



Sultan Qaboos University
College of Science
Department of Mathematical and Statistics

Predictors of Business Mathematics Grades

Muhammad Idrees Ahmad
Ontario International Development Agency
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Outline

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- Descriptive Analysis
- Ordinal Logistic Model
- Conclusion and Recommendation



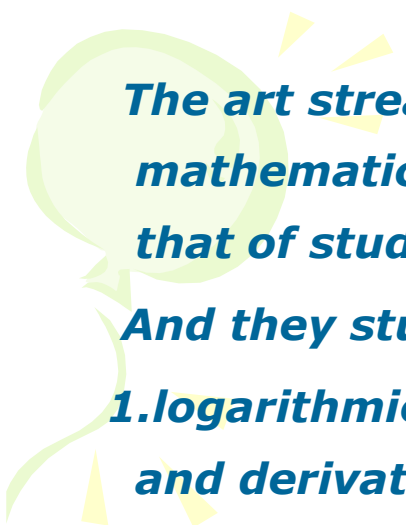
Introduction

The student of commerce and economics (art and science) must take at least two mathematics courses and two courses of statistics from department of mathematics and statistics in college of science.

The students who are science stream study two courses which are business Math I(Math1101) and business Math II(1102).

The art stream students study three courses which are Mathematics for College of Commerce and Economics I, Mathematics for College of Commerce and Economics II and Mathematics for College of Commerce and Economics III. And both (art and science) students study two courses of statistics which are business stat I and business stat II.

All courses are graded as: (A, A-, B+, B, B-, C+, C, C-, D+, D and F).

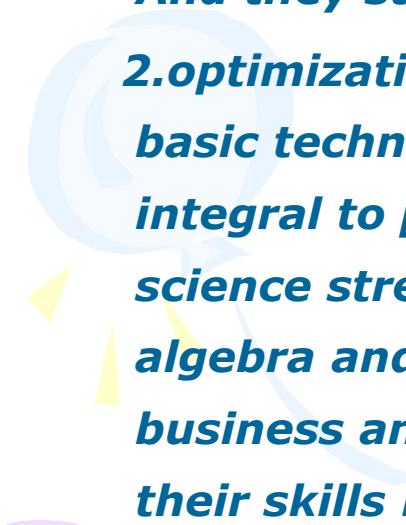


The art stream students study the first course to provide them with mathematics necessary to bring them up to a level comparable with that of students with science background

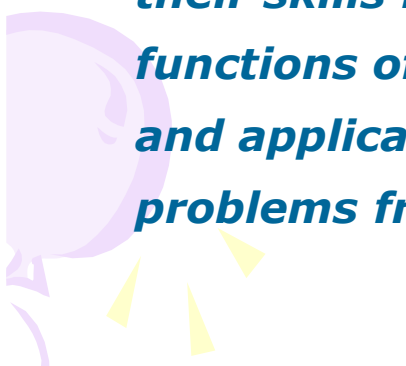
And they study the second course to introduce them to:

1. logarithmic and exponential functions, progressions, differentiation and derivatives,

And they study the third course to cover:



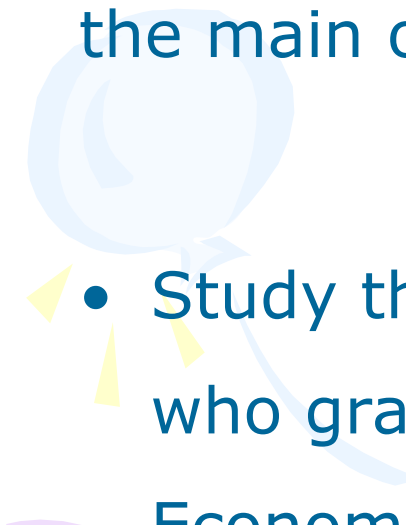
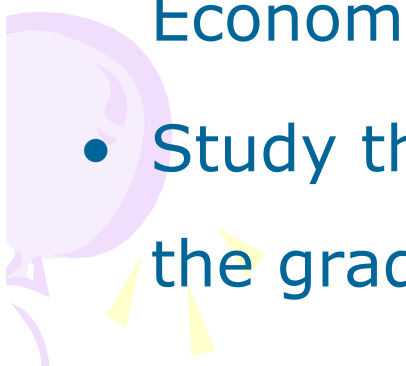
2. optimization techniques for functions of one and several variables, basic techniques of integration and the applications of the definite integral to problems from economics and social sciences. Whereas the science stream students study the first course to learn more about algebra and differential calculus and their applications to the fields of business and economics, then they study the second course to improve their skills in differential calculus, optimization techniques for functions of one and two variables, basic techniques of integration, and applications of differentiation and integration to various real life problems from economics and the social sciences.





