Math in Seoul

Many friends of mine often complained how they did not see the point of doing math proofs in class. This project was carried out to encourage students' interests in math and in the project, I analyzed my city, Seoul, mathematically, in order to show how math is used or can be used in our lives.

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1) Statistics in Seoul

Seoul is the biggest city[1] out of all cities of OECD countries and its population reaches about ten million. (en.wikipedia.org/wiki/Seoul) Since South Korea's population reaches about fifty million, this data shows that one out of five South Koreans lives in Seoul. Seoul National Capital Area which includes cities around near Seoul such as Incheon, Suwon, etc. is the second largest National Capital Area and has population of over 25million. According to Global Financial Centres Index which rates cities based on their infrastructure, market access, business environment and other, Seoul is currently in the world's sixth place, leading the innovation among cities and has outplayed Tokyo in the world's seventh place (en.wikipedia.org/wiki/Global_Financial_Centres_Index). In order to analyze this gigantic Seoul, I used statistics provided by Seoul City Government (http://stat.seoul.go.kr/). Out of broad statistics the city provides from business to education, I focused on the population change in sex, nationality and age.

a. Population of Seoul

Currently Seoul's population is 9,794,304. Out of these people, 1.7% of them are foreigners and the number of women outweigh that of men by 1.9%.

	Men	Women	Total
Korean	4,726,028	4,905,454	9,631,482
Foreigner	77,345	85,477	162,822
Total	4,803,373	4,990,931	9,794,304

1) Areas or designations should not be confused with cities. For instance, New York is an area that consists of New York City and other small cities around New York City. When New York's population is about 17 million which exceeds the population of Seoul, New York City's population is about 9 million which is below the population of Seoul.

b. Inclination of the Population

Population									
				Korean			Foreigner		
Year	Sum	Male	Female	Sum	Male	Female	Sum	Male	Female
1955	1,574,868	786,159	788,709	1,568,746	782,461	786,285	6,122	3,698	2,424
1960	2,445,402	1,222,695	1,222,707	2,436,630	1,218,002	1,218,628	8,772	4,693	4,079
1966	3,793,280	1,894,739	1,898,541	3,783,200	1,889,243	1,893,957	10,080	5,496	4,584
1970	5,433,198	2,666,129	2,767,069	5,422,735	2,660,533	2,762,202	10,463	5,596	4,867
1975	6,889,502	3,432,182	3,457,320	6,879,464	3,425,991	3,453,473	10,038	6,191	3,847
1980	8,364,379	4,168,875	4,195,504	8,350,616	4,160,059	4,190,557	13,763	8,816	4,947
1985	9,639,110	4,795,086	4,844,024	9,625,755	4,787,720	4,838,035	13,355	7,366	5,989
1990	10,612,577	5,326,341	5,286,236	10,603,250	5,321,357	5,281,893	9,327	4,984	4,343
1995	10,231,217	5,138,935	5,092,282	10,217,177	5,131,249	5,085,928	14,040	7,686	6,354
2000	9,895,217	4,966,993	4,928,224	9,853,972	4,943,550	4,910,422	41,245	23,443	17,802
2005	9,820,171	4,869,761	4,950,410	9,762,546	4,837,112	4,925,434	57,625	32,649	24,976
2010	9,794,304	4,803,373	4,990,931	9,631,482	4,726,028	4,905,454	162,822	77,345	85,477

This chart above can put in to a graph below.

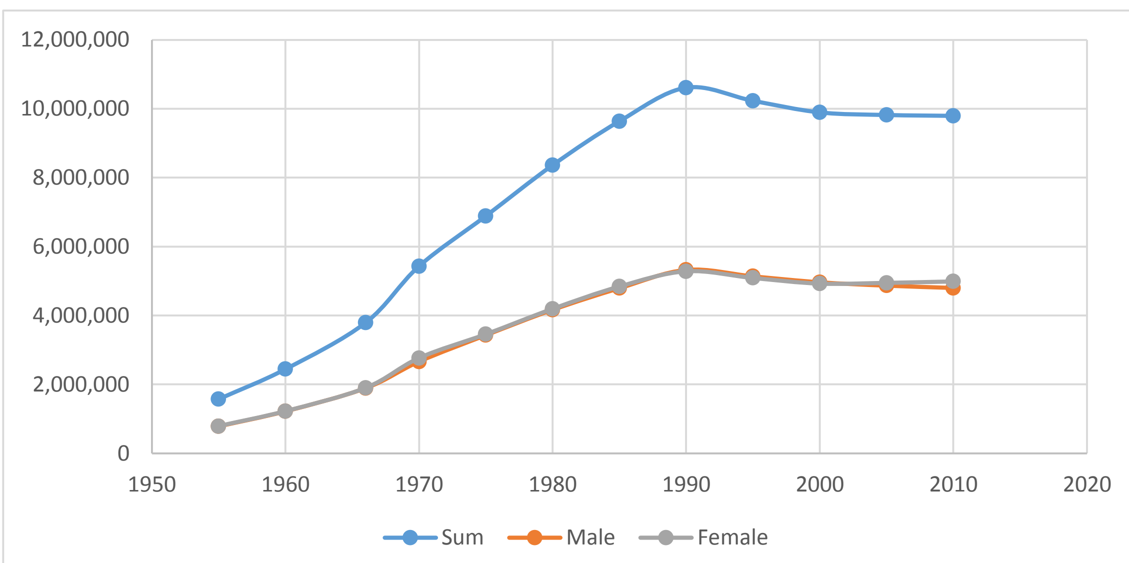


Figure 1 Population Change In Whole

According to the graph, Seoul's population increases about 1.3 million every five years from year 1955 to 1990 and decreases by a little afterwards.

