

Running Monte Carlo Markov Chains on NZ Crime Statistics

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For Computational Statistics project
2011

Overview

Questions...

- Is ethnicity and resolution independent for drug related crimes in NZ?

The Algebraic Method

Intro 2

- We run a Monte Carlo Markov Chain (MCMC) starting from the observed table.

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- We walk to tables which have the same row and column sums as the observed table.
- We can calculate how different each table we walk to is from the expected table.
- We count what proportion of tables are more unlikely to occur than the observed table.

The data sets I looked at

Intro 3

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- Drugs - Cannabis.

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- Drugs - Cannabis.
- Drugs - Not Cannabis. (LSD, depressents, "other")

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- Drugs - Cannabis.
- Drugs - Not Cannabis. (LSD, depressents, "other")
- Drugs - New Drugs (Methamphetamine, Amphetamine)

Conditions on Contingency Tables

Intro 5

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- Count data. Count of apprehensions
- Two categorical values. Ethnicity and resolution
- **Counts must be greater than 5**

Data

Cannabis

Table: Cannabis drug related convictions in NZ from 2009

Resolution	Caucasian	Maori	Asiatic	Indian	Other	Pacific Isle	Unknown
FGC	27	38	1	2	0	1	1
Other	128	78	6	5	6	12	3
Prosecution	8454	5603	123	101	124	526	112
Warned	2203	1348	28	36	43	92	57
Youth Aid	323	294	5	2	1	17	2

Data

Not Cannabis

Table: Non cannabis drug related convictions in NZ from 2009

Resolution	Caucasian	Maori	Asiatic	Indian	Other	Pacific Isle	Unknown
FGC	2	0	0	0	0	0	0
Other	22	9	5	1	5	2	1
Prosecution	850	416	124	18	46	55	7
Warned	122	45	19	3	14	9	4
Youth Aid	311	12	0	0	0	0	0

Data

New Drugs

Table: New drug related convictions in NZ from 2009

Resolution	Caucasian	Maori	Asiatic	Indian	Other	Pacific Isle	Unknown
FGC	1	0	0	0	0	0	0
Other	80	29	6	6	6	8	0
Prosecution	2079	1198	126	32	31	159	11
Warned	28	15	1	1	1	4	0
Youth Aid	5	3	0	0	0	0	0

summary of methods

- Randomly walk on observed table by proposing new tables from the table we are currently in using **Markov Bases**.
- For each proposed table decide if we will move to it or draw a new proposed table.
- We do not allow negative counts.

Markov Bases

Initial

NotCannabis	Asiatic	Caucasian	Indian	Maori	Other	TOT
FGC	0	2	0	0	0	2
Other	5	22	1	9	5	42
Prosecute	124	850	18	416	46	1454
Warning	19	122	3	45	14	203
Y.Aid	0	11	0	12	0	23
TOTAL	148	1007	22	482	65	1724

Move, Markov Base

NotCannabis	Asiatic	Caucasian	Indian	Maori	Other	TOT
FGC	0	0	0	0	0	0
Other	+1	0	0	-1	0	0
Prosecute	0	0	0	0	0	0
Warning	-1	0	0	+1	0	0
Y.Aid	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0

Proposed Table

NotCannabis	Asiatic	Caucasian	Indian	Maori	Other	TOT
FGC	0	2	0	0	0	2
Other	6	22	1	8	5	42
Prosecute	124	850	18	416	46	1454
Warning	18	122	3	46	14	203
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TOTAL	148	1007	22	482	65	1724

To Accept the Proposed Table or Not

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To Accept the Proposed Table or Not

- Probability of going to proposed table (from current table)
- Draw random number between 0 and 1
- if the random number is less than the probability of the proposed table, accept proposed table
- otherwise reject and propose another table

Probability of Going to Proposed Table

- Two cells in proposed table will be +1
- multiply the proposed tables value at these points

Probability of Going to Proposed Table

- Two cells in proposed table will be $+1$
- multiply the proposed tables value at these points
- Two cells in proposed table will be -1
- divide the observed tables value at these points

Probability of moving to Proposed table

Initial

NotCannabis	Asiatic	Caucasian	Indian	Maori	Other	TOT
Other	5	22	1	9	14	42
Warning	19	122	3	45	14	203

Proposed Table

NotCannabis	Asiatic	Caucasian	Indian	Maori	Other	TOT
Other	6	22	1	8	14	42
Warning	18	122	3	46	14	203

- +1, proposed table values **6** and **46**
- -1, observed table values **19** and **9**

$$\frac{6 * 46}{19/9} = 0.6196$$

- **Prob Move is 0.6196**

Is the table extreme or not?

- The expected table is constant as the row and column totals are the same for all tables.
- Chi square statistic calculated for each accepted proposed table.
- Chi square statistic calculated for observed table.
- percentage proposed tables with chi square statistic larger than the observed tables chi square statistic gives P-value

- only for 2009 data

- only for 2009 data
- combined gender

- only for 2009 data
- combined gender
- combined districts

- only for 2009 data
- combined gender
- combined districts
- combined age groups

Introduction

Data

Using MCMC to randomly walk on observed table

Calculating if observed table is extreme

Results and Discussion

Data

Whats up???

Summary

Results...

BurnIn 5000, 10000

ThinOut 1000

NumSam 10000

Results...

BurnIn 5000, 10000

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Drug Cannabis p-val 0.000004

Results...

