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$$z_i = \quad ^{-} (\quad _6(\quad _i) \qquad ($$

w $_6$ i s h e t

g r $_i$ s

d i s t

u n i n f

T h e

p e a k

i n f e

t

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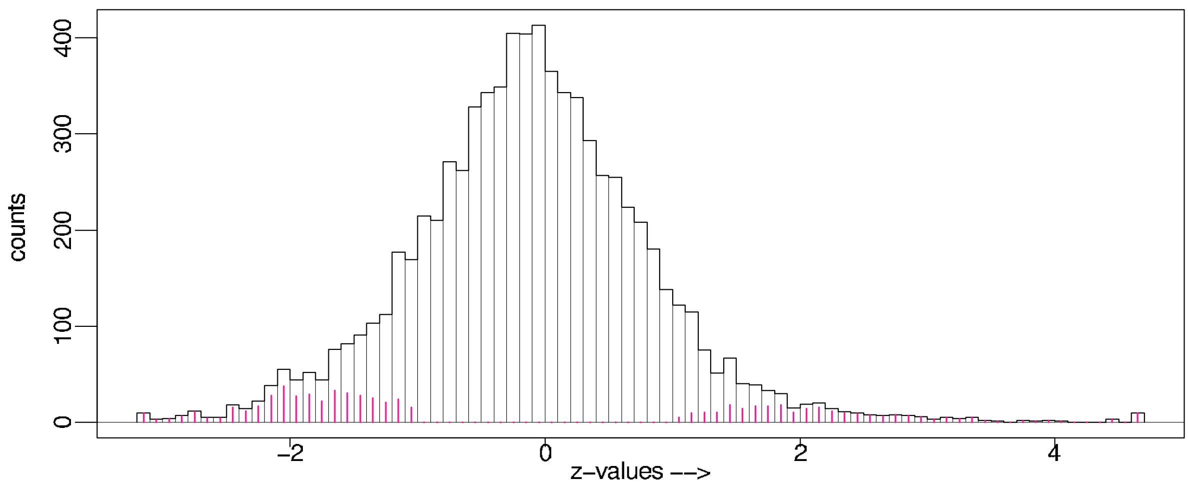

F
bar *s ar*
values have been tr *uncated,*
(2003), discussed in G

c a n g
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I n o
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S e c
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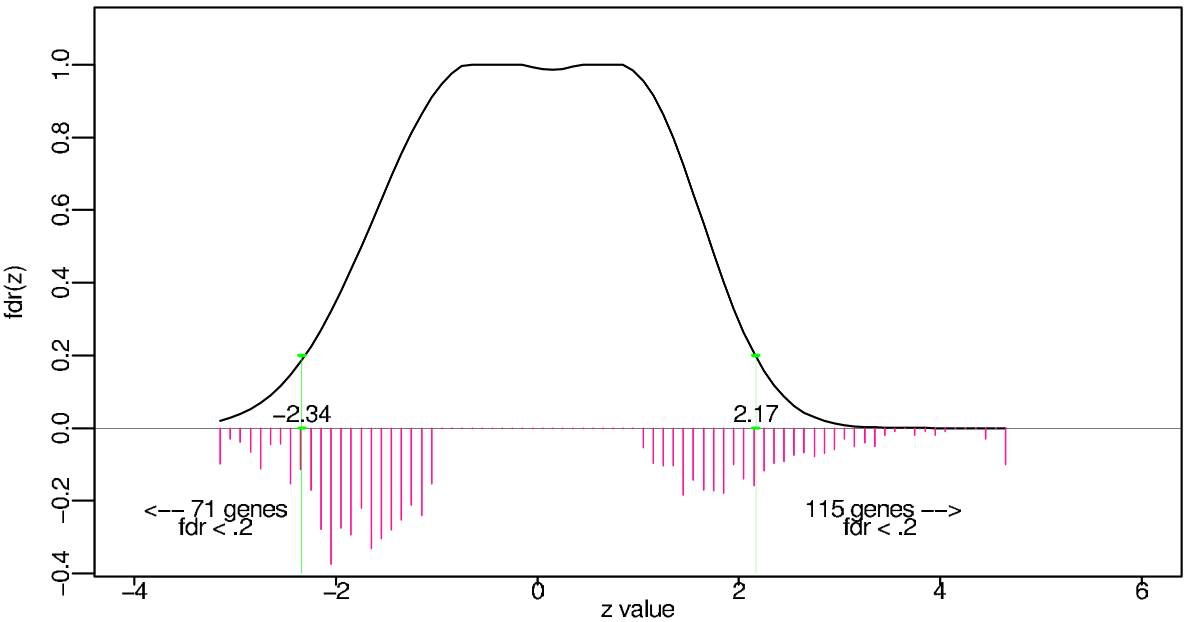

F
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fr *om F*

o f i t
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F d r
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2 . F

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S u p p o
s t
N $_1$, $_2$, u$_i$, $_N$ H . l . (. l
T $_1$, $_2$, $_i$, $_N$ z . e. .