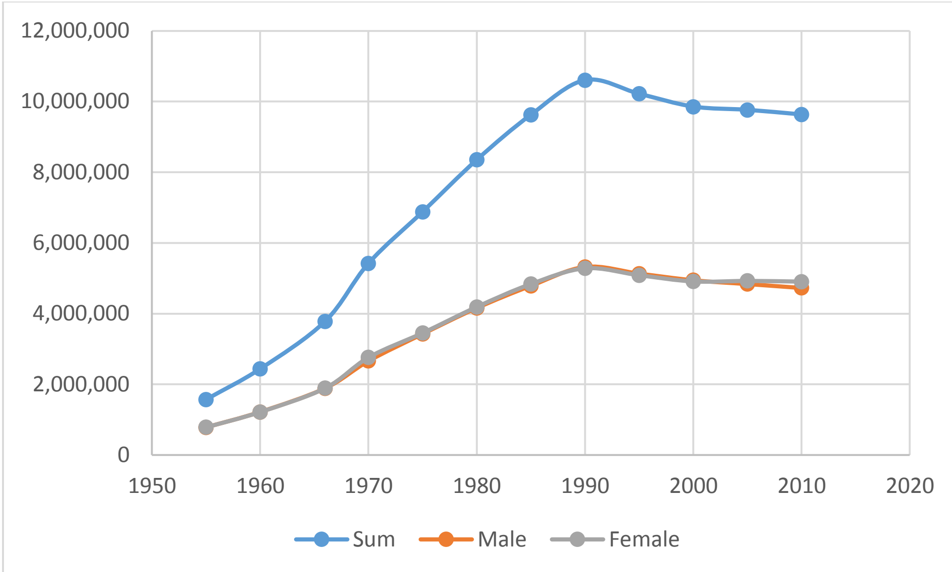


Figure 2 Population Change In Korean Seoul Residents

As the percentage of foreign Seoul residents does not even reach 1% of the whole population, this graph shows how change in foreign residents' population barely impacts the population in whole. A graph on inclination of the foreign residents' population, on the other hand, seems to reveal an interesting fact.

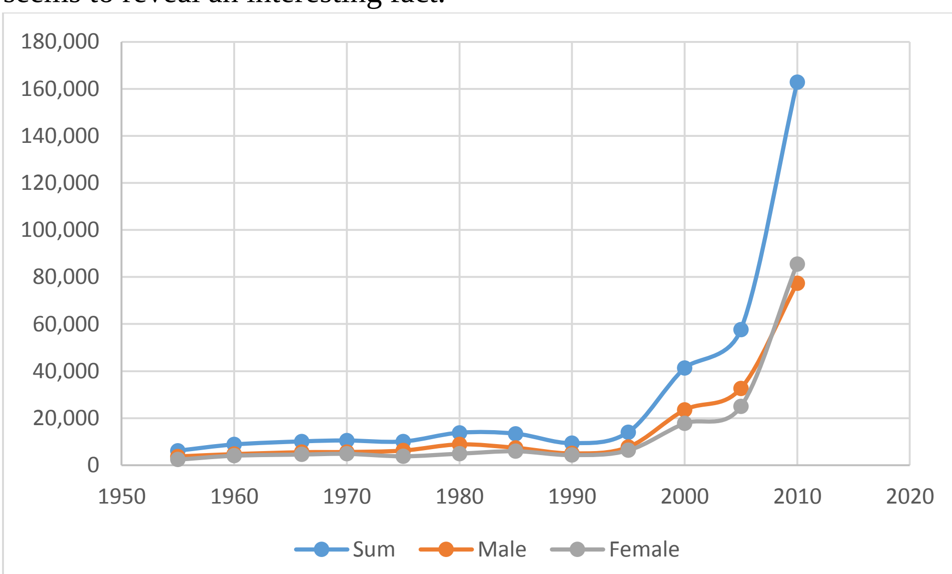


Figure 3 Population Change In Foreign Seoul Residents

While the foreign residents' population stayed within 10 thousand until 1995, it started to increase significantly afterwards. Also the number of male foreign residents was way bigger than the number of female foreign residents until 2005 but in 2010, the number of female foreign residents outweighed the number of male foreign residents for about 11%.

c. Aging Seoul
The city government provides not only data on past population but also predictions on future population. Below is a table that arranged the provided predictions for every five years.

Year	Sum	Male	Female	0~14	15~64	65+
1970	5,685,932	2,864,147	2,821,785	2,061,279	3,529,115	95,538
1975	7,005,007	3,493,989	3,511,018	2,390,052	4,468,154	146,801
1980	8,516,450	4,274,921	4,241,529	2,668,394	5,638,269	209,787
1985	9,725,447	4,876,533	4,848,914	2,768,496	6,678,573	278,378
1990	10,473,252	5,272,803	5,200,449	2,588,293	7,516,847	368,112
1995	10,342,224	5,212,363	5,129,861	2,229,958	7,678,526	433,740
2000	10,078,434	5,075,696	5,002,738	1,869,569	7,670,195	538,670
2005	10,011,324	4,998,012	5,013,312	1,667,679	7,631,239	712,406
2010	10,050,508	4,964,202	5,086,306	1,402,018	7,709,438	939,052
2015	10,025,756	4,922,659	5,103,097	1,222,010	7,615,453	1,188,293
2020	10,135,026	4,953,324	5,181,702	1,188,565	7,464,991	1,481,470
2025	10,214,422	4,976,220	5,238,202	1,194,187	7,114,190	1,906,045
2030	10,202,243	4,958,051	5,244,192	1,168,042	6,709,144	2,325,057
2035	10,101,828	4,896,440	5,205,388	1,105,666	6,315,203	2,680,959
2040	9,924,373	4,800,386	5,123,987	1,009,061	5,921,604	2,993,708

Figure 4 Inclination of Ages

This chart can be put into a graph below.

