



# MTH253 PROJECT:

Comparing the overall benefit of select schools  
against other sets of schools...

Project by Ari Zeto and Jordan Borst



# WELCOME!

Let us introduce our project to all of you...:

**General Idea:** Comparing a set of (higher education) schools against others.

**Goal:** To determine what set of schools may be valuable to a prospective student.

**Educations include:** Community College, Universities (and their graduate programs)

# Here are some need to knows before proceeding...:

- School selections are arbitrary. You will find out why.
- Programs, while similar, are also arbitrary.
- The data we present was collected off of the official <http://studentaid.gov> link. The data selection is large, as you will see.
- Scaling was necessary in order for clear computations.

## Keywords that you should know...:

### **Repayment Rate Denominator**

Often called a “Collection rate”, “Recovery rate”, “loan recuperation”. The idea of this is a set amount of money paid out per a certain interval of time, also referred to as installment rates.

### **So...what is the “Denominator?” from the above?**

The denominator is the unpaid balance on every loan. This does account for late payments and non-late payments.

### **Mean Annual Earnings**

The sum amount of income that was made of all individuals in said program throughout the business/calendar year.



# QUESTIONS BEFORE MOVING ON?

No...? ☺

# How does comparing Education between a set of schools operate in a project like this?

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- **Question:** What sort of inconsistencies may we run into?
- **Question:** Could another glorious Calculus 3 topic be utilized to tackle this data?
- **EXCELLENT QUESTIONS! We'll address these 😊**

# So, what components will use to fill the dot product?

**Note:** Tried to have some fun with the presentation, so here is some fake looking engineering paper with our components in them ☺



Time, Repayment Rate Denominator, Mean Annual Earnings

**TIME**

**REPAYMENT RATE  
DENOMINATOR**

**MEAN ANNUAL  
EARNINGS**

Data per component will obviously vary...

Given ... :

$$\vec{a} = \langle x_1, y_1, z_1 \rangle \quad \vec{b} = \langle x_2, y_2, z_2 \rangle$$

$$\vec{a} \cdot \vec{b} = \langle x_1, y_1, z_1 \rangle \cdot \langle x_2, y_2, z_2 \rangle = \text{Scalar}$$

$$\cos \theta = \frac{\vec{a} \cdot \vec{b}}{\|\vec{a}\| \|\vec{b}\|}$$

$$\text{Where } \|\vec{a}\| = \sqrt{(x_1)^2 + (y_1)^2 + (z_1)^2}$$

$$\|\vec{b}\| = \sqrt{(x_2)^2 + (y_2)^2 + (z_2)^2}$$

## Let's recall the Dot Product:

We're aware you know this, but as our project relies on the Dot Product we kept this information in the slides:

A **Vector** – Consists of magnitude and direction. The position of some point in space, starts on the origin on the (x,y,z) plane.

A pair of Vectors may be multiplied to create some scalar.

The angle between the set of vectors can be located. The magnitude (distance formula) is utilized to find this...

## Redstone College pitted against Carrington College...

<Time, Repayment Rate Denominator, Mean Annual Earnings>

**Redstone College – Airframe Technology**

**< 2 , 2625307 , 26168 >**

**Carrington College - Dental**

**< 2 , 2374556 , 42375 >**

- **Note 1: Recall that the programs themselves are arbitrary, and do not mean too much as far as our actual data that we are looking for. Throughout the project, we will compare very similar programs to each other, and those that are not so similar to each other.**
- **Note 2: For the formatting purposes of our presentation slides, we will scale the components to make it easier on the eyes.**

## Redstone College pitted against Carrington College...

<Time, Repayment Rate Denominator, Mean Annual Earnings>

Redstone College – Airframe Technology

< 2 , 3.6, 2.6 >

Carrington College - Dental

< 2 , 2.3 , 4.2 >

- In order to tackle this project appropriately, scaling was necessary in order to find some data that we could gain some insight on. It can be noted that if we kept the values from the previous slides, the initial component (time) would be rather meaningless.

Let Redstone College =  $a$  (vector  $a$ ), and Carrington College =  $b$  (vector  $b$ )

$$a \bullet b = 23.2$$

Note: Inconsistency number 1! What the hell does this scalar mean?

## Redstone College pitted against Carrington College...

<Time, Repayment Rate Denominator, Mean Annual Earnings>

Redstone College – Airframe Technology

< 2 , 3.6, 2.6 >

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- In order to tackle this project appropriately, scaling was necessary in order to find some data that we could gain some insight on. It can be noted that if we kept the values from the previous slides, the initial component (time) would be rather meaningless.

