## Probability and Random Processes ECS 315

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6.2 Independence


Office Hours:<br>BKD 3601-7<br>Monday 14:00-16:00<br>Wednesday 14:40-16:00

## Sally Clark


[http://www.sallyclark.org.uk/]
[http://en.wikipedia.org/wiki/Sally_Clark] [http://www.timesonline.co.uk/tol/comment/obituaries/article1533755.ece]

## Sally Clark

- Falsely accused of the murder of her two sons.
- Clark's first son died suddenly within a few weeks of his birth in 1996.
- After her second son died in a similar manner, she was arrested in 1998 and tried for the murder of both sons.
- The case went to appeal, but the convictions and sentences were confirmed in 2000.
- Released in 2003 by Court of Appeal
- Wrongfully imprisoned for more than 3 years
- Never fully recovered from the effects of this appalling miscarriage of justice.


## Misuse of statistics in the courts

- Her prosecution was controversial due to statistical evidence
- This evidence was presented by a medical expert witness Professor Sir Roy Meadow,

- Meadow testified that the frequency of sudden infant death syndrome (SIDS, or "cot death") in families having some of the characteristics of the defendant's family is 1 in 8500 .
- He went on to square this figure to obtain a value of 1 in 73 million for the frequency of two cases of SIDS in such a family.


## Royal Statistical Society

- "This approach is, in general, statistically invalid."
- "It would only be valid if SIDS cases arose independently within families, an assumption that would need to be justified empirically."
- "There may well be unknown genetic or environmental factors that predispose families to SIDS, so that a second case within the family becomes much more likely."


## Engineering Ethics: IEEE Code of Ethics

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

1. to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;
2. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;
3. to be honest and realistic in stating claims or estimates based on available data;
4. to reject bribery in all its forms;
5. to improve the understanding of technology; its appropriate application, and potential consequences;
6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;
7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;
8. to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin;
9. to avoid injuring others, their property, reputation, or employment by false or malicious action;
10. to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

## Epilogue

- Clark's release in January 2003 prompted the Attorney General to order a review of hundreds of other cases.
- Two other women convicted of murdering their children had their convictions overturned and were released from prison.
- Trupti Patel, who was also accused of murdering her three children, was acquitted in June 2003.
- In each case, Roy Meadow had testified about the unlikelihood of multiple cot deaths in a single family.


## How Juries Are Fooled by Statistics

- By Peter Donnelly


Professor of Statistical
Science (Dept Statistics) at University of Oxford
(a) 11:15-13:50 Disease Testing
(a) 13:50-18:30 Sally Clark

## Prosecutor's Fallacy

- Aside from its invalidity, figures such as the 1 in 73 million are very easily misinterpreted.
- Some press reports at the time stated that this was the chance that the deaths of Sally Clark's two children were accidental.
- This (mis-)interpretation is a serious error of logic known as the Prosecutor's Fallacy.
- The jury needs to weigh up two competing explanations for the babies' deaths: 1) SIDS or 2) murder.
- Two deaths by SIDS or two murders are each quite unlikely, but one has apparently happened in this case.
- What matters is the relative likelihood of the deaths under each explanation, not just how unlikely they are under one explanation (in this case SIDS, according to the evidence as presented).


## Probability and Random Processes ECS 315

## Asst. Prof. Dr. Prapun Suksompong

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6.3 Bernoulli Trials


Office Hours:
Rangsit Library:
Tuesday 16:20-17:20
BKD3601-7:
Thursday 16:00-17:00

## Elements of digital commu. sys.



## System considered



## The ASCII Coded Character Set



## Example: ASCII Encoder

| Character | Codeword |
| :---: | :---: |
| $\vdots$ |  |
| E | 1000101 |
| $\vdots$ | 1001100 |
| L |  |
| $\vdots$ | 1001111 |
| O |  |
| $\vdots$ | 1010110 |
| V |  |

## MATLAB:

```
>> M = 'LOVE';
>> X = dec2bin(M,7);
>> X = reshape(X',1,numel(X))
X =
1001100100111110101101000101
```



## Example: ASCII Encoder and BSC



## System considered



## Results

THE WIZARD OF OZ (1900)
written by L. Frank Baum

Introduction

Folklore, legends, myths and fairy tales have followed childhood through the ages, for every healthy youngster has a wholesome and instinctive love for stories fantastic, marvelous and manifestly unreal. The winged fairies of Grimm and Andersen have brought more happiness to childish hearts than all other human creations.
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## Results

```
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```


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- The whole book which is saved in the file "OZ.txt" has 207760 characters
(symbols).
- The ASCII encoded string has $207760 \times 7=1454320$ bits .
- The channel corrupts 14545 bits.
- This corresponds to 14108 erroneous characters (symbols).


## Results