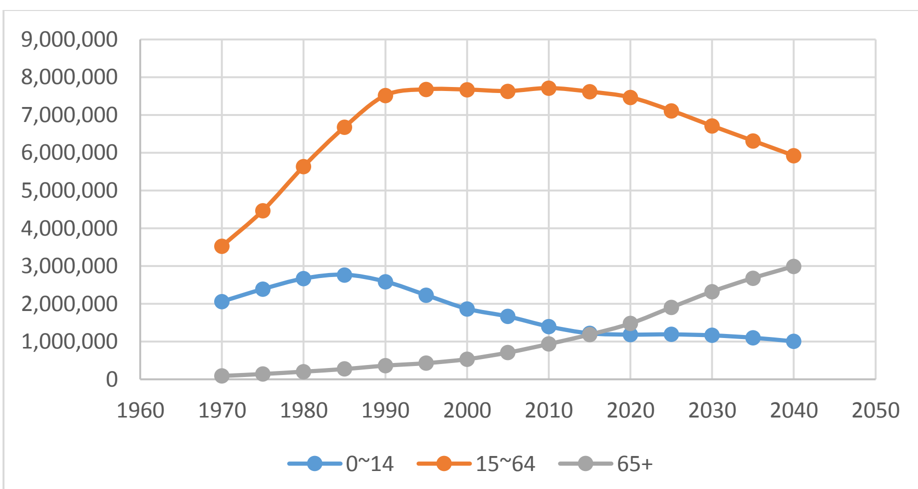


Figure 5 Inclination of Ages

According to Figure 5, population of people over 65 years old increases quickly after 2010 that it reaches about 30% around year 2040. Working population, on the other hand, of people from 15 to 64 years old decreases significantly that around 2040, it falls behind 60% of the whole population. Even though I had heard many news alerting our society becoming a graying society, none of them was surprising as these graphs were.

d. Comparatively Young Seocho-gu
Index of aging is "a ratio of young people at age of 0~14 to old people at age over 65 which shows degree of graying" (Naver Encyclopedia). "Increasing index of aging is basically the number of people who need support outweighing the number of people who are capable of working" (Naver Encyclopedia). I compared my district with Seoul to figure out if my neighborhood is comparatively young or not.

Year	Childhood Dependency Raito (%)	Elderly Dependency Ratio (%)	Index of Aging (%)
2002	23.5	7.9	33.5
2003	23	8.3	36.2
2004	22.5	8.9	39.3
2005	21.9	9.4	42.9
2006	21	9.9	47.4
2007	20.2	10.7	53
2008	19.9	11.5	57.6
2009	19.1	12	62.8
2010	18.2	12.7	69.9
2011	17.7	13.4	75.5

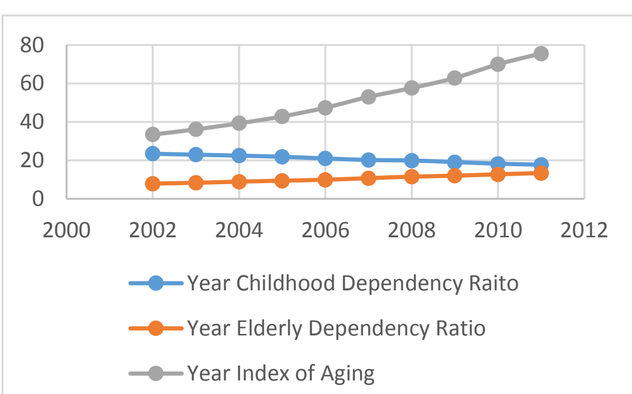
Seoul's Aging Index

Year	Childhood Dependency Raito(%)	Elderly Dependency Ratio(%)	Index of Aging(%)
2002	21.2	6.9	32.7
2003	21.1	7.2	34.1
2004	20.9	7.6	36.3
2005	20.6	8	38.7
2006	20.3	8.4	41.5
2007	20	9.1	45.6
2008	19.6	9.8	50.1
2009	19.6	10.4	52.8
2010	19.3	11.1	57.6
2011	19.3	11.8	61.1

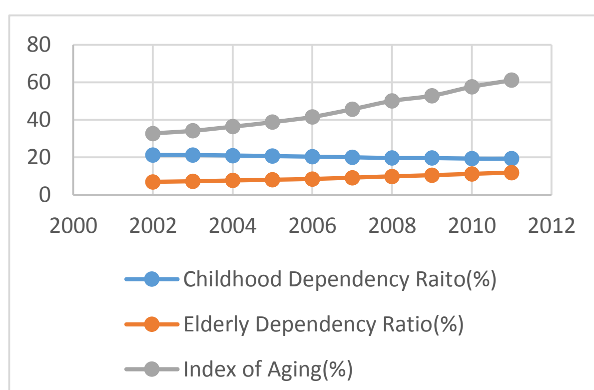
Seocho-gu Aging Index

In both tables, the index of aging and elderly dependency kept raising.

