Statistical Methods in Astrophysics

主讲：刘桂琳

God does not play dice.

--Albert Einstein

Statistical Methods in Astrophysics

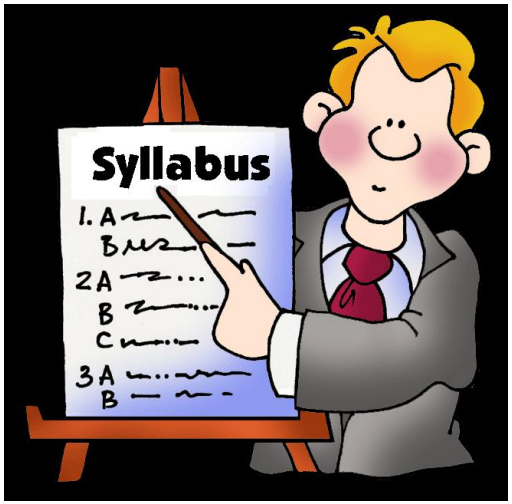
主讲：刘桂琳

God not only plays dice. He also sometimes throws the dice where they cannot be seen.

--Stephen Hawking

课程介绍

- 学分：3　　周学时：3
- 教师：刘桂琳, glliu@ustc.edu.cn 办公室：理化大楼18006
- 语言：汉语、英语结合
- 授课方式：课件、板书结合
- 作业：约每2次课一次，上交纸质（不要用本子）



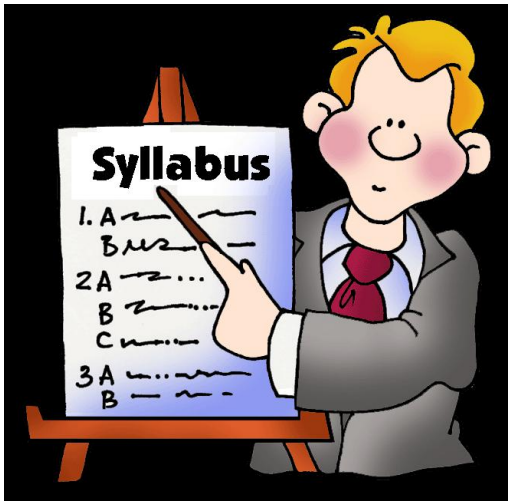
课程介绍

- 分组：每组3-4人合作完成，提交纸质报告并做口头报告。
  - 每个小组在期中需要选定一个小课题，要求调研至少一种课上没有讲到的数据分析或信号/图像处理方法，讨论其在科研（不限于天文）中的应用状况，用真实数据重复他人结果，或自己做出新的分析，并在课堂上讲解其背景、原理、方法、分析结果。

- 课件、作业、通知：http://staff.ustc.edu.cn/~glliu

  点“teaching”（永远处于建设中）

- 最终成绩(计划)：
  - 平时作业（40%）
  - 小课题书面（15%）+口头报告（15%）
  - 期末考核（30%）



参考书 不要读中文版！

- 参考书A0：*An Introduction to Error Analysis* - by John R. Taylor
- 参考书A: *Mathematical Statistics and Data Analysis*
  - by John A. Rice, 2007, 3rd edn （有电子版）
  - 系统的教科书，内容丰富而深入，实例众多，宜常备的基础统计书
- 参考书B：*Data Reduction and Error Analysis for the Physical Sciences*
  - by PR Bevington & DK Robinson, 2003, 3rd edn, 制本厂有影印本
  - 内容精炼，简洁清晰，以实用至上的风格广受赞誉
- 参考书C：*Practical Statistics for Astronomers*
  - by JV Wall and CR Jenkins, 2012, 2nd edn
  - 实用、全面、易读、跟进时代，宜常备的天文统计书

其他：*Numerical Recipes in C/C++/FORTRAN*, by WH Press et al.

- 最经典的天文工具箱，在学术界有圣经般的地位

Modern Cosmology, by S Dodelson

- 末章集中讲解宇宙学中常用的统计方法，宇宙学数据分析入门必读

不要读中文版！ 不要读中文版！

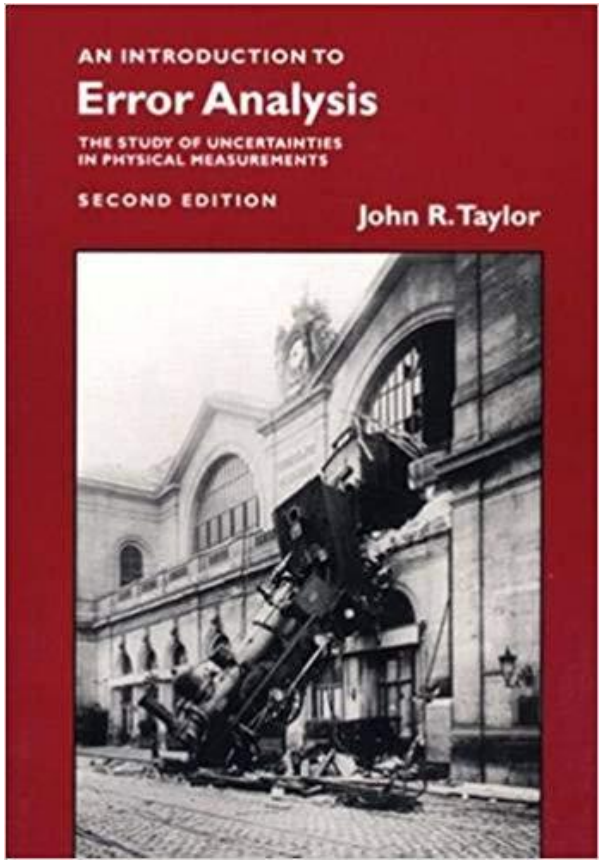
参考书A0 不要读中文版！

An Introduction to Error Analysis

-- The Study of Uncertainties in Physical Measurements

by John R. Taylor

- 在美国最广受赞誉的本科生入门书，初学适宜，复习有收获



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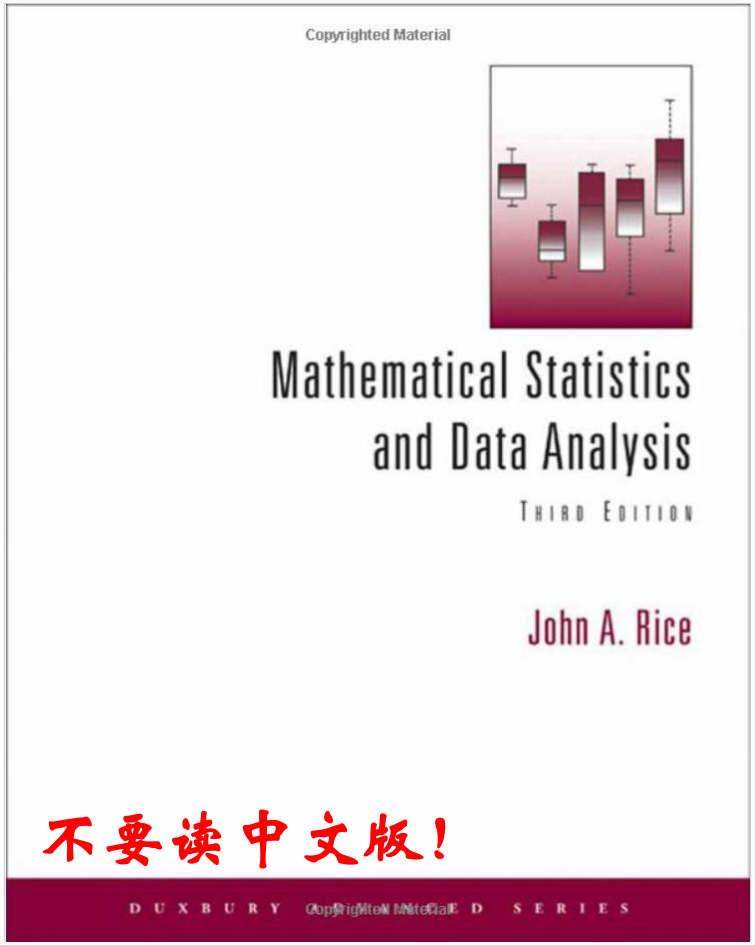
  - U California (Berkeley) 教材，无天文应用