N m u s $_i$ n e
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o r $_0$ o $_1$ = $_0p$ r a

s t

$$p_0 = \quad {}_0(\qquad\qquad ($$
$$p_1 = \quad {}_1($$

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p o s
$f_1($ ${}_0$ v

, $$p_0 \geq \qquad ($$

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$$f_0^+(\quad {}_0 f_0(\qquad ($$

a n d t

$$f \quad {}_0 f_0(\quad {}_1 f_1(\qquad ($$

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T h e
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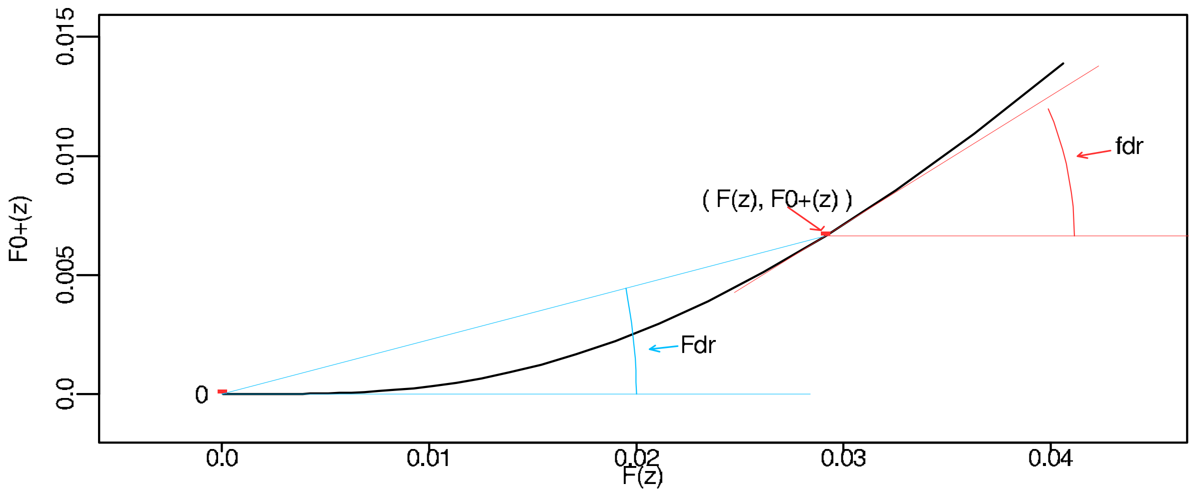
d ${}_0^+($ ${}_0 F_0($ e ${}_0 F_0($ ${}_1 F_1($ fi
c a s

$$F \quad d \ {}_0^+(\quad r$$

(
a r
b e t

B e
w h e
d i s
c o r
a g i v
F d r

$$F \quad \int_{-}^{z} f \quad d \int_{-}^{z} f \quad r \qquad (\quad d$$
$$= \ {}_f\{f \qquad d$$



F $_0^+($
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" $_f$" E i n d i
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$F_1($ $_0($ $^{\alpha}$, [(α

i t

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r r

g i v
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m o r
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A ny c h
l i s
f $_i$) d r
p r
s i t
t
F a l s
t
i n $_i$' d s e
e s
“ o n e
p o $_i$ g s i v

3 . E s

T h e
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t
c e
C o m p
a n $_0^+$(d d e

3 . 1 E

N o n p a
s i t
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c i e

S u p $_1$,p$_2$, $_K$ s o y .
T h e
t $_k$ t

$$y_k^{i} \sim (\quad _k)^{n} \qquad d \qquad ($$

w $_k$ p r i (” $_k$) t o f

$$\nu_k = \quad (\,) \quad _k \quad) \qquad ($$

M $_k$) (om $_k$) a d
P o i s
e s

$$f \qquad \left\{ \sum_{j}^{7} \beta_j z^j \right\} \qquad ($$

=

($_1$, $_2$, $_7$) β $_0$.f . . r
d $\widehat{f}$ e d n r o
w i t
d e v
h a d l i
D $_i$’ s $_k$’ s
b u t
i n S e
A v
p a r
A l l i s
s m o o
e t
t
c l o s
e s