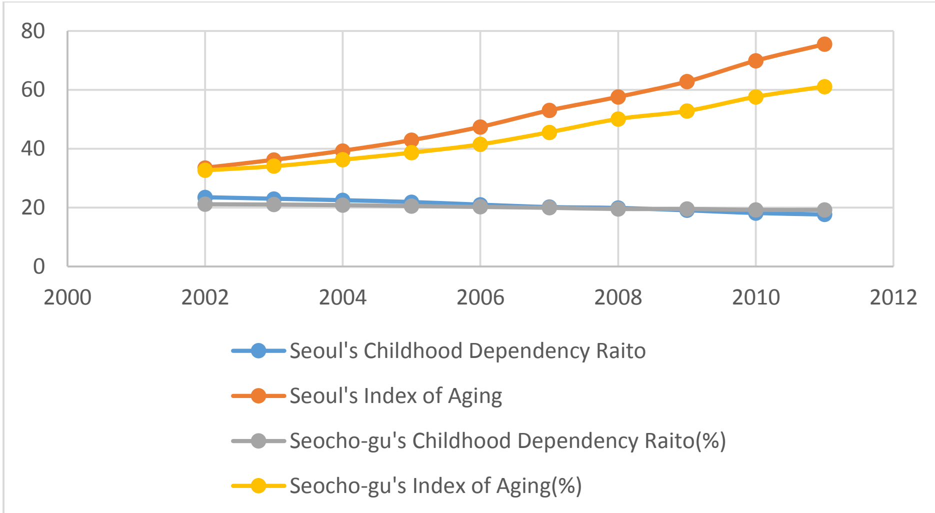
Seoul



Seocho-gu



It was hard to compare two graphs separately so I merged two graphs above into one.



In the graph above, gap between aging index of Seocho-gu and Seoul is growing bigger. Since 2009, Seocho-gu's child dependency ratio also has exceeded Seoul's child dependency ratio. From this, it can be inferred that there are comparatively many young residents in Seocho-gu. Then I wondered, how much is Seocho-gu younger than Seoul? What is the youngest neighborhood with in Seocho-gu? These two questions have to do with data on population mortality. Difference between born population and population mortality in Jamwon-dong, my neighborhood, for instance, was 311 (424 born and 113 dead) which was over the whole population of another district, Jongro-gu. I guess analysis on Seoul and its statistics can go on further but I decided to stop here since my purpose was to analyze Seoul overall.

Province	B-D	Number of Birth(B)			Number of Death(D)		
		Sun	Male	Female	Sum	Male	Female
Chongro	269	1,103	561	542	834	508	326
Chung	439	1,105	550	555	666	398	268
Yongsan	1,213	2,309	1,190	1,119	1,096	633	463
Sungdong	1,524	2,776	1,437	1,339	1,252	702	550
Gwangjin	1,925	3,184	1,615	1,569	1,259	708	551
Dongdaemoon	1,162	2,947	1,484	1,463	1,785	1,069	716
Jungrang	1,560	3,450	1,777	1,673	1,890	1,084	806
Seongbook	2,346	4,414	2,315	2,099	2,068	1,204	864
Gangbook	1,105	2,789	1,421	1,368	1,684	989	695
Dobong	1,462	3,005	1,564	1,441	1,543	893	650
Nowon	2,627	5,063	2,560	2,503	2,436	1,334	1,102
Eunpyung	2,205	4,318	2,167	2,151	2,113	1,221	892
Seodaemoon	948	2,368	1,171	1,197	1,420	840	580
Mapo	2,244	3,859	1,917	1,942	1,615	945	670
Yangcheon	2,029	3,727	1,997	1,730	1,698	905	793
Gangseo	3,507	5,753	2,937	2,816	2,246	1,245	1,001
Guro	3,050	4,633	2,369	2,264	1,583	919	664
Geumcheon	846	1,927	952	975	1,081	634	447
Yongdeungpo	2,429	4,050	2,000	2,050	1,621	957	664
Dongjak	2,284	3,837	1,964	1,873	1,553	855	698
Gwanak	2,784	4,729	2,418	2,311	1,945	1,105	840
Seocho	2,877	4,190	2,167	2,023	1,313	702	611
Gangnam	3,123	4,761	2,448	2,313	1,638	798	840
Songpa	4,371	6,574	3,444	3,130	2,203	1,145	1,058
Gangdong	2,877	4,655	2,428	2,227	1,778	977	801
Sum	51,206	91,526	46,853	44,673	40,320	22,770	17,550

2) Golden Ratio

There is a ratio of width to height that people find beautiful and this ratio is called golden ratio. The golden ratio can be found commonly in our daily lives and a golden quadrangle is a quadrangle that fulfills the condition below.

(length of the shorter side):(length of the longer side)
= (length of the longer side):(length of the shorter side + length of the longer side

Let the length of the shorter side be *x* and the length of the longer side be *y*.

$$x : y = y : x + y$$
$$y2 = x(x + y)$$
$$y2 - xy - x2 = 0$$

Since *x*>0, we can divide the equation above by x^2.

$$(y/x)2 - (y/x) - 1 = 0$$
$$\frac{y}{x} = (1 \pm \sqrt{5})/2$$

Since *y/x* >0,

$$\frac{y}{x} = (1 + \sqrt{5})/2$$
$$\sqrt{5} \sim 2.236$$
$$\frac{y}{x} = (1 + \sqrt{5})/2 \sim 1.618$$

Therefore, a ratio of a golden quadrangle's length of the shorter side to the length of the longer side is 1:1.618.
Below is a table of ratios of lengths of sides of commonplace stuff.

Kind	Height	Width	Height/ Width
School Window	1.9cm	2.94cm	1.55
Parking Sign	30cm	45cm	1.5
School Sports Zone Sign	33cm	48cm	1.45
Children Protection Zone Sign	8.5cm	15.3cm	1.8
Elevator Mirror	48.5cm	78cm	1.61

Figure 6 School windows

The height of the school window was 1.9cm and the width of the window was 2.94cm. The ratio between those two lengths was 1.55 and close to the golden ratio.

