Analysing QDA data with SensoMineR

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Characterizing products from both univariate and multivariate points of view: how to obtain an automatic description of the products and confidence ellipses around products.

The data

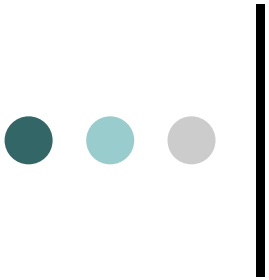
- 6 chocolates
- 12 panelists
- 14 descriptors
- 1 replication

The data table

Session	Panelist	Rank	Product	CocoaA	MilkA	CocoaF	MilkF	Caramel	Vanilla
1	1	1	choc6	7	6	6	5	5	3
1	1	2	choc4	8	5	4	4	4	4
1	1	3	choc2	8	6	5	4	7	4
1	1	4	choc5	7	5	3	5	6	2
1	1	5	choc1	7	8	8	3	3	2
1	1	6	choc3	6	7	2	7	8	4
1	2	1	choc4	6	1	8	1	0	0
1	2	2	choc5	4	1	7	1	0	0
1	2	3	choc6	5	1	8	1	0	0
1	2	4	choc3	4	2	3	4	0	0
1	2	5	choc2	5	2	8	1	0	0
1	2	6	choc1	6	1	8	0	0	0
1	3	1	choc2	8	1	6	2	6	1
1	3	2	choc6	5	6	5	3	3	2
1	3	3	choc1	8	2	8	1	3	1
1	3	4	choc4	6	1	5	0	5	2
1	3	5	choc3	5	3	2	9	6	7
1	3	6	choc5	7	2	7	3	6	3
1	4	1	choc1	9	2	9	1	6	0

How to obtain an automatic description of the products…

- …when considered as a whole
  - What are the sensory descriptors that best characterize my set of products (F-test)?
- …when taken one by one
  - What are the main sensory features of each product (t-test)?



Let's say we want to analyze the data right after the first session

AoV model: Sticky~Product + Panelist

```
$Ftest
            Sum Sq  Df      CM F value    Pr(>F)
Product     102.84   5 20.568  5.0467  0.000183 ***
Panelist    890.28  28 31.796  7.8014 < 2.2e-16 ***
Residuals 1279.74 314  4.076
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

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Residuals 1279.74 314  4.076
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Products are different according to the sensory descriptor « Sticky »

AoV model: Acidity~Product + Panelist

```
$Ftest
           Sum Sq  Df      CM F value    Pr(>F)
Product    325.01   5 65.003 17.1151 5.669e-15 ***
Panelist   916.72  28 32.740  8.6204 < 2.2e-16 ***
Residuals 1192.57 314  3.798
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Products are different according to the sensory descriptor « Acidity »

Summary for all the descriptors

```
resdecat$resF
                  Vtest      P-value
MilkF         16.399353 9.664309e-61
Bitterness    13.342729 6.529461e-41
Crunchy       12.661745 4.816702e-37
Caramel       11.531656 4.568473e-31
Sweetness     11.440951 1.305044e-30
Astringency    8.958706 1.642558e-19
Melting        8.414849 1.967006e-17
Acidity        7.723275 5.668927e-15
Vanilla        7.317675 1.261519e-13
Granular       4.370921 6.186172e-06
Sticky         3.563447 1.830085e-04
```

Summary for all the descriptors

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                Vtest      P-value
MilkF       16.399353 9.664309e-61
Bitterness  13.342729 6.529461e-41
Crunchy     12.661745 4.816702e-37
Caramel     11.531656 4.568473e-31
Sweetness   11.440951 1.305044e-30
Astringency  8.958706 1.642558e-19
Melting      8.414849 1.967006e-17
Acidity      7.723275 5.668927e-15
Vanilla      7.317675 1.261519e-13
Granular     4.370921 6.186172e-06
Sticky       3.563447 1.830085e-04
```

P-value associated with the F-test of the product effet for each descriptor
P-value
0.0
0.2
0.4
0.6
0.8
1.0
MilkF
Bitterness
Crunchy
Caramel
Sweetness
Astringency
Melting
Acidity
Vanilla
Granular
Sticky

AoV model: Sticky~Product + Panelist

