

# MATLAB入门后杂谈

王洋 @张弢课题组

2014-9-16

# 大纲

- 引子
- 微机接口与RTFM
- 模块化程序设计与KISS
- 时间与空间的权衡

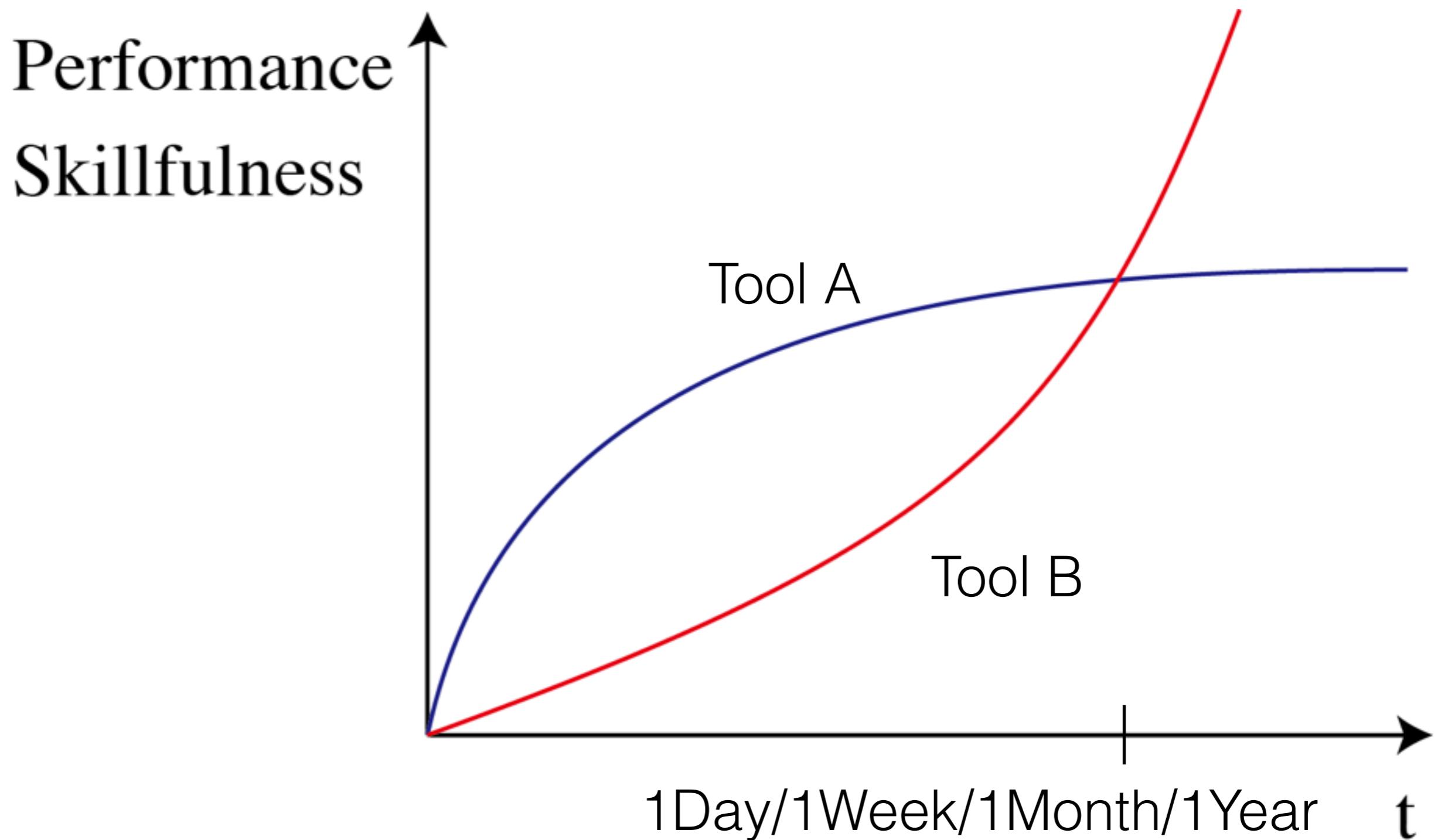
[https://github.com/yangscar/Matlab\\_Training.git](https://github.com/yangscar/Matlab_Training.git)

# 大纲

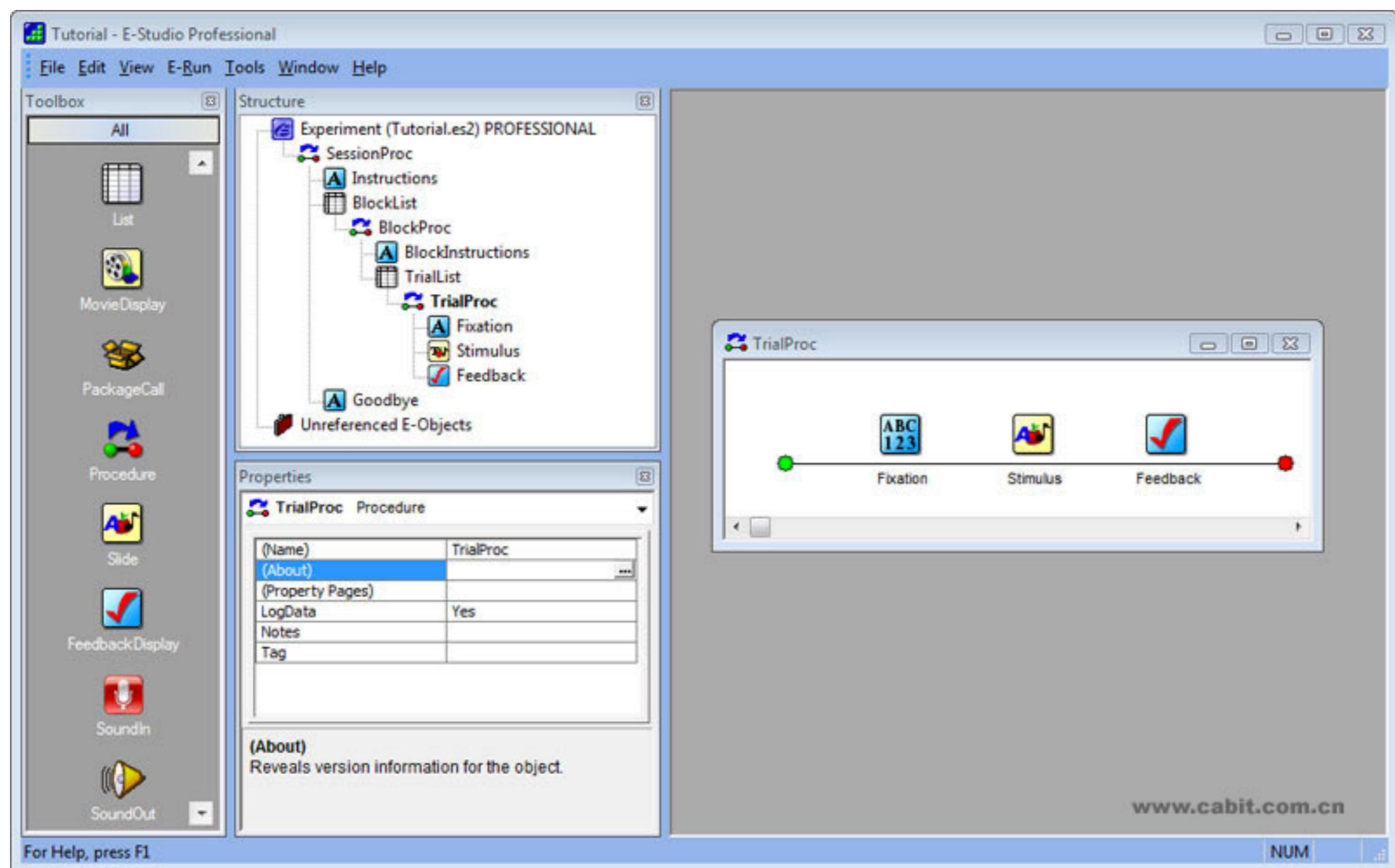
- 引子
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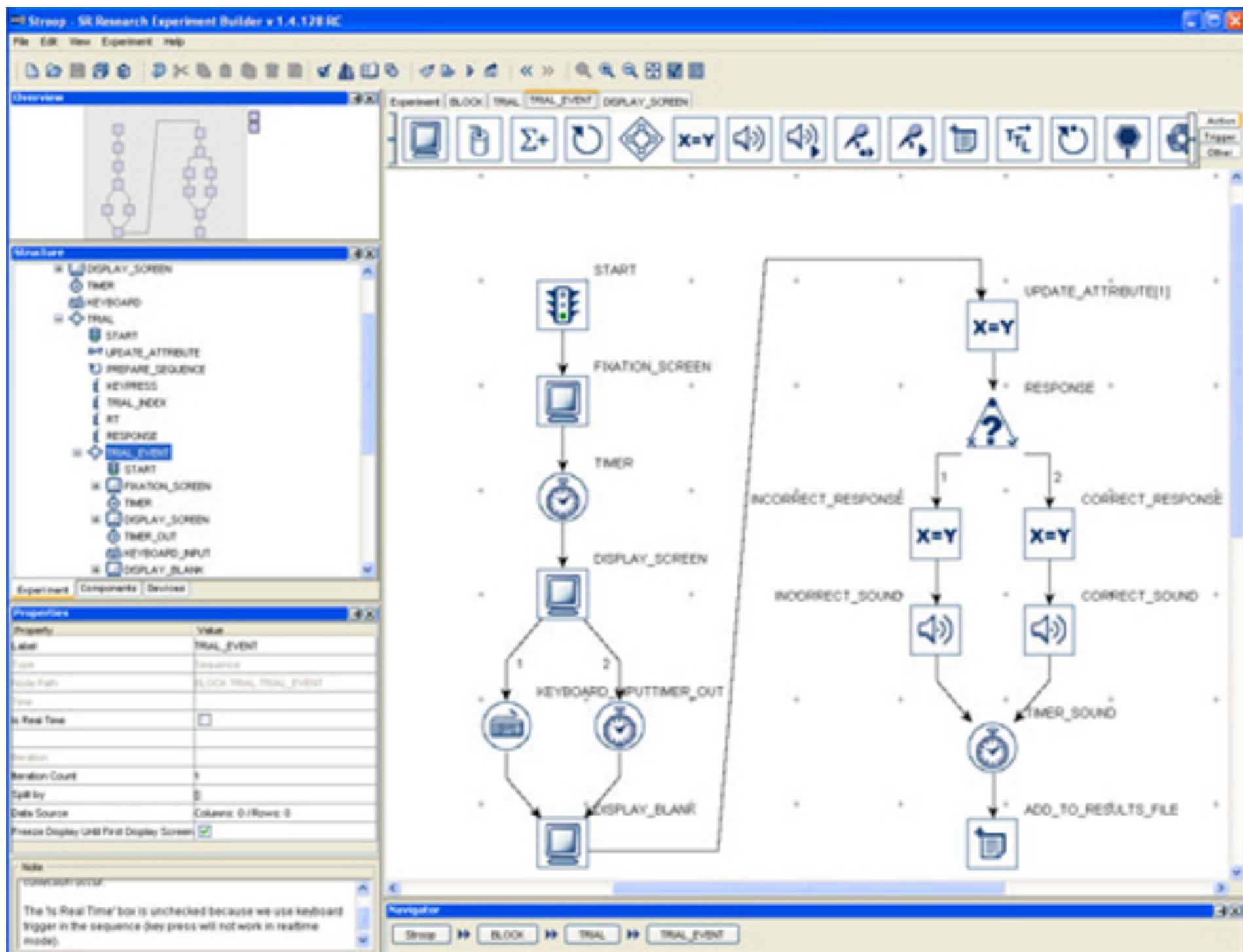
# 你到底需要啥工具？