Figure 7 Parking Lot Sign

The height of the parking lot sign one the school fence was 30cm and the width was 45cm. The ratio between those two lengths was 1.5, close to the golden ratio.

Figure 8 School Sports Zone Sign

The school sports zone sign had a height of 33cm and a width of 48cm. The ratio between these two numbers was about 1.5 and was close to the golden ratio.

Traffic signs including the children protection zone sign seemed to be maintaining a constant size but since they were all held high by street lights, I could not measure the lengths of the sides of the traffic signs. With a ruler, I estimated the width and the height of the children protection zone sign like I am doing in the picture beside. Even though I could not get the accurate lengths, I could still conclude that the ratio of the height to the width is pretty close to the golden ratio.

Figure 9 Children Protection Zone Sign

The ratio of the height to the width was close to the golden ratio.

3) The Highest and the Lowest Spots in Seoul

I did some research on internet before I actually went out to measure the depths and heights of places. Before I did the research, I expected 63 Building or Seoul N Tower to be the highest in Seoul. According to Naver Encyclopedia, however, Dogok Tower Palace and Mokdong Hyperion were higher than 63 Building each with height of 264m and 256m. The 63 Building and the N Tower, on the other hand, were not as tall as I had expected; the 63 Building happened to be 249m tall and the N tower, including the small steel tower on top, happened to be only about 236.7m. When I took the heights of the buildings from the sea level instead of the ground in to consideration, though, the N Tower was the clearly highest since it is on Namsan Mountain. When the height of the mountain itself from the sea level was 265m, the height of the 63 Building from the sea level was 264m and even though I could not find the exact height of the Tower Palace from the sea level, it could be easily inferred that the distance from the ground Tower Palace lies on to the sea level is less than 30m, the height of the Namsan Mountain. Therefore, I chose the N Tower as the highest place in Seoul to measure its height.

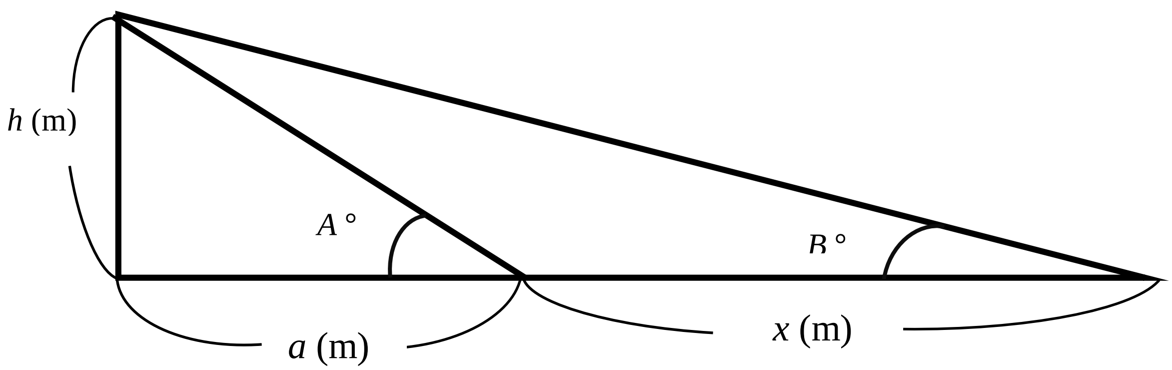
Unlike finding the highest building in Seoul, finding the lowest spot was hard and I did not gain much credible information from the internet. Some people listed the Yeouinaru Station as the lowest place with the most depth, and then Line 8 Sanseong Station and Line 6 Beotigogae Station as the second and third. I could not find any evidence to support this ranking, though, and I decided to measure just the depth of the Line 6 Beotigogae Station instead of measuring the depths of all three stations.

In order to measure the depth and the height of the places, I made a protractor with a pendulum myself. First, I got a plastic protractor and I made a hole at the middle point of the bottom line of the protractor with a heated needle. Afterwards, I put a thread through the hole to hang a pendulum. In my case, I used a nail clipper as a pendulum. I wrapped the cylindrical metal part of the nail clipper which connects a nail clipper's upper body and the lower body with the thread and the roundness of the cylinder somewhat minimized the friction between the pendulum and the thread. With decreased friction, I could increase the pendulum's movement by gravity.

Figure 10 Making the Protractor with a Pendulum

a. Height of the Seoul N Tower

According to internet, N Tower’s altitude is 479.7m and its steel tower and its main body are each 101m tall and 135.7m tall. To measure the height, myself, I used trigonometry and the picture below. Let the height of N Tower be *h* (m), the distance between random two points aligned with the tower *x* (m) and the upward angles from those two points be *A*° and *B*°.



$$\begin{cases} h = \mathrm{a} * \tan(\mathrm{A}°) \\ h = (a + x) * \tan(B°) \end{cases}$$

I solved for a using the first equation and got

$$a = h/\tan(A°)$$

Substitute a in the second equation with the obtained a above.

$$h = \left(\frac{h}{\tan(A°)} + x\right) * \tan(B°)$$

$$h * tan(A°) = \left(h + x * tan(A°)\right) * \tan(B°)$$

$$h * \tan(A°) = h * \tan(B°) + x * \tan(A°)\tan(B°)$$

$$h * (\tan(A°) - \tan(B°)) = x * \tan(A°)\tan(B°)$$

$$h = \frac{xtan(A°)\tan(B°)}{\tan(A°) - \tan(B°)}$$

To measure *x* (m), *A*°, *B*°, I went up to the top of Namsan Mountain by electric bus. Unfortunately, once I got to the highest observatory, there were lots of people and it was hard to find enough space where I can measure the distance x and upward angles $A°$and $B°$. More than anything, the tip of the main body of the tower was somewhat out of sight from the observatory that it was almost impossible to measure the upward angles. Other areas a little off from the observatory were too far away from the bottom of the tower, though, that I found measuring angles and the distance at those places meaningless. So, I stayed at the observatory and made my measurements there. At first, I tried to use a measuring tape to measure the distance. Within 5m, the furthest the measuring tape could reach, the tip of the tower could not be seen, though, and for two points further apart than 10m, there was no such straight path where the ruler could be used. So I tied a string around one end of a guardrail which I picked as one of the two points and then cut it at the other point that I chose. I measured the length of the string once I got home.