Objective

In the present study we aim to apply a number of statistical approaches for the analysis of grades of students in Business Mathematics. Following are the main objectives:-

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- Study the grades of business math for students who graduated from the College of Commerce and Economics according to the cohort and gender.
 - Study the effect of high school percent marks on the grades in Mathematics

A decorative graphic on the left side of the slide features three balloons: a light green one at the top, a light blue one in the middle, and a light purple one at the bottom. Each balloon has a string and several small yellow triangular shapes radiating from it, resembling a sun or a burst of light.

Data

➤ We have taken the grades of all the students by gender who graduated from 2003 to 2008 from admission and registration files on the following variables:

- The percentages in high school.
- The grades of four mathematics courses



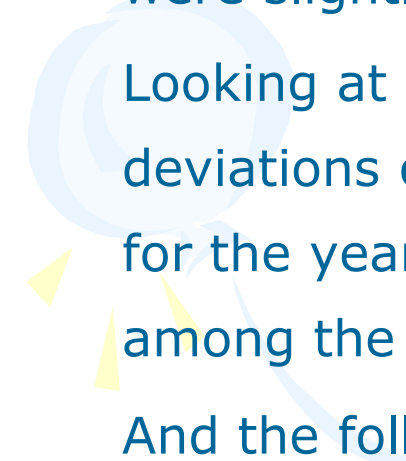
Summary statistic of high school percentages according to the year of graduation:

	min	Q1	median	Q3	max	mean	Std.deviation
2003	81.99	87.64	90.93	93.16	98.49	90.54	3.218413
2004	82.63	87.43	90.07	92.5	96.97	90.00	2.996468
2005	81.51	87.6	89.21	92.04	96.45	89.72	2.743791
2006	80.26	86.64	89.61	91.085	96.51	89.04	3.480046
2007	80.2	84.93	88.95	90.53	96.09	87.93	3.677436
2008	81.18	88.39	90.07	91.84	96.64	89.96	2.911714

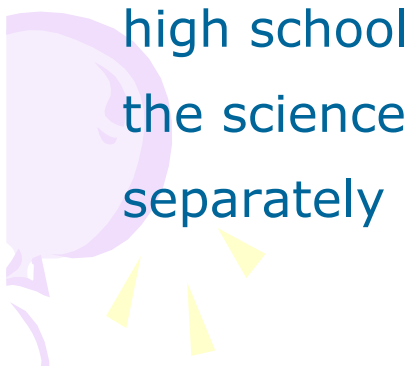


Summary Statistics of High School Percentage Marks

The highest median and mean were for the students graduated in 2003. The averages of high school percents of the six cohorts were slightly close.



Looking at the dispersion estimator we found the standard deviations of all percentage groups were mostly high especially for the year 2007 so this group has the highest volatility among the other groups.



And the following tables contain the descriptive statistics of the high school percentages according to the year of graduate for the science stream students and the arts stream students separately

Summary statistic of high school percentages according to the year of graduation for science stream students

	min	Q1	median	Q3	max	mean	Std.deviation
2003	83.42	87.7925	91.32	93.29	98.49	90.7649	3.218515
2004	82.63	87.63	90.53	92.76	96.97	90.33333	2.986219
2005	81.51	87.5525	89.01	92.04	96.45	89.63794	2.796328
2006	80.26	86.61	89.67	91.085	96.51	89.03346	3.510004
2007	80.2	84.8525	88.42	90.39	94.61	87.73747	3.599995
2008	81.18	88.36	89.74	91.78	96.05	89.7079	2.843601

Summary statistic of high school percentages according to the year of graduation for art stream students

	min	Q1	median	Q3	max	mean	Std.deviation
2003	81.99	87.29	89.79	91.07	93.86	89.23543	2.932166
2004	85.21	86.765	87.57	90.1075	95.71	88.49225	2.577263
2005	86.93	89.36	91.14	92.29	93	90.65105	1.872799
2006	88.29	88.3425	88.965	90.765	91.21	89.3575	1.330648
2007	87.73	88.9475	92.85	94.2975	96.09	92.03	2.941059
2008	88.2	90.935	93.125	94.1575	96.64	92.515	2.38391