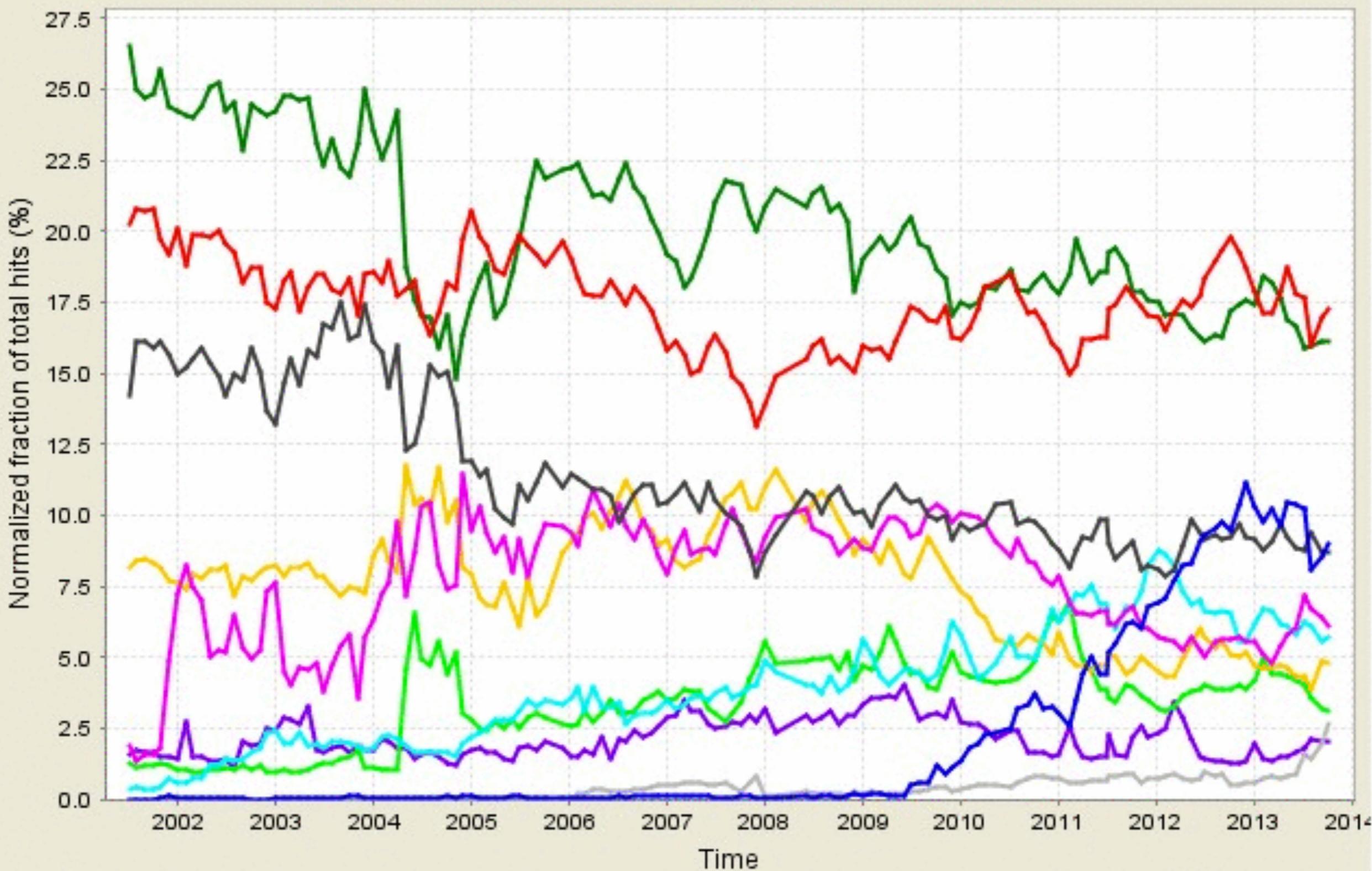
# E-Prime



# Experiment Builder



# TIOBE Programming Community Index

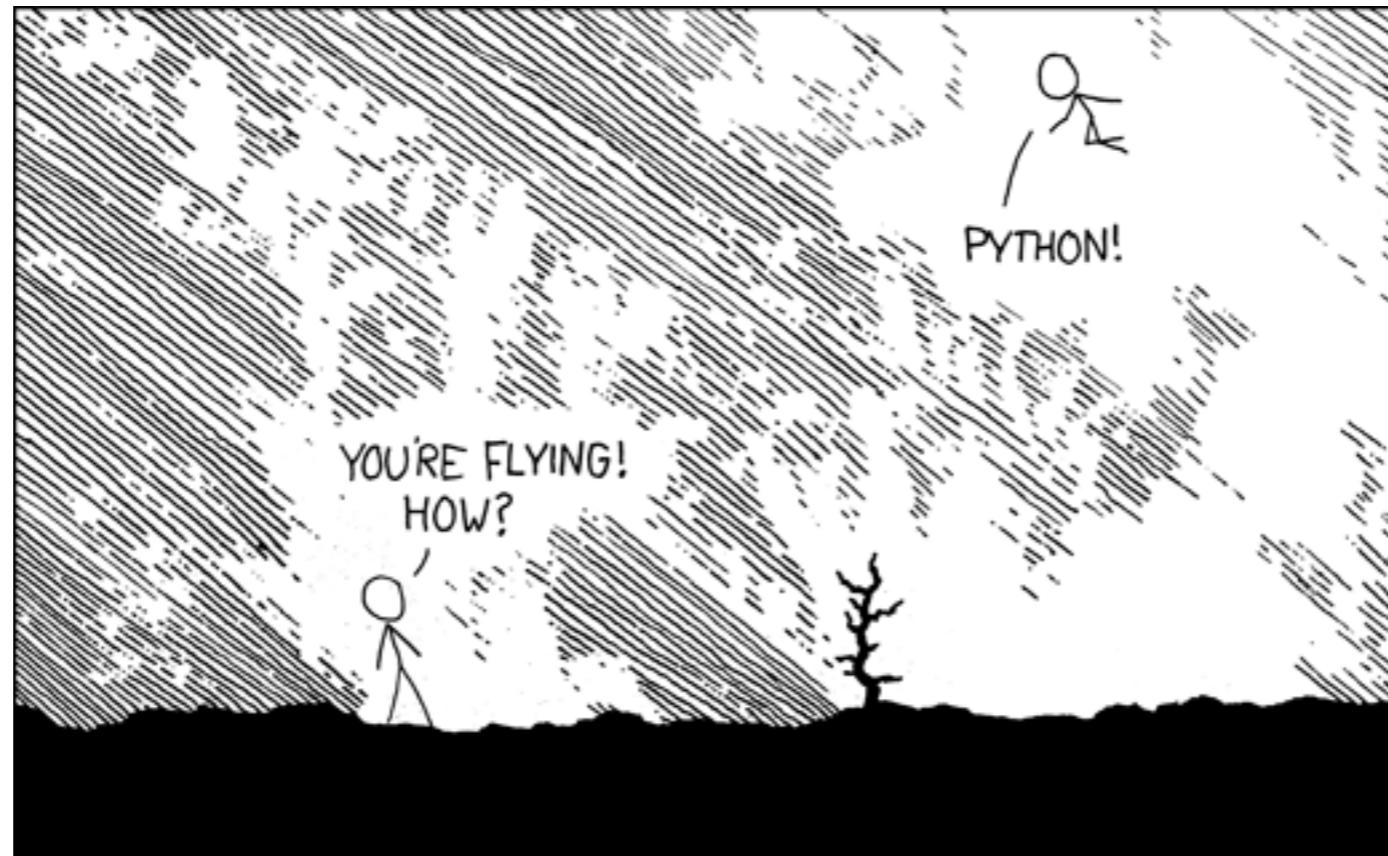


C	Objective-C	PHP	(Visual) Basic	Transact-SQL
Java	C++	C#	Python	JavaScript

# Language Rank

Sep 2014	Sep 2013	Change	Programming Language	Ratings	Change	Position	Programming Language	Ratings
1	1		C	16.721%	-0.25%	21	R	0.801%
2	2		Java	14.140%	-2.01%	22	SAS	0.780%
3	4	▲	Objective-C	9.935%	+1.37%	23	ABAP	0.755%
4	3	▼	C++	4.674%	-3.99%	24	Logo	0.739%
5	6	▲	C#	4.352%	-1.21%	25	ML	0.732%
6	7	▲	Basic	3.547%	-1.29%	26	Lisp	0.726%
7	5	▼	PHP	3.121%	-3.31%	27	PostScript	0.700%
8	8		Python	2.782%	-0.39%	28	OpenEdge ABL	0.598%
9	9		JavaScript	2.448%	+0.43%	29	Assembly	0.582%
10	10		Transact-SQL	1.675%	-0.32%	30	ActionScript	0.581%
11	11		Visual Basic .NET	1.532%	-0.31%	31	COBOL	0.575%
12	12		Perl	1.369%	-0.32%	32	D	0.448%
13	13		Ruby	1.281%	-0.10%	33	Ada	0.427%
14	-	▲	Visual Basic	1.272%	+1.27%	34	C shell	0.425%
15	14	▼	Delphi/Object Pascal	1.157%	+0.26%	35	Fortran	0.411%
16	26	▲	F#	0.990%	+0.49%			
17	15	▼	Pascal	0.893%	+0.01%			
18	-	▲	Swift	0.852%	+0.85%			
19	19		MATLAB	0.818%	+0.18%			
20	17	▼	PL/SQL	0.809%	+0.13%			

# Life is Short



I LEARNED IT LAST NIGHT! EVERYTHING IS SO SIMPLE!  
I  
HELLO WORLD IS JUST  
print "Hello, world!"

I DUNNO...  
DYNAMIC TYPING?  
WHITESPACE?  
COME JOIN US!  
PROGRAMMING IS FUN AGAIN!  
IT'S A WHOLE NEW WORLD UP HERE!  
BUT HOW ARE YOU FLYING?

I JUST TYPED  
import antigravity  
THAT'S IT?  
I  
... I ALSO SAMPLED  
EVERYTHING IN THE  
MEDICINE CABINET  
FOR COMPARISON.  
I  
BUT I THINK THIS  
IS THE PYTHON.

