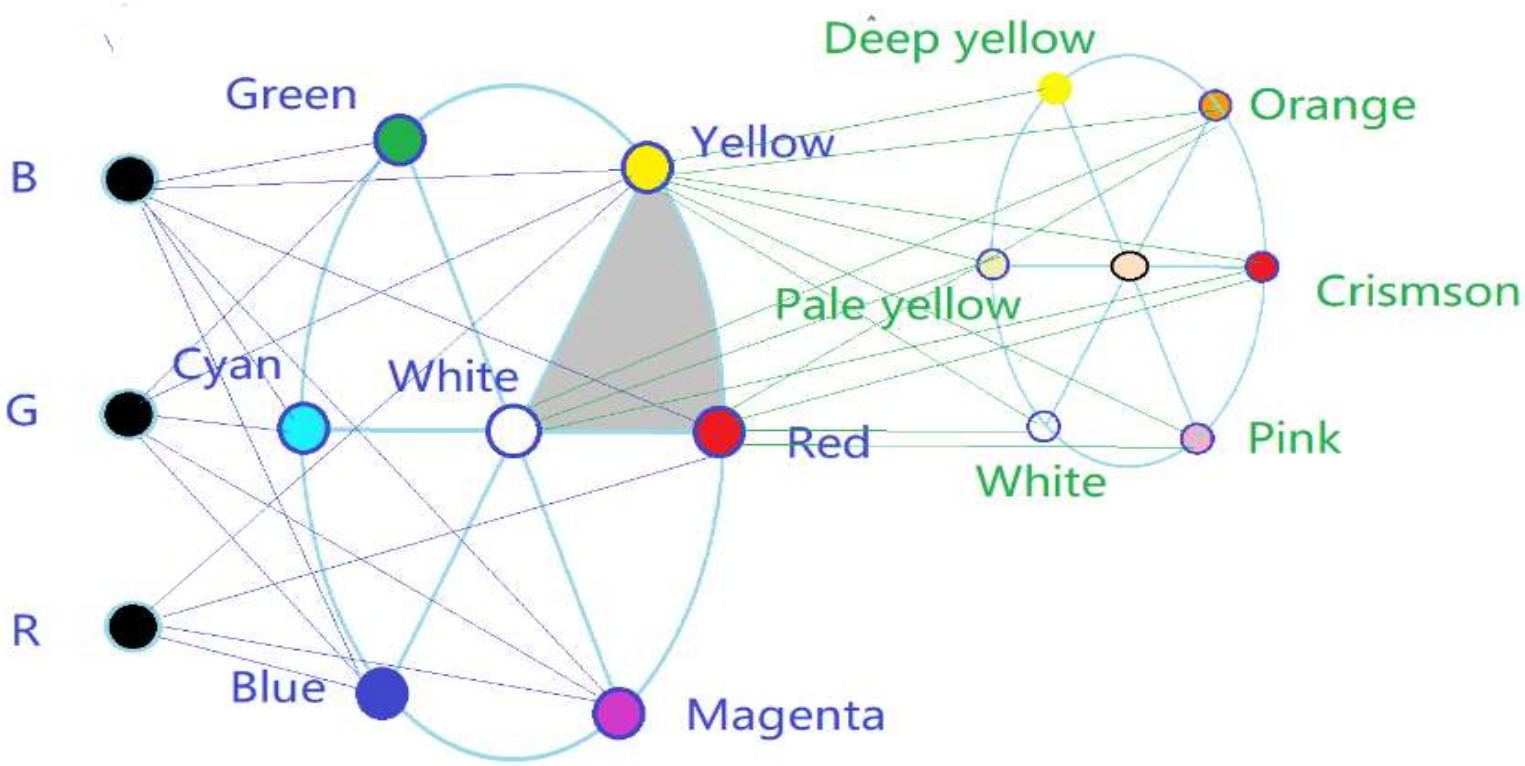
- 这两种一样， 不可区分



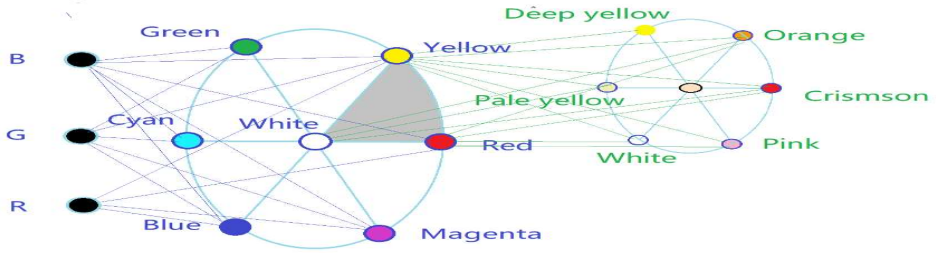


Illustrating Color Recognition
图解颜色识别

Color decoding in cortex—by decoding again
从神经节细胞到脑皮层的颜色解码？



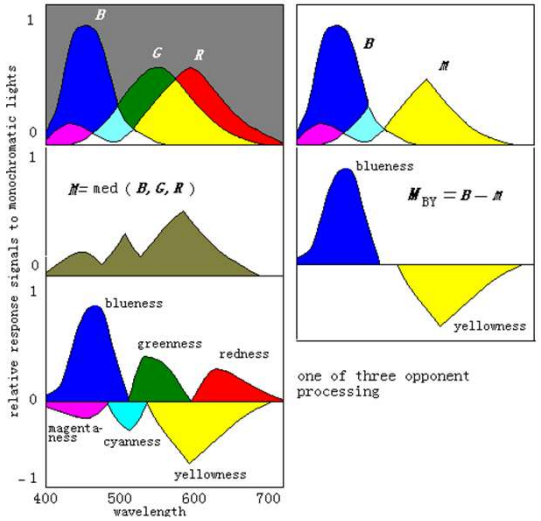
Potential Applications of the Decoding Neural Network
译码神经网络的潜在应用

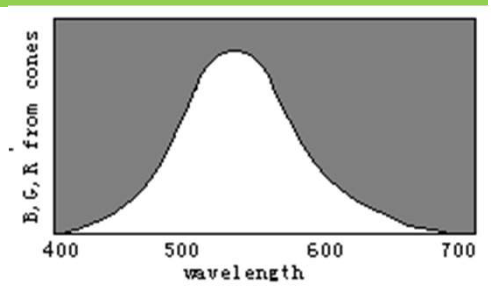


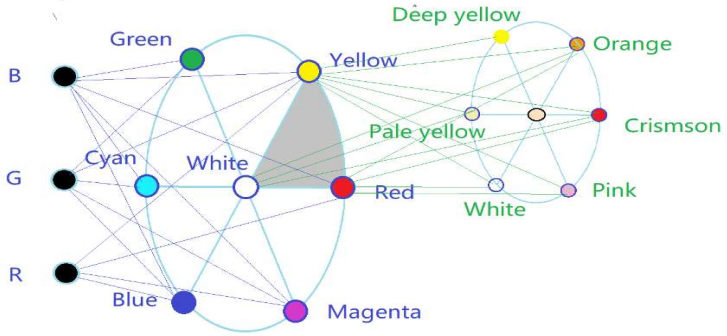
- The above Figure remind us that we can use several or many 3-8 or n-2^n decoders to construct a two-layer or multi-layer Decoding Neural Network (DNN).
- 用两层或多层译码器构造译码神经网络