Unconditional Probabilities

Course	Gender	A	A-	B+	B	B-	C+	C	C-	D+	D
MATH1062	Male	0.058	0.042	0.100	0.050	0.058	0.083	0.050	0.058	0.033	0.042
	Female	0.017	0.058	0.083	0.058	0.017	0.067	0.050	0.042	0.025	0.008
	Total	.075	.10	.18	.10	.075	.15	.10	.10	.058	.05
MATH1063	Male	0.033	0.042	0.067	0.042	0.050	0.100	0.050	0.075	0.050	0.067
	Female	0.000	0.017	0.058	0.058	0.025	0.075	0.075	0.042	0.017	0.058
	Total	.033	.058	.12	.10	.075	.17	.12	.11	.066	.12
MATH1101	Male	0.031	0.035	0.038	0.057	0.046	0.077	0.088	0.051	0.042	0.030
	Female	0.045	0.054	0.052	0.053	0.055	0.076	0.085	0.036	0.026	0.023
	Total	.075	.088	.090	.10	.10	.15	.17	.086	.067	.053
MATH1102	Male	0.029	0.045	0.035	0.035	0.046	0.061	0.061	0.061	0.044	0.038
	Female	0.048	0.043	0.055	0.079	0.055	0.055	0.057	0.047	0.038	.025
	Total	.076	.087	.090	.13	.10	.11	.13	.10	.082	.063