不要读中文版！



不要读中文版！

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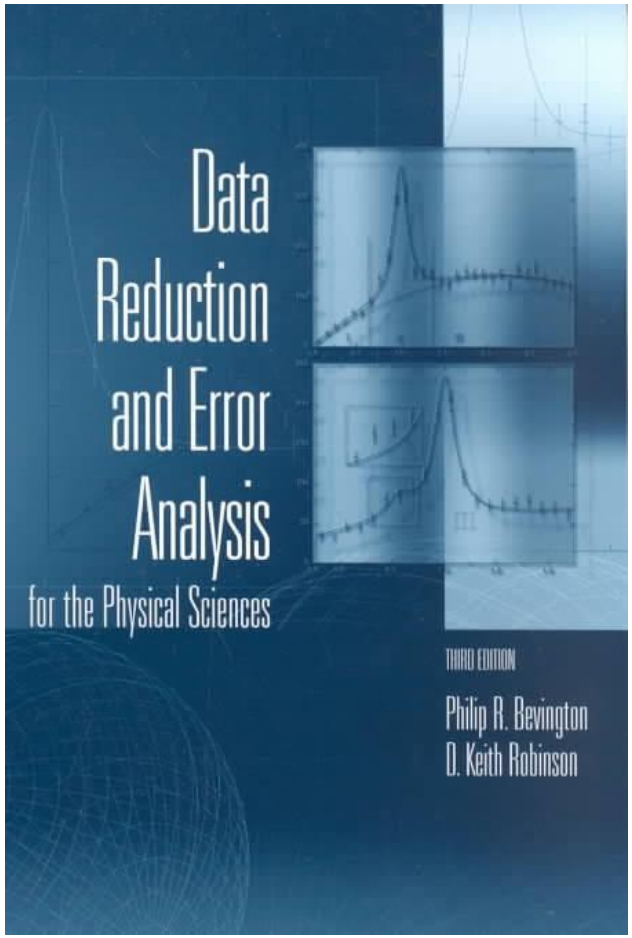
  - by PR Bevington & DK Robinson, 2003, 3rd edn, 制本厂有影印本
  - 内容精炼，简洁清晰，以实用至上的风格广受赞誉
  - 内容太少，宽度深度均不足

不要读中文版！



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参考书 不要读中文版！

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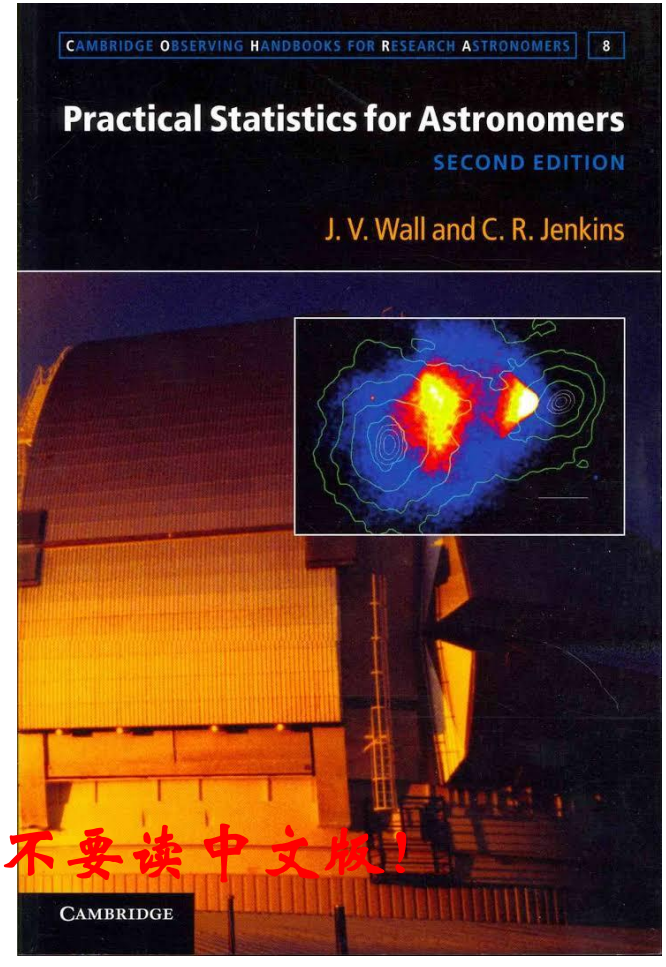
  - by JV Wall and CR Jenkins, 2012, 2nd edn
  - 实用、全面、易读、跟进时代，宜常备的天文统计书
  - 观点过高，语焉不详，不适合初学



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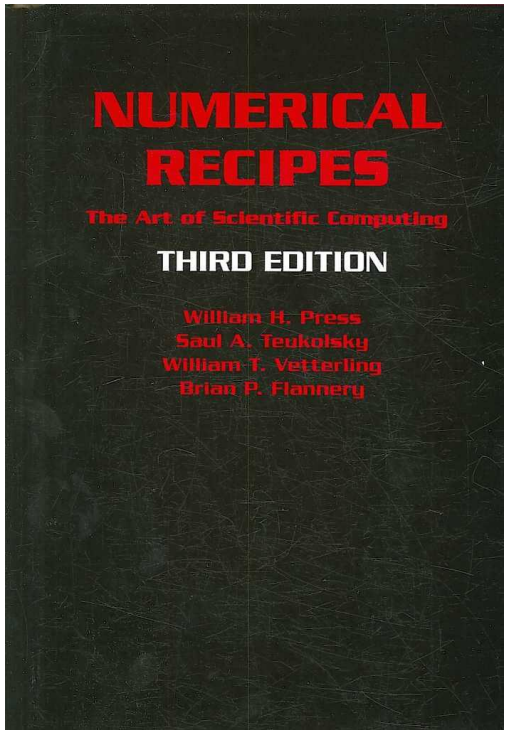

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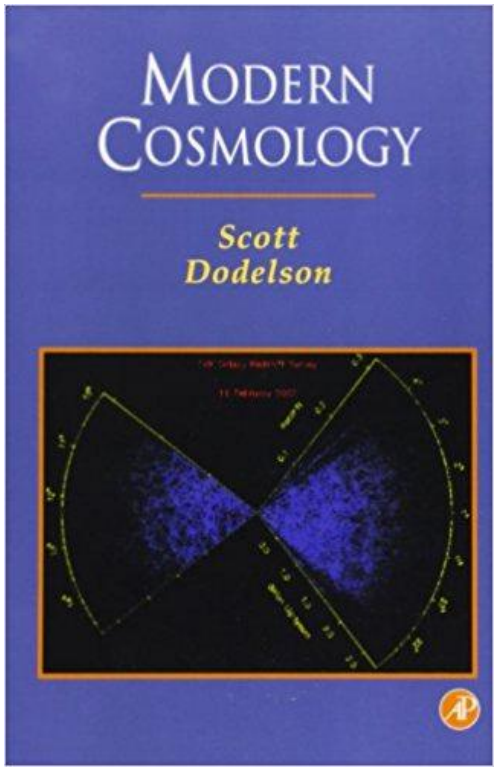


不要读中文版！

Lecture	*Preliminary arrangement*
1	Syllabus, background knowledge census, groups, IDL, probability
2	Random variables
3	Joint distributions
4	Expectations
5	Prediction and approximation
6	Central limit theorems
7	Correlation, **project selected**
8	Survey and sampling
9	Parameter estimation
10	Maximum likelihood estimation
11	Bayesian parameter estimation
12	Hypothesis testing
13	Goodness of fit
14	Summarizing data
15	**In-class final exam**
16	Mann-Whitney test, linear regression, etc.
17	**Project report and presentation**

自我回顾

1. 你的姓名、年级（**本课默认面向硕一**）

2. 你学过概率论和数理统计吗？上课还是自学？

3. 如果学过，请回答为什么高斯（正态）分布随处可见？

4. 你认为自己懂得的最深的概统知识是什么？

5. 你在实际天文工作中用过概统知识吗？怎样用的？

6. 你希望这门课怎样进行？

A. 我没什么基础，希望从零开始讲，到期末讲完概统的全部基础内容；

B. 我学过概统，但没学通是怎么回事，还想再听一遍基础内容；

C. 我已经有相当基础了，不想再听，更想听浮光掠影式的天文统计方法介绍，开开眼界，对我更重要；

D. 我很迷茫，不知道概率统计有多大用，老师说了算；

E. 以上都不好，我的想法是……（混点学分/晚上无聊/跟我女神来的）

Philosophy time!

正确的理念是核心！

一切数据分析处理方法都要在合理观念的指导下运用

学而不思则罔（要有理念）

思而不学则殆（要懂技术）

A list of what it is **NOT** (may be infinite... and arguable):

- Building instruments
- Observing
- Reducing data
- Making graphs
- Writing code
- Writing papers
- Reading the literature
- Learning the trade: physics/astronomy/mathematics

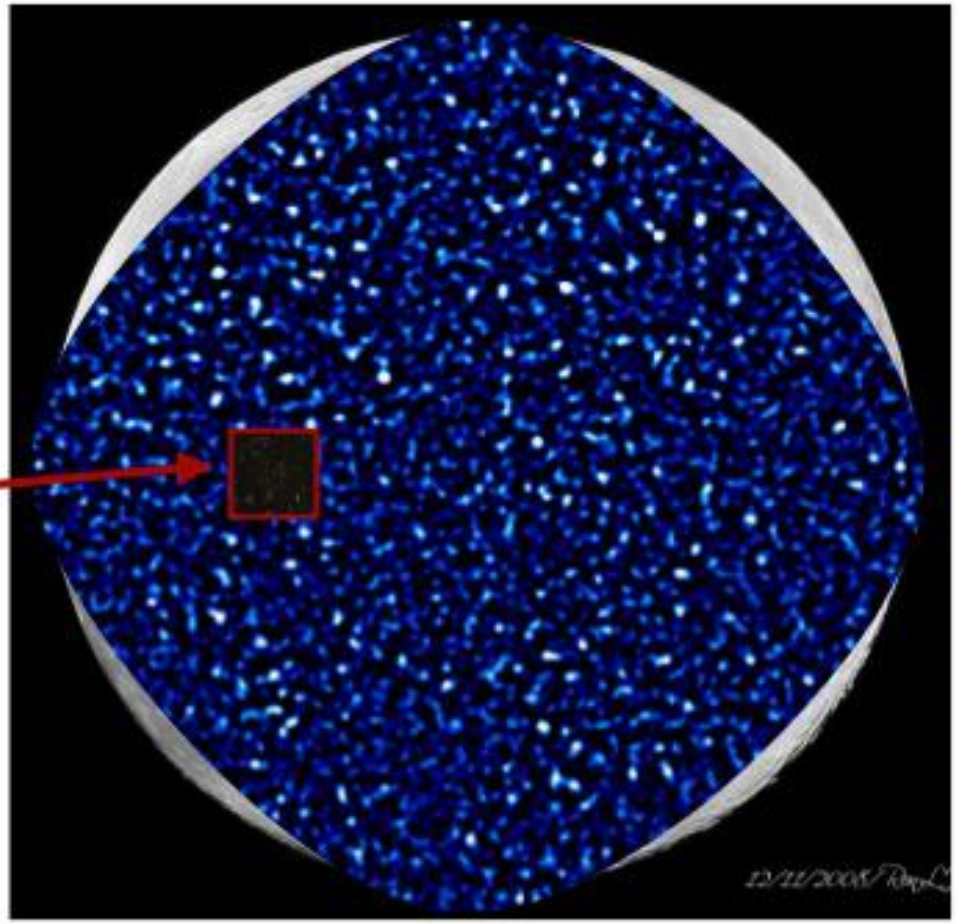
These may be tools of science: but as for science itself, only decision counts.