Figure 11 Using a Measuring Tape (above)

/ Using a string (below)

The measured length of the string was 21m 70cm. Sadly, I was still unable to calculate the height of the main body of the tower after attaining the distance *x*. Despite my effort to find spots where the tip of the tower becomes visible, the tip of the main body of the tower was totally masked by the round part of the part below the steel tower as seen below.

Figure 12 Seoul N Tower

After I realized this unfeasibility, my second plan was to measure the distance of the red line drawn on the picture above. The upward angle to the round part of the tower was 82°. Using this angle, the calculated length of the red line was

$$21.7\ (\mathrm{m}) * \tan(82°) \sim 21.7 * 7.1 = 154.07\ (m)$$

The calculated value above was way too bigger than the height of the main body of the tower on internet which was 137.5m. The inaccuracy in the angle probably attributed the most to the gap between the calculated value and the actual value.

Now to measure the whole height of the tower including the steel tower on top, I measured the upward angle at the same place I measured the angle above and got *A*=86°. 3m away from the point where I measured *A*°, I measured the other upward angle to the top of the steel tower *B*° and got 85°.

$$\mathrm{h} = \frac{xtan(A°)\tan(B°)}{\tan(A°) - \tan(B°)}$$
$$= \frac{3\tan(86°)\tan(85°)}{\tan(86°) - \tan(85°)}$$
$$\sim \frac{3 * 14.3 * 11.4}{14.3 - 11.4}$$
$$= 168.6\ (\mathrm{m})$$

If I add my height, 160cm, to this calculated value, I get 170.2m and this also had a significant gap between the acutal value on internet, 236.7m. I measured the upward angles by aligning my sight and the tip of the steel tower with the bottom line of the prosecutor (Figure 8). Probably because my arm was not fixed, the upward angles were imprecise. From this experience, I learned that one needs an accurate measuring instrument to measure a height of a building. The inaccuracy of these measurements also made me question what kind of a machine Tales would have used to measure the height of the pyramids.

Figure 13 Measuring the Angles

b. Depth of the Escalator at Beotigogae Station
   As I did to calculate the height of the Seoul N Tower, I used the protractor with a pendulum to measure the slope of the escalator at Beotigogae Station.

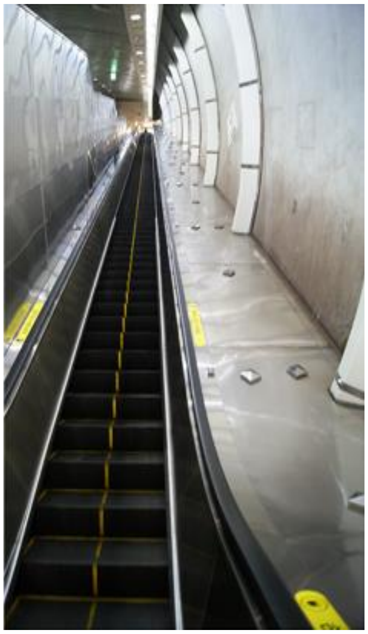
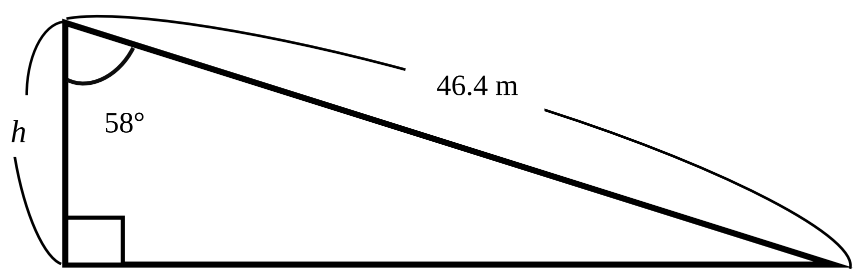


Figure 14 Escalator at Beotigogae Station

The escalator’s constantly moving made it impossible to measure the slope of the escalator on the escalator; due to inertia, the angles measured on the escalator were larger than the actual slope of the escalator. Instead of measuring the angle on the escalator, I used the stairs next by the escalator to measure the slope and measuring angles at four different places on the stairs, I got 57°, 58°, 59° and and 58°. Unlike I expected the stairs to be parallel to each other, the stairs were not and I used the average of those four values as the slope of the escalator.

Figure 15 Measuring the Angles at the Stairs

In order to measure the length of the escalator, I then asked one person to hold a string at the end of an escalator and unraveled the string slowly as the escalator went up. After I got home, I cut the string by 2m and the string turned out to be 46.4m. Using trigonometry I learned in 8^{th} grade, I calculated h.



$$46.4\text{m} * \cos(58°) \sim 24.6\text{m}$$

In order to check the accuracy, I requested the depth of the escalator on the information desk at the station. The officer at the desk called somewhere and told me that the station is 43m deep. The actual depth was almost twice the calculated depth. This time, it was unlikely that the inaccuracy came from the measurement of angles. Not only I measured the angle four times, even if the angle was 57°, there would not have been much a difference in the calculated height. (If the angle was 57°, the height would be 25.3m). I also considered my grabbing the thread loose as a factor of inaccuracy but that was also unlikely since the calculated value was lower than the actual value. I wondered if the information the officer had given me was inaccurate and decided to try another method to measure the depth.