# 基于Python的心理学实验工具

VPython	Vision Egg	PsychoPy	PyEPL
Stopwatch PIL	Numpy PyOpenGL Pygame PIL Setuptools	Numpy PyOpenGL Pygame PIL Setuptools Scipy Matplotlib Piglet WxPython Pywin32 (Windows)	Numpy PyOpenGL Pygame PIL Libsndfile Libsamplerate SWIG Ode ALSA Pyrex PyODE

- <https://github.com>

# Example: Psychopy

psychopy / psychopy

Watch 22 Star 130 Fork 124

tree: 3ebea725b7

psychopy / psychopy / iohub / devices / eyetracker / hw / sr\_research / eyelink / +

BF: another 4 element color ...  
Sol Simpson authored on Apr 9 latest commit 4a5c92ff59

..

win32  
ENH: Alpha Alpha TextBox stim 10 months ago

\_\_init\_\_.py  
very quick integration of iohub into psychopy a year ago

5 months ago

10 months ago

5 months ago

10 months ago

5 months ago

5 months ago

## CereLink

Blackrock Microsystems Cerebus Link

The software development kit for Blackrock Microsystems neural signal processing hardware includes:

c++ library (cbsdk): cross platform library for two-way communication with hardware

MATLAB wrapper (cbmex): MATLAB executable (mex) to configure and pull data using cbsdk

Python wrapper (cbpy): Python binding for cbsdk to configure, pull data, and receive callbacks

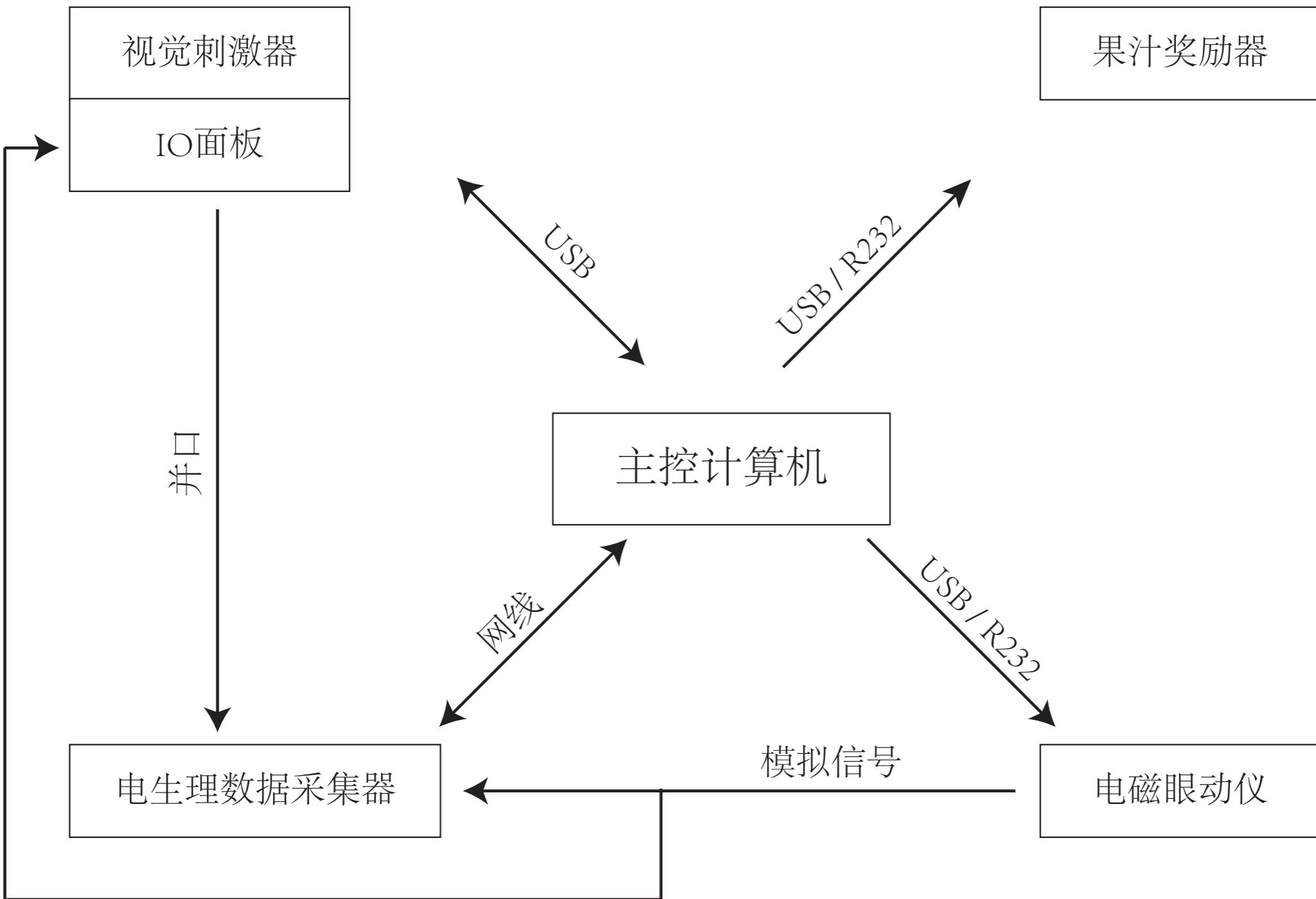
File conversion utility (n2h5): Converts nsx and nev files to hdf5 format

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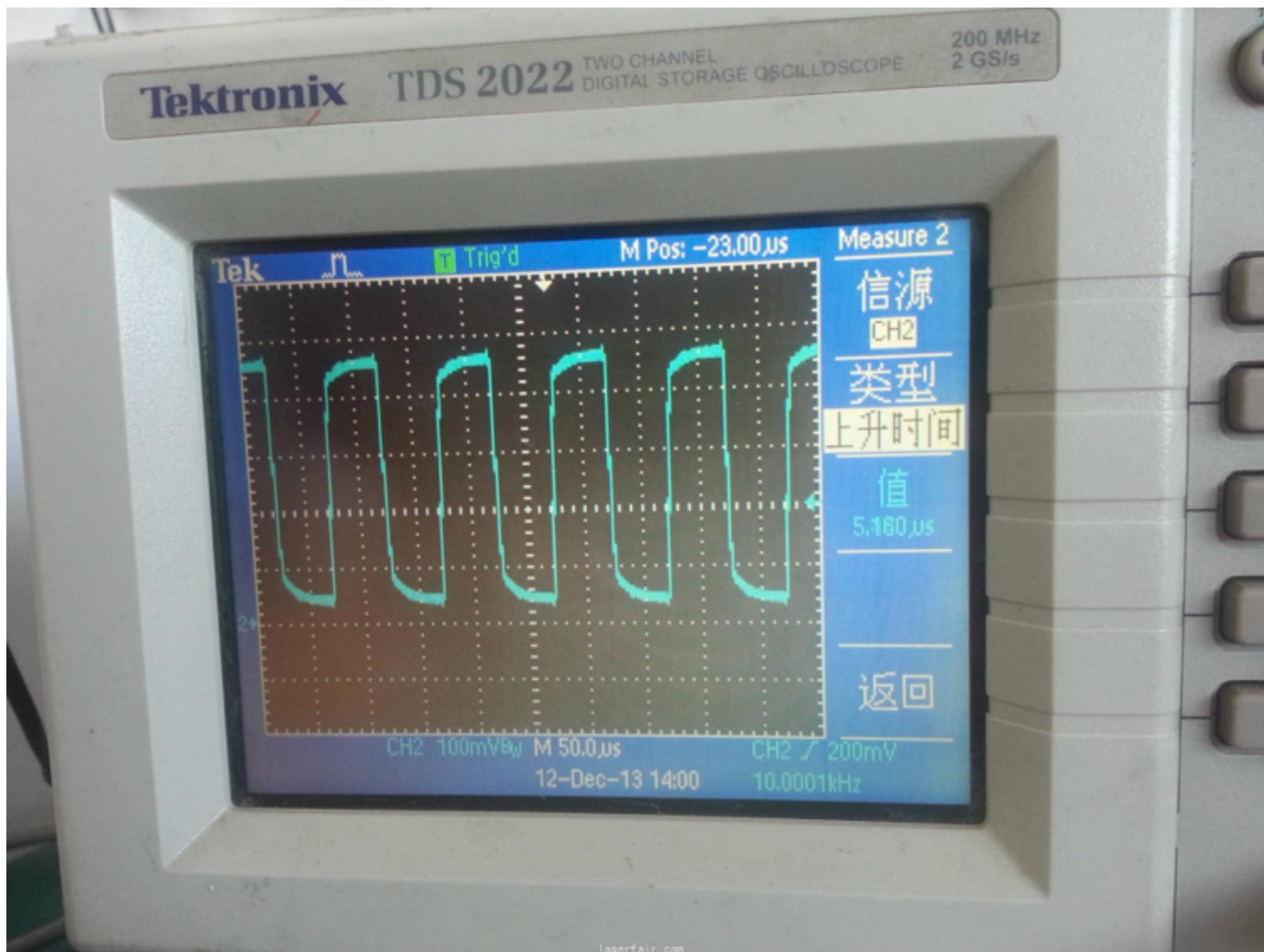
# 系统架构



# 数字与模拟

- 数字信号(Digital signal): 0-1, 离散
- 模拟信号(Analog signal): 连续。
- ADDAADDAAADDAADDA...

# 上升沿与下降沿



# 并口与串口

- 并行接口，简称并口。并口采用的是25针D形接头。所谓“并行”，是指8位数据同时通过并行线进行传送，这样数据传送速度大大提高，但并行传送的线路长度受到限制，因为长度增加，干扰就会增加，数据也就容易出错。并行接口主要作为打印机端口（LPT）等。

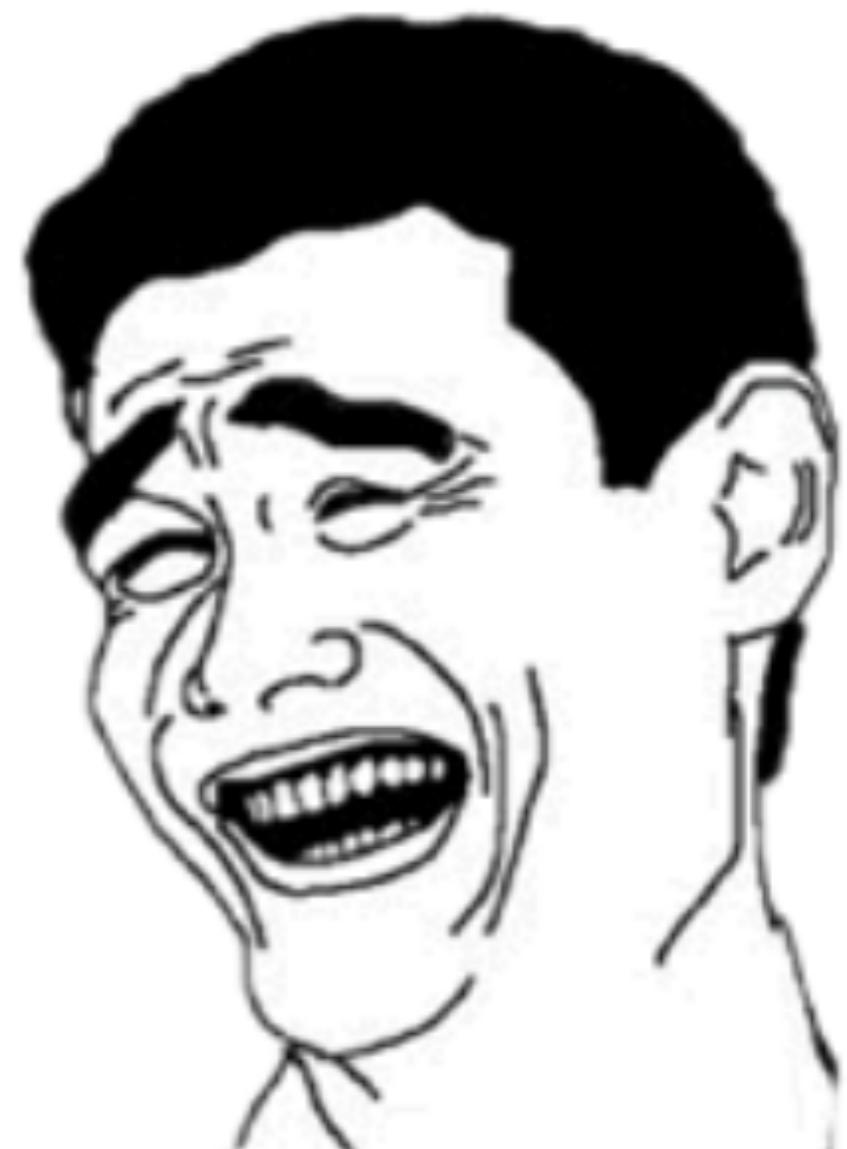


- 串口叫做串行接口，也称串行通信接口，即COM口。按电气标准及协议来分包括RS-232-C、RS-422、RS485、USB等。串行(serial)的意思是一次传送一个比特，异步(asynchronous)的意思是数据传输可以在任何时候进行。