```
$Ttest
                     Estimate Std. Error    t value      Pr(>|t|)
(Intercept)       3.97988506  0.1082198 36.7759474 7.832145e-116
Product - choc1 -0.22126437  0.2419868 -0.9143655  3.612264e-01
Product - choc2 -0.15229885  0.2419868 -0.6293684  5.295655e-01
Product - choc3  1.05459770  0.2419868  4.3580796  1.779888e-05
Product - choc4  0.12356322  0.2419868  0.5106197  6.099762e-01
Product - choc5 -0.75574713  0.2419868 -3.1230925  1.956357e-03
Product - choc6 -0.04885057  0.2419868 -0.2018729  8.401468e-01
```

AoV model: Sticky~Product + Panelist

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Product - choc2 -0.15229885  0.2419868 -0.6293684  5.295655e-01
Product - choc3  1.05459770  0.2419868  4.3580796  1.779888e-05
Product - choc4  0.12356322  0.2419868  0.5106197  6.099762e-01
Product - choc5 -0.75574713  0.2419868 -3.1230925  1.956357e-03
Product - choc6 -0.04885057  0.2419868 -0.2018729  8.401468e-01
```

- The coefficient (estimated value: -0.75) associated with choc5 is significantly different from zero (p-value: 0.00195)
- The adjusted mean (estimated value: 3.22 =3.97-0.75) associated with choc5 is significantly different from the overall mean (estimated value: 3.97)

For the only product choc5

```
$resT$choc5
             Coeff Adjust mean     P-value     Vtest

Sticky  -0.7557471    3.224138 0.001956357 -3.096779
```

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- The adjusted mean (estimated value: 3.22 =3.97-0.75) associated with choc5 is significantly different from the overall mean (estimated value: 3.97)

AoV model: CocoaA~Product + Panelist

```
$Ttest
                  Estimate Std. Error     t value      Pr(>|t|)
(Intercept)     6.28735632 0.09051659 69.46081908 1.200398e-192
Product - choc1  0.79885057 0.20240124  3.94686595  9.775537e-05
Product - choc2  0.26436782 0.20240124  1.30615708  1.924551e-01
Product - choc3 -1.61494253 0.20240124 -7.97891605  2.790894e-14
Product - choc4 -0.02873563 0.20240124 -0.14197360  8.871919e-01
Product - choc5  0.50574713 0.20240124  2.49873528  1.297443e-02
Product - choc6  0.07471264 0.20240124  0.36913135  7.122786e-01
```

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(Intercept)      6.28735632 0.09051659 69.46081908 1.200398e-192
Product - choc1  0.79885057 0.20240124  3.94686595  9.775537e-05
Product - choc2  0.26436782 0.20240124  1.30615708  1.924551e-01
Product - choc3 -1.61494253 0.20240124 -7.97891605  2.790894e-14
Product - choc4 -0.02873563 0.20240124 -0.14197360  8.871919e-01
Product - choc5  0.50574713 0.20240124  2.49873528  1.297443e-02
Product - choc6  0.07471264 0.20240124  0.36913135  7.122786e-01
```

For the only product choc5

```
$resT$choc5
             Coeff Adjust mean     P-value     Vtest
CocoaA   0.5057471     6.793103 0.012974434  2.484470


Sticky  -0.7557471     3.224138 0.001956357 -3.096779
```

For the only product choc5

```
$resT$choc5
             Coeff Adjust mean     P-value      Vtest
CocoaA    0.5057471    6.793103 0.012974434  2.484470
Crunchy   0.5172414    6.637931 0.019580555  2.334290
CocoaF    0.4482759    6.793103 0.019958372  2.327130
Sticky   -0.7557471    3.224138 0.001956357 -3.096779
```

For the only product choc1

$resT$choc1

	Coeff	Adjust mean	P-value	Vtest
Bitterness	2.4568966	7.068966	2.519811e-23	9.950080
Astringency	1.6465517	4.758621	1.403971e-12	7.083659
Acidity	1.4798851	4.655172	8.212101e-10	6.140773
Vanilla	-0.9655172	1.103448	1.879676e-06	-4.765948
Caramel	-1.6810345	1.672414	2.820023e-12	-6.986413
Sweetness	-1.9454023	3.137931	1.120178e-16	-8.291300
MilkF	-1.8850575	1.568966	3.429035e-18	-8.696293

For the only product choc2