Science is decision.

An Extragalactic Survey at λ=1.1 mm

Example: Is the faint smudge on an image a star, a galaxy, a false detection, or simply "clustered" noise?

- **AzTEC/COSMOS survey**
  - 0.7 deg^2
  - 500× area of HUDF
  - 160 hrs versus 270 hrs for HUDF
  - 130 mm-bright galaxies



We decide by comparing...

Real detection???

- Measure and describe the noise.
- Consider all possible abnormal noise behaviors and instrumental artifacts.
- The image of the object, is now represented by a *statistic* (e.g. S/N=7)

▸ Make your decision!

If real, a star or a galaxy?

- Measure full width at half maximum, the FWHM.
- Measure FWHM of the point-spread function (e.g. a sample of stars).
- The data set is AGAIN represented by a *statistic* (e.g. FWHM ratio=1.3 ± 0.2)

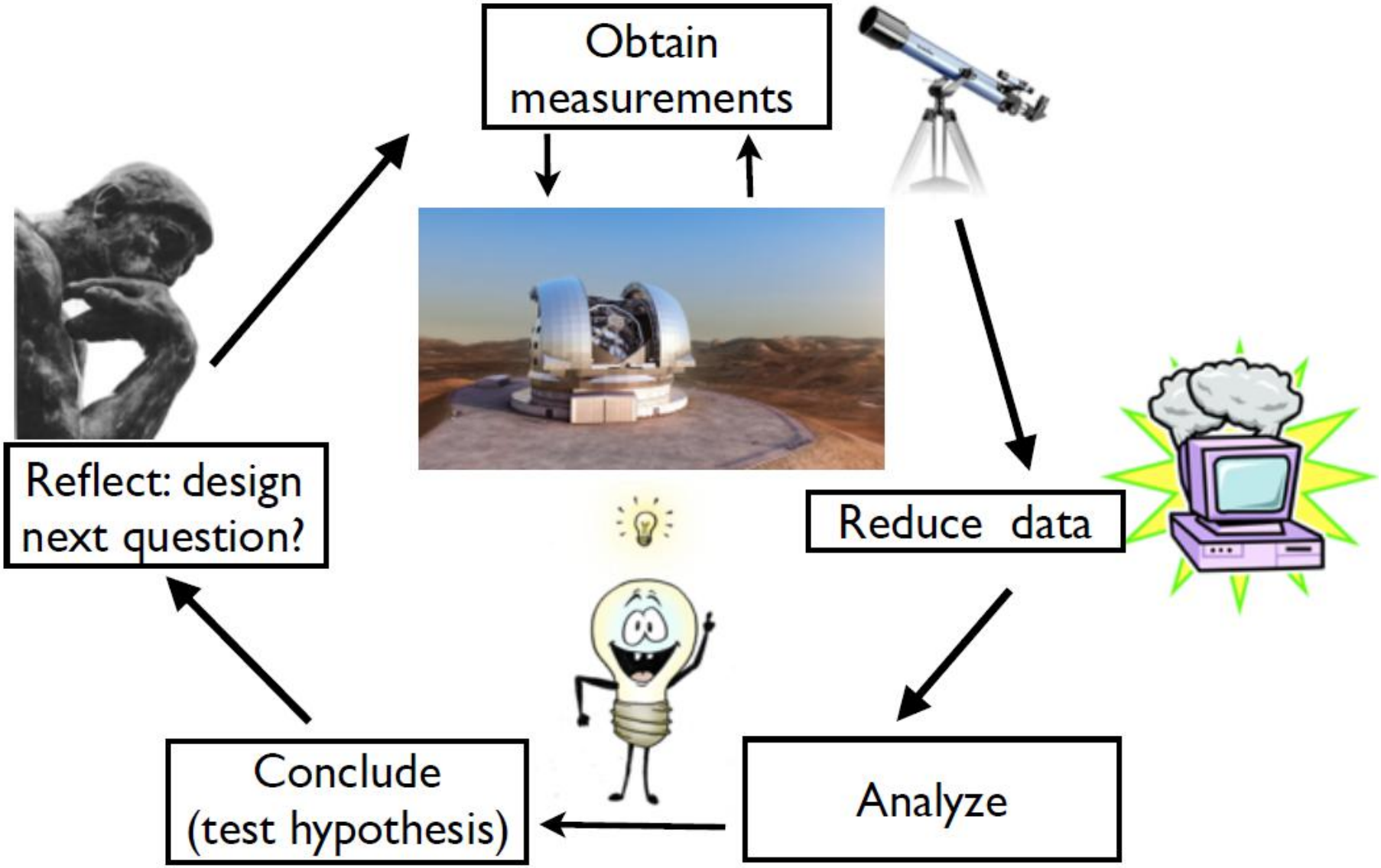
▸ Make your decision!

Statistics are there for decision against a "background".

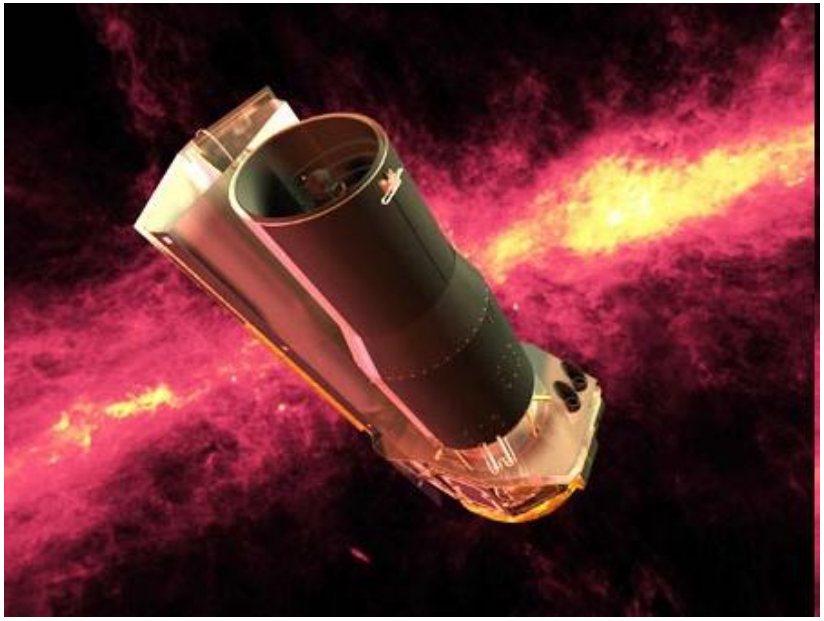
Every measurement, parameter or value we derive, requires an error estimate, a measure of range (expressed in terms of probability) that encompasses our belief of the true value of the parameter.

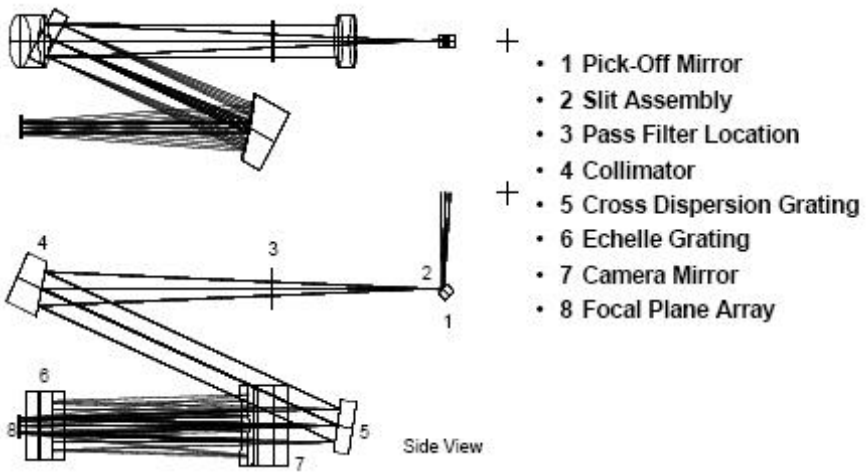
No measured quantity or property is of the slightest use in decision unless it has a "range quantity" attached.