Let Redstone College = a (vector a), and Carrington College = b (vector b)

$$a \bullet b = 23.2$$

We toyed around with the idea of using the scalar to represent our data we're seeking, but ultimately came to terms that we didn't like the scalar itself. It was a bit too simple, and we could not compare it to much.

We came to terms with using the dot product formula, but the variation that allows us to find the angle between a set of vectors.

## Redstone College pitted against Carrington College...

<Time, Repayment Rate Denominator, Mean Annual Earnings>

Redstone College – Airframe Technology

< 2 , 3.6, 2.6 >

Carrington College - Dental

< 2 , 2.3 , 4.2 >

Let Redstone College = a (vector a), and Carrington College = b (vector b)

Recall the Dot Product formula for finding an angle between two vectors...:  $\cos(\theta) = \frac{(a \bullet b)}{\|a\| \|b\|}$

Goal: Locate the angle between the set of vectors. Here is the setup...:

$$a \bullet b = 23.2 \quad \|a\| = \sqrt{(2)^2 + (3.6)^2 + (2.6)^2} \quad \|b\| = \sqrt{(2)^2 + (2.3)^2 + (4.2)^2}$$

Here is the dot product worked through...(some steps skipped to conserve space)...:

$$\cos(\theta) = \frac{a \bullet b}{\|a\| \|b\|} = \frac{23.2}{\sqrt{(2)^2 + (3.6)^2 + (2.6)^2} \sqrt{(2)^2 + (2.3)^2 + (4.2)^2}}$$

$$\cos(\theta) = \frac{23.2}{\sqrt{14.36} \sqrt{23.94}}$$



$$\cos^{-1}(\cos(\theta)) = \frac{23.2}{\sqrt{14.36} \sqrt{23.94}}$$

$$\theta = 23.373^\circ$$



Redstone College pitted against Carrington College...

<Time, Repayment Rate Denominator, Mean Annual Earnings>

Redstone College – Airframe Technology

< 2 , 3.6 , 2.6 >

Carrington College - Dental

< 2 , 2.3 , 4.2 >

$$\theta = 23.373^\circ$$

We're getting closer to the idea of data that may be of some use for our objective. Recall that we are looking for overall benefit between school data sets. So, while it's unique that we got this angle between these schools...what does it all mean?

A closer explanation as to what we're seeking...:

- Now that the general idea has been made for what we want, (the angle between two vectors utilizing our components), what makes an angle good? What makes an angle bad? What can we say or do to determine if angle is good or bad for what we're looking for?

# What makes an angle good? What makes an angle bad?

## Good Angle properties:

- Getting an angle to read  $0^\circ$  would be the most optimal, as our data will show you later!

## Bad Angle properties:

- Getting an angle to read  $90^\circ$  would be the least optimal, as our data will show you later!

Recall our angle from the last slide...:  $\theta = 23.373^\circ$

Western International University pitted against University of Phoenix...

< Time, Repayment Rate Denominator , Mean Annual Earnings >

Western Digital University – Behavior

< 4 , 1.1 , 3.1 >

University of Phoenix – Behavior

< 2 , 3.8 , 1.5 >

Objective: Determine the angle between the vectors, ideally hoping for as close to 90 degrees as possible for orthogonality.

Let Western Digital University = a , and University of Phoenix = b

$$a \bullet b = < 4 , 1.1 , 3.1 > \bullet < 2 , 3.8 , 1.5 > = 16.8$$

$$\|a\| = \sqrt{(4)^2 + (1.1)^2 + (3.1)^2} \quad \|b\| = \sqrt{(2)^2 + (3.8)^2 + (1.5)^2}$$

$$\cos(\theta) = \frac{16.8}{\sqrt{(4)^2 + (1.1)^2 + (3.1)^2} \sqrt{(2)^2 + (3.8)^2 + (1.5)^2}}$$

Steps reduced as we all know the setup and steps, and space is needed to be saved...

$$\theta = 44.505^\circ$$

**Note:** Our angle is closer to 90 degrees, closer to orthogonality.

## Virginia College pitted against Westwood College...

< Time , Repayment Rate Denominator , Mean Annual Earnings >

Virginia College – Criminal Justice

< 2 , 1.6 , 1.9 >

Westwood College – Criminal Justice

< 4 , 9.9 , 2.5 >

**Note:** Can anyone predict what may happen here with our angle here? Take a look at one of the components inside the vectors...

