



The Selection Of The Best City To Live

Hierarchical Model

Team 5

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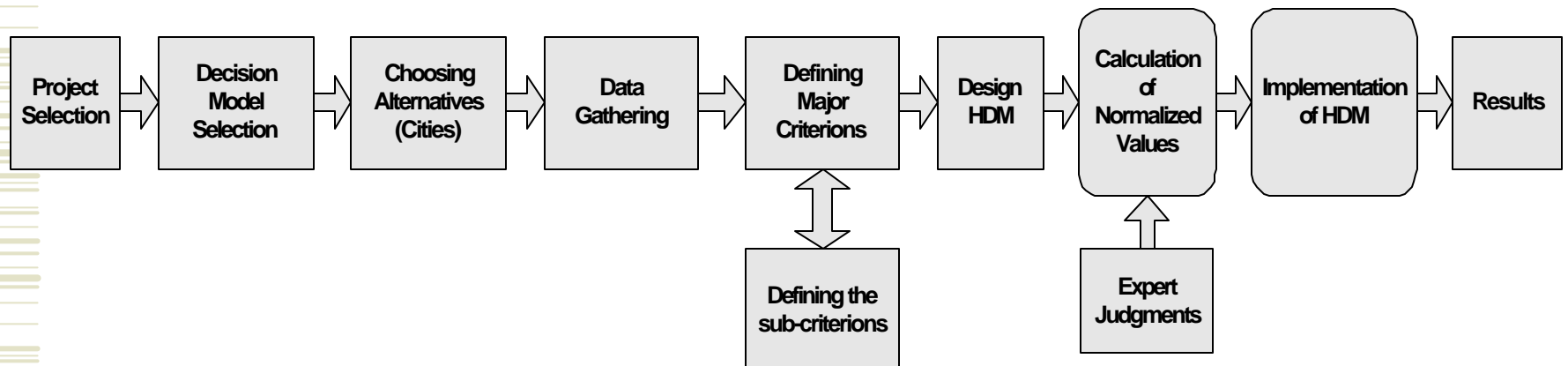


Agenda



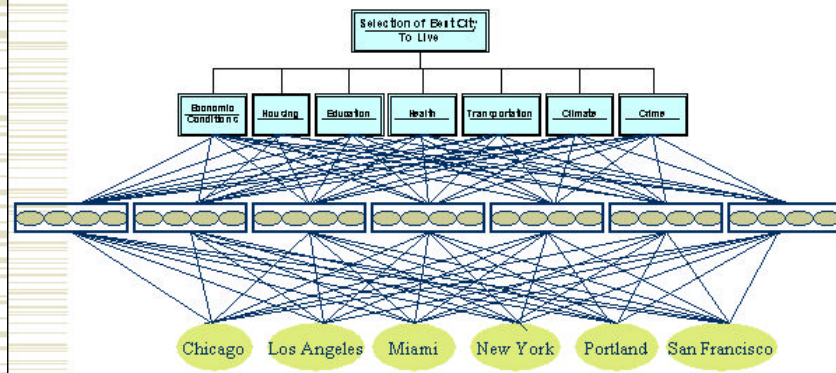
- ◆ Problem Statement
- ◆ Methodology
- ◆ Model Assumptions
- ◆ Decision Model
- ◆ Results
- ◆ Model Improvements
- ◆ Conclusion