# 二进制与十六进制

这世界上一共有10种人，  
懂二进制的和不懂二进制  
的。



ASCII	Dec	Hex	Octal	Binary	ASCII	Dec	Hex	Octal	Binary	ASCII	Dec	Hex	Octal	Binary
+	043	2B	053	0010 1011	A	065	41	101	010 00001	V	086	56	126	0101 0110
,	044	2C	054	0010 1100	B	066	42	102	0100 0010	W	087	57	127	0101 0111
-	045	2D	055	0010 1101	C	067	43	103	0100 0011	X	088	58	130	0101 1000
.	046	2E	056	0010 1110	D	068	44	104	0100 0100	Y	089	59	131	0101 1001
/	047	2F	057	0010 1111	E	069	45	105	0100 0101	Z	090	5A	132	0101 1010
0	048	30	060	0011 0000	F	070	46	106	0100 0110	[	091	5B	133	0101 1011
1	049	31	061	0011 0001	G	071	47	107	0100 0111	\	092	5C	134	0101 1100
2	050	32	062	0011 0010	H	072	48	110	0100 1000	]	093	5D	135	0101 1101
3	051	33	063	0011 0011	I	073	49	111	0100 1001	^	094	5E	136	0101 1110
4	052	34	064	0011 0100	J	074	4A	112	0100 1010	_	095	5F	137	0101 1111
5	053	35	065	0011 0101	K	075	4B	113	0100 1011	'	096	60	140	0110 0000
6	054	36	066	0011 0110	L	076	4C	114	0100 1100	a	097	61	141	0110 0001
7	055	37	067	0011 0111	M	077	4D	115	0100 1101	b	098	62	142	0110 0010
8	056	38	070	0011 1000	N	078	4E	116	0100 1110	c	099	63	143	0110 0011
9	057	39	071	0011 1001	O	079	4F	117	0100 1111	d	100	64	144	0110 0100
:	058	3A	072	0011 1010	P	080	50	120	010 10000	e	101	65	145	0110 0101
;	059	3B	073	0011 1011	Q	081	51	121	0101 0001	f	102	66	146	0110 0110
a	060	3C	074	0011 1100	R	082	52	122	0101 0010	g	103	67	147	0110 0111
=	061	3D	075	0011 1101	S	083	53	123	0101 0011	h	104	68	150	0110 1000
>	062	3E	076	0011 1110	T	084	54	124	0101 0100	i	105	69	151	0110 1001
?	063	3F	077	0011 1111	U	085	55	125	0101 0101	j	106	6A	152	0110 1010
@	064	40	100	0100 0000						k	107	6B	153	0110 1011

FFFFFF 255,255,255	CCCCCC 204,204,204	999999 153,153,153	666666 102,102,102	333333 51,51,51	000000 0,0,0	FFCC00 255,204,0	FF9900 255,153,0	FF6600 255,102,0	FF3300 255,51,0
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99CC00 153,204,0	CC9900 204,153,0	FFCC33 255,204,51	FFCC66 255,204,102	FF9966 255,153,102	FF6633 255,102,51	CC3300 204,51,0	CC0033 204,0,51
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CCFF00 204,255,0	CCFF33 204,255,51	333300 51,51,0	666600 102,102,0	999900 153,153,0	CCCC00 204,204,0	FFFF00 255,255,0	CC9933 204,153,51	CC6633 204,102,51	330000 51,0,0	660000 102,0,0	990000 153,0,0	CC0000 204,0,0	FF0000 255,0,0	FF3366 255,51,102	FF0033 255,0,51
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99FF00 153,255,0	CCFF66 204,255,102	99CC33 153,204,51	666633 102,102,51	999933 153,153,51	CCCC33 204,204,51	FFFF33 255,255,51	996600 153,102,0	993300 153,51,0	663333 102,51,51	993333 153,51,51	CC3333 204,51,51	FF3333 255,51,51	CC3366 204,51,102	FF6699 255,102,153	FF0066 255,0,102
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66FF00 102,255,0	99FF66 153,255,102	66CC33 102,204,51	669900 102,153,0	999966 153,153,102	CCCC66 204,204,102	FFFF66 255,255,102	996633 153,102,51	663300 102,51,0	996666 153,102,102	CC6666 204,102,102	FF6666 255,102,102	990033 153,0,51	CC3399 204,51,153	FF66CC 255,102,204	FF0099 255,0,153
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33FF00 51,255,0	66FF33 102,255,51	339900 51,153,0	66CC00 102,204,0	99FF33 153,255,51	CCCC99 204,204,153	FFFF99 255,255,153	CC9966 204,153,102	CC6600 204,102,0	CC9999 204,153,153	FF9999 255,153,153	FF3399 255,51,153	CC0066 204,0,102	990066 153,0,102	FF33CC 255,51,204	FF00CC 255,0,204
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00CC00 0,204,0	33CC00 51,204,0	336600 51,102,0	669933 102,153,51	99CC66 153,204,102	CCFF99 204,255,153	FFFFCC 255,255,204	FFCC99 255,204,153	FF9933 255,153,51	FFCCCC 255,204,204	FF99CC 255,153,204	CC6699 204,102,153	993366 153,51,102	660033 102,0,51	CC0099 204,0,153	330033 51,0,51
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33CC33 51,204,51	66CC66 102,204,102	00FF00 0,255,0	33FF33 51,255,51	66FF66 102,255,102	99FF99 153,255,153	CCFFCC 204,255,204	CC99CC 204,153,204	996699 153,102,153	993399 153,51,153	990099 153,0,153	663366 102,51,102	660066 102,0,102	660066 102,0,102	660066 102,0,102
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006600 0,102,0	336633 51,102,51	009900 0,153,0	339933 51,153,51	669966 102,153,102	99CC99 153,204,153	FFCCFF 255,204,255	FFCCFF 255,204,255	FF99FF 255,153,255	FF99FF 255,153,255	FF66FF 255,102,255	FF33FF 255,51,255	FF00FF 255,0,255	CC66CC 204,102,204	CC33CC 204,51,204
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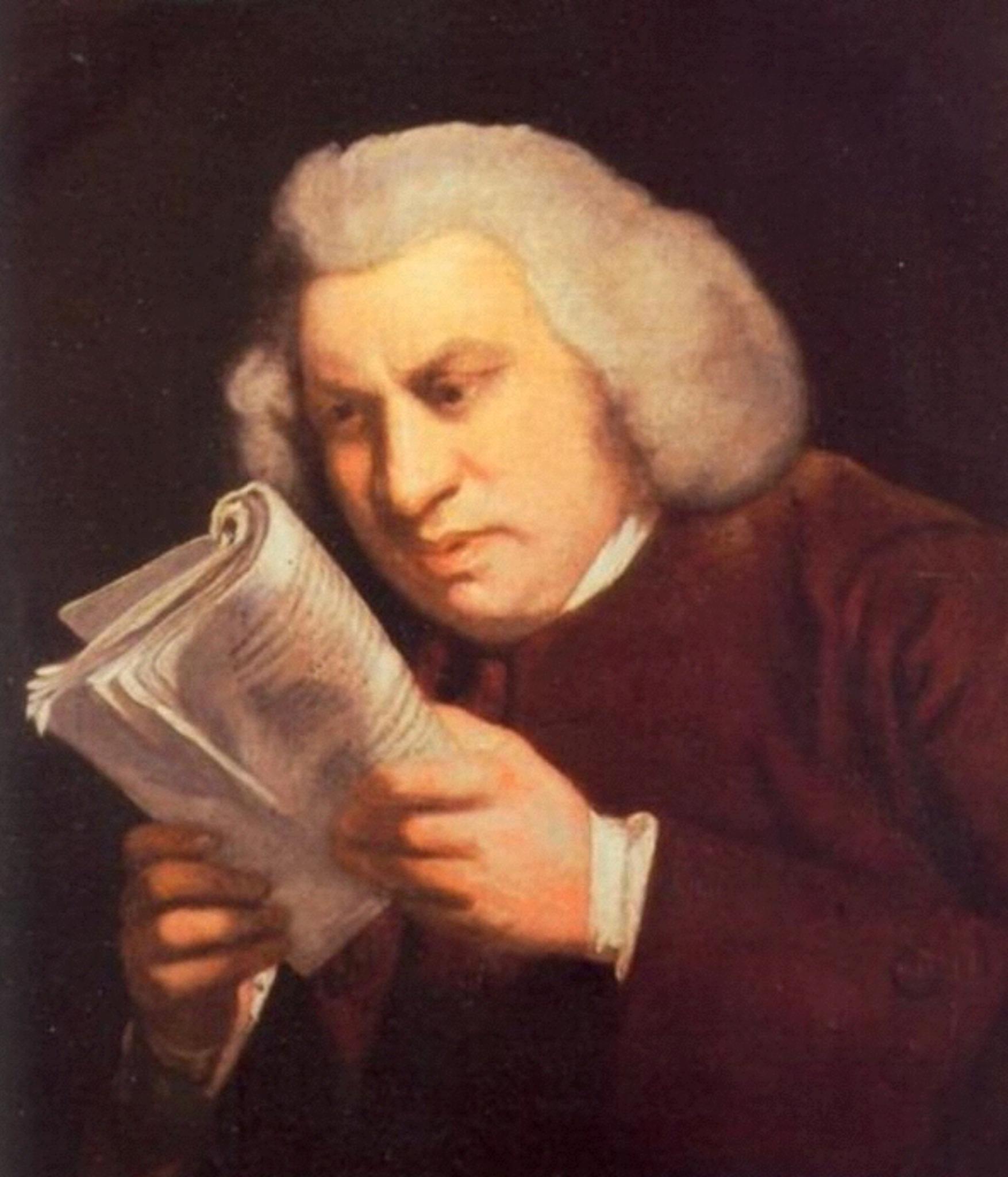
003300 0,51,0	00CC33 0,204,51	006633 0,102,51	339966 51,153,102	66CC99 102,204,153	99FFCC 153,255,204	CCFFFF 204,255,255	3399FF 51,153,255	99CCFF 153,204,255	CCCCFF 204,204,255	CC99FF 204,153,255	9966CC 153,102,204	663399 102,51,153	330066 51,0,102	9900CC 153,0,204	CC00CC 204,0,204
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00FF33 0,255,51	33FF66 51,255,102	009933 0,153,51	00CC66 0,204,102	33FF99 51,255,153	99FFFF 153,255,255	99CCCC 153,204,204	0066CC 0,102,204	6699CC 102,153,205	9999FF 153,153,255	9999CC 153,153,204	9933FF 153,51,255	6600CC 102,0,204	660099 102,0,153	CC33FF 204,51,255	CC00FF 204,0,255
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00FF66 0,255,102	66FF99 102,255,153	33CC66 51,204,102	009966 0,153,102	66FFFF 102,255,255	66CCCC 102,204,204	669999 102,153,153
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**最常见的打MARK**