```
$resT$choc2
               Coeff Adjust mean      P-value     Vtest
Crunchy    1.5862069    7.706897 4.604927e-12  6.917251
Sweetness -0.4626437    4.620690 3.772958e-02 -2.077780
Caramel   -0.5775862    2.775862 1.296646e-02 -2.484689
Melting   -0.6235632    4.327586 9.609057e-03 -2.589589
MilkF     -1.0747126    2.379310 2.457818e-07 -5.160888
```

For the only product choc2

```
$resT$choc2
                Coeff Adjust mean      P-value     Vtest
Crunchy     1.5862069    7.706897 4.604927e-12  6.917251
Sweetness -0.4626437    4.620690 3.772958e-02 -2.077780
Caramel   -0.5775862    2.775862 1.296646e-02 -2.484689
Melting   -0.6235632    4.327586 9.609057e-03 -2.589589
MilkF     -1.0747126    2.379310 2.457818e-07 -5.160888
```

A summary of all that for all the products

	MilkF	Caramel	Vanilla	Sweetness	Acidity	Bitterness	Astringency	Crunchy	Melting	Sticky	Granular
choc1	1,57	1,67	1,10	3,14	4,66	7,07	4,76	5,97	4,74	3,76	3,45
choc2	**2,38**	**2,78**	1,81	**4,62**	3,14	4,95	3,16	**7,71**	**4,33**	3,83	3,16
choc3	7,71	6,33	3,67	7,60	1,57	1,40	1,21	2,98	7,31	5,03	1,60
choc4	2,59	2,67	2,12	4,29	3,93	5,19	3,69	6,10	4,38	4,10	3,55