Methodology

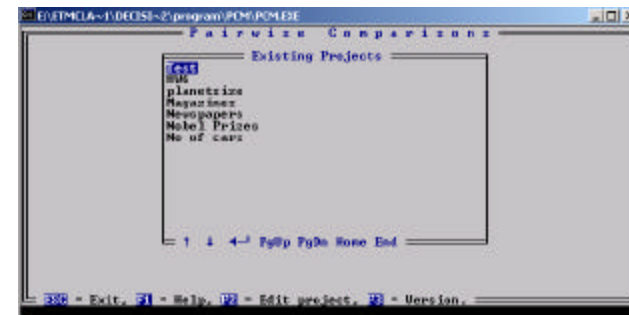


Decision-Making Tools

Hierarchy Decision Model



Pairwise Comparison PCM program



(S1)	(S2)	(S3)	(S4)	(S5)	(S6)	(S7)	(S8)
0.09	0.10	0.06	0.21	0.09	0.14	0.18	0.15

X

	New York	Portland	Los Angeles	San Francisco	Chicago	Miami
S1	0.11	0.20	0.16	0.12	0.19	0.22
S2	0.17	0.19	0.15	0.19	0.17	0.13
S3	0.19	0.16	0.19	0.13	0.19	0.14
S4	0.15	0.20	0.14	0.21	0.14	0.16
S5	0.12	0.19	0.18	0.12	0.21	0.19
S6	0.23	0.14	0.13	0.18	0.18	0.15
S7	0.14	0.14	0.21	0.20	0.11	0.20
S8	0.23	0.15	0.20	0.21	0.11	0.10

=

Los Angeles	0.17256
Portland	0.17038
Miami	0.17266
San Francisco	0.18722
New York	0.15549
Chicago	0.16562

C = DECISION

Matrix Calculations

Problem Statement

- ◆ Determining the best city to live for 4 different profiles
 - The Single College Student
 - The Married couple w/out Kids
 - The Married couple w/ Kids
 - The Retiree



Model Assumptions



- ◆ Only 6 cities as alternatives
- ◆ No outside influence (such as relatives)
- ◆ No Recreation, Art and Culture criteria

Profile - Single College Student

Preferences

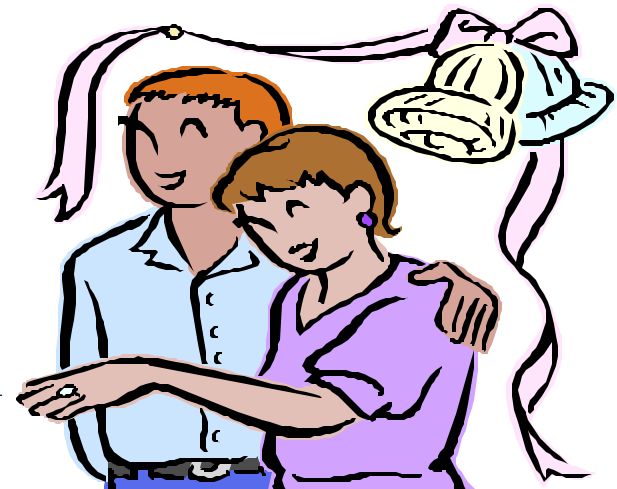
- ◆ Better economic conditions (e.g. cost of living)
- ◆ Climate (e.g. # of sunny days)
- ◆ Less expensive housing
- ◆ Good transportation system



Profile- Married Couple w/out Kids

Preferences

- ◆ Less expensive housing
- ◆ Low health cost
- ◆ Low crime rate
- ◆ Good transportation system



Profile- Married Couple w/ Kids

Preferences

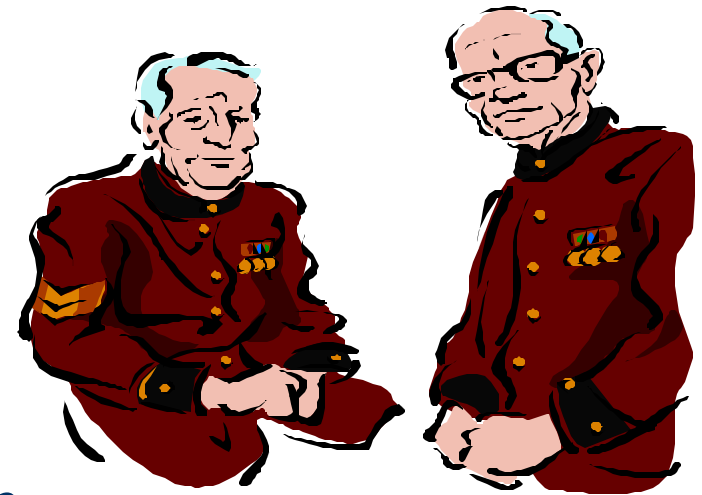
- ◆ Good education possibilities
- ◆ Better economic conditions
- ◆ Low crime rate
- ◆ Low home cost



Profile- Retiree

Preferences

- ◆ Good health system
- ◆ Sunny climate
- ◆ Low crime rate
- ◆ Good transportation system



Decision Alternatives

- ◆ We determined six cities as our decision alternatives that are among the most popular cities in the United States.