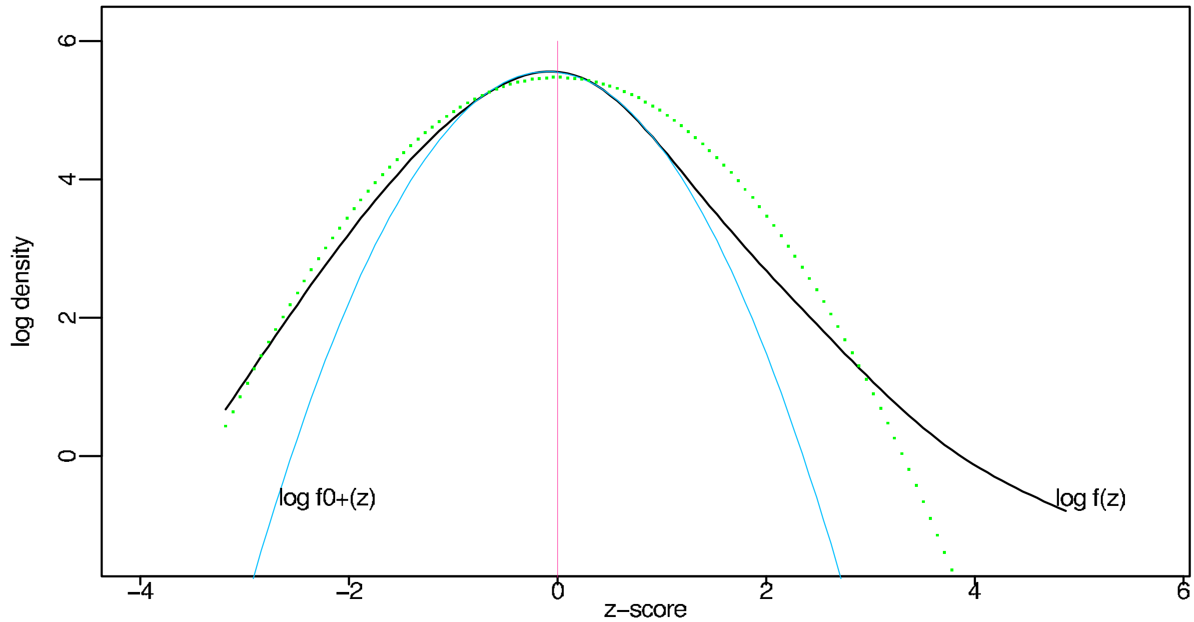
3.2 E $_0^+$(

T $_0^+$($_0 f_0$(h e
t $_0$(
v $_0$(
t
empir *ical null,*
a n d $_0^+$(w
T $\widehat{f}$ h e
t $\widehat{f}$
a r $\widehat{f}_0^+$($_0^+$. T

t $\widehat{f}_0^+($ $_0 =$
a $,\widehat{f}_0 \sim$ $^2)$ 0 − d . 7 4

$$, \quad . \quad \widehat{f}_0(\quad _7 \quad - \quad (\quad _4 \left[\varphi_\delta \quad (\quad \left\{-\frac{1}{2}\left(\frac{z \quad \delta}{\sigma}\right)^2\right\}\Big/\sqrt{2 \quad ^2}\right]. \quad \pi$$

T h$\widehat{f}$ e
o v



F $_0^+($ $_0 f_0($
cur $\widehat{f}$ *ve is* $\log$ $\widehat{f}_0^+($ *of P*
. *best-fitting quadr* 1 $\widehat{f}$ 0 $_0 =$ $\widehat{f}_0 \sim$ $^2)$ 0 *atic to* 1 −
D $\widehat{f}_0^+$ *for* *otted cur* *the*

T h e
o f $_0,$ F δ i
q
a p p l $_0($ i
t $_0$ (, $_1$ $_0$ i $_0^+ =$ $_0 f_0$ r n f
t
T h e $_0$ a
f_1. S o m e
a s s
w $_i =$ $_6(\, _i)$ i t
n e $_0,$ a t r

n e $_0$ e a r x
w i l l
s o m e
T $_0$ *is* a ff h e
S e c

T $_0 \sim$ h 0 e ,
v $_0$ n e
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t $_0 =$

T h e
s u b s
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n u m b e
t
d e n o

M i s
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M o r
a 7 6 8 0
C h u r
c a n b
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l i t
b e c
p e r $^2)$

F i $_0$ ig su r
i t
c i r $_0$;
i n c l

T h e
i n t $\widehat{f}$
e $\widehat{f}_0^+$, x y
0 . 2 4 .
w i l l
u p n e

4 . E s

T lf e

z_1, $_2$, $_N$. z . H . o . w ,

f f o r d

T h e

a r f $_0$, $\widehat{f}_0$,

a $\widehat{f}$ n d ,

i s d

B e

$$z_i^{\text{i}} \sim \quad _i, \quad ^{\text{n}} \qquad \begin{cases} \mu_i = \quad \mu \quad 1 \quad ^{\text{d}} \\ \mu_i \sim \end{cases} \qquad) \quad 3 \qquad (\qquad ,$$

f o r

e $_i$' a s c

N (f

l F o d g r $\widehat{f}$ $\widehat{f}_0^+$ t $\widehat{F}$ $\widehat{F}_0^+$

f o r

T h e

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0 . 4 5 f d

m F r d r

w i t

I n p

c o r

t

s a m $\sqrt{N}$ .p

T h e

b o r

b u t

E f

t

m o d e

5 r f d

T a F b d l

a r f d

$\widehat{F}$ $\bar{F}$

s e

H o c $\bar{F}$

t F d r

p o w e

P o i f

a F n d d r s

S e (, ^{2} (, ^{7}) (k k) z) k . c) $_0$ b .
K $_0$ m a m $_0^+$) t $_0$ h (, ^{2}(a) k k) z)
e $_0$ = $_0$ i m s ′ f p i

L $\widehat{f}_0^+($ $\widehat{f}$ $_0$ b *ocfdr* i $_0$"
d e $_0$, fi

$$\widetilde{X} \quad {}_0, \qquad \widetilde{X}_0 = \quad {}_0[\ {}_0, \quad] \qquad \mathbf{i} \ ] \ (\ a$$

o $_0\times$ f $_0\times$ $_0$. m m A d l i

$$\widehat{G} \quad ' \text{ d} \qquad \widetilde{G}_0 = \widetilde{X}_0'\widetilde{X}_0, \qquad a \ =$$ g

w h e_k = $\widehat{f}$ ( ) k
i n (

F $\widehat{\ell}$ i m $\widehat{\ell}_k$ = $\widehat{f}$ ( ) a $\widehat{\ell}_0^+$ f k) l
($\widehat{f}_0^+$(( ) $\widehat{\ell}$ k k f $\widehat{f}$) ( ) k) o d r