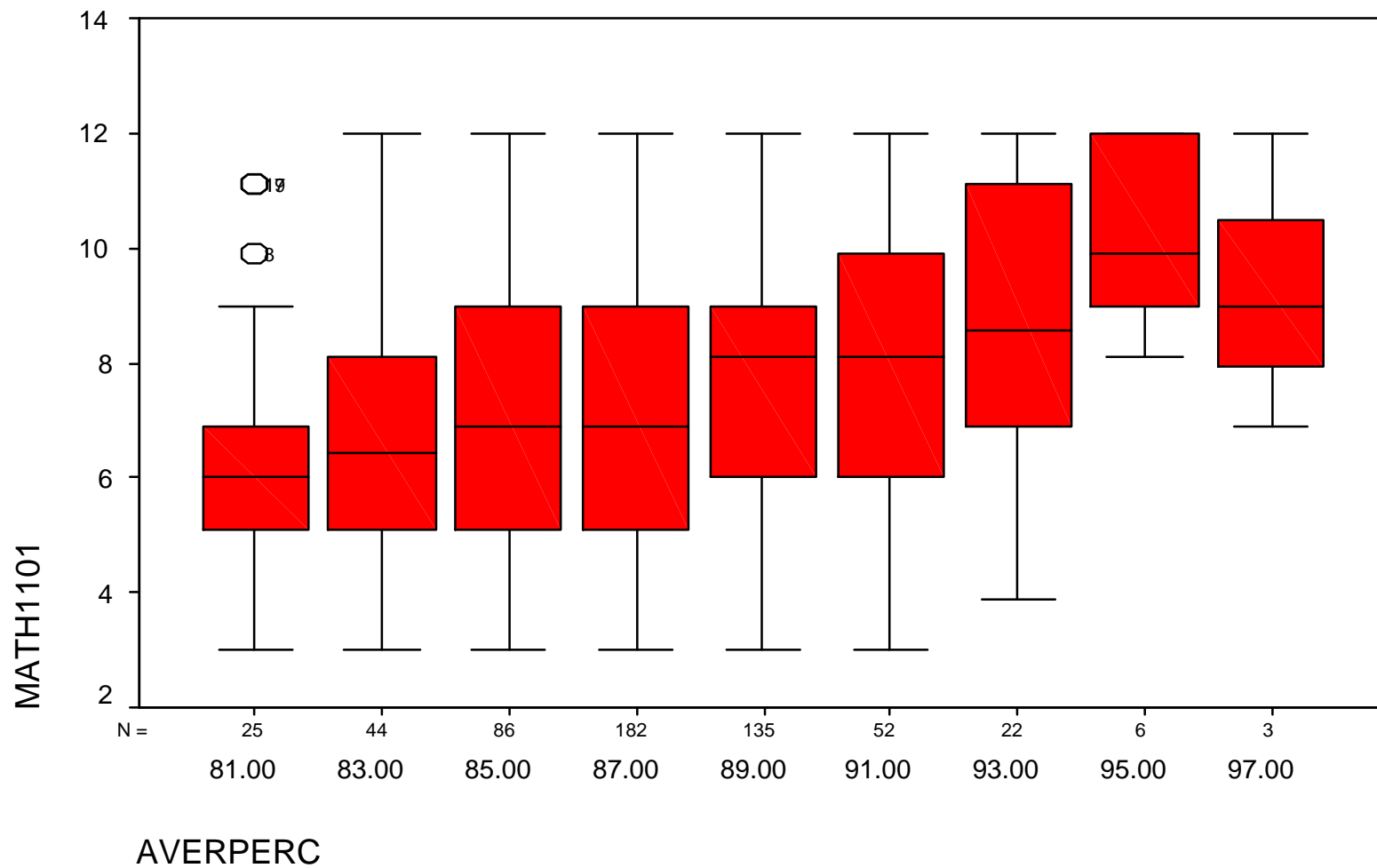
Unconditional Probabilities

- **This table shows that the science students in the course(math1101) and the art students in the course(math1062) have approximately same proportions in getting various grads (A-D) and this gives indicator that the first elective course for art student which is math1061 was kept the level of them at the same level of science students.**
- **On the other hand the science students in the second course (math1102) have more proportions than the art students in the course (math1063) in getting high grades.**
- **Also in the previous table shows that the males were more than females in getting high grades except the grade A in math1061.In math (1062) the table shows that the males and females are approximately equal in getting high grades and in math1063 the high grades were scored by male students more than female students (no female got an A in math1063).**
- **These results push us to say that the males art students were quietly better than females in mathematics.**
- **Whereas this table shows that the female's science students were better than males in getting high grades as shown in the analysis of both courses math1101 and math1102.**

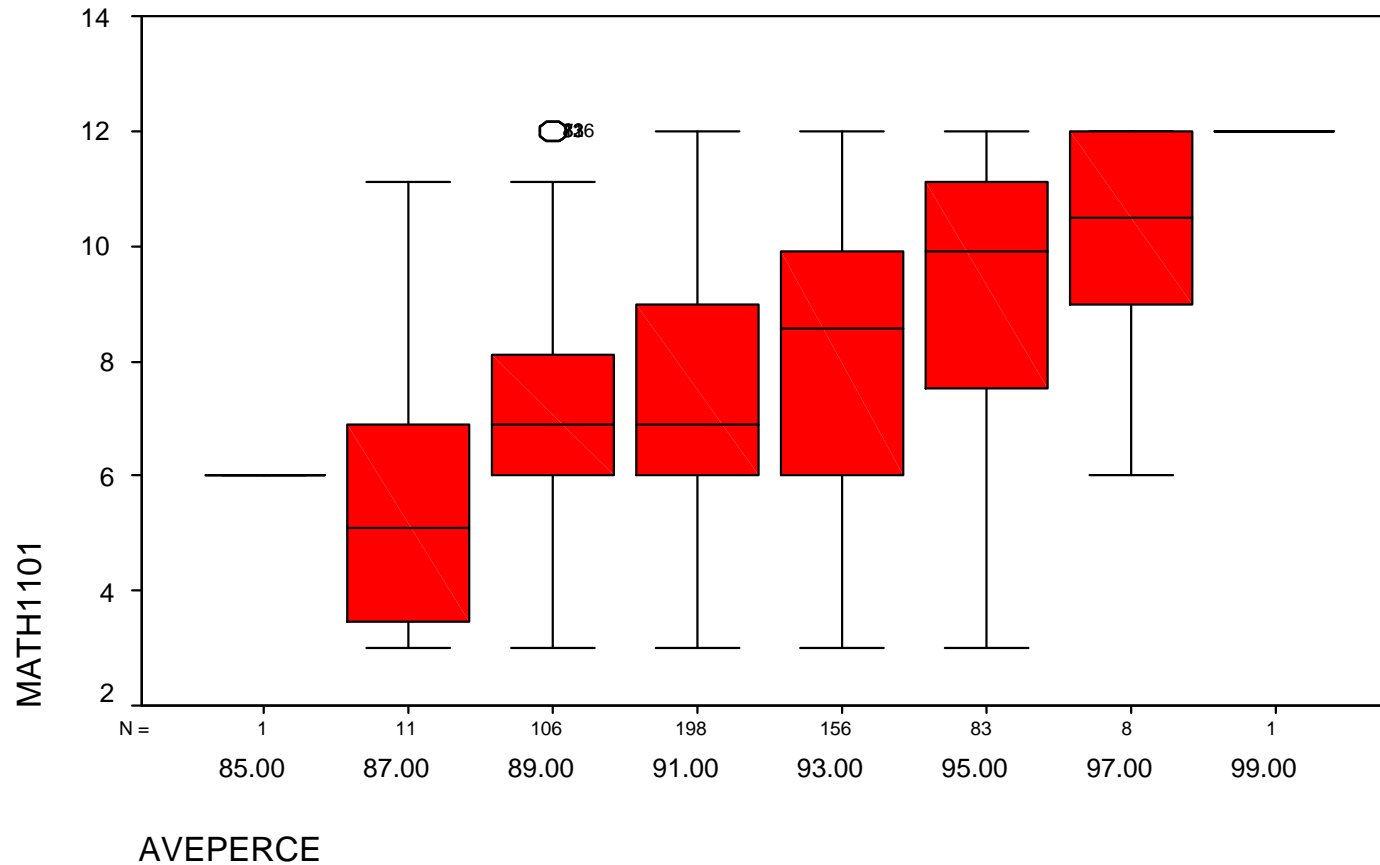
Summary statistic for math1101 grades according to percentage group and gender