BurnIn 5000, 10000

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Drug Cannabis p-val 0.000004

Drug Not Cannabis p-val 0.0917

Results...

BurnIn 5000, 10000

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Drug Cannabis p-val 0.000004

Drug Not Cannabis p-val 0.0917

Drug New Drugs p-val 0.0834

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Youth Aid	323	294	5	2	1	17	2

Results - Caucasian, Maori all Resolutions

BurnIn 5000

ThinOut 1000

NumSam 10000

Table: Non Cannabis drug related convictions in NZ from 2009 for Maori and Caucasian

Resolution	Caucasion	Maori
FGC	2	0
Other	22	9
Proseccion	850	416
Warning	122	45
Youth Aid	11	12

Results - Caucasian, Maori all Resolutions

BurnIn 5000

ThinOut 1000

NumSam 10000

Table: Non Cannabis drug related convictions in NZ from 2009 for Maori and Caucasian

Resolution	Caucasion	Maori
FGC	2	0
Other	22	9
Prosection	850	416
Warning	122	45
Youth Aid	11	12

Drug Cannabis p-val 0.000008

Results - Caucasian, Maori all Resolutions

BurnIn 5000

ThinOut 1000

NumSam 10000

Table: Non Cannabis drug related convictions in NZ from 2009 for Maori and Caucasian

Resolution	Caucasion	Maori
FGC	2	0
Other	22	9
Prosection	850	416
Warning	122	45
Youth Aid	11	12

Drug Cannabis p-val 0.000008

Drug Not Cannabis p-val 0.0943

Results - Caucasian, Maori all Resolutions

BurnIn 5000

ThinOut 1000

NumSam 10000

Table: Non Cannabis drug related convictions in NZ from 2009 for Maori and Caucasian

Resolution	Caucasian	Maori
FGC	2	0
Other	22	9
Prosecution	850	416
Warning	122	45
Youth Aid	11	12

Drug Cannabis p-val 0.000008

Drug Not Cannabis p-val 0.0943

Drug New Drugs p-val 0.25229

Results - Caucasian, Maori, Other, Prosecute, Warning, Other

BurnIn 5000

ThinOut 1000

NumSam 10000

Table: Non Cannabis drug related convictions in NZ from 2009.

Resolution	Caucasion	Maori	Other
Prosecution	850	416	250
Warning	122	45	49
Other	35	21	14

Results - Caucasian, Maori, Other, Prosecute, Warning, Other

BurnIn 5000

ThinOut 1000

NumSam 10000

Table: Non Cannabis drug related convictions in NZ from 2009.

Resolution	Caucasion	Maori	Other
Prosecution	850	416	250
Warning	122	45	49
Other	35	21	14

Drug Cannabis p-val 0.0006

Results - Caucasian, Maori, Other, Prosecute, Warning, Other

BurnIn 5000

ThinOut 1000

NumSam 10000

Table: Non Cannabis drug related convictions in NZ from 2009.

Resolution	Caucasion	Maori	Other
Prosecution	850	416	250
Warning	122	45	49
Other	35	21	14

Drug Cannabis p-val 0.0006

Drug Not Cannabis p-val 0.0808

Results - Caucasian, Maori, Other, Prosecute, Warning, Other

BurnIn 5000

ThinOut 1000

NumSam 10000

Table: Non Cannabis drug related convictions in NZ from 2009.

Resolution	Caucasion	Maori	Other
Prosecution	850	416	250
Warning	122	45	49
Other	35	21	14

Drug Cannabis p-val 0.0006

Drug Not Cannabis p-val 0.0808

Drug New Drugs p-val 0.0051

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Multiple Testing

- As we are running multiple tests on the same database we would expect 5% of the tests we run to be significant at the 5% level.
- Bonferroni-corrected alpha for 9 tests at the 5% significance level is $1 - (1 - 0.05)^{(1/9)} = 0.0057$.
- All of the cannabis tests and one of the new drugs tests are still significant at the 0.0057 level.

Where is the difference?

Cannabis

Observed
Cannabis data

Resolution	Caucasian	Maori	Other
Prosecution	8454	5603	986
Warning	2203	1348	256
Other	478	410	64

Where is the difference?

Cannabis

Observed
Cannabis data

Resolution	Caucasian	Maori	Other
Prosecution	8454	5603	986
Warning	2203	1348	256
Other	478	410	64

Expected
Cannabis Data

Resolution	Caucasian	Maori	Other
Prosecution	8459	5592	992
Warning	2141	1415	251
Other	535	354	63

Where is the difference?

NewDrugs

Observed
New Drugs
data

Resolution	Caucasian	Maori	Other
Prosecution	2079	1198	359
Warning	28	15	7
Other	86	32	26

Where is the difference?

NewDrugs

Observed
New Drugs
data

Resolution	Caucasian	Maori	Other
Prosecution	2079	1198	359
Warning	28	15	7
Other	86	32	26

Expected
New Drugs
Data

Resolution	Caucasian	Maori	Other
Prosecution	2082	1182	372
Warning	29	16	5
Other	82	47	15

Summary

Answers

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- Is ethnicity and resolution independent for drug related crimes in NZ?
- What happens when we include age in the analysis?
- Is there a difference between males and females?
- Do different years have different results?
- Do different parts of NZ have different results?

Thanks

Thanks to

Raazesh Sainudiin and Paul Brouwers who helped with this project.

Questions? Comments?