L $\widehat{\text{f}}$ **e** d

$$\left(\frac{d \quad\quad k}{d \quad \ell}\right) = \quad \widehat{G}^- \ X', \qquad\qquad ($$

w h e

$$X \qquad A = \quad {}_0\widetilde{G}_0^- \ \widetilde{X}_0'\widetilde{X} \qquad\qquad ($$

P r
$d\widehat{\ell}$ $\widehat{\ell}$

$$d\widehat{\ell} \qquad \widehat{G}^- \ X'd \qquad\qquad ($$

S $\widehat{\ell}_0^+ =$ $_0$ ^ i $_0$- m $\widetilde{\ell}$ i $\widehat{\ell}$ $_0$] l ,

$$d \qquad \widetilde{G}_0^- \ \widetilde{X}_0' d\widetilde{\ell} \qquad\qquad \widehat{\ell}_0^+ = \quad {}_0\widetilde{G}_0^- \ \widetilde{X}_0' d\widetilde{\ell}$$

B $\widetilde{\ell}$ $\widehat{\ell}$ $_0$]
$\widetilde{X}\widehat{G}^- \ X'd$

$$d\widehat{\ell}_0^+ = \quad {}_0\widetilde{G}_0^- \ \widetilde{X}_0'\widetilde{X}\widehat{G}^- \ X'd \qquad\qquad ($$

f r

$$d \ \widehat{\ell \quad X} \qquad \widehat{\ell}_0^+ - \widehat{\ell} \qquad {}_0\widehat{G}_0^- \ \widetilde{X}_0'\widetilde{X} \qquad \widehat{G}^- \ X'd$$

v

T h $\widehat{\ell}$ e
a s

$$\widehat{c} \quad \widehat{\ell} \qquad \widehat{G}^- \ X') \qquad \widehat{G}^- \ X')' \qquad o \qquad (\qquad v$$
$$= \quad \widehat{G}^- \ X') \qquad \widehat{G}^- \ X')',$$

1 1

u n d $\widehat{G}$ ′ d e i a =
s i m p

T he f ( ) $_k$)

$$c \; (\quad \widehat{G}^{-} A \qquad (\; o$$

w i t

T h e
e r
d f e d v r

A f ℓ $_k$ = F o ( )

$$c \; \ell \quad \widehat{G}^{-} B', \qquad (\; o$$

$$B \quad \widehat{S}_0 X_0 \widetilde{G}_0^{-} \; \widetilde{X}_0' \widetilde{X} \quad \widehat{S} \qquad (X$$

w F $\widehat{S}_0$ a $\widehat{S}$ h d n e ar d r

$$\widehat{S}_k = \frac{\widehat{f}_\ell}{\widehat{F}_k} \; a \quad \widehat{S}_0 = \frac{\widehat{f}_0}{\widehat{F}_0} \; f \; n \quad \ell \; \ell \; k \qquad d$$

C o m p
1 f : F d d r r
t
t
c a l c

T a b l
m a $_0$, t δ $_0$ i s
f $_0$ = r f $_0 \widehat{f}_0($ $\widehat{f}$
o n l y
s e
n e n t
H o w $_0$ a c e
d i s c

T h e $\widehat{\delta}$
a n d $_0$ o f F n d
“ k
s t

F f o r d r

$$l \; f \quad {}_0 + \; g\widehat{f}_0(\quad \widehat{f} \quad g \quad d$$

a l l f o w
e m p i

		T		H
z	$\widehat{\text{f}}$		td	r
N	=			
1		.	5	.
2		.	0	.
2		.	5	.
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3		.	5	.
4		.	0	.
N	=			
1		.	5	.
2		.	0	.
2		.	5	.
3		.	0	.
3		.	5	.
4		.	0	.
N	=			
1		.	5	.
2		.	0	.
2		.	5	.
3		.	0	.
3		.	5	.
4		.	0	.

T a bl
s $\widehat{\text{f}}$ $\widehat{\text{Ft}}$ dl
($\widehat{\text{f}}$ $\widehat{\text{f}}$ d
o v
f o r

p_0	δ	(0	t	h
N =				
N =				
[	f	[	o	
N =				

T a bl
r $_0$, δ $_0$ e
B r

t $\widehat{f}_0($ $_0$ a n
r f d
a s $\widehat{f}_0($ $\widehat{f}$ s
p_0 e f x d r

S t
$\widehat{\theta}$ $_0, \widehat{\delta}$

$$D = \begin{pmatrix} 1 & \widehat{\delta} & {}^2 + \widehat{\delta}^2 \\ 0 & {}^2 & 2\widehat{\delta} \quad {}^2 \\ 0 & & {}^3 \end{pmatrix} \widetilde{G}_0^{-} \; \widetilde{X}_0' \widetilde{X} \quad 0$$

i n t

$$c \; \widehat{\theta} \quad \widehat{G}^{-} \; D' - \begin{pmatrix} \frac{1}{N} & 0 & \\ 0 & & \\ 0 & & \end{pmatrix}, \quad \begin{matrix} & 0 & \\ 0 & o & 0 \\ 0 & & 0 \end{matrix}$$

t
1 5 0 0 ,
v

S i m p $_0)$ l
u s i

$$v \quad {}_0\} = \; {}_0^{-} \; \widehat{G}^{-} \; {}^{-\prime}_0 - \frac{1}{N}, \qquad x \quad ($$

w $_0$ i s $\widetilde{X}_0$. h e t

F o r
e $_0, \widehat{\delta}$ m p $_i$' i
l i k
P o i s
e x $_i \sim$ $_i,$ n
a s i $_i$'
f o r