Figure 16 Measuring the Height of the Stairs

The stairs in whole were composed of three stacks of fifteen stairs and five stacks of sixteen stairs. I measured the few stairs' heights of the first stack and the heights were in a range of 15.7cm~18.4cm. Using this range, I found a range of the depth of the escalator.

$$125 * 15.7\ \mathrm{cm} \le \mathrm{h}\ \le 125 * 18.4\ \mathrm{cm}$$

$$19.6\ \mathrm{m}\ \le \mathrm{h}\ \le 23.0\ \mathrm{m}$$

The range was a little too wide that I decided to look for another way to measure the depth. The third method I came up with was to use the heights of the steps of the escalator. At the top end of the escalator, I cued a person to get on the escalator and I counted the number of steps of the escalator until the person got to the top. Out of 120 steps I counted, I excluded 6, 3 level steps from each end, and the height of a step of the escalator was 20.3cm.

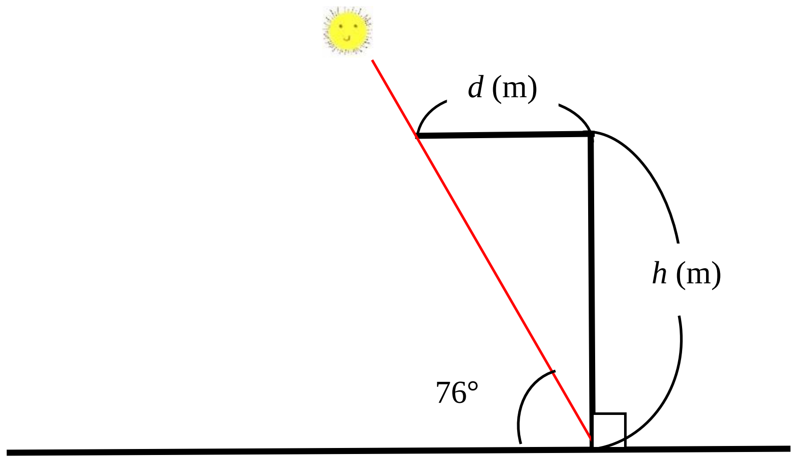
$$\mathrm{h} = 114 * 20.3\ \mathrm{cm} \sim 23.1\mathrm{m}$$

As the results I obtained from three different results were about the same, I was sure that the information the officer had given me was wrong. When I had asked him the depth of the escalator, it seemed like he had given me the distance from the ground to the very bottom floor of the station.

4) Wisdom in Lengths of Eaves
Last summer, my mom's friend from America and I went to Deoksugung Palace. As we looked around the palace, the guide told us how wise our ancestors were to build such an efficient palace back in the days and I came to wonder what the guide meant by the word efficient. Soon I was able to find out what he meant because the weather got torrid real quick. Unlike outside the palace, inside was really cool and filled with brisk wind. I was surprised by how architectural features could block heat and absorb wind so efficiently and we just sat at the stairs at the palace gazing around. Lift-up-doors seemed to really open out the palace, letting the wind in, and eaves formed shadows, blocking the heat and sunlight. I decided that I want to find out the ideal ratio of the length of eaves to the height of the palace.

Figure 17 Deoksugung Palace

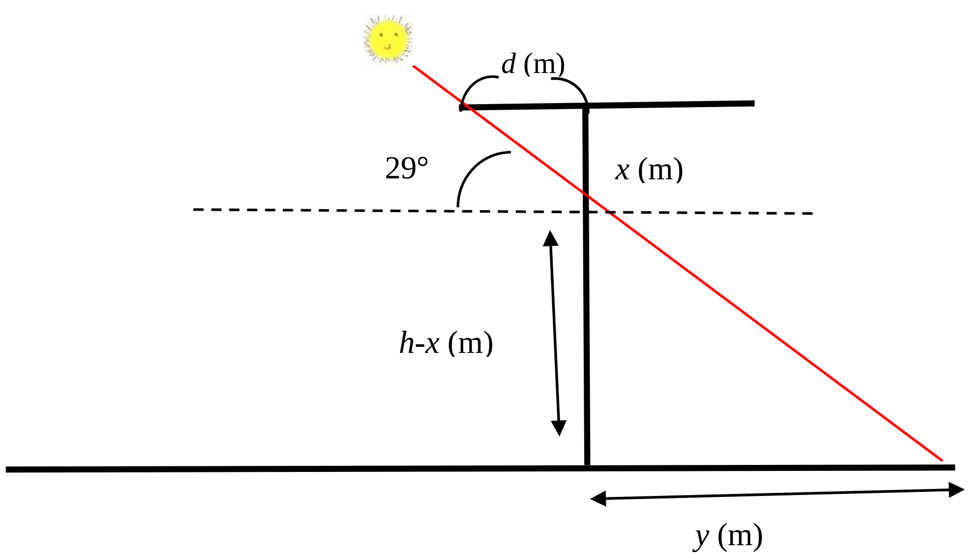
Eaves not only block rain but also regulate the amount of sunlight entering the buildings, keeping the building cool and pleasant. To fulfill this role of letting in the least sunlight during summer, lengths of eaves is probably the most important factor, more crucial than other features of eaves like shapes of the eaves. Since Seoul's latitude is 37.5°, its meridian transit altitude during summer would be $90° - 37.5° + 23.5° = 76°$. Let the height of the building be h (m) and the length of eaves d (m).



$$d = h * \tan(90° - 76°) \sim 0.25h$$

Since I could not risk of damaging a cultural asset, I could not find out the actual height of the palace. I just assumed the height to be 3m, and got 75cm as the length of the eaves that would block the sunlight the most during summer. Since the floor of the palace sticks out 60~70cm from the outermost wall, the efficient length of the eaves for the palace would be 135~145cm.