Chicago



Los Angeles



Miami



Portland



New York



San Francisco

Data Gathering

- ◆ Source: www.bestplaces.net, its database is used by CNN.com
- ◆ Statistical information of 3000 city profiles

The screenshot shows the Sperling's BestPlaces website. At the top, there's a banner for "Stressful Cities" with a city skyline background and a link to "Click here for our full report...". Below this is a navigation bar with links: HOME, CITIES, CRIME, CLIMATE, COST OF LIVING SALARY CALC., FIND YOUR BEST PLACE, SCHOOLS, and ABOUT US. A secondary bar contains "What's New", "Reviews", "Articles", "Partner with BestPlaces.net", "Sign Up!", and "Email Us". The main content area is divided into several sections. On the left, there's a "City info" section with links to "City Profiles", "Compare two cities", "Sort on a category", and "Notes". Below this is a "Cost of Living calc" section with "Start", "Help", and "Notes" links. Then a "School statistics" section with "Start", "Help", and "Notes" links. Next is a "Best Place finder" section with "Quick version", "Full version", "Help", and "Notes" links. Finally, a "Crime" section with "City crime rates", "MSA crime rates", "Compare two cities", and "Sort on a category" links. The main content area also features a large "Sperling's BestPlaces" logo. To the right of the logo, there are three featured articles: 1. "NEW! Now with 3,000 City Profiles" with a description about comparing cities in housing, costs of living, crime, education, economy, health and climate. 2. "NEW! Cost of Living and Salary Calculator" with a description about moving from Walla Walla to Wall Street and an exclusive tool. 3. "NEW! School Statistics" with a description about getting facts on 87,000 U.S. public schools in 16,000 districts. Each article has a small icon and a "Get the inside story..." link.

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Best Place finder
[Quick version](#)
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Crime
[City crime rates](#)
[MSA crime rates](#)
[Compare two cities](#)
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NEW! Now with 3,000 City Profiles
Compare cities in housing, costs of living, crime, education, economy, health and climate. Choose any two cities and see them displayed side-by-side.

NEW! Cost of Living and Salary Calculator
Moving from Walla Walla to Wall Street? Our exclusive tool show you how much you'll need to earn to maintain that wild wild Walla Walla lifestyle.