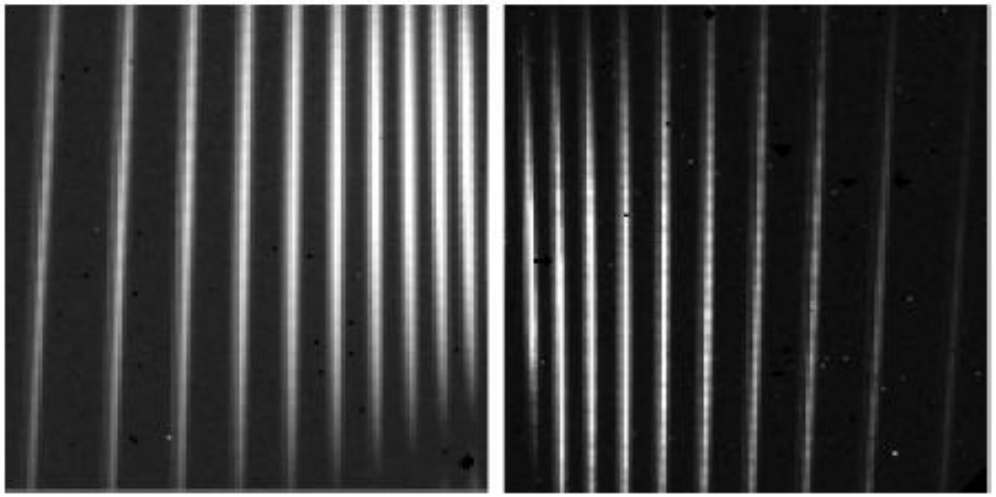
The process of science

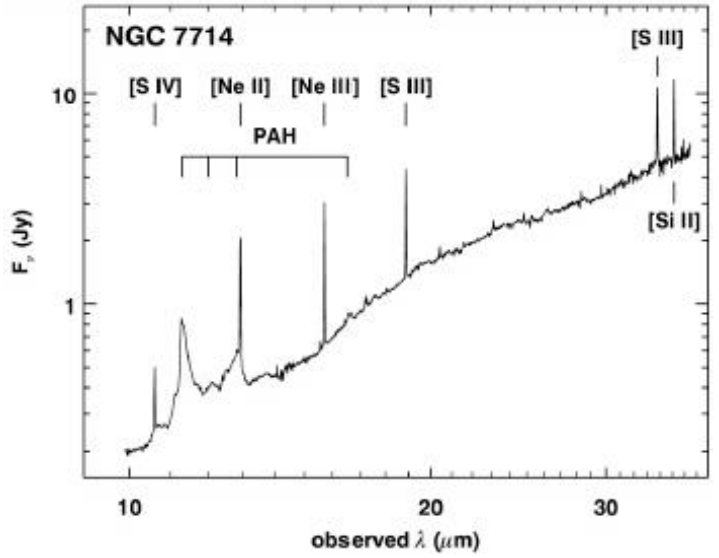


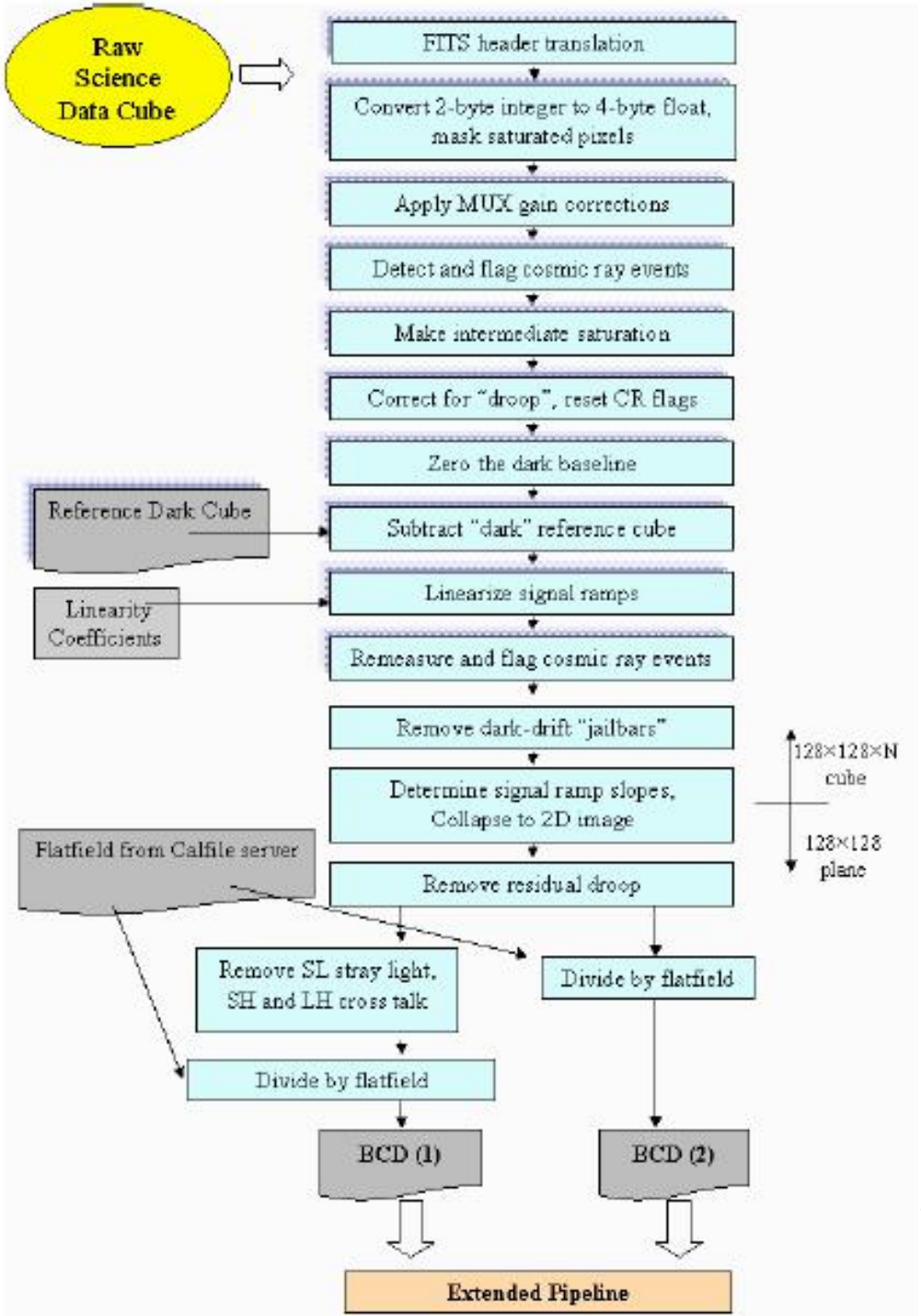
Facility Pipeline

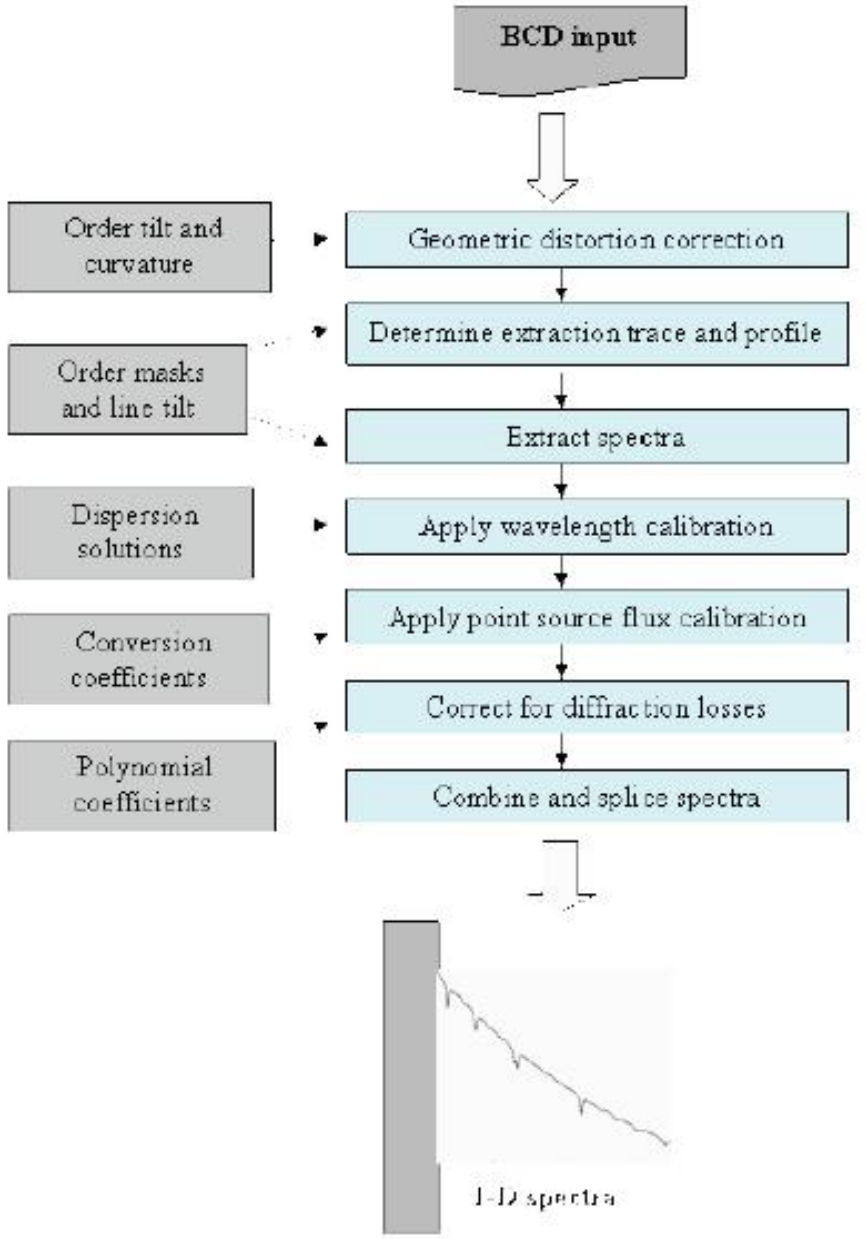












Spitzer IRS Data Reduction Procedure

Typical Imaging Data Reduction Steps

- Bias subtraction
- Dark current removing
- Making flats
- Flat fielding
- Optical distortion correction (large FoV)
- Sky subtraction
- Bad pixel masking
- Cosmic ray rejection
- Alignment & Coadding
- PSF matching (mult-wavelength)
- **...**

We cannot avoid statistics...

...and there are several reasons for this unfortunate situation:

1. Error (range) assignment - ours, and theirs - what do they mean?

2. How can data be used best? Or at all?

3. Correlation, testing the hypothesis, model fitting; how do we proceed?

4. Incomplete samples, samples from an experiment which cannot be rerun, upper limits; how can we use these to best advantage?

5. Others describe their data and conclusions in statistical terms. We need some self-defense.

6. Above all, we must decide. The decision process cannot be done without some methodology, no matter how good the experiment.

Common uses of statistics

- Measuring a quantity ("parameter estimation") : given some data, what is our best estimate of a particular parameter? What is the uncertainty in our estimate?

- Searching for correlations : are two variables we have measured correlated with each other, implying a possible physical connection? Graphics important!

- Testing a model ("hypothesis testing") : given some data and one or more models, are our data consistent with the models? Which model best describes the data?

The point of statistics

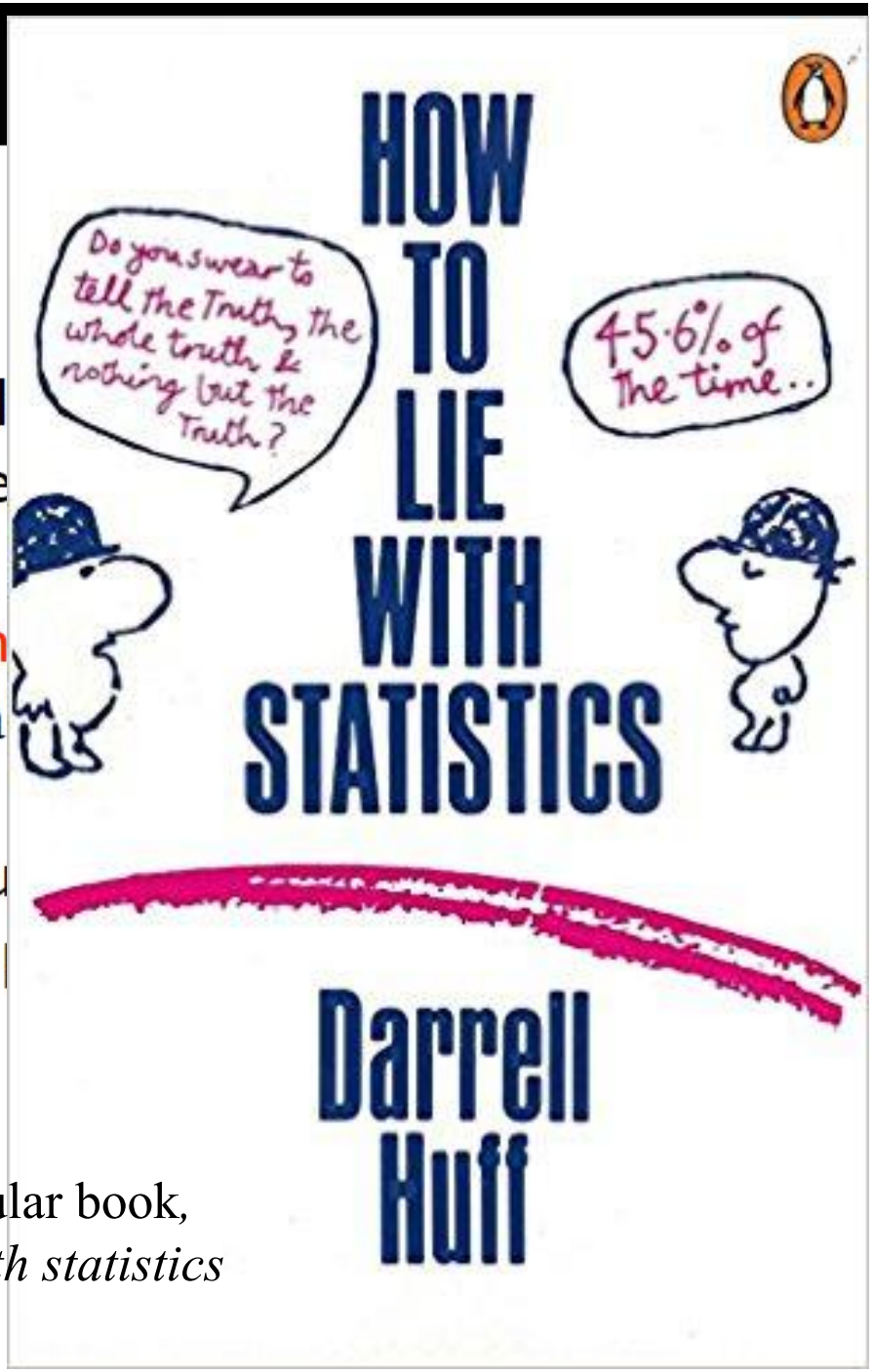
- It allows us to formulate the logic of what we are doing and why. It allows us to make precise statements.
- It allows us to quantify the uncertainty in any measurement, which should always be stated.
- It allows us to avoid pitfalls such as confirmation bias (distortion of conclusions by preconceived beliefs)

先入为主的

- DECISION

The point of statistics

- It allows us to formulate the l
  and why. It allows us to make
- It allows us to quantify the un
  measurement, which should a
- It allows us to avoid pitfalls su
  (distortion of conclusions by