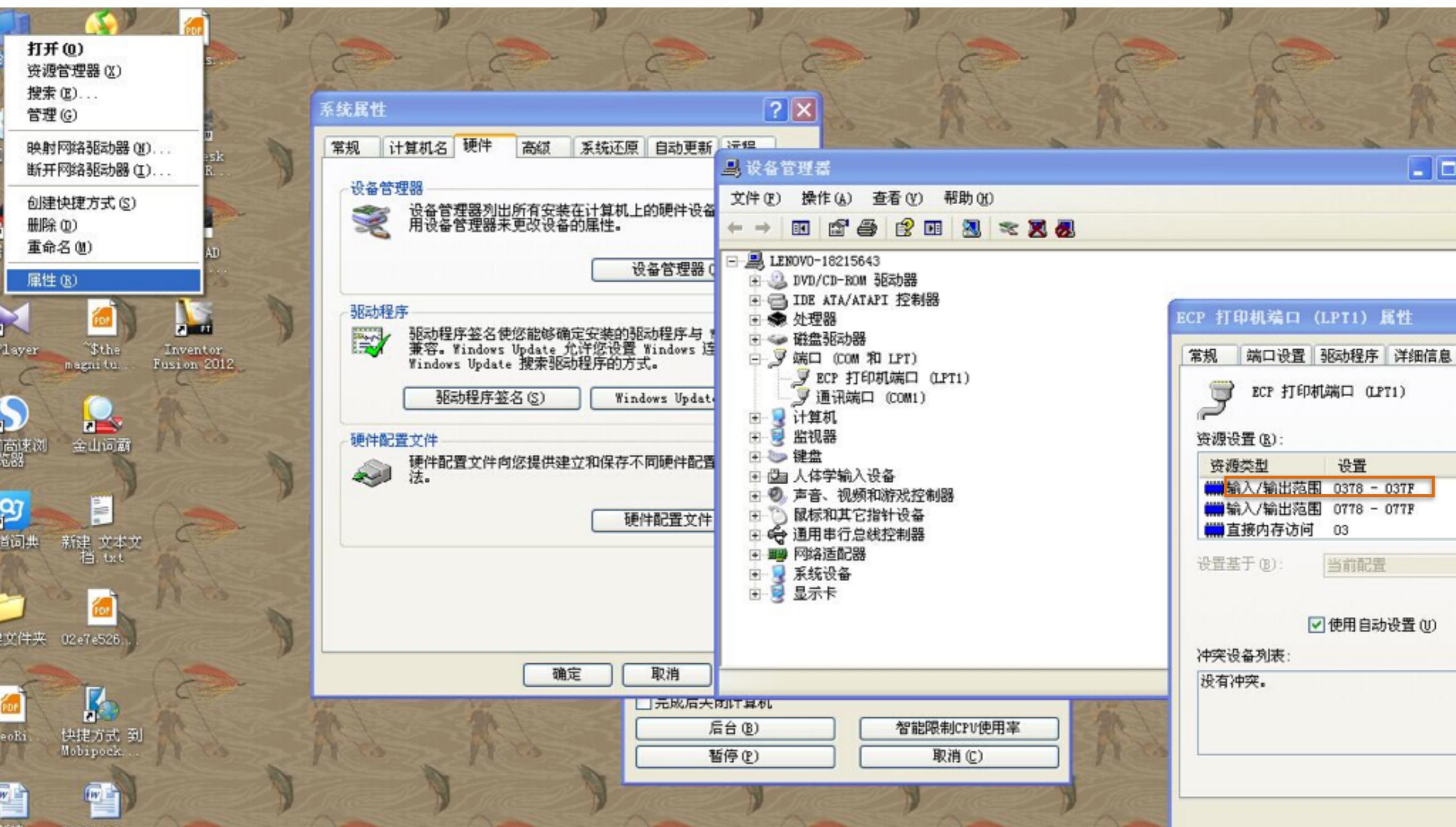
# THE READ BUCKINGHAM ANNUAL



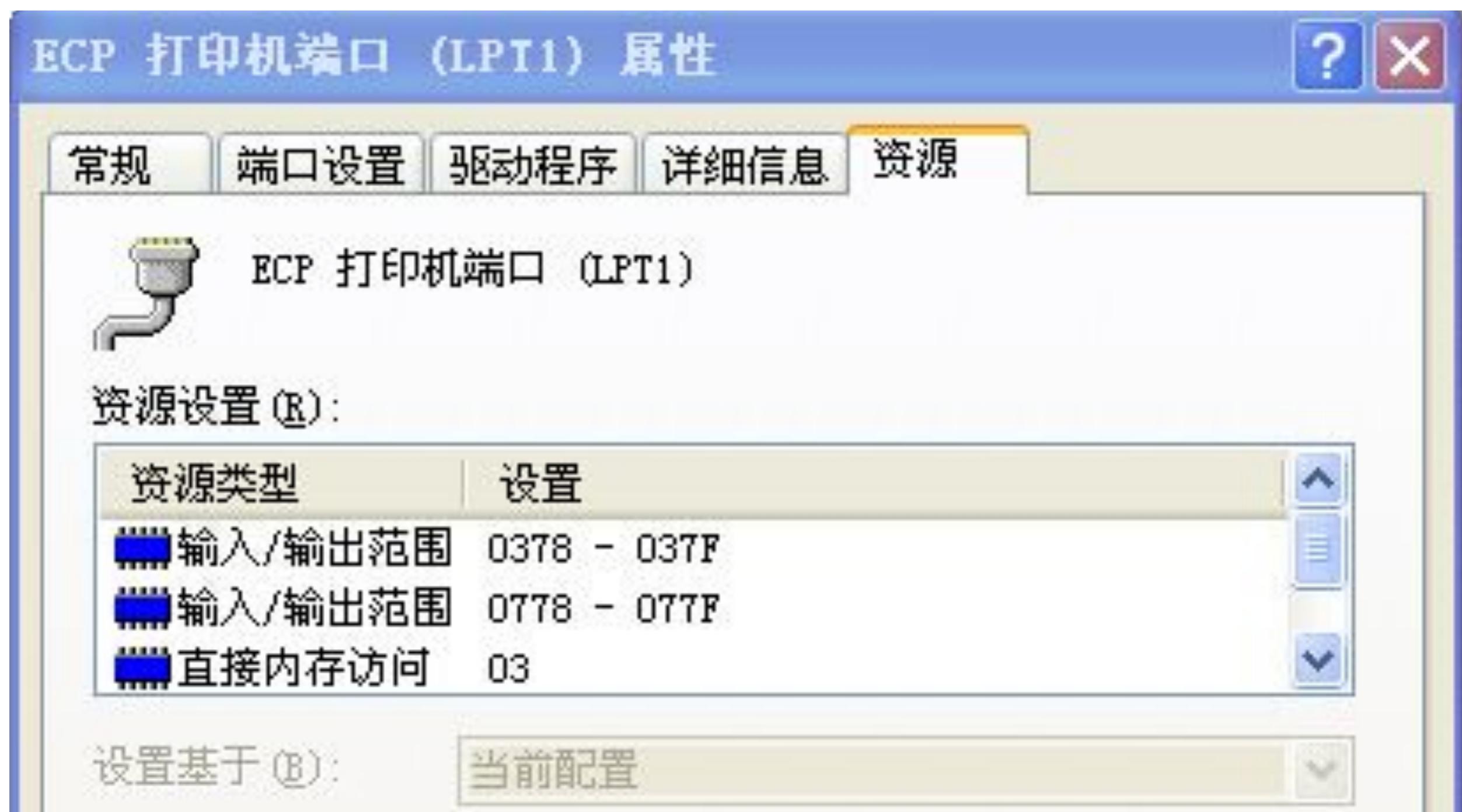
# 例1.1: lptwrite

```
function lptwrite(port, value)
% LPTWRITE write byte to port
% Usage:
%     lptwrite(port, value)
%
% Arguments:
%     port - double Port address (e.g., 888 = 0x378
% for LPT1 on many machines)
%     value - double value to write (0-255)
%
% Examples:
%     lptwrite(888, 42);
```

# 端口地址怎么找？



# 端口地址怎么找？



# 进制转换

```
dec2hex(888) == '378'
```

```
hex2dec('378') == 888
```

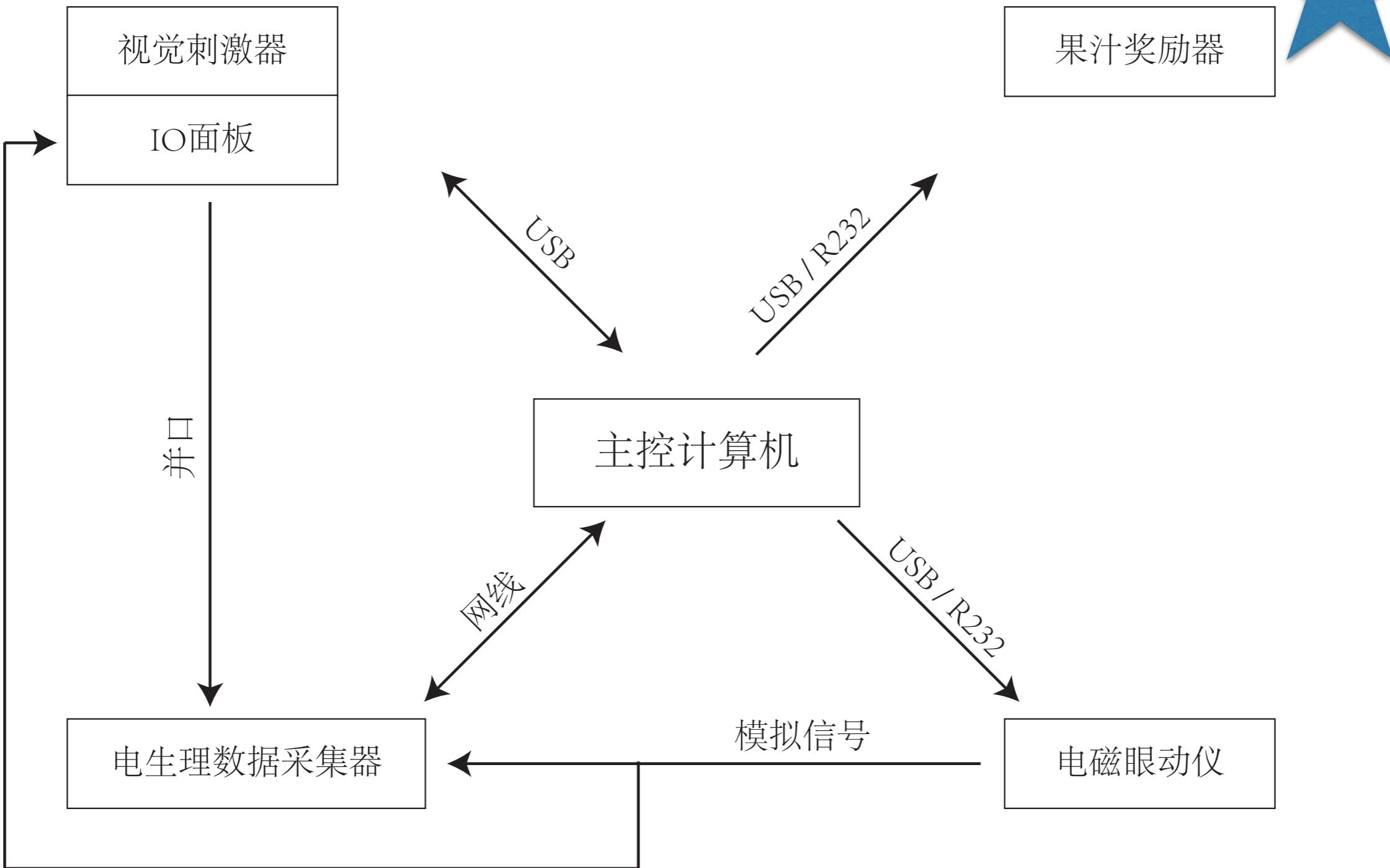
```
dec2bin(888) == '1101111000'
```

```
bin2dec('1101111000') == 888
```