```
>> ErrorProbabilityoverBSC
biterror =
    14545
BER =
    0.010001237691842
theoretical_BER =
    0.0100000000000000
symerrror =
            14108
SER =
    0.067905275317674
theoretical_SER =
    0.067934652093010
```


$\frac{14108}{207760} \approx 0.0679$

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$$
1-(1-p)^{7}
$$

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A character (symbol) is successfully recovered if and only if none of its bits are corrupted.

## Crossover probability and readability

When the first novel of the series, Harry Potter and the Philosopher's Stone (published in some countries as Harry Potter and the Sorcerer's Stone), opens, it is apparent that some significant event has taken place in the wizarding world--an event so very remarkable, even the Muggles notice signs of it. The full background to this event and to the person of Harry Potter is only revealed gradually through the series. After the introductory chapter, the book leaps forward to a time shortly before Harry Potter's eleventh birthday, and it is at this point that his magical background begins to be revealed.

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$$
p=0.01 \quad P(E) \approx 0.07
$$

## English Redundancy: Ex. 1

J-st tr- t-r--d th-s s-nt-nc-.

## English Redundancy: Ex. 2

yxx cxn xndxrstxnd whxt x xm wrxtxng xvxn xf x rxplxcx xll thx vxwxls wxth xn 'x' ( t gts lttl hrdr fy dn't vn kn whr th vwls r).


## English Redundancy: Ex. 3

To be, or xxx xx xx , xxxx $x$ x $x x$ x $x x x x x x x$

## Crossover probability and readability

w(en th $\%$ birst .ovo, 'of the serieq, Hcrry Potter(and the Phidosop 'er's Suone (xub|ishe\$(in some! Countries as @arry Potter and t'e Snr\#erer's S|ong)- opens, it is apparent thatsoee smgfificant erent ha3 taieN place in the wizardino world-, an event!so very remarkable, even thE Eugglds notiae qigns of it. Tledfull back'tound to this event ane to the perron of Harry Popter is onl $\{$ reveqned gsadeally thro $\} \mathrm{gH}$ th $\% \$$ serias. After the int2oducpory chcptur, the 0 jook deaps forward to"a!tmme shmrtly befosE Harry"Potter's eleventh jirthdiy cnd ht is a ${ }^{\log } \mathrm{i} 3$ po\{nt tHat @ is mAgiial background begijs to rm rerealed.

$$
p=0.02 \quad P(E) \approx 0.13
$$

Whethe first nOwgl nf the susi-Q-@Harr\} PoutEr(and |he PhilosoxhEr's Ctonepuclyshed in som \% coultries as Harrx @ $\square$ tter and the S_rcermr7s Spone), opdns, id is apparent that \{omg'signifikant evmnt ias taKen!Placa in tHe 7ijardIng world--an event so Very remaroqble, eve.!thE MugglaC fotice signc of"it. Uhe full backf2ound'to thas even | ant'0o the pEssoj of @arry Qotteb iw only revealed gradu!lly vhvoug` the rerier. Afte2 the IndRoductori chaptar, t'e book leats ForwaRf tc a 4 imE shostl= before! Hcssy potter's u|Eveoth $\$$ firthdA \{, and iT is ad this pomNt uhav 'ir magica, back'bound cegins to bE 2evealed.

$$
p=0.03 \quad P(E) \approx 0.19
$$

## Crossover probability and readability

When phe fir $\square$ vokval ov"th\% serie3, @ 'rry0Pntter efdxtxe Thil $\square_{\text {soph }}$ \%rs Stone0(p $\}$ blisjed!in $\{$ ooe c $\square$ un |pye \{ agav0y Potter aj’ (the sorcerer"s S4o|e) < opdns- mt"Is!apParEnt 4hat somu siwnidiga.v evant iAs take."plhge in(uhe w)zard)ng wo \{ | d--An event so very Rumar \{ablel eteN0Dhe \%ugcles $\$ n \square$ t)ce signs of $\$$ At. Tje!\&ul|!backep/und Dk thkw `event ajt(to vhd per \{On of8Ikxry P_Pter is oN,y rereAeud gredualli 4hroufh5ie qeriesn Af|ir the )~trofUctkry!ciapter, \$tle r\%ok lE'ps for $\square$ erd8to!a d)hg 3Hostly redobd HArry(Potter/r elavent(birpl\%ay) ${ }^{2}$ )nd(iD i3 1 t tlis hohlt vhat iis $\$$ iagical bac+ gropnd bedans to bg rEve!ied/

$$
p=0.05 \quad P(E) \approx 0.30
$$

Whef th\% \&i2sv nkvdl"On(txE"serm-s< HaRtY Qo|p\%R\$anlthe Phi\$)qop8gb'rYtoNe (puclirhed in23/ee c $\square$ uNpr9es aZ Harby!PovDdZ qnd0THA!Uorojev's Qpof'), $\square$ pegsL iT isOaqazenP Tiet ' \{nle sau*!fICQ $\sim t$ eve.t' xA\# raken pOqb\%\%)D \} Hm 'wizprdYjv"wOrnd--a~\%W\%Jv s' tury 2 maskABdd \$ 'eden(tl| LuxGxec`nOtike c)gzq of kt Tiu!f5mm"cackG@ \(\square\) Ud(to"vhhQ a~aNd alt tn0vid veRckn of HaRvq\$Xntter\#isxohk \{ regea,ed@\&saduadLy u(2otGh"tau griEs."AfTex0T`g mntr $\square$ DUCt $\square$ ry kh 'ter, $\$$ thd(fomN0j' apv ngrwarTt-0c t,me" 1 xortly bEemsL |ar2q Pnfter'3 aMen-n5i@Fipth\$'q, aoh It i3d1t piac0pmhnP d*if Zas mafibin"je\#k7poUndpb\%dirg tk 'be qe6e!lgd.

$$
p=0.10 \quad P(E) \approx 0.52
$$

## BER vs. SER