To extend, I asked myself what might be the efficient positions of windows and doors to let in the most sunlight during winter. I used the same method I did above to answer this question. The meridian transit altitude on winter's solstice in Seoul is $90° - 37.5° - 23.5° = 29°$. Let the length of eaves *d* (m) and the distance between windows and the ceiling *x* (m).



$$x = d * \tan(29°) \sim 0.55d = 0.55 * 0.25h \sim 0.14h\ (m)$$

$$y = (h - x)\tan(90° - 29°) \sim 1.8(h - x) \sim 0.86h * 1.8 \sim 1.5h$$

Therefore, for a building that is 3m tall, it would be best to place windows or doors at $0.86 * 3 \sim 2.6\ (\mathrm{m})$. That way, sunlight would reach as far as $1.5 * 3 = 4\ (\mathrm{m})$ inside the building and the building would no loss of sunlight during winter. Now for the palace, since the length of the eaves was around 140cm, $\mathrm{x} = 0.55\mathrm{d} = 0.55 * 140 = 77\ (\mathrm{cm})$ and the door would be around 223cm high.

5) Geometrical Beauty of Buildings

As even simplest part of an architecture like the length of eaves requires math, one can infer how important math is in building buildings. In this part, I decided to look for geographical configurations and patterns used on buildings' faces or outer walls. Since there are so many buildings in Seoul, I could not adventure through every part of the city, though. So I used my own pictures and Naver images for latter pictures.

Figure 18 Danchung Patterns

According to Newsis, Italian artist Laura Carraro applauded at the geometrical shapes and vivid colors of Danchung patterns and said that the patterns would look great in European buildings. (Newsis, 2011-07-04)

Figure 19 Gangnam Prugio Valley

This building, nearby my neighborhood, used concentric circles of various sizes.

Figure 20 Shinsa Street Buildings

Many buildings in my neighborhood have unique geometrical features. The one on very left uses round faces and straight lines. The middle one has small rectangular parallelepipeds taken out from a big rectangular parallelepiped. The one right uses quadrangles and lines.

Figure 21 S-Oil Building Using A Line (Naver Image)

Figure 22 Donga Building Using Circles (Naver Image)

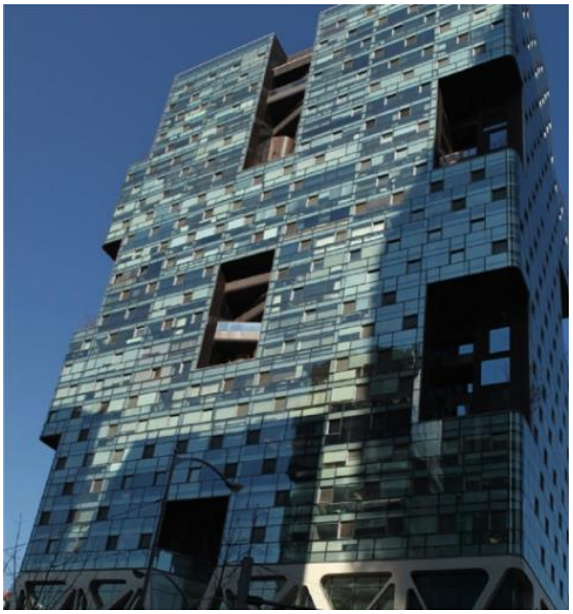


Figure 24 Uses Rectangular Parallelepipeds to Bring Out 3-D (Naver Image)

Figure 25 Hanskin Building Using Circles (Naver Image)

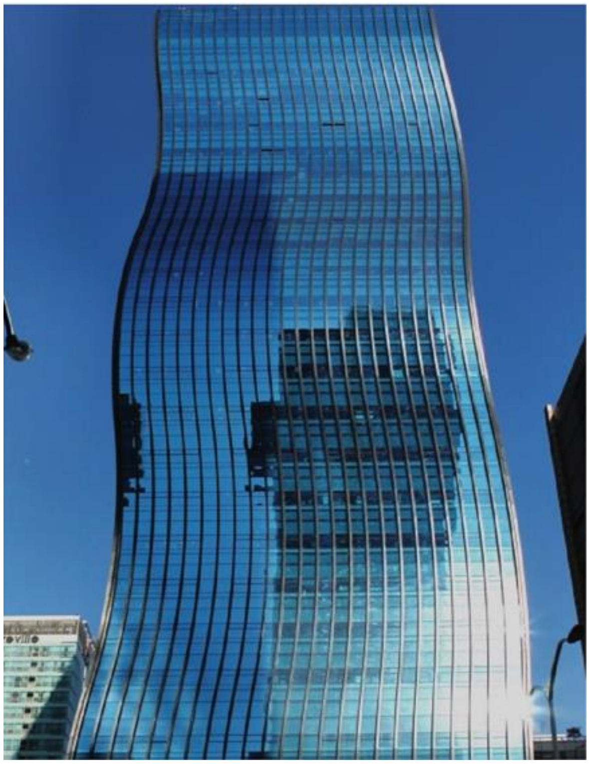


Figure 23 Gt Tower Using Curves

Figure 26 International Building Using A circle And Lines (Naver Image)

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