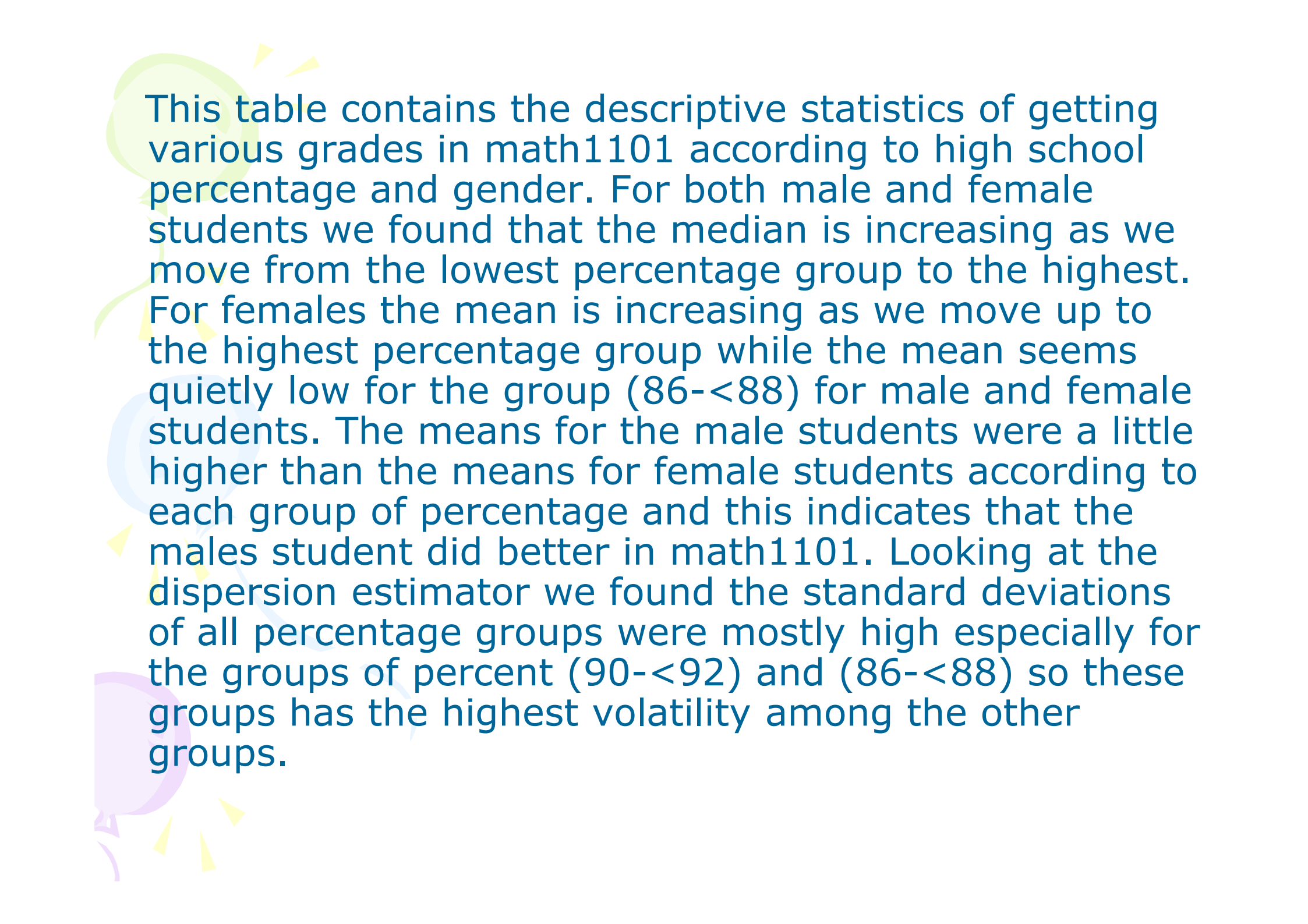
	Gender	min	Q1	median	Q3	max	mean	Std.deviation
80-<82	Female							
	Male	3	4.5	6	6.9	11.1	6.19	2.30
82-<84	Female							
	Male	3	5.1	6.45	8.1	12	6.65	2.11
84-<86	Female							
	Male	3	5.1	6.9	9	12	7.02	2.42
86-<88	Female	3	3	5.1	6.9	11.1	5.73	2.62
	Male	3	5.1	6.9	9	12	6.96	2.48
88-<90	Female	3	6	6.9	8.325	12	7.26	2.35
	Male	3	6	8.1	9	12	7.54	2.47
90-<92	Female	3	6	6.9	9	12	7.36	2.49
	Male	3	6	8.1	9.9	12	8.11	2.64
92-<94	Female	3	6	8.55	9.9	12	8.19	2.39
	Male	3.9	6.675	8.55	11.1	12	8.48	2.57
94-<96	Female	3	6.9	9.9	11.1	12	9.14	2.33
	Male	8.1	8.775	9.9	12	12	10.15	1.58
96-<98	Female	6	8.55	10.5	12	12	10.13	2.16
	Male	6.9	6.9	9	.	12	9.3	2.56