- DECISION



A highly popular book,
How to lie with statistics

Let's revisit the probability theory

- Probability theory is the foundation of statistics and data analysis.

- More importantly, *the spirit (and many crucial ideas) of the statistics and data analysis derives from the probability theory*

为避免盲目套结论、套统计方法，
对概率思想的足够理解必不可少

Birthday problem: a famous counterintuitive problem

1. Suppose that a room contains *n* people. What is the probability that at least two of them have a common birthday?

猜猜看

2. How many people must you ask to have a 50 : 50 chance of finding someone who shares your birthday?

猜猜看

Birthday problem: a famous counterintuitive problem

1. Suppose that a room contains *n* people. What is the probability that at least two of them have a common birthday?

$$P(A) = 1 - \frac{365 \times 364 \times \cdots \times (365 - n + 1)}{365^n}$$

n	$P(A)$
4	.016
16	.284
23	.507
32	.753
40	.891
56	.988

2. How many people must you ask to have a 50 : 50 chance of finding someone who shares your birthday?

$$P(A) = 1 - \frac{364^n}{365^n}$$

p=0.5, n=253

Probability is crucial in decision process, but how to understand it?

Interpretation of probability, and the philosophy behind it:

Frequentist's vs. Bayesian interpretation

Question: Will it rain tomorrow?

Frequentist vs. Bayesian approach

Example: **average**

- we expect it bears some relation to the true mean
- we calculate the *sampling distribution* ≡ the probability of various values it may assume if we (hypothetically) repeat the experiment many times.
- we then know the probability that some range around our single measurement will contain the true mean.

This is precisely the utility of statistics: they are laboriously-discovered combinations of observations which converge, for large sample sizes, to some underlying parameter we want to know.

Frequentist vs. Bayesian approach

Invert the reasoning just described: The **data** are unique and known!

Example: in the previous example it is the **mean that is unknown**, that should have probability attached to it. We instead calculate **the probability of various values of the mean**, given the data we have.

The approach comes far closer to answering the questions that we actually ask. Of course it allows us to make decisions.