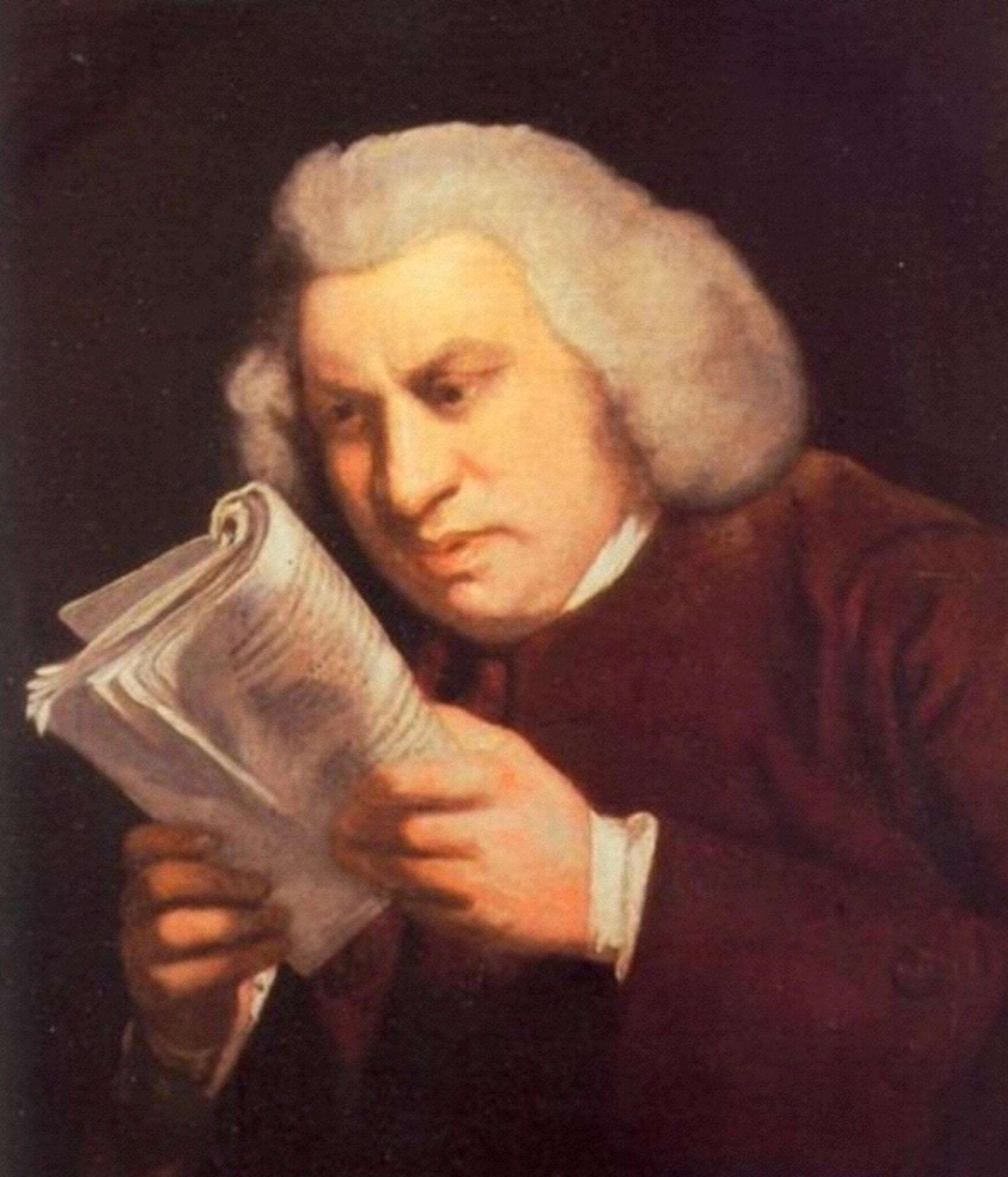


想象有8根线...

# 系统架构



# THE READ BUCKINGHAM ANNUAL



# 例1.2：果汁奖励

1. Characters are single ANSCII characters (“ ”) unless defined as HEX data (0xnn).
2. XSUM is the Checksum and is the sum of the HEX values of all data prior to the XSUM byte. ie > Give Reward message: @ G 0x00 0x64 0x00 0x00 0x00 0xEB  
 $(0x40 + 0x47 + 0x00 + 0x64 + 0x00 + 0x00 = 0xEB)$   
If sum exceeds one byte, only the remainder is used : 0x2D4 -> 0xD4
3. Comm Port setup is:
  - a. BAUD Rate
  - b. Parity
  - c. Length
  - d. Stop Bits
4. NUL = 0, (0x00)

# 例1.2：果汁奖励

All messages have format of:

Byte 0 Type

38.4k. None 8 Bits 1

@ = Cmd from PC, # = CmdtoPC,

\* = Calibration from PC & = DatafromPC

Byte 1 Function

Byte 2 → (N-1) Data (if required) Byte N Xsum

# 应该发送哪些信息？

Give Reward Message

Byte 0	@	
Byte 1	G	
Byte 2	NUL	
Byte 3	Time – LSB 0x0001 -> 0xC350	.1ms to 5.0000 sec, LSB = .1ms
Byte 4	Time – MSB	
Byte 5	Vol – LSB 0x0000 -> 0xFFDC, 0 -> 65.5 ml, LSB = .001ml	
Byte 6	Vol – LSB	此处应为Vol-MSB
Byte 7	Xsum	

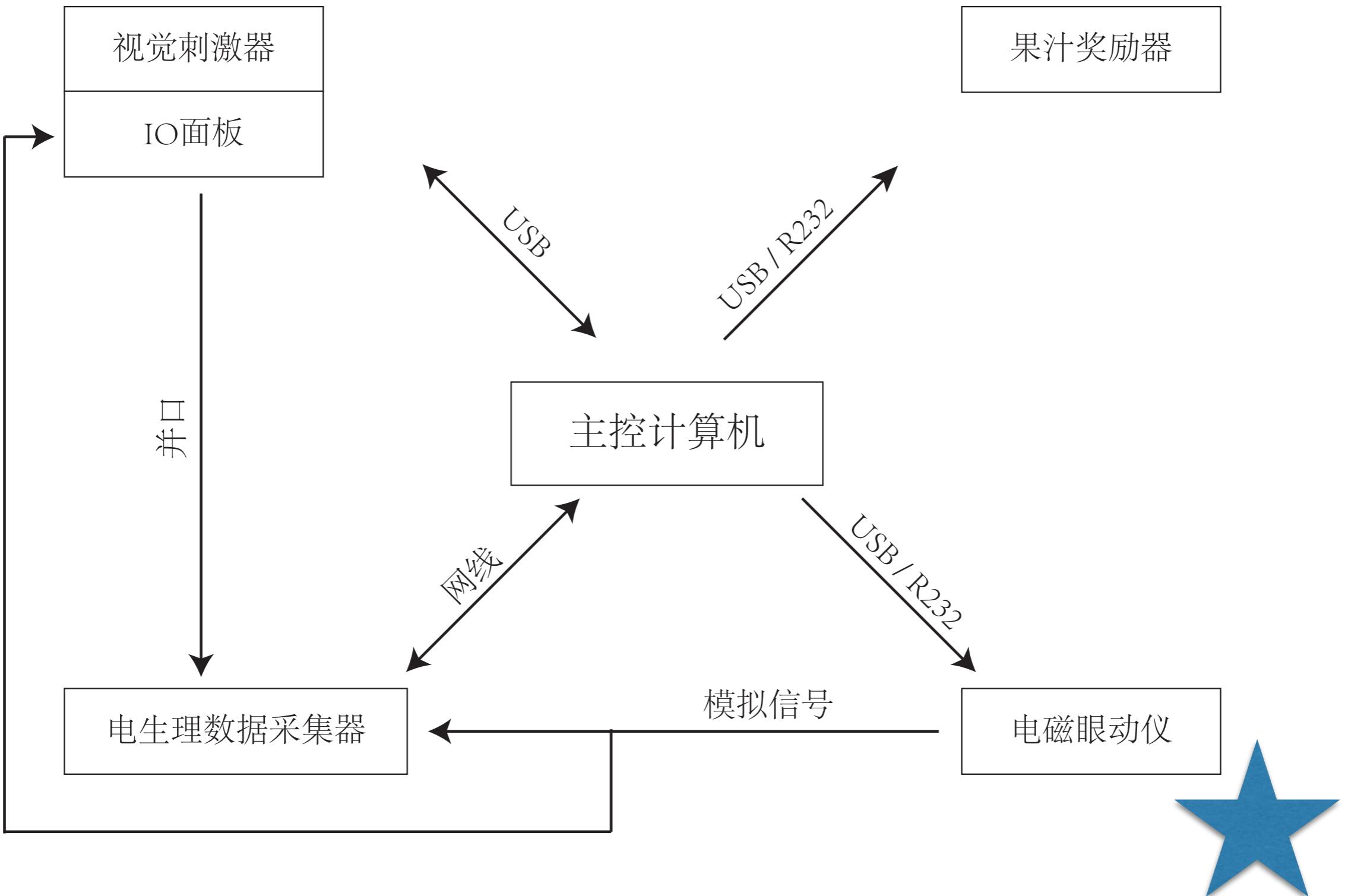
# 初始化端口

```
function Cus_Init_reward()
% This function init the reward handle and set
some properties
global reward_handle
handle=serial('COM4');
set(handle,'Parity','none','BaudRate',
38400,'StopBits',1,'BytesAvailableFcnCount',8);
fopen(handle);
reward_handle=handle;
end
```

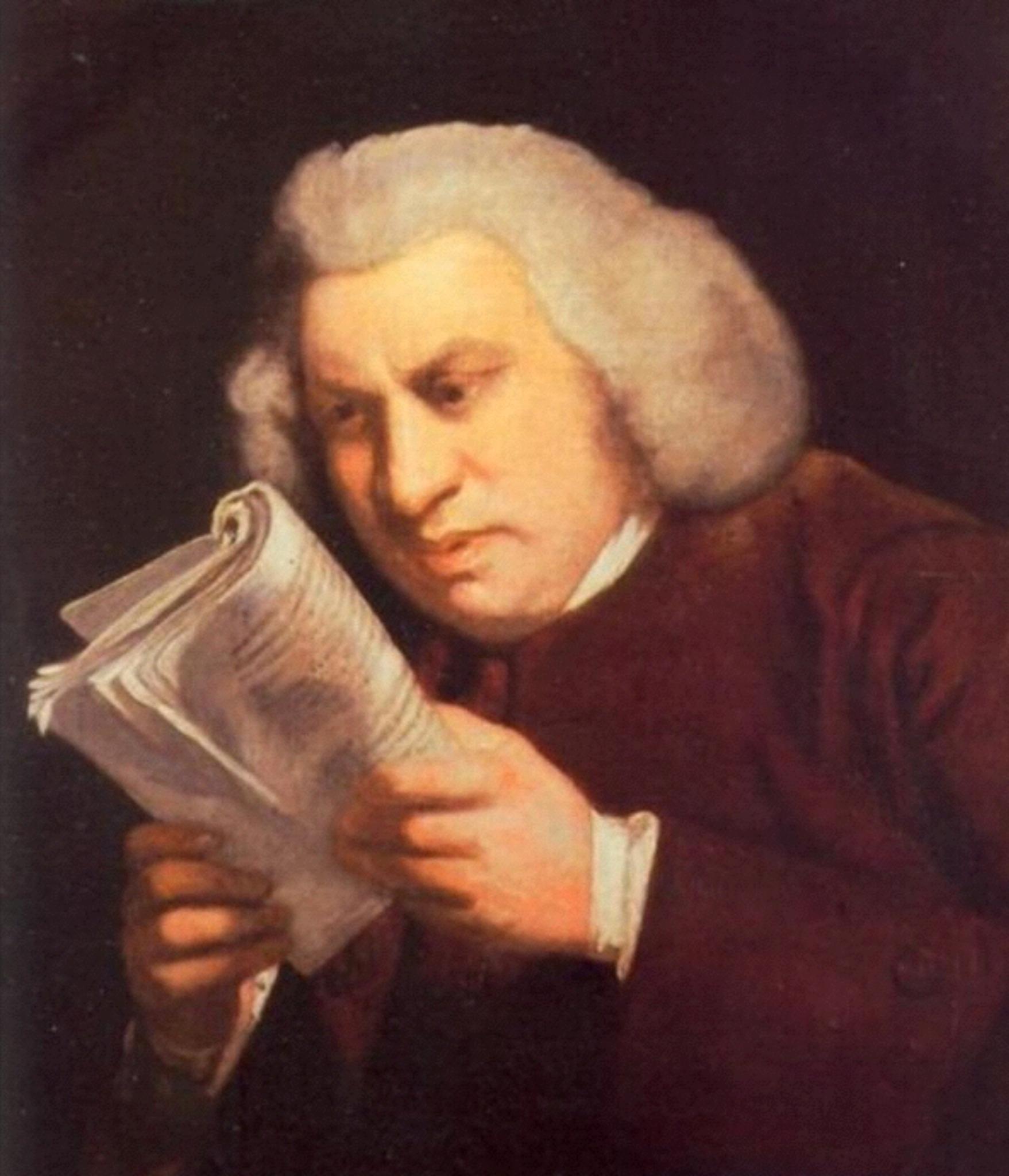
# 发送指令

```
function Cus_Reward(reward_time_ms)
%This function give reward for about 1s.
%Input: reward time/1ms.
global reward_handle
data=[1*'@' 1*'G' 0
mod(reward_time_ms*10,256)
floor(reward_time_ms*10/256) 0 0];
data=[data,mod(sum(data),256)];
fwrite(reward_handle,data,'uint8','async');
end
```