O
a v
a s (
b o o t
m a t
a b l y
m i c r
n o t
a r
a n a f l y

5 . P o w

T h e
t
c a n a
d i f s d
e a s
d e p e

T h e

$$f_1^+(\quad {}_1 f_1($$

t
g $_1^+($ r $_1 =$ $_0 p$

$$p_1 = \int_-^\infty f_1^+(\quad \int_-^\infty (\qquad f$$

s o t

$$f_1(\quad \int_-^\infty (\quad ') \quad ') \quad '. \qquad f$$

P $_1($ o w $_1($
p o r

T h $_1.$ e R
($_k$ i n (, $\widehat{K}_k = \widehat{f}$ h $_k$)) l $_k$ i
f $_k$ = f ( ) $\widehat{f}$ $_k$ f) d d r rd
g i v

$$\widehat{}_1 = \sum_k^K (\quad \widehat{f}_k) \widehat{f}_k = \quad {}_0 \widehat{} \qquad {}_1 \qquad (\qquad d$$

a n d

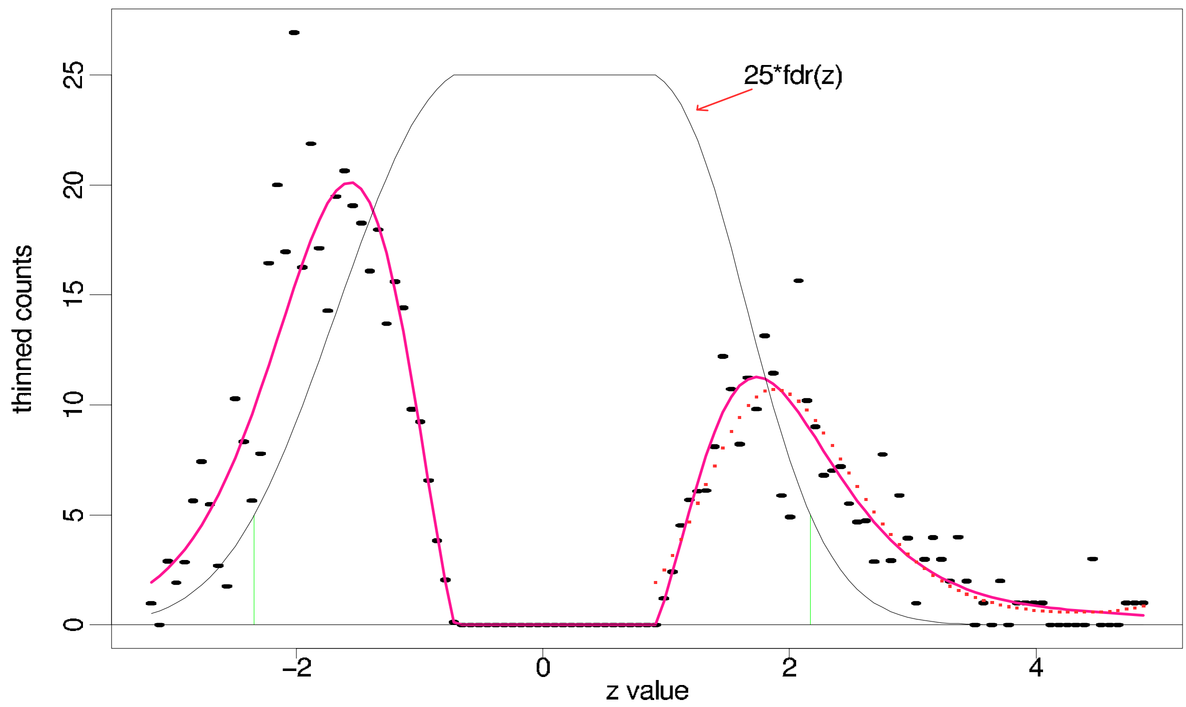
$$\widehat{f}_1 \equiv \widehat{f}_1(\, (\,) \quad {}_k \quad \widehat{f}_k) \widehat{f}_k / \; {}_1,) \qquad ($$

T h $_1$" e i
e t
w a s $_i$"
m a f x d
i s a

P $\widehat{f}_1($ f w
t f $_1$, E $_1$, s p d r f r a

$$\widehat{E} \quad \sum_k^K \widehat{f}_k \widehat{f}_1 \qquad {}_k \qquad {}_1 \qquad f \qquad d$$

$$= \sum_k^K \widehat{f}_k (\quad \widehat{f}_k) \widehat{f}_k / \sum_k^K (\quad \widehat{f}_k) \widehat{f}_k, \qquad {}_1 \qquad d \qquad d \qquad {}_1$$



F $\widehat{f}_1($

study; light cur $\widehat{f}$ d *ve pr*

dotted, has been fit dir *ectly to*

the expected non-null false discover $\widehat{E}_1,$ s

a t

T $\widehat{E}_1$' s a f b l

f $\widehat{E}_1,$ a a v f v

7 e $\widehat{E}_1$ v x $\widehat{E}_1$ v f

w e r

p e r

e m

$\hat{}_1$ $\widehat{E}_1$ $\hat{}_1$ $\widehat{E}_1$ f

m e a

s t

c o e

T **a** $_1$ a $\widehat{E}_1$ f **bl** n

N =

O $\widehat{E}_1$ e f q

n u l l)