But wait! The brain works the other way, other people works the other way, the data may not be given to us in a form we can Bayesiate it, there may not be a model, one has to use a prior that carries his/her prejudice, stupidity and ignorance

Conditional probability

DEFINITION

Let A and B be two events with $P(B) \neq 0$. The conditional probability of A given B is defined to be

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)}$$

■

LAW OF TOTAL PROBABILITY

Let $B_1, B_2, \ldots, B_n$ be such that $\bigcup_{i=1}^{n} B_i = \Omega$ and $B_i \cap B_j = \emptyset$ for $i \neq j$, with $P(B_i) > 0$ for all i. Then, for any event A,

$$P(A) = \sum_{i=1}^{n} P(A \mid B_i) P(B_i)$$

BAYES' RULE

Let A and $B_1, \ldots, B_n$ be events where the B_i are disjoint, $\bigcup_{i=1}^{n} B_i = \Omega$, and $P(B_i) > 0$ for all i. Then

$$P(B_j \mid A) = \frac{P(A \mid B_j) P(B_j)}{\sum_{i=1}^{n} P(A \mid B_i) P(B_i)}$$

The proof of Bayes' rule follows exactly as in the preceding discussion. ■

简单的公式，深刻的思想

1. Bayes公式是认识论和学习理论中主观或“贝叶斯”方法的基本数学成分

2. 根据Bayesian理论，有关世界的个人认知可以概率化

3. 根据Bayesian理论，人凭经验和知识判断概率，但遇到新信息时，个人的认知要修改，*P*(明天下雨)变为*P*(明天下雨|天气预报说不会下)

Thomas Bayes (1701-1761)

简单的公式，深刻的思想

4. 大量研究表明，**人类实际上并不擅长在评估信息时进行概率计算**（即使是训练有素、有大量实践经验的专家）。

实例：Eddy (1982)的癌症研究。设总患病概率是1%；如果患病，正确诊断概率80%；如果为良性病变，误诊率为10%。

问100名医生：筛查呈阳性的患者患病概率是多少？

95名医生估计~75%上下；你的估计是多少？

简单的公式，深刻的思想

4. 大量研究表明，**人类实际上并不擅长在评估信息时进行概率计算**（即使是训练有素、有大量实践经验的专家）。

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95名医生估计~75%上下；Bayes公式给出7.5%！

5. Bayesian概率计算方式不是人类实际消化信息的方式。倡导者断定该学习理论描述了人类“应该思考”的方式，更温和的观点主要只承认嵌入计算机程序的便利性。Bayesian学习理论是人工智能的核心部分——**机器学习也许正在颠覆当代天文学**！

Assignment

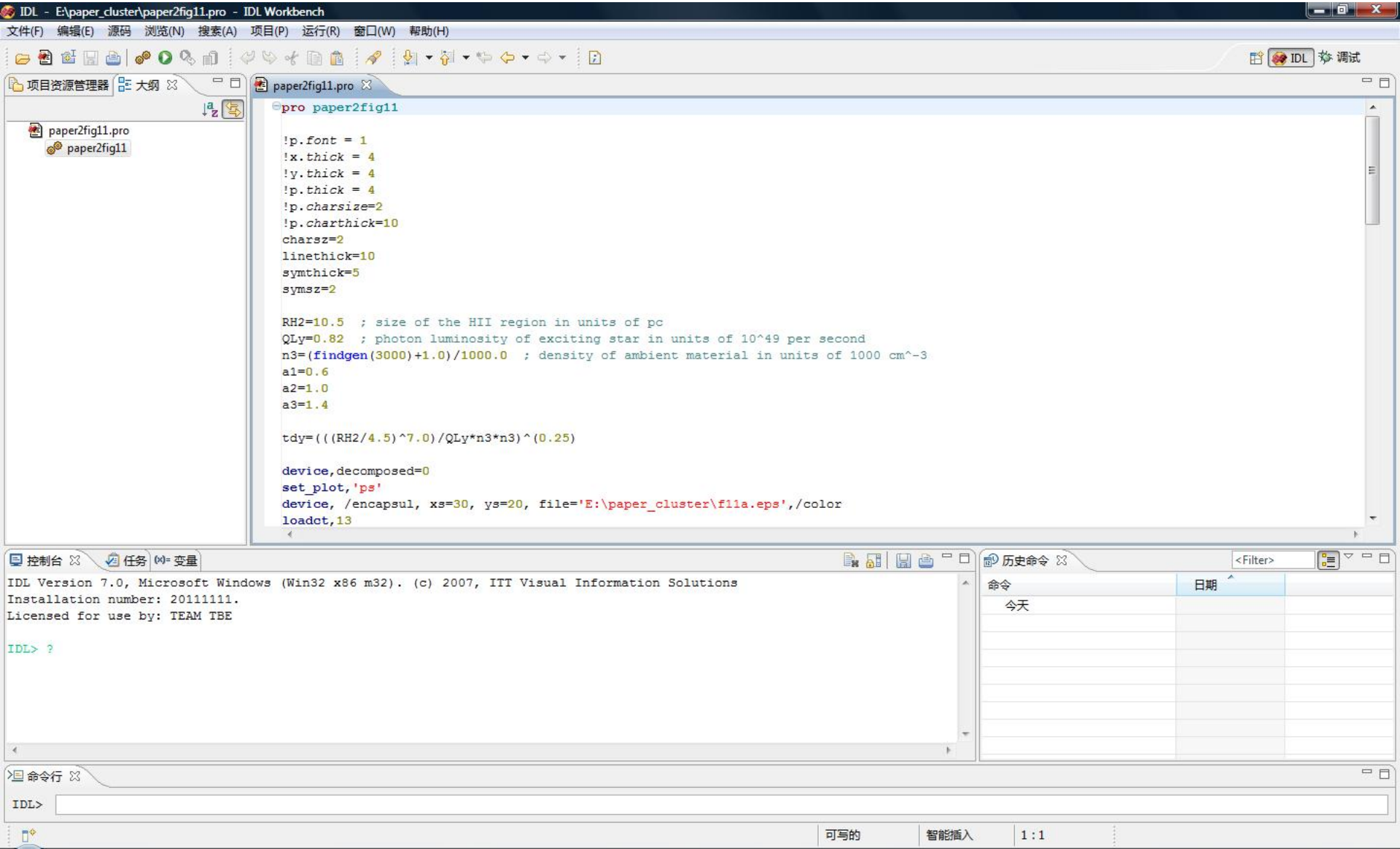
Find your favorite book on probability theory, it should be deep and broad enough (but not too technical for you to really digest). Those for maths/statistics majors often rely on measure theory （测度论）, which you should avoid (unless you already mastered it, but it's not useful for astronomers).

If your undergrad textbook is reasonable, you may start from re-reading it. However, Chinese undergrad textbooks are generally not broad enough.

If you cannot find such a good book, try John Rice's Mathematical statistics and data analysis. You'll probably love it (like me).

Basics of Interactive Data Language (IDL)

IDLDE


IDL - E:\paper_cluster\paper2fig11.pro - IDL Workbench
文件(F) 编辑(E) 源码 浏览(N) 搜索(A) 项目(P) 运行(R) 窗口(W) 帮助(H)
IDL 调试
项目资源管理器 大纲
paper2fig11.pro
paper2fig11
paper2fig11.pro
pro paper2fig11
!p.font = 1
!x.thick = 4
!y.thick = 4
!p.thick = 4
!p.charsize=2
!p.charthick=10
charsz=2
linethick=10
symthick=5
symsz=2
RH2=10.5 ; size of the HII region in units of pc
QLy=0.82 ; photon luminosity of exciting star in units of 10^49 per second
n3=(findgen(3000)+1.0)/1000.0 ; density of ambient material in units of 1000 cm^-3
a1=0.6
a2=1.0
a3=1.4
tdy=(((RH2/4.5)^7.0)/QLy*n3*n3)^(0.25)
device,decomposed=0
set_plot,'ps'
device, /encapsul, xs=30, ys=20, file='E:\paper_cluster\f11a.eps',/color
loadct,13
控制台 任务 变量
IDL Version 7.0, Microsoft Windows (Win32 x86 m32). (c) 2007, ITT Visual Information Solutions
Installation number: 20111111.
Licensed for use by: TEAM TBE
IDL> ?
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日期
今天
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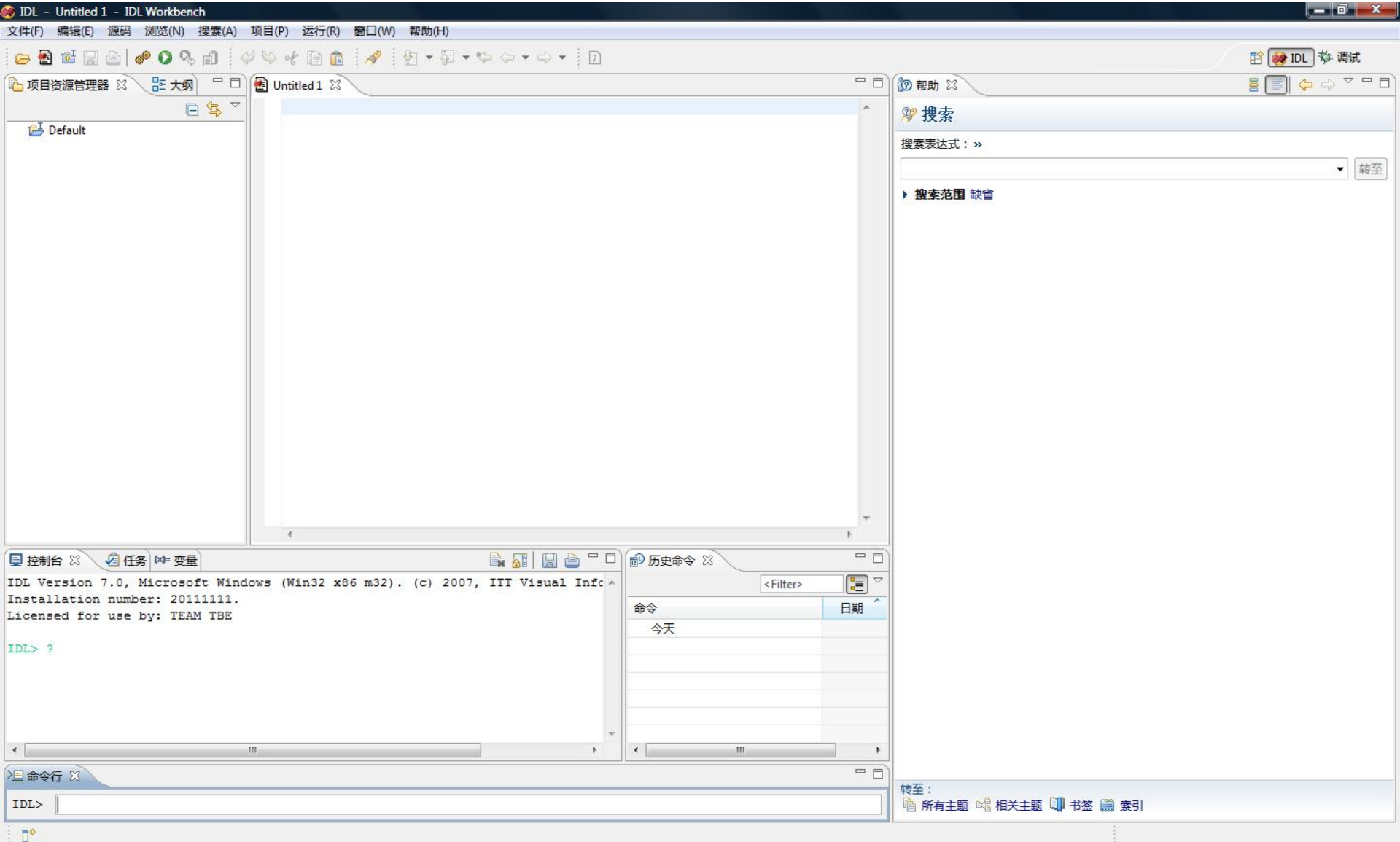
1 : 1