Let Virginia College = **a**, and Westwood College = **b**

$$a \bullet b = \langle 2, 1.6, 1.9 \rangle \bullet \langle 4, 9.9, 2.5 \rangle = 28.4$$

$$\|a\| = \sqrt{(2)^2 + (1.6)^2 + (2.5)^2} \quad \|b\| = \sqrt{(4)^2 + (9.9)^2 + (2.5)^2}$$

$$\cos(\theta) = \frac{28.4}{\sqrt{(2)^2 + (1.6)^2 + (2.5)^2} \sqrt{(4)^2 + (9.9)^2 + (2.5)^2}}$$

We will be skipping some steps to conserve some space for the rest of the slide...

$$\theta = 35.700^\circ$$

**Note:** Once again, we get an angle that is not at 90 degrees. We can continue to do this over and over for various data sets, but that would be redundant. So, why don't we take another approach?

Let us identify an ideal vector to compare all our data vectors with. That way we can find the ideal sets of schools. Here is an example from our data within the next slide...

$$\langle 0, 0, 1 \rangle$$

**Here is an excel spreadsheets of numerous amounts of data relating to our components and our ideal vector of  $\langle 0, 0, 1 \rangle$  ...:**

Institution Name	CIP Code Program Name	Credential Level	Repayment Rate Denominator	Verified Student Count	Average Repayment Rate of Individual	Mean SSA Earnings Amount	Angle of Ide
UNIVERSITY OF PHOENIX	Health Information/Medical Records Technology/Technician.	02	334,500	15917	21.0152667	58,140	0
EMPIRE BEAUTY SCHOOL	Aesthetics/Esthetician and Skin Care Specialist.	01	111,369	1570	70.93566879	21,142	0
CATHERINE HINDS INSTITUTE OF ESTHETICS	Aesthetics/Esthetician and Skin Care Specialist.	01	87,129	1276	68.28291536	19,004	0
UNIVERSITY OF PHOENIX	Junior High/Intermediate/Middle School Education and Teaching.	05	643,683	3701	173.9213726	36,470	0
ENID BEAUTY COLLEGE	Cosmetology/Cosmetologist, General.	01	156,357	1594	98.09096612	14,027	0
UNIVERSITY OF PHOENIX	Professional, Technical, Business, and Scientific Writing.	02	415,484	797	521.3099122	65,755	0
UNIVERSITY OF PHOENIX	Pharmacy Technician/Assistant.	02	117,053	248	471.9879032	56,219	0
EAGLE GATE COLLEGE	Dental Assisting/Assistant.	01	409,246	804	509.0124378	52,427	1
CAREER TECHNICAL INSTITUTE	Computer Technology/Computer Systems Technology.	01	79,722	283	281.7031802	26,995	1
EMPIRE BEAUTY SCHOOL	Aesthetics/Esthetician and Skin Care Specialist.	01	255,469	428	596.8901869	50,668	1
ELMIRA BUSINESS INSTITUTE	General Office Occupations and Clerical Services.	01	95,989	274	350.3248175	29,690	1
WOOD TOBE - COBURN SCHOOL	Hotel/Motel Administration/Management.	02	432,322	169	2558.118343	154,686	1
CONTINENTAL SCHOOL OF BEAUTY CULTURE	Nail Technician/Specialist and Manicurist.	01	105,738	401	263.6857855	15,185	1
BUTLER TECHNOLOGY AND CAREER DEVELOPMENT	Corrections and Criminal Justice, Other.	01	180,770	444	407.1396396	21,352	1
EAGLE GATE COLLEGE	Pharmacy Technician/Assistant.	02	496,058	674	735.9910979	37,520	1
BAKER COLLEGE	Child Development.	01	144,688	243	595.4238683	30,152	1
ERIE INSTITUTE OF TECHNOLOGY	Computer Graphics.	02	443,991	1527	290.7603143	14,433	1
EMPIRE BEAUTY SCHOOL	Cosmetology/Cosmetologist, General.	01	795,593	1166	682.3267581	32,560	1
UNIVERSITY OF PHOENIX	Elementary Education and Teaching.	03	2,207,812	3572	618.0884658	29,020	1
EAGLE GATE COLLEGE	Business Administration and Management, General.	02	588,629	451	1305.16408	57,763	1
AMERICAN PUBLIC UNIVERSITY SYSTEM	International/Global Studies.	05	234,691	129	1819.310078	66,600	2
COLLEGE OF HEALTH CARE PROFESSIONALS	Medical/Clinical Assistant.	01	256,682	644	398.5745342	12,308	2
CATTARAUGUS/ALLEGANY/ERIE/WYOMING	Licensed Practical/Vocational Nurse Training.	01	248,659	361	688.8060942	21,222	2
COMMUNITY CARE COLLEGE	Dental Assisting/Assistant.	01	441,958	371	1191.261456	35,086	2
CENTER FOR EMPLOYMENT TRAINING	Accounting Technology/Technician and Bookkeeping.	01	162,651	123	1322.365854	37,261	2
BROOKS INSTITUTE	Graphic Design.	02	153,982	112	1374.839286	36,570	2
CENTER FOR EMPLOYMENT TRAINING	Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician.	01	387,631	173	2240.641618	58,614	2
BUCKS COUNTY SCHOOL OF BEAUTY CULTURE	Cosmetology/Cosmetologist, General.	01	136,689	106	1289.518868	30,598	2
UNIVERSITY OF PHOENIX	Family Practice Nurse/Nursing.	05	4,621,461	2100	2200.695714	51,891	2
BROWNSON TECHNICAL SCHOOL	Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician.	01	317,319	458	692.8362445	16,272	2
CASA LOMA COLLEGE	Medical/Clinical Assistant.	01	169,703	250	678.812	15,762	2
CAREER ACADEMY OF BEAUTY	Aesthetics/Esthetician and Skin Care Specialist.	01	198,225	80	2477.8125	57,510	2
ELMIRA BUSINESS INSTITUTE	Accounting.	02	327,398	218	1501.825688	33,012	3
AUTOMECA TECHNICAL COLLEGE	Mechanic and Repair Technologies/Technicians, Other.	01	126,245	62	2036.209677	44,661	3
DELTA COLLEGE	Licensed Practical/Vocational Nurse Training.	01	127,060	190	668.7368421	14,400	3
EVEREST COLLEGE	Massage Therapy/Therapeutic Massage.	01	299,042	302	990.205298	20,869	3
BUTLER TECHNOLOGY AND CAREER DEVELOPMENT	Licensed Practical/Vocational Nurse Training.	01	741,882	739	1003.899865	21,108	3