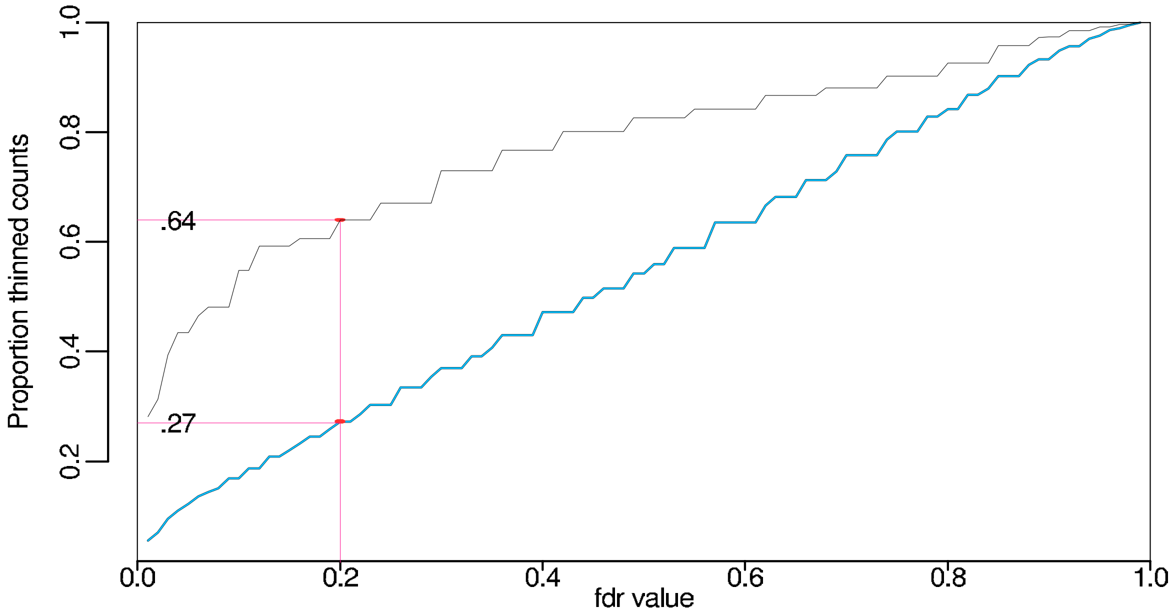
e $\widehat{f}$ x d

T 1, c h e o
b y
($\widehat{E}_1$ = e $\widehat{E}$ r i = f g h f f_t
w i l l
O $\widehat{f}$ $\widehat{f}_1$ a r d
$\widehat{E}_1$, f f o

$$\widehat{S}_1 = \left[\sum_{k}^{K} \widehat{f}_k^{\,2} \cdot {}_1 \;\; d\widehat{E}_1^{\,2} \right]^1 , \; k \quad / \quad 2 \quad (\quad d$$

w h i i' c s
b i a s
G $\widehat{f}$ $\widehat{f}_1$ i T
i $\widehat{f}_1$ c $\widehat{f}$ F i d d g f

$$\widehat{G} \quad \sum_{\hat{f}_k \leq} \widehat{f}_1 \Big/ \sum_{k}^{K} \widehat{f}_1 \, . \quad k \quad k \quad ((\quad 1 \quad d$$



F $\widehat{f}$ $\widehat{f}_1$. *H* d *ea*
H *I*
displays gr $\widehat{E}_1$, *equals 0.45 for* f *eater*

F $\widehat{G}$ o r (
l e s
s $\widehat{G}$ e (

T h e
[1] r f $\widehat{G}^{-}$ (
e t
T h e
c $_k$ a s o u n
y_1 = f $_k$) $_{k\,k}$. (d
S $_k$ i i s n c f $_1$ i $_k$ t s
u n b i a
t
T r
e x
t
a n s

$$z_i \sim \quad {}_i, \ {}^2_0) \quad \mu \quad \sigma \quad ($$

t $_i$ h $_i$, a i s $^2_0$, t
$\mu_i =$
W e i
w $_i$ i h s i c

$$\widetilde{\ }_i = \sum_j^c z_i \,/\sqrt{c} \quad \sqrt{c} \quad {}_i, \ {}^2_0) \quad \sigma \quad (\quad {}_j \quad =$$

T h $_i \sim$ $^2_0$) i 0 s ,
n o n $\sqrt{c}$ -
C o n s
a ^{2}) n d v
m e a n

$$Z \quad {}^2) \quad {}^2 + \ {}^2_0) \quad \sim \quad A, \ ($$

a c $\widetilde{Z}$ c ”

$$\widetilde{Z} \quad \widetilde{A}, \widetilde{B}^2) \quad \sqrt{c} \quad {}^2 + \ {}^2_0) \sim \quad ($$

C o m p

$$\widetilde{Z} \quad \sqrt{c} \quad {}^2 = = \quad {}^2_0/ \ {}^2] \quad A + \ ($$

g $\widetilde{Z}$ i t v
F r

$$\widehat{A} = \frac{\sum z_{(} \ y_1}{\sum y_1} = \quad {}^k \ {}_k \ {}^k \ \widehat{B}) \quad \left[\frac{\sum z^2_{(} \ y_1}{\sum y_1} - \widehat{A}^2 \right]^{\frac{1}{2}} = {}^k_k \ {}^k \ )$$

t (> k) $_0$ =
h o $_i$' w s t
s i $_k$ m $_1$ i $_k$ i
t

T $\widehat{\mathrm{E}}_1$, (a b f l
1 , 1 . 5
w $\widehat{\mathrm{E}}_1$ f o f ru l
e r
a r
f a s