IDLDE


IDL - Untitled 1 - IDL Workbench
文件(F) 编辑(E) 源码 浏览(N) 搜索(A) 项目(P) 运行(R) 窗口(W) 帮助(H)
IDL 调试
项目资源管理器 大纲
Default
Untitled 1
帮助
搜索
搜索表达式：»
转至
搜索范围 缺省
控制台 任务 变量
IDL Version 7.0, Microsoft Windows (Win32 x86 m32). (c) 2007, ITT Visual Info
Installation number: 20111111.
Licensed for use by: TEAM TBE
IDL> ?
历史命令
<Filter>
命令
日期
今天
命令行
IDL>
转至：
所有主题 相关主题 书签 索引

大小写不敏感，Unix/Linux系统文件名例外

帮助：help，？

注释：；

续行符：$

字符串：’　　’ 或者”　　”

系统变量起始符：!

命令格式：Command, Variable_list, Keyword_list

```
Contour, peak, lon, lat, XStyle=1, YStyle=1, /Follow,$
 Levels=vals, C_Label=[1,0,1,0,0,1,1,0]
```

过程和函数调用：

过程调用：command, variable_list, keyword_list

函数调用：a=command(variable_list, keyword_list)

批处理：a.script:

```
command1
command2
…
commandn
```

命令行：@a.script

- 命令行

```
PRINT,   'Hello, World!'
```

- 菜单-文件-新建-IDL源文件 hello_world.pro

```
PRO hello_world
   PRINT, 'Hello, World!'
END
```

- a.pro:

```
 PRO a
   print, hello('World!')
END

Function hello, par1
   RETURN, 'Hello, '+par1
END
```

- 命令行

```
.r hello_world.pro
.r a.pro
```

- 变量

  name='Tom'
  age=20
  height=1.80
  salary=1.0e5
  ID=0
  score=0.0

- 数组

  name=['Tom'， 'Bob'， 'Eva']
  age=[20，19，21]
  height=[1.80，1.75，1.70]
  salary=[1.0e5，1.0e5，1.0e5]
  ID=indgen(3)
  score=findgen(3)*0.0

- 程序结构

  pro, function, return, end

- 条件转移

  IF *expression* THEN *statement* [ELSE *statement*]

  or

  IF *expression* THEN BEGIN

  statements

  ENDIF [ELSE BEGIN

  statements

  ENDELSE]

  CASE *expression* OF

  expression: *statement*

  …

  expression: *statement*

  [ELSE: *statement*]

  ENDCASE

  SWITCH *Expression* OF

  Expression: *Statement*

  …

  Expression: *Statement*

  [ELSE: *Statement*]

  ENDSWITCH

- 循环

  FOR *variable* = *init*, *limit* [, *Increment*] DO *statement*

  or

  FOR *variable* = *init*, *limit* [, *Increment*] DO BEGIN

  statements

  ENDFOR

  REPEAT *statement* UNTIL *expression*

  or

  REPEAT BEGIN

  statements

  ENDREP UNTIL *expression*

  WHILE expression DO statement

  or

  WHILE expression DO BEGIN

  statements

  ENDWHILE

- 一般命令

PRINT [, *Expr1*, ..., *Exprn*] [, FORMAT=*value*]
PRINTF [, *Unit*, *Expr1*, ..., *Exprn*] [, FORMAT=*value*]

READ, [*Prompt*,] *Var1*, ..., *Varn* [, FORMAT=*value*]
READF, [*Prompt*,] *Unit*, *Var1*, ..., *Varn* [, FORMAT=*value*]

OPENR, Unit, File
OPENW, Unit, File
OPENU, Unit, File

CLOSE, Unit

- WINDOW [, *Window_Index*] [, COLORS=*value*] [, /FREE] [, /PIXMAP] [, RETAIN={0 | 1 | 2}] [, TITLE=*string*] [, XPOS=*value*] [, YPOS=*value*] [, XSIZE=*pixels*] [, YSIZE=*pixels*]

- PLOT, [*X*,] *Y* [, /ISOTROPIC] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, NSUM=*value*] [, /POLAR] [, THICK=*value*] [, /XLOG] [, /YLOG] [, /YNOZERO]

  Graphics Keywords: [, BACKGROUND=*color_index*] [, CHARSIZE=*value*] [, CHARTHICK=*integer*] [, CLIP=*[X0*, *Y0*, *X1*, *Y1]*] [, COLOR=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, FONT=*integer*] [, LINESTYLE={0 | 1 | 2 | 3 | 4 | 5}] [, /NOCLIP] [, /NODATA] [, /NOERASE] [, POSITION=*[X0*, *Y0*, *X1*, *Y1]*] [, PSYM=*integer*{0 to 10}] [, SUBTITLE=*string*] [, SYMSIZE=*value*] [, /T3D] [, THICK=*value*] [, TICKLEN=*value*] [, TITLE=*string*]
  [, {X | Y | Z}CHARSIZE=*value*]
  [, {X | Y | Z}GRIDSTYLE=*integer*{0 to 5}]
  [, {X | Y | Z}MARGIN=*[left*, *right]*]
  [, {X | Y | Z}MINOR=*integer*]
  [, {X | Y | Z}RANGE=*[min*, *max]*]
  [, {X | Y | Z}STYLE=*value*]
  [, {X | Y | Z}THICK=*value*]
  [, {X | Y | Z}TICK_GET=*variable*]
  [, {X | Y | Z}TICKFORMAT=*string*]
  [, {X | Y | Z}TICKINTERVAL= *value*]
  [, {X | Y | Z}TICKLAYOUT=*scalar*]
  [, {X | Y | Z}TICKLEN=*value*]
  [, {X | Y | Z}TICKNAME=*string_array*]
  [, {X | Y | Z}TICKS=*integer*]
  [, {X | Y | Z}TICKUNITS=*string*]
  [, {X | Y | Z}TICKV=*array*]
  [, {X | Y | Z}TITLE=*string*]
  [, ZVALUE=*value*{0 to 1}]

- CONTOUR, *Z* [, *X*, *Y*] [, C_ANNOTATION=*vector_of_strings*] [, C_CHARSIZE=*value*] [, C_CHARTHICK=*integer*] [, C_COLORS=*vector*] [, C_LABELS=*vector*{each element 0 or 1}] [, C_LINESTYLE=*vector*] [, C_ORIENTATION=*degrees*] [, C_SPACING=*value*] [, C_THICK=*vector*] [, /CELL_FILL | , /FILL] [, /CLOSED] [, /DOWNHILL] [, /FOLLOW] [, /IRREGULAR] [, /ISOTROPIC] [, LEVELS=*vector*] [, NLEVELS=*integer*{1 to 60}] [, MAX_VALUE=*value*] [, MIN_VALUE=*value*] [, /OVERPLOT] [{, /PATH_DATA_COORDS, PATH_FILENAME=*string*, PATH_INFO=*variable*, PATH_XY=*variable*} | , TRIANGULATION=*variable*] [, /PATH_DOUBLE] [, /XLOG] [, /YLOG] [, ZAXIS={0 | 1 | 2 | 3 | 4}]