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DEVRY UNIVERSITY	Business Administration, Management and Operations, Other.	03	94,006,373	35	2685896.371	13,506	90
COLORADO TECHNICAL UNIVERSITY	Business Administration and Management, General.	03	72,041,309	10	7204130.9	47,633	90
COLORADO TECHNICAL UNIVERSITY	Business Administration and Management, General.	05	33,501,147	19	1763218.263	17,920	89
DEVRY UNIVERSITY	Business Administration and Management, General.	03	103,189,185	37	2788896.892	38,986	89
WALDEN UNIVERSITY	Education, General.	05	89,571,828	26	3445070.308	52,208	89
WALDEN UNIVERSITY	Psychology, General.	06	13,462,058	10	1346205.8	24,610	89
DEVRY UNIVERSITY	Computer Systems Networking and Telecommunications.	03	28,995,599	20	1449779.95	29,773	89
DEVRY UNIVERSITY	Computer Systems Analysis/Analyst.	03	44,251,490	35	1264328.286	27,152	89
COLORADO TECHNICAL UNIVERSITY	Criminal Justice/Law Enforcement Administration.	03	26,977,021	17	1586883.588	35,388	89
COLORADO TECHNICAL UNIVERSITY	Business Administration and Management, General.	02	12,365,836	20	618291.8	14,294	89
WESTERN INTERNATIONAL UNIVERSITY	Information Technology.	02	6,569,574	10	656957.4	17,393	88
DEVRY UNIVERSITY	Electrical, Electronic and Communications Engineering Technology/Technician.	03	18,799,971	25	751998.84	20,432	88
ALLEN SCHOOL	Medical/Clinical Assistant.	01	6,535,575	13	502736.5385	14,505	88
EVEREST COLLEGE	Medical/Clinical Assistant.	01	4,346,127	16	271632.9375	8,536	88
DEVRY UNIVERSITY	Electrical, Electronic and Communications Engineering Technology/Technician.	02	23,978,904	17	1410523.765	48,501	88
EMPIRE BEAUTY SCHOOL	Cosmetology/Cosmetologist, General.	01	2,975,331	12	247944.25	8,780	88
AMERICAN INTERCONTINENTAL UNIVERSITY	Information Technology.	03	27,051,602	46	588078.3043	21,732	88
CAPELLA UNIVERSITY	Educational/Instructional Technology.	06	3,932,784	18	218488	8,584	88
COLORADO TECHNICAL UNIVERSITY	Computer and Information Systems Security/Information Assurance.	05	7,195,009	11	654091.7273	26,477	88
COLORADO TECHNICAL UNIVERSITY	Accounting.	03	8,067,868	21	384184.1905	20,235	87
DEVRY UNIVERSITY	Computer Systems Networking and Telecommunications.	02	8,635,660	29	297781.3793	16,131	87
COLORADO TECHNICAL UNIVERSITY	Information Technology Project Management.	05	6,708,015	12	559001.25	30,376	87
AMERICAN INTERCONTINENTAL UNIVERSITY	Educational/Instructional Technology.	05	25,460,308	50	509206.16	28,464	87
DEVRY UNIVERSITY	Health Information/Medical Records Technology/Technician.	02	9,457,524	44	214943.7273	12,600	87
EMPIRE BEAUTY SCHOOL	Cosmetology/Cosmetologist, General.	01	5,040,495	32	157515.4688	9,365	87
BRANFORD HALL CAREER INSTITUTE	Legal Assistant/Paralegal.	01	1,872,893	11	170263	11,992	86
AMERICAN INTERCONTINENTAL UNIVERSITY	Information Technology.	05	9,359,877	26	359995.2692	27,760	86
ACADEMY OF ART UNIVERSITY	Animation, Interactive Technology, Video Graphics and Special Effects.	03	4,238,575	13	326044.2308	26,362	85
BROOKS INSTITUTE	Cinematography and Film/Video Production.	03	5,134,820	34	151024.1176	12,370	85
ECPI UNIVERSITY	Network and System Administration/Administrator.	02	10,733,486	41	261792.3415	21,459	85
DEVRY UNIVERSITY	Computer Engineering Technology/Technician.	03	12,193,425	72	169353.125	14,589	85
SANFORD-BROWN COLLEGE	Medical/Clinical Assistant.	01	20,974,211	68	308444.2794	26,930	85
BERKELEY COLLEGE	Business Administration and Management, General.	02	5,431,220	34	159741.7647	14,387	85
BRYANT & STRATTON COLLEGE	Registered Nursing/Registered Nurse.	02	3,817,279	20	190863.95	17,373	85
BRYANT & STRATTON COLLEGE	Business/Commerce, General.	02	10,370,145	31	334520.8085	31,770	85
ART INSTITUTE OF ATLANTA (THE)	Culinary Arts/Chef Training.	02	4,201,938	27	155627.3333	15,427	84
CARRINGTON COLLEGE	Medical/Clinical Assistant.	01	6,009,757	35	171707.3429	17,288	84