T h e
t $_1$; $_k$ t

$$y_1 \text{ i} \sim (\quad _1)^{\text{n}} \quad _k \quad _k \quad \text{d} \quad ($$

f $_1$) $_k$ (o , $_k$) r s

$$(\quad _1) \quad _1\beta \quad _k \quad ($$

w $_1$ a $_1$ × $_1$ s K m_1 i i s t $_1$ tt
o $_1$ = f p a

\# S u b
$\widehat{\mathrm{E}}_1$: **0** f.

T a $\widehat{\mathrm{E}}_1$, f f **bl**
s $\widehat{\mathrm{E}}_1$ f t

T $\widehat{\beta}$ h e

$$\widehat{G}_1^- = \quad '_1 \text{ d} \quad _1) \quad _1)^- . \quad \text{i}_k \quad (\text{ a}$$

H o w $_1$ = $\widehat{\mathrm{f}}$ $_k$) $_{kk}$ h e
v $_k$) $_1$, $_k$ l $_1$ a $_k$e s
a c c

$$\widehat{\mathrm{C}} \quad \widehat{\beta} \quad \widehat{G}_1^- [\quad '_1 \text{ d} \quad \widehat{\mathrm{f}} \quad _k) \quad _1) X_1 \text{i})^- \quad \widehat{G}_1^- , \quad _k\text{o} \quad \text{a} \quad \text{v}$$

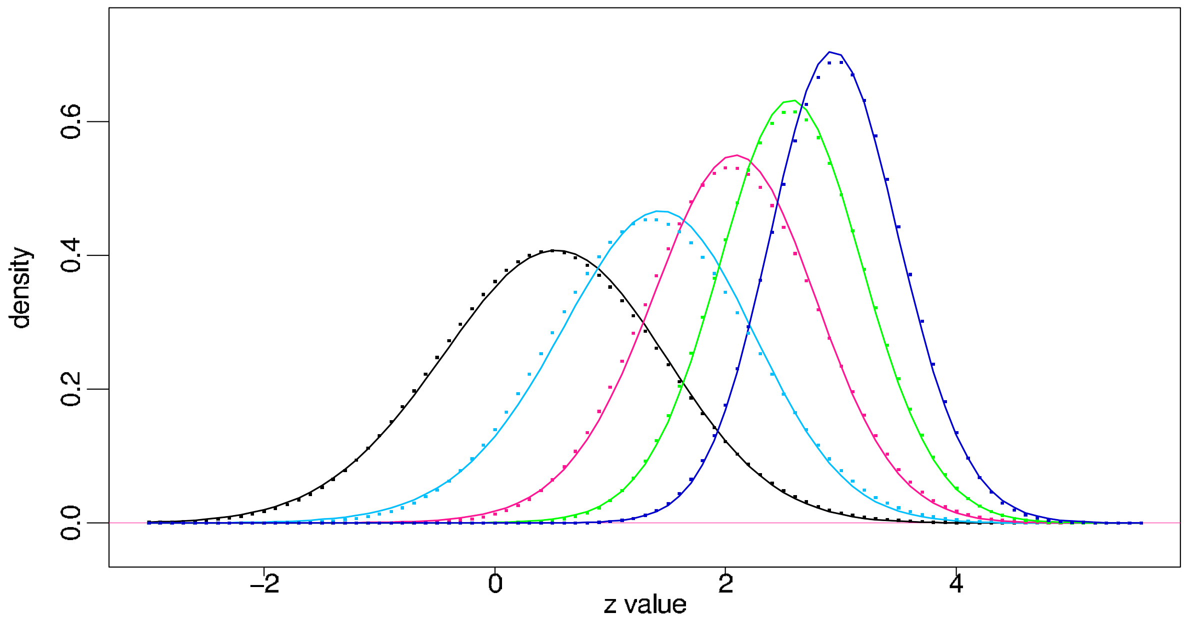
E $\widehat{f}_1$ d i s r
g l o b a
m o d e
n o $\widehat{f}_1$ w $_1$ i $_k$ r $_k$ n i (t

6 . T he

A k
v
o f z
, σ Z $^2_\mu)$. (

w h e
r $^-$)
1 σ_μ · $+$ $^{-\frac{1}{2}})$
a w e
F i g u $_i$ h r
n o n c

N ($t_i \sim \dfrac{\theta}{S^1}$ [/ $_2$ W $^2_\nu/$



F $_i$ *is non-centr*
non-centr *ality par*
2.96; stdevs 0.98, 0.88, 0.75, 0.65, 0.58. D

B $_i \sim$ 0 , y 1
w e
o $_i =$ $^-$ ($_6($ $_i)$ f $_\mu$ d e z
θ

R
t $_0$: θ $\widehat{\theta}$ $_\theta$,

Z $^-$ ($_0(\widehat{\theta}$ $=$ (

2 0

W $\widehat{\theta}$ e a s
a n o t
a p p r

$$\widehat{\theta} \quad {}_{\theta}/ \quad {}_{\theta}/\sqrt{n} \quad {}_{\theta}/\sqrt{n} \quad {}_{\theta}/$$