- Compared with the popular neural network, the DNN has different characteristics: 比较：
- It uses fuzzy logic without parameters. 使用模糊逻辑，没有参数
- Every nerve cell in the next layer has inputs that are selected from one sector of the previous layer. 每层输出一个扇区
- The number of non-zero outputs is equal to the number of inputs. 每层不为0的输入个数不变。

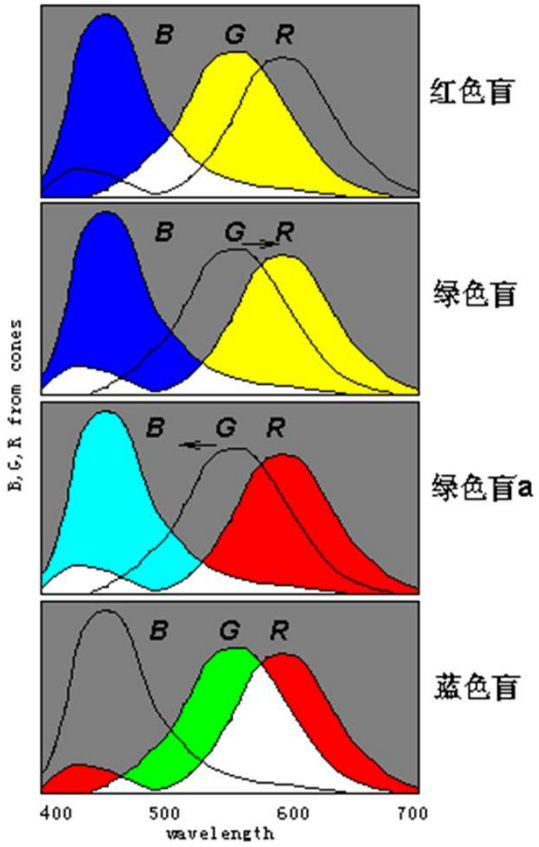
Conclusions 结论

- 1. Can better explain
- Opponent Process
- Color Evolution
- Color Blindness
- Color Recognization
- 2. Constructing the
- Decoding Neural Network
- for potential
- applications









- **Thank you for your patience !**