choc5	3,12	3,41	1,79	5,22	3,09	4,88	3,10	6,64	4,74	3,22	3,07
choc6	3,36	3,26	1,91	5,62	2,67	4,19	2,76	7,33	4,21	3,93	3,17

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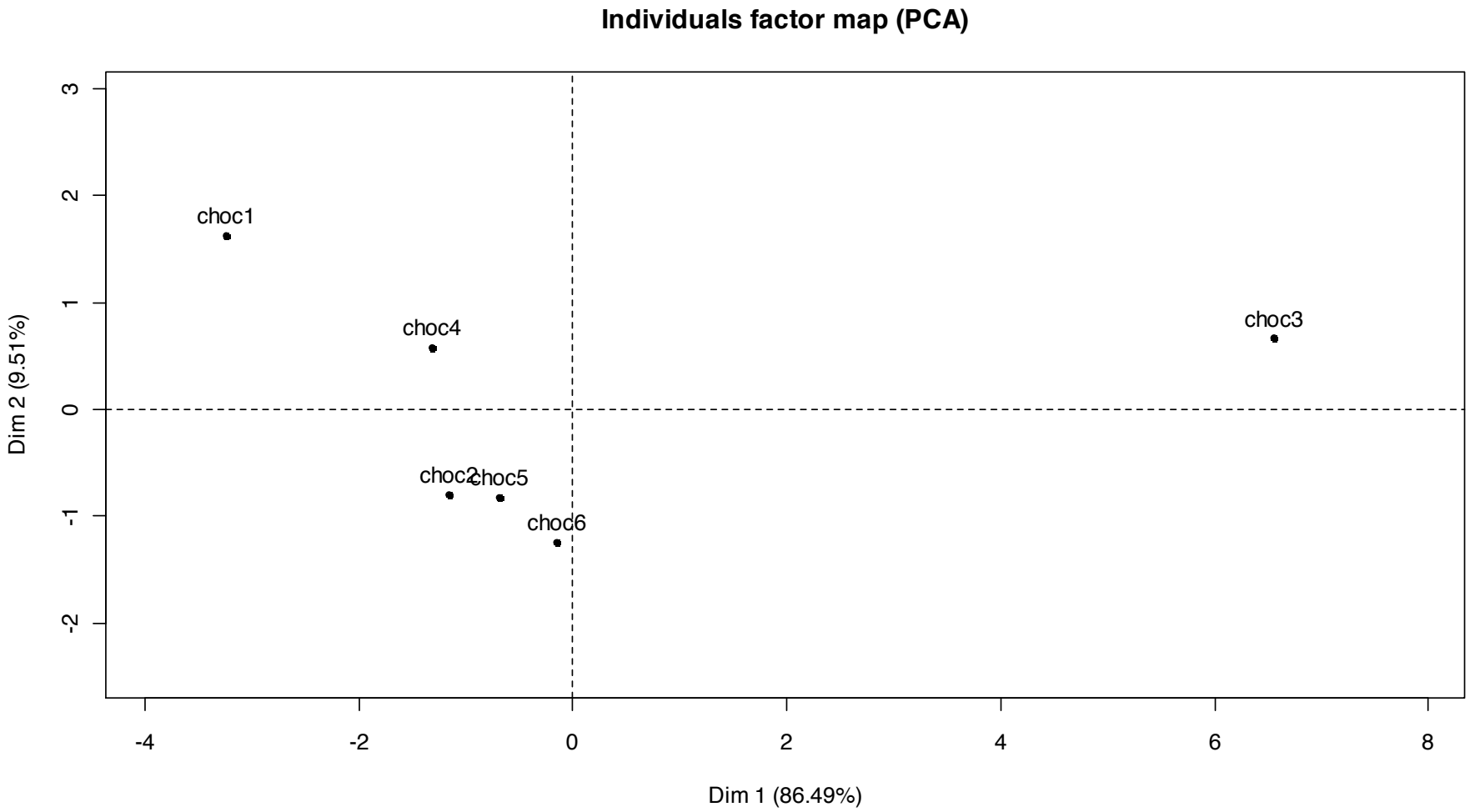
	MilkF	Caramel	Vanilla	Sweetness	Acidity	Bitterness	Astringency	Crunchy	Melting	Sticky	Granular
choc1	**1,57**	**1,67**	**1,10**	**3,14**	**4,66**	**7,07**	**4,76**	5,97	4,74	3,76	3,45
choc2	**2,38**	**2,78**	1,81	**4,62**	3,14	4,95	3,16	**7,71**	**4,33**	3,83	3,16
choc3	**7,71**	**6,33**	**3,67**	**7,60**	**1,57**	**1,40**	**1,21**	**2,98**	**7,31**	**5,03**	**1,60**
choc4	**2,59**	**2,67**	2,12	**4,29**	**3,93**	**5,19**	**3,69**	6,10	**4,38**	4,10	**3,55**
choc5	3,12	3,41	1,79	5,22	3,09	4,88	3,10	**6,64**	4,74	**3,22**	3,07
choc6	3,36	3,26	1,91	**5,62**	**2,67**	4,19	2,76	**7,33**	**4,21**	3,93	3,17

A summary of all that for all the products

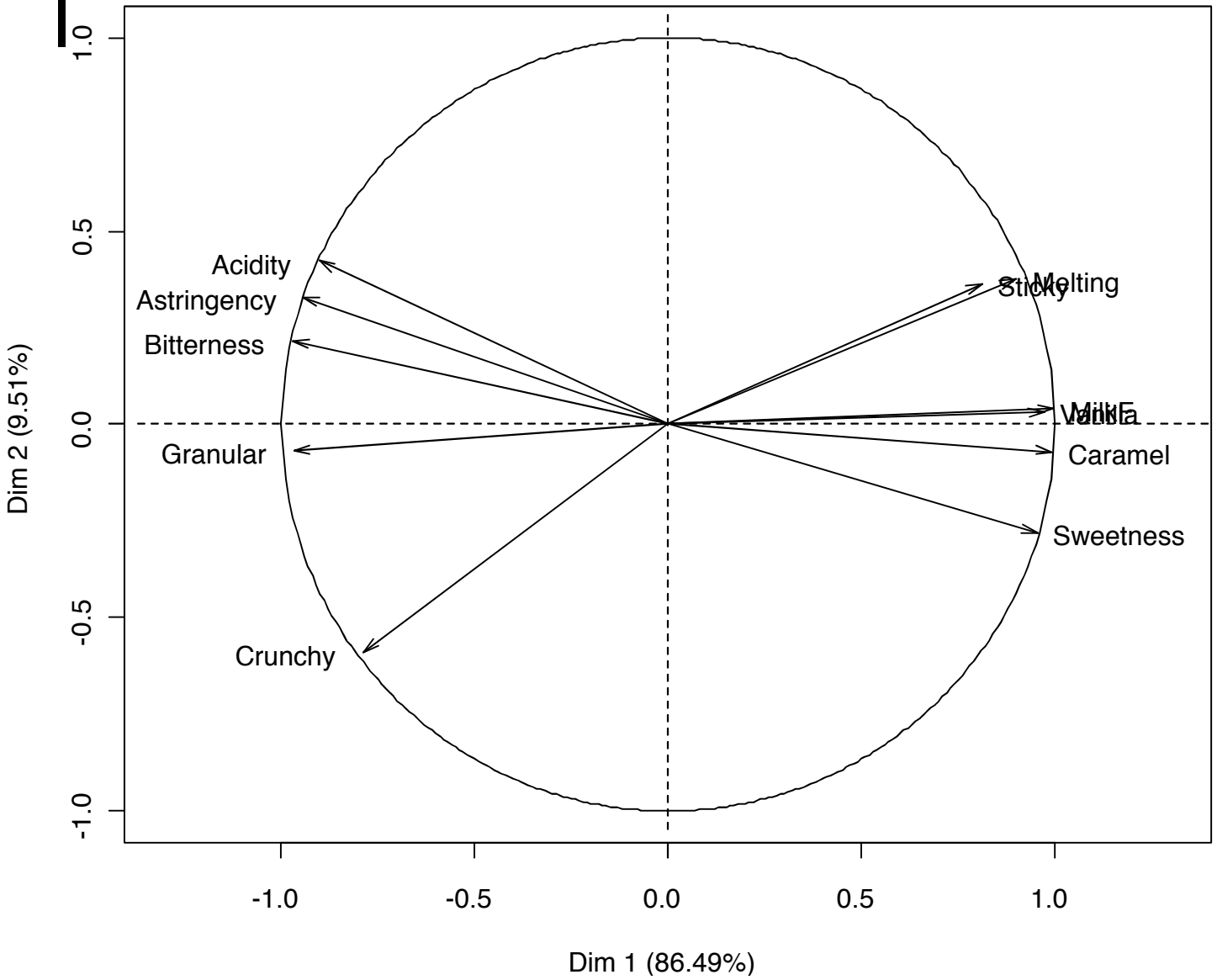


A summary of all that for all the products

	Dim 1	Dim 2
choc1	-3,25	1,62
choc2	-1,16	-0,80
choc3	6,56	0,66
choc4	-1,31	0,58
choc5	-0,68	-0,82
choc6	-0,16	-1,24

	Dim 1	Dim 2
choc1	-3,25	1,62
choc4	-1,31	0,58
choc2	-1,16	-0,80