# 系统架构



# THE READ BUCKINGHAM ANNUAL



# 例1.3：眼动信号(1)

```
% using the PsychToolbox's Screen  
function.  
  
screenNumber=max(Screen('Screens'));  
window=Screen('OpenWindow', screenNumber);  
  
%% eye calibration  
el=EyelinkInitDefaults(window);  
  
EyelinkInit(dummymode, 1)
```

# 例1.3: 眼动信号(2)

% 设置记录文件格式

```
Eyelink('Command', 'link_sample_data =  
LEFT,RIGHT,GAZE,PUPIL,AREA');  
Eyelink('Command', 'link_event_data = ...  
GAZE,GAZERES,HREF,AREA,VELOCITY');  
Eyelink('command', 'link_event_filter = ...  
LEFT,RIGHT,FIXATION,BLINK,SACCADE,BUTTON'  
);  
% open file to record data to  
Eyelink('Openfile', file_name);
```

# 例1.3：眼动信号(3)

‰ 漂移校正

```
EyelinkDoTrackerSetup(el);
```

‰ 开始记录

```
Eyelink('StartRecording');
```

‰ 这其实是个mark

```
Eyelink('Message', 'write_what_u_like');
```

‰ 记录完就关闭

```
Eyelink('CloseFile');
```

# 例1.3: 眼动信号(4)

% 把文件从Eyelink下载到计算机上

```
try
    status=Eyelink('ReceiveFile',file_name);
    if status > 0
        fprintf('ReceiveFile status %d\n', status);
    end
catch rdf
    fprintf('Problem receiving data file ''%s''\n',
file_name );
end

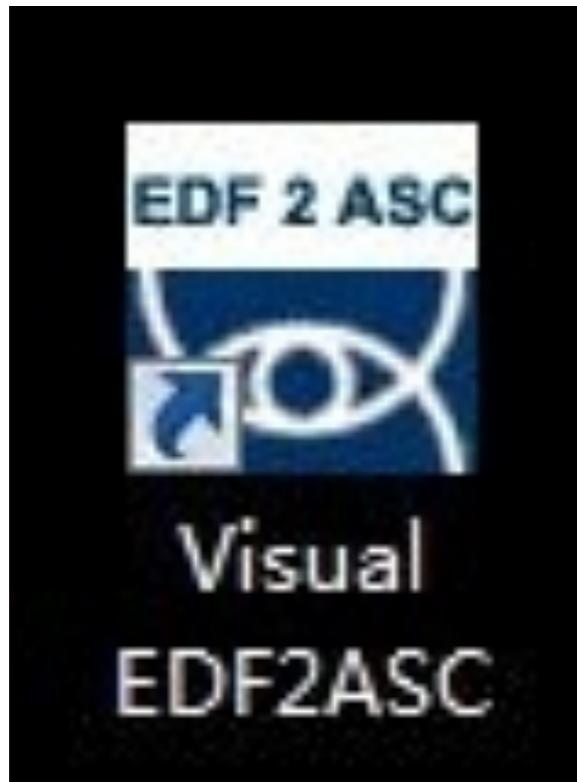
Eyelink('Shutdown');
ListenChar(0); % Restore keyboard output to Matlab:
sca;
```

# 实时监控？

```
function currentFix=getCurrentFix(el)
% return eye location [x y] where [0 0] for center
global EXP
currentFix = EXP.screen_corner_p;% fix @ corner as default
if Eyelink( 'NewFloatSampleAvailable') > 0
    % get the sample in the form of an event structure
    evt = Eyelink( 'NewestFloatSample');
    % if we do, get current gaze position from sample
    x = evt.gx(el.LEFT_EYE+1); % +1 since MATLAB array
    y = evt gy(el.LEFT_EYE+1);
    if x~=el.MISSING_DATA && y~=el.MISSING_DATA &&
    evt.pa(1)>0
        currentFix = [x,y]-EXP.screen_center_p;
    end
end % if sample available
end
```

# Eyelink edf2...

- Notepad++



展示一下数据文件.asc

# 大纲

- 引子
- 微机接口与RTFM
- 模块化程序设计与**KISS**
- 时间与空间的权衡

[https://github.com/yangscar/Matlab\\_Training.git](https://github.com/yangscar/Matlab_Training.git)



KEEP IT SIMPLE, STUPID  
SIMPLE&STUPID  
SWEET&SIMPLE  
SHORT&SIMPLE  
SIMPLE&SMART  
SPECKLESS&SANS  
SUPER SIMPLE

# 魔数

```
for i = 1:52
    j = i +randi(53-i) -1;
    swap(i,j);
end
```

```
DECK_SIZE = 52;
for i = 1:DECK_SIZE
    j = i +randi(DECK_SIZE+1-i) -1;
    swap(i,j);
end
```

```
function shuffle(deck_size)
    for i = 1:deck_size
        j = i +randi(deck_size+1-i) -1;
        swap(i,j);
    end
end
```

# 如何建立自己的库

- 避免命名冲突，用'+'。
- 面向对象，用'@'。

# 之前Reward的代码

```
function Cus_Init_reward()
    % This function init the reward handle and set some properties
    global reward_handle
    handle=serial('COM4');
    set(handle,'Parity','none','BaudRate',38400,'StopBits',
    1,'BytesAvailableFcnCount',8);
    fopen(handle);
    reward_handle=handle;
end

function Cus_Reward(reward_time_ms)
    %This function give reward for about 1s.
    %Input: reward time/1ms.
    global reward_handle
    data=[1*'@' 1*'G' 0 mod(reward_time_ms*10,256)
    floor(reward_time_ms*10/256) 0 0];
    data=[data,mod(sum(data),256)];
    fwrite(reward_handle,data,'uint8','async');
end
```

# 生成Condition

- 见Cus\_Generate\_condition\_index
- shuffle

# 函数小百科

- 先编个Fibonacci 练练手，掌握输入输出。
- 调用顺序：变量名优先，近的优先。
- Example: myOperator1 and myOperator2

# Debug杂谈

- 不加分号?
- disp(xx2str(var));
- fprintf('Hello d%B', 2);
- Evaluation
- 加断点?

# Try-Catch

- 出错了我有东西没做怎么办？
- if-else写得很烦躁怎么办？
- 多重循环跳不出来，没有Goto 怎么办？

# 大纲

- 引子
- 微机接口与RTFM
- 模块化程序设计与KISS
- 时间与空间的权衡

[https://github.com/yangscar/Matlab\\_Training.git](https://github.com/yangscar/Matlab_Training.git)



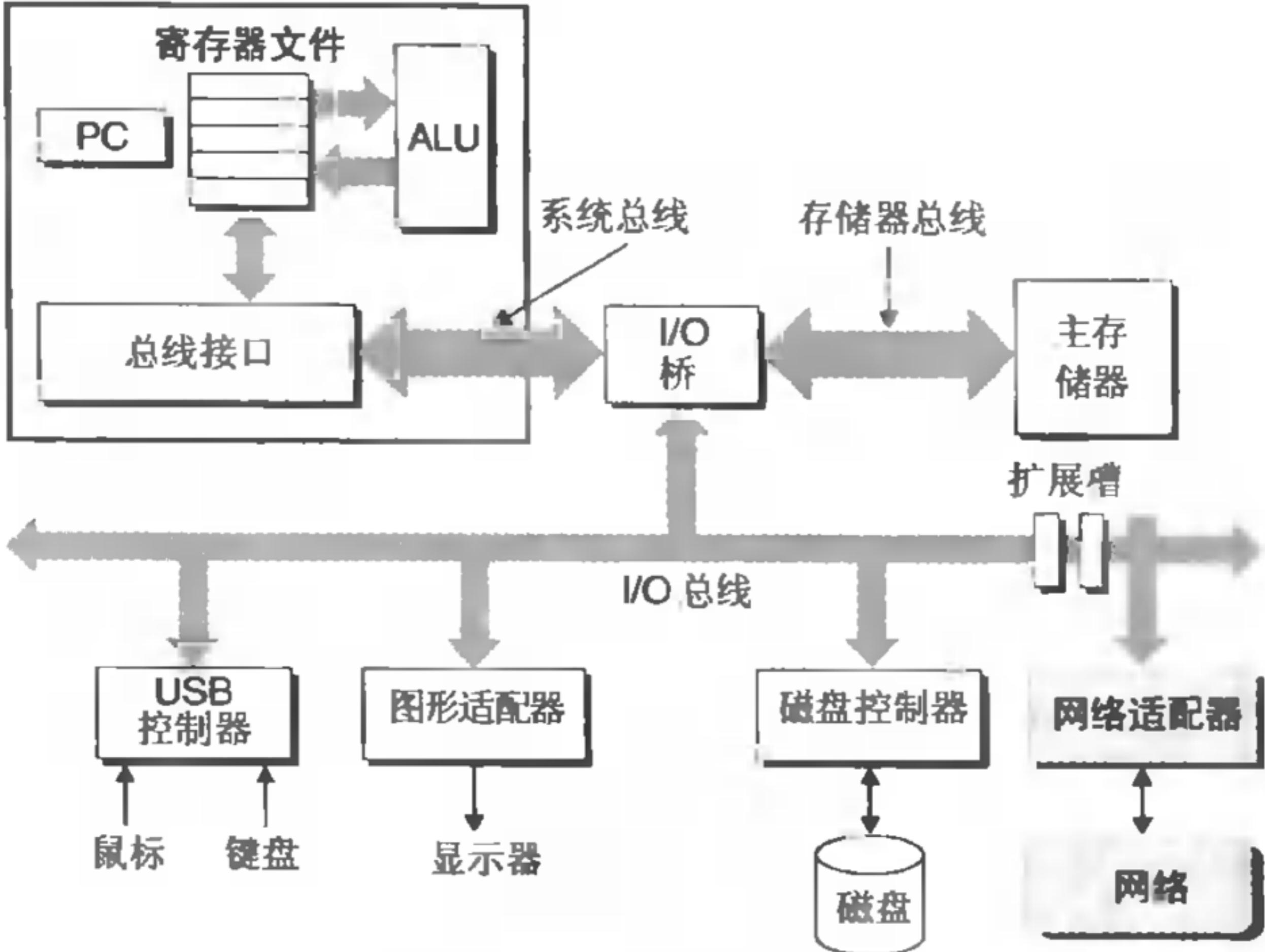
# 解释型与编译型语言

- 计算机不能直接理解高级语言，只能直接理解机器语言，所以必须要把高级语言翻译成机器语言，计算机才能执行高级语言编写的程序。
- 编译型语言写的程序执行之前，需要一个专门的编译过程，把程序编译成为机器语言的文件，比如exe文件。
- 解释则不同，解释性语言的程序不需要编译，省了道工序，解释性语言在运行程序的时候才翻译，一句一句的翻译。
- NB的解释型语言也不一定慢，比如JavaScript。现在程序员一般不谈这个了。