**Inconsistency number 2!** Notice that on our last two slides, that we included “Repayment Rate Denominator of Individual”. Originally within the first few slides of setup, our component was the overall “Repayment Rate Denominator”, whereas, we should have been looking at “Repayment Rate Denominator of Individual” as the idea is to determine sets of schools best suited for an individual.

## **Conclusion: Addressing the Inconsistences...**

Throughout the slides, we posed a question “What does the scalar mean (when using the dot product)?”. While useful, it doesn’t exactly tell us anything of itself. It served its purpose with our angle formula, therefore it is not meaningless.

Toward the end of our presentation, we included data from an excel spreadsheet that incorporated “Repayment Rate Denominator of Individual”, as the focus of the topic was for certain individuals. In the beginning slides, we did the overall “Repayment Rate Denominator”. We have since made that correction as it is shown on our excel spreadsheet.

## **Conclusion: What is a good angle, what is a bad angle?**

As determined from our previous data shown, 0 degrees is optimal (or around 0 degrees). Anything larger, especially as it approaches 90 degrees (or 90 degrees) is NOT optimal.

As unique of an idea as using the dot product was for this topic, there are certainly additional tools used to analyze great data for a set of schools for an individual. Obviously, using more and more components would yield more accurate results.

## **Conclusion: Is there an additional Calc 3 topic we can use to analyze this data?**

Unfortunately, we brainstormed this idea for a significant amount of time. However, we could not conclude an ideal alternative method to approach this topic rather than the dot product angle formula.