Box-plot of Summary statistic for math1101 grades according to percentage group for male students



Box-plot of Summary statistic for math1101 grades according to percentage group for female students





This table contains the descriptive statistics of getting various grades in math1101 according to high school percentage and gender. For both male and female students we found that the median is increasing as we move from the lowest percentage group to the highest. For females the mean is increasing as we move up to the highest percentage group while the mean seems quietly low for the group (86-<88) for male and female students. The means for the male students were a little higher than the means for female students according to each group of percentage and this indicates that the males student did better in math1101. Looking at the dispersion estimator we found the standard deviations of all percentage groups were mostly high especially for the groups of percent (90-<92) and (86-<88) so these groups has the highest volatility among the other groups.



Summary statistic of GPA according to the year of graduation:

	min	Q1	median	Q3	max	mean	Std.deviation
2003	2	2.57	2.91	3.14	3.86	2.891975	.406158
2004	2.02	2.53	2.84	3.19	3.68	2.856816	.400645
2005	2.02	2.445	2.82	3.145	3.93	2.814936	.444679
2006	2.04	2.44	2.7	3.1	3.66	2.756029	.409063
2007	2	2.4575	2.72	2.98	3.82	2.758046	.38856
2008	2.02	2.355	2.67	3.08	3.77	2.743567	.447696



Ordinal logistic regression

Ordinal regression is a statistical technique that is used to predict behavior of dependent variables (conditional probability) with a set of independent variables. Minitab provides three link functions—logit (the default), normit (also called probit), and gompit (also called complementary log-log)—allowing you to fit a broad class of ordinal response models. These are the inverse of the standard cumulative logistic distribution function (logit), the inverse of the standard cumulative normal distribution function (normit), and the inverse of the Gompertz distribution function (gompit). This class of models is defined by:

$$g(c_k) = q_k + \mathbf{x}'\mathbf{b}, \quad k = 1, \dots, K-1$$

K = the number of distinct categories of the response

c_k = the cumulative probability up to and including category k , ($p_1 + \dots + p_k$)

$g(c_k)$ = the link function (described below)

q_k = the constant associated with the k th distinct response category.