# .m & .p

- 代码运行太慢怎么办？
- 不想让人看见源代码怎么办？
- pcode function.m

# CPU 芯片



更小，  
更快，  
(每字节)  
更贵的  
存储设备

更大  
更慢  
(每字节)  
更便宜的  
存储设备

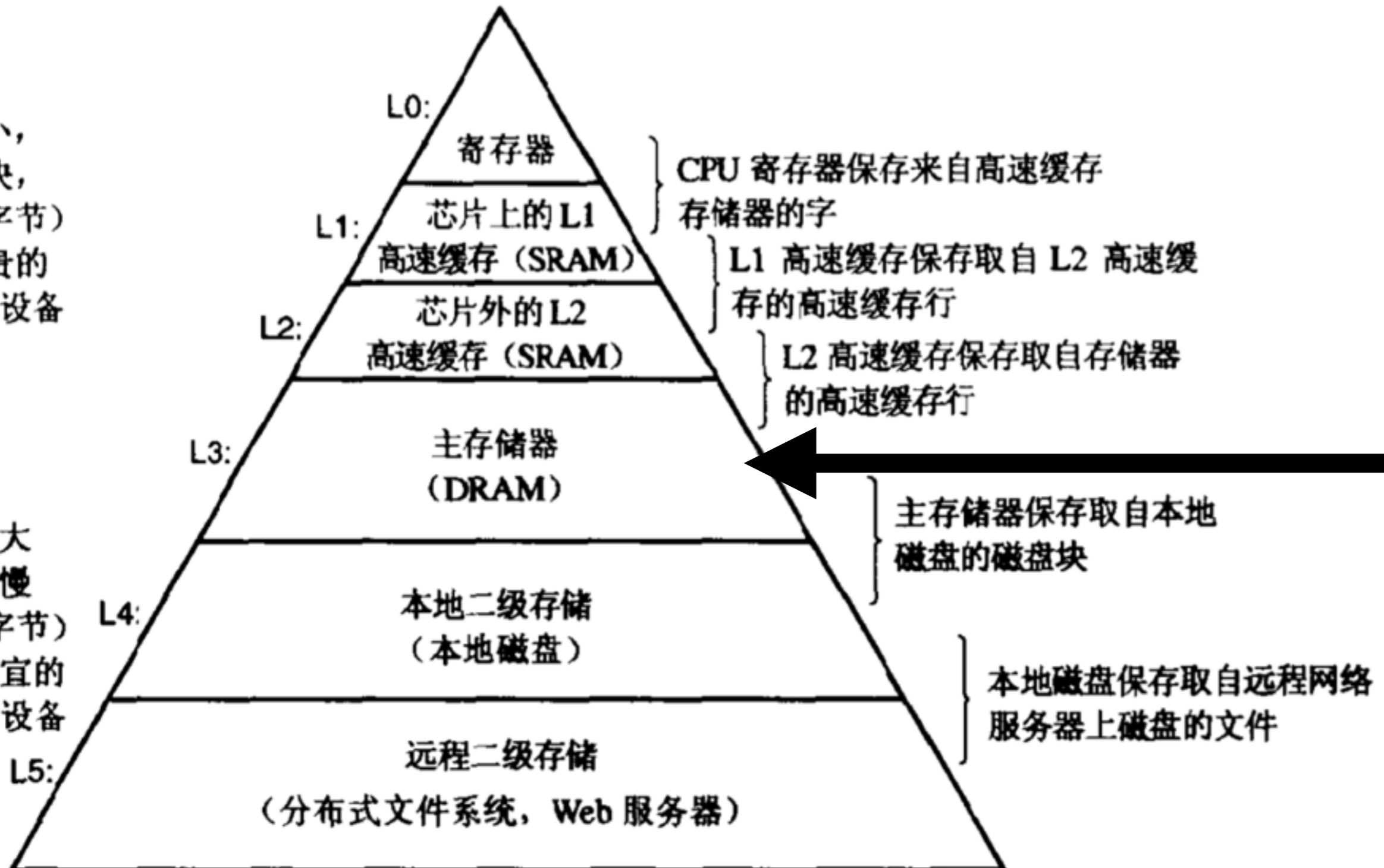
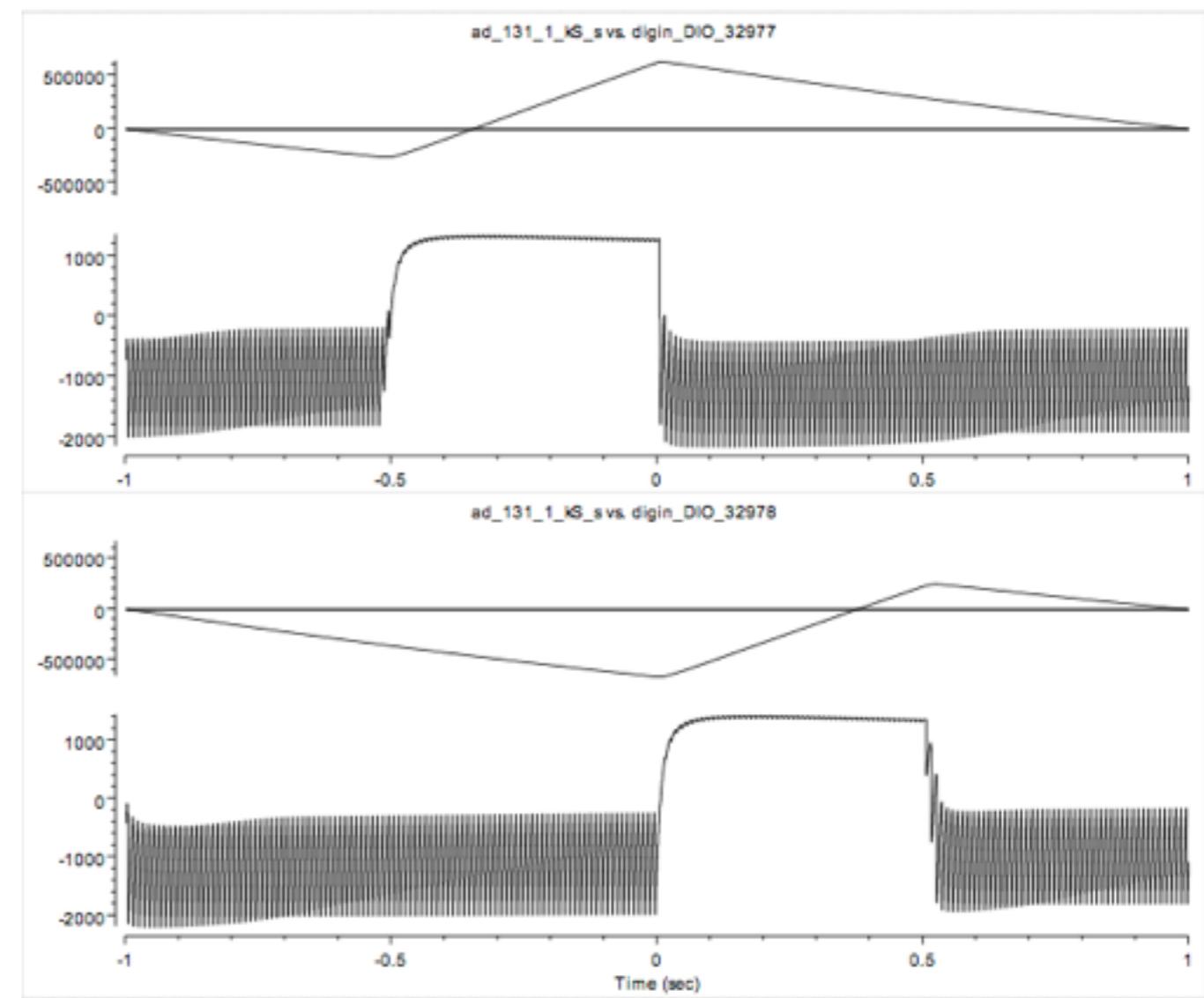
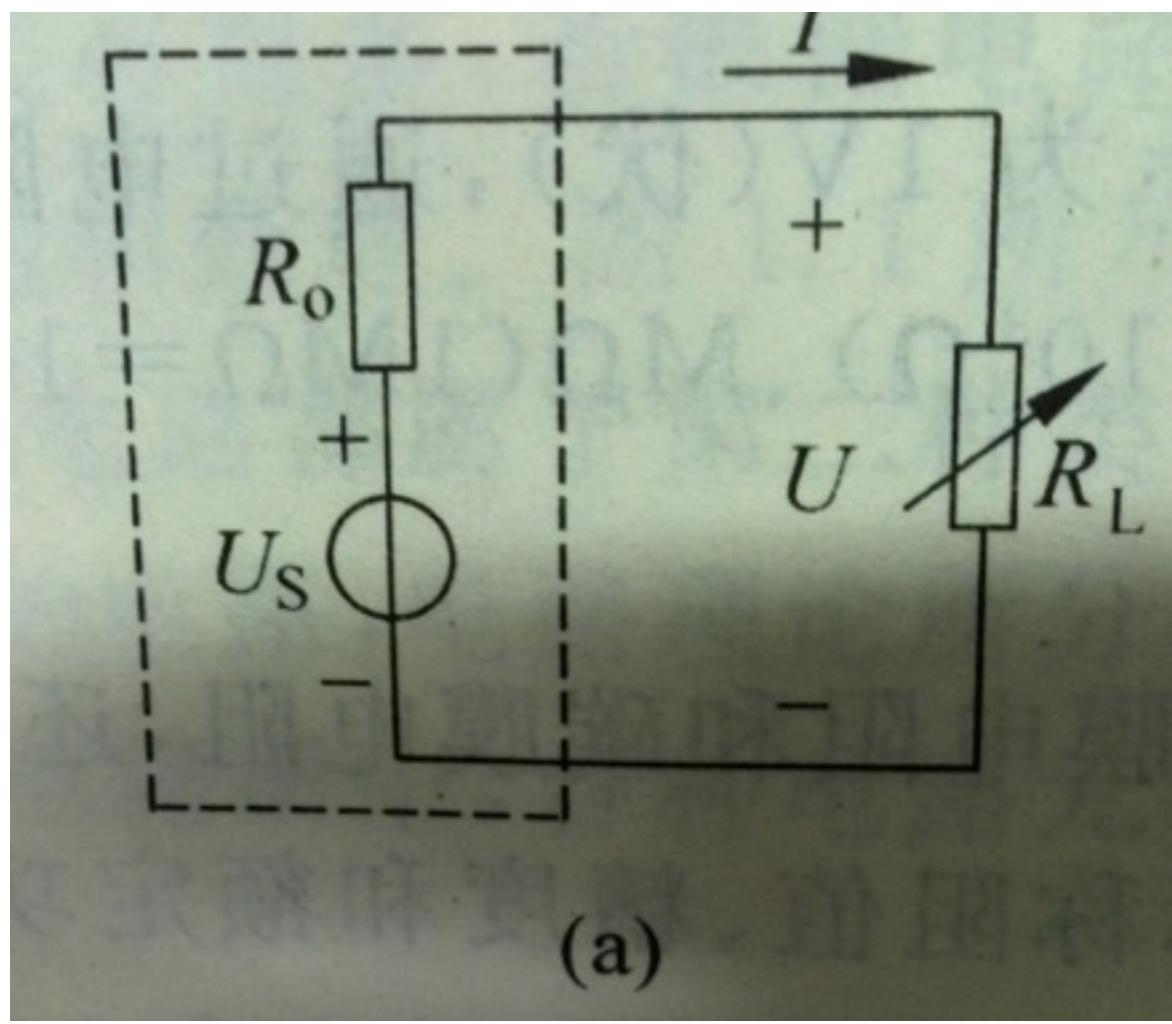


图 1.9 一个存储器层次模型的示例

# Mark的精度

利用光敏电阻



还有什么需要补充的么？

# 存数据

- .mat 是首选
  - '-append' 选项很有用，经常存存防死机。
- .csv 是通用好格式
- 取个时间避免重复。 sprintf() 与 datestr()
- saveas 保存图表

# 各种条件选取各种逻辑

- & | ~
- && ||
- not and or xor
- sum(A==a)

# MATLAB怎么开多线程？

- Example: myTimer

# 炫酷GUI?

- 如果还有时间的话。 . .

我不生产代码，我只是Github  
和StackOverFlow的搬运工。

— 某程序猿签名

# 一些其他资源

- Google
- Yahoo Group: Psychotoolbox
- MathWorks