choc5	-0,68	-0,82
choc6	-0,16	-1,24
choc3	6,56	0,66

A summary of all that for all the products



A summary of all that for all the products

	Dim 1	Dim 2
MilkF	1,00	0,04
Caramel	0,99	-0,07
Vanilla	0,97	0,03
Sweetness	0,95	-0,28
Acidity	-0,90	0,42
Bitterness	-0,97	0,22
Astringency	-0,94	0,33
Crunchy	-0,79	-0,59
Melting	0,90	0,38
Sticky	0,81	0,36
Granular	-0,97	-0,07

	Dim 1	Dim 2
Bitterness	-0,97	0,22
Granular	-0,97	-0,07
Astringency	-0,94	0,33
Acidity	-0,90	0,42
Crunchy	-0,79	-0,59
Sticky	0,81	0,36
Melting	0,90	0,38
Sweetness	0,95	-0,28
Vanilla	0,97	0,03
Caramel	0,99	-0,07
MilkF	1,00	0,04

Ajusted mean

	Bitterness	Granular	Astringency	Acidity	Crunchy	Sticky	Melting	Sweetness	Vanilla	Caramel	MilkF
choc1	7.069	3.448	4.759	4.655	5.966	3.759	4.741	3.138	1.103	1.672	1.569
choc4	5.19	3.552	3.69	3.931	6.103	4.103	4.379	4.293	2.121	2.672	2.586
choc2	4.948	3.155	3.155	3.138	7.707	3.828	4.328	4.621	1.81	2.776	2.379
choc5	4.879	3.069	3.103	3.086	6.638	3.224	4.741	5.224	1.793	3.414	3.121
choc6	4.19	3.172	2.759	2.672	7.328	3.931	4.207	5.621	1.914	3.259	3.362
choc3	1.397	1.603	1.207	1.569	2.983	5.034	7.31	7.603	3.672	6.328	7.707