B_{θ}, ${}_{\theta}$, ${}_{\theta}$, ${}_{\theta}$ a C D a r n d E

F o l l o
i n $\widehat{\phi}$ $\widehat{\theta}$ c r

$$\widehat{\phi} \quad {}_{0}) \qquad ($$

w ${}_{0}$, i t t
o ${}^{-\frac{1}{2}})$ r $\widehat{\phi}$ ${}_{0}$, $\widehat{\phi}$ ${}_{0}$ 1.) T

$$Z \quad {}_{0}) \quad \cdot \quad {}^{2})$$

(${}_{0} =$ $-$)

$$\sigma_{\mu} = \qquad ($$

T h ${}_{\mu}$ d ${}_{0}$ e= e
d e $\dot{\ell}_0)$ $\dot{\ell}_0$ a r t

A s a

$$y_1, \; {}_2, \; {}_n \overset{\text{i}}{\sim} \; {}_1 \; [{}^{\text{n}} \; y_1 < \; {}^{-}] P^{\text{d}} \; . \quad r, \quad .$$

s $\widehat{\theta}$ ${}_n/$ o t
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$$\left.\frac{d \; {}_{\mu}}{d}\right|_{\theta_0} = \qquad ($$

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$$f \quad \int_{-}^{\infty} \varphi \quad \Big[\varphi \quad {}^{-\frac{1}{2}x^2} / \sqrt{2} \Big], \quad \pi$$

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$$f \quad \int_{-}^{\infty} \varphi \quad\quad ($$

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$$\ell^{(} \; (\quad \frac{d^j 1 \quad {}^j}{d \quad {}^j} \Big|_{z} \quad ._{=} \quad o \quad\quad (\quad g_0 \quad)$$

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N $\int_-^\infty e^z$ d[μ tφ
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$$\frac{d^j m}{d^{\ j}}|_z \equiv \int_-^\infty \mu^j \frac{\varphi}{f} d \qquad 0$$

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gr f $\frac{1}{2}z^2 -$
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$$p_0 = \Big[\int_-^\infty f_0^+(\Big]^- . \qquad) \quad ($$

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f r

$$\text{f} \quad \frac{f}{f} e^{E_0 z \ \bar{V}_0 z^2 / \ _0 z^3/2}, \quad 6 \quad + \quad \text{d}($$

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p_0:	$\sqrt{2}$ $\sqrt{2}$ $E_0^2/$	f $\pi^2\sqrt{\frac{2}{\bar{V}_0}}$ $e^{E_0^2/\pi\bar{V}_0}$	2 π
$f_0($	$_0,$	$_0/\bar{V}_0,$ $\bar{V}_0)$ 1	1)
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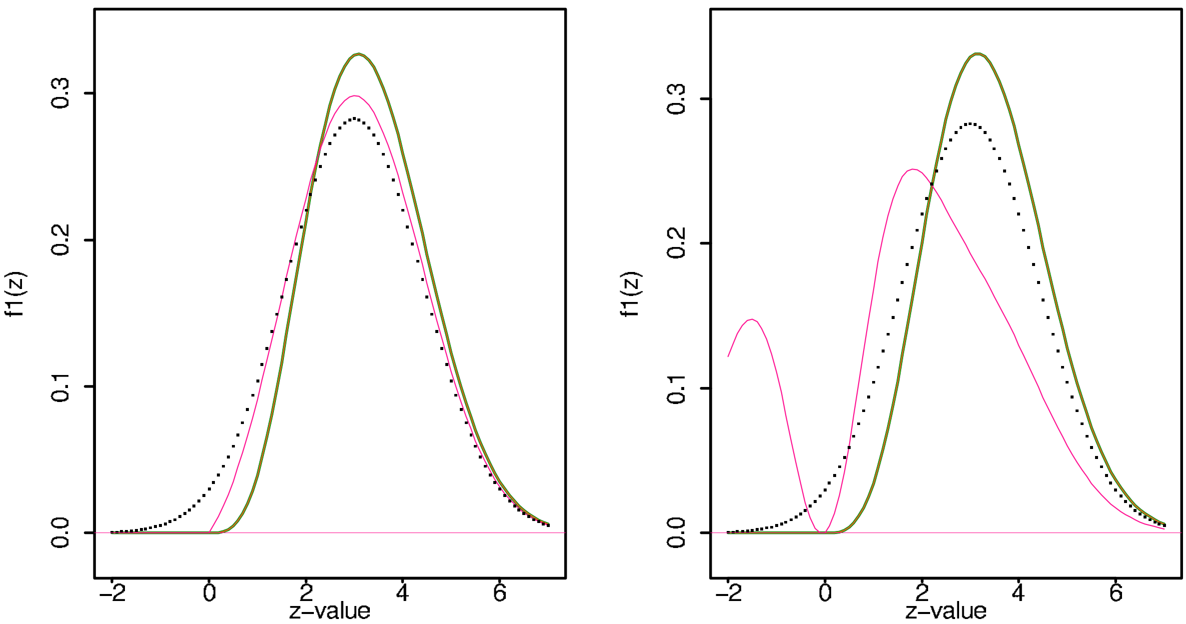

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(7.13); R *ight panel model (7.14).*

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