\mathbf{b} = a vector of coefficients associated with the predictors

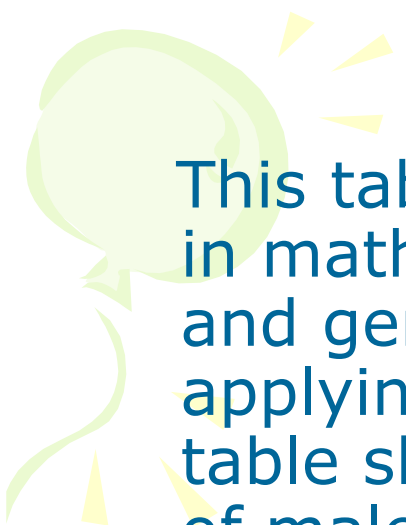
\mathbf{X} = a vector of predictor variables

Estimation of logit function.

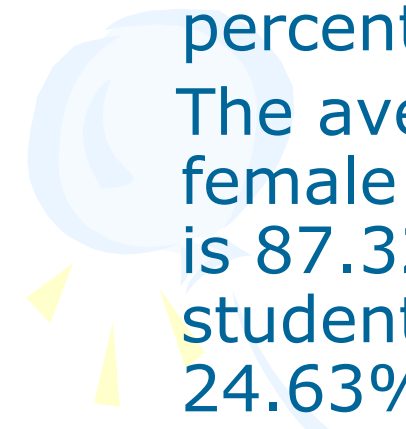
	Math1101	Math1102
	estimated coefficients	estimated coefficients
D	13.3914	4.67599
D+	14.2981	5.72518
C-	14.9567	6.57342
C	15.8430	7.40799
C+	16.4990	8.06188
B-	16.9458	8.64236
B	17.4931	9.54201
B+	18.0683	10.2835
A-	18.9665	11.3547
Percent	-0.185048	-0.0440357
Gender	0.414510	-0.0256117
Math1101		-0.546232
Math1102		

Estimation of logit function.

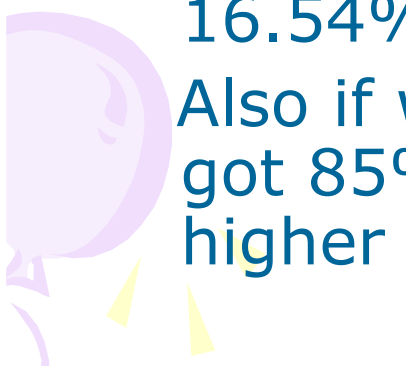
	Female 95.99	male 96.45	Female 85.26	Male 85.00	Female aver percent 91.79	male aver percent 87.32
D	.0188	.0115	.1223	.0880	.0399	.0592
D+	.0265	.0164	.1342	.1050	.0535	.0755
C-	.0385	.0250	.1434	.1229	.0726	.0964
C	.0979	.0661	.2180	.2126	.1597	.1907
C+	.1179	.0874	.1390	.1550	.1563	.1626
B-	.1004	.0825	.0727	.0880	.1110	.1029
B	.1362	.1236	.0642	.0822	.1225	.1044
B+	.1364	.1427	.0436	.0583	.1015	.0793
A-	.1620	.1988	.0361	.0502	.0994	.0721
A	.1654	.2463	.0265	.0378	.0836	.0570



This table presents the probability of getting grade in math1101 according to the high school percent and gender for some student as an example by applying ordinal regression on them and also this table shows some comparison between a number of males and females with their high school percent.



The average of high school percentages of the female science students is 91.79 and for the males is 87.32. We can see from the table that the male student who got 96.45% at the high school has 24.63% chance to get A whereas the female who got 95.99% which is close to male percentage has 16.54% chance to score A grade.



Also if we compare a male and a female who were got 85% we find that the male student has the higher chance to get A grade in math 1101.

Estimation of logit function.

	Math 1062	Math 1063
	Estimated Coefficients	Estimated Coefficients
D	5.77	8.57
D+	6.63	9.18
C-	7.46	10.00
C	8.05	10.76
C+	8.80	11.75
B-	9.15	12.19
B	9.67	12.88
B+	10.75	14.12
A-	11.75	15.29
Percent	0.08	0.08
Gender	0.25	0.50
Math 1061	-0.27	0.09
Math 1062		-0.47



Conclusion

- Male students are mostly better than females in mathematics when they are compared with same high school percentage.
- Usually the best grades in mathematics are scored by the students who have got high school percentages.
- The grades of the pre-request courses normally effect the grades of advance courses.



**Thank you for your
attention**