  Graphics Keywords: Accepts all graphics keywords accepted by PLOT except for: LINESTYLE, PSYM, SYMSIZE

- TV, *Image* [, *Position*] [, /CENTIMETERS | , /INCHES] [, /ORDER] [, TRUE={1 | 2 | 3}] [, /WORDS] [, XSIZE=*value*] [, YSIZE=*value*]

  or

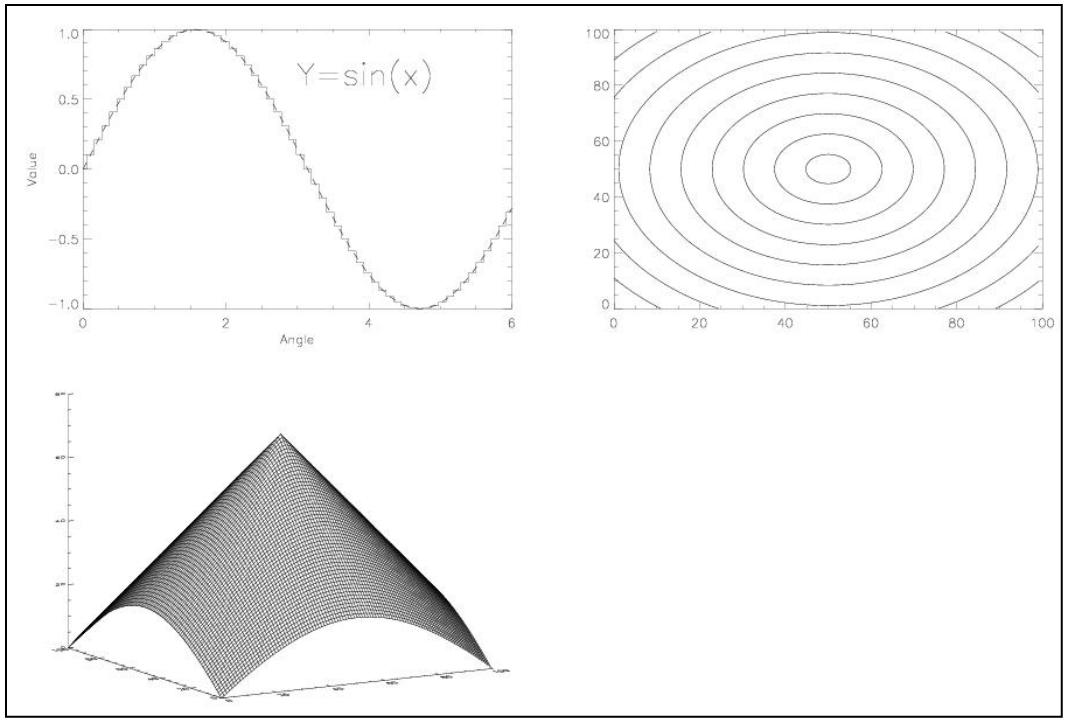
  TV, *Image* [, *X*, *Y* [, *Channel*]] [, /CENTIMETERS | , /INCHES] [, /ORDER] [, TRUE={1 | 2 | 3}] [, /WORDS] [, XSIZE=*value*] [, YSIZE=*value*]

  Graphics Keywords: [, CHANNEL=*value*] [, /DATA | , /DEVICE | , /NORMAL] [, /T3D] [, Z=*value*]

- XYOUTS, [*X*, *Y*,] *String* [, ALIGNMENT=*value*{0.0 to 1.0}] [, CHARSIZE=*value*] [, CHARTHICK=*value*] [, TEXT_AXES={0 | 1 | 2 | 3 | 4 | 5}] [, WIDTH=*variable*]

  Graphics Keywords:[, CLIP=*[X0, Y0, X1, Y1]*] [, COLOR=*value*][, /DATA | , /DEVICE | , /NORMAL] [, FONT=*integer*] [, ORIENTATION=*ccw_degrees_from_horiz*] [, /NOCLIP] [, /T3D] [, Z=*value*]

```
pro Mydemo

charsz=2
linethick=10
symthick=5
symsz=2

angle=findgen(60)/60.*2.0*!pi
sinx=sin(angle)
x=findgen(100)
y=findgen(100)
map=fltarr(100,100)
For i=0, n_elements(x)-1 do begin
      for j=0, n_elements(y)-1 do begin
           map(I,j)=sqrt((x(i)-50.0)^2 + (y(j)-50.0)^2)
      endfor
Endfor
map=max(map)-map
set_plot,'ps'
device, /encapsul, xs=30, ys=20,
      file='C:\Users\xxx\Desktop\fig.eps'
!p.multi=[0,2,2]

plot, angle,sinx,xran=[0,6],yran=[-1.0,1.0],xtitle='Angle', $
       ytitle='Value',psym=10
oplot, angle,sinx, linestyle=2
xyouts,3.,0.6,'Y=sin(x)',charsize=2.5
Contour,map,x,y, nlevels=10
surface,map

device,/close
set_plot,'win'

Return
end
```



Astrolib: Multiplot.pro

帮助 - IDL Workbench

搜索(S): 执行 搜索范围: 所有主题

内容

- About IDL
- IDL Workbench Guide
- IDL API Reference Guides
- IDL Users' Guides
- IDL Programmers' Guides
- Supplemental IDL Guides

IDL Help

Welcome to the IDL 7.0 help system. This home page provides links to information on important IDL topics, including:

IDL 7.0 News

- What's New in IDL 7.0
- IDL 7.0 Release Notes

Popular Help Topics

- IDL Workbench Super Quick Start!
- A tour of the IDL Workbench interface
- Using the IDL help system
- IDL Tutorials
- IDL Workbench Tips and Tricks

On the Web

- ITT Visual Information Solutions Home Page
- IDL Home Page

The IDL Astronomy User's Library

The IDL Astronomy Users Library is a central repository for low-level astronomy software written in the commercial language IDL. The Library is not meant to be an integrated package, but rather is a collection of procedures from which users can pick and choose (and possibly modify) for their own use. Submitted procedures are given a cursory testing, but are basically stored in the Library as submitted. Instrument-specific software is generally not included in the IDL Astronomy Library, but can be found at the Links to Other Astronomy and IDL related sites.

The entire contents of the Library can be downloaded in a tar file or in a .zip file from the the download site . Additional software, not included in the tar files, is available in a contrib directory. Individual procedures can be copied by browsing through a list of one-line descriptions. Changes to the contents of the Library are recorded in a news file.

Documentation is available describing the various options for working with FITS data in IDL.

The IDL Astronomy Library requires at least IDL V6.1. However, separate (frozen) versions of the Library that work with earlier versions of IDL are available at the /old download site.

The success of the IDL Astronomy User's Library depends on the willingness of users to give as well as take. Please inform Wayne Landsman of any possible contributions to the Library, programming bugs or documentation errors, or of relevant web sites.

- One-line descriptions of procedures
- Links to Other Astronomy and IDL related sites
- IDL Astronomy Library download site
- Searchable index of all IDL Astronomy Library procedures
- Chronological list of changes to the Library
- Frequently Asked Questions (FAQ)

Curator: Wayne Landsman
NASA Official: Theodore Gull
Last Updated: Mar-2008

http://idlastro.gsfc.nasa.gov/homepage.html

Contents of IDL Astronomy User's Library

"Astrolib"

Astronomical Utilities

- README
- ADSTRING() Format RA and DEC as a character string
- AIRTOVAC Convert air wavelengths to vacuum wavelengths
- AITOFF Convert longitude,latitude to X,Y using Aitoff equal-area projection
- AITOFF_GRID Create an overlay grid using the AITOFF projection
- ALTAZ2HADEC Convert Horizon (Alt-Az) coordinates to Hour Angle and Declination
- ARCBAR Draw an arcbar over an image showing the astronomical plate scale
- ARROWS Given a FITS header, display a "weathervane" showing N-E orientation
- ASTDISP Display formatter for pixel + astronomical coordinates
- ASTRO Interactive driver to compute astronomical precession, or coordinate conversions (calls EULER and PRECESS).
- BARYVEL Compute components of barycentric Earth velocity, given Julian date
- BPRECESS Precess coordinates, proper motion from J2000 to B1950
- CALZ_UNRED Deredden a galaxy spectrum using the Calzetti et al. (2000) parameterization.
- CCM_UNRED Deredden a spectrum using the Cardelli, Clayton and Mathis (1989) parameterization.

背景调查问卷

1. 你的姓名、年级（**本课默认面向硕一**）

2. 你学过概率论和数理统计吗？上课还是自学？如果学过，请回答为什么高斯（正态）分布随处可见？

3. 你认为自己懂得的最深的概统知识是什么？

4. 你在实际天文工作中用过概统知识吗？怎样用的？

5. 你希望这门课怎样进行？

A. 我没什么基础，希望从零开始讲，到期末讲完概统的全部基础内容；

B. 我学过概统，但没学通是怎么回事，还想再听一遍基础内容；

C. 我已经有相当基础了，不想再听，更想听浮光掠影式的天文统计方法介绍，开开眼界，对我更重要；

D. 我很迷茫，不知道概率统计有多大用，老师说了算；

E. 以上都不好，我的想法是……（混点学分/晚上无聊/跟我女神来的）