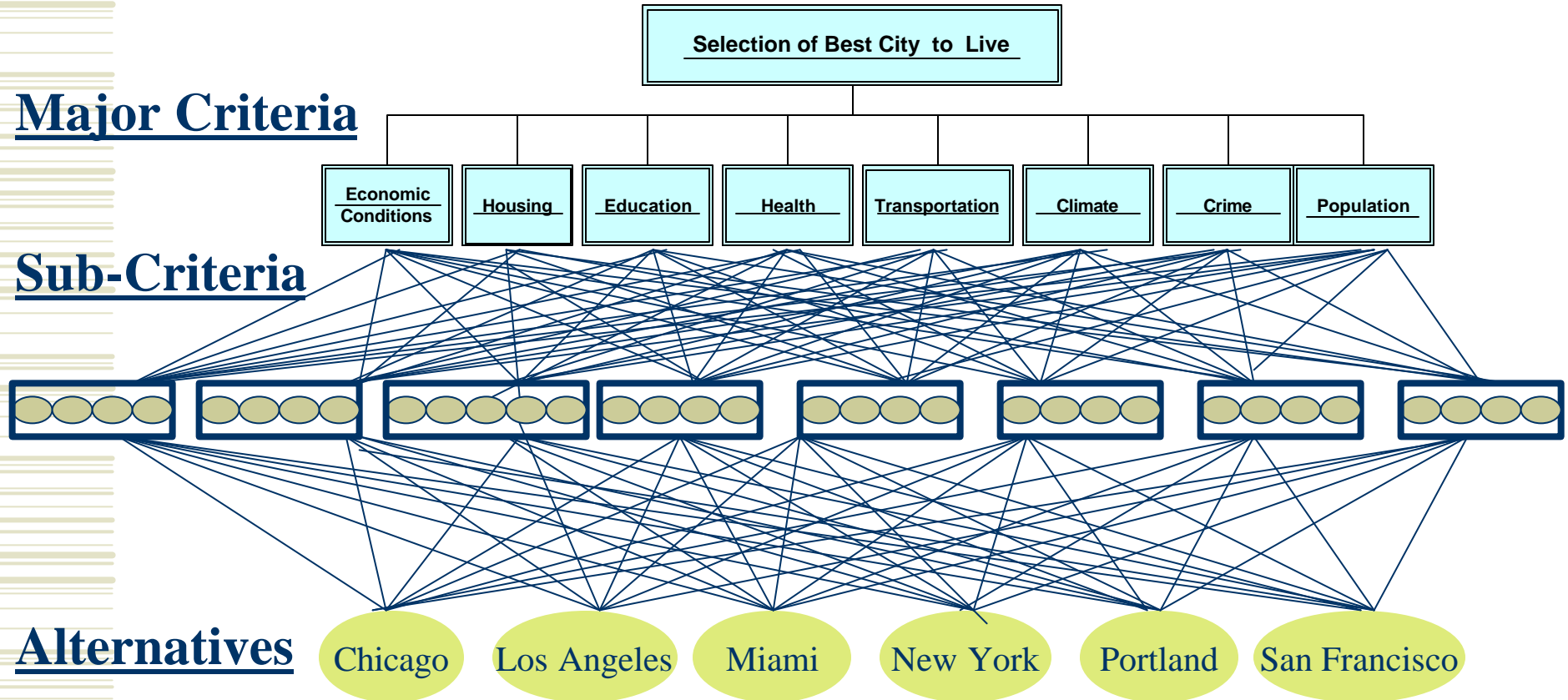
EXCLUSIVE! Find your Best Place to Live

Get the inside story...
Click here to [learn more](#) about Bert Sperling and his work on "Best Places."

NEW! School Statistics
By popular demand! Get the facts on 87,000 U.S. public schools in 16,000 districts. Find the school which best meets the needs of your student.

Decision Model (HDM)

- ◆ 8 major criteria, 33 sub-criteria in total.



Sub-Criteria

Economic Conditions

- Cost of living
- Low Sale Income & Tax Rate
- Job Growth
- Unemployment Rate

Housing

- Median Home Cost
- Home Appreciation
- Property Tax Rate
- Home Cost Index

Climate

- Temperature
- Rainfall
- Sunny Days
- Comfort Index

Health

- Air Quality
- Water Quality
- Physicians Per Capita
- Health Cost Index

Transportation

- Commute Time
- Carpool
- Mass Transit
- Bike or Walk

Crime

- Murder
- Robbery
- Burglary
- Auto-Theft

Education

- High School Graduates
- 4 year College Graduates
- Highly Educated People (MS-PhD Graduates)
- School Expenditures
- Student/Teacher Ratio

Population

- Population Range
- Population Density
- Population Change
- Median Age

Measurement 1

Relative importance of each major criterion

By using PCM software, we calculated the following values for each profile.

Profiles

Single College Student

Couple without Kids

Couple with Kids

Retiree

Economic Conditions	Education	Population	Health	Housing	Transportation	Climate	Crime
0.2	0.06	0.07	0.11	0.16	0.14	0.18	0.08
0.23	0.07	0.09	0.12	0.19	0.14	0.07	0.1
0.17	0.15	0.07	0.11	0.13	0.11	0.1	0.16
0.09	0.1	0.06	0.21	0.09	0.14	0.18	0.15

Measurement 2 – Relative weights for each sub-criterion

Major Criterion : Economic Condition



Profiles

Single College Student

Couple without Kids

Couple with Kids

Retiree

Cost of living	Low Sales + Income Tax Rate	Job Growth	Unemployment Rate
0.35	0.34	0.13	0.19
0.31	0.14	0.28	0.27
0.30	0.22	0.21	0.26
0.59	0.21	0.10	0.09

Measurement 2 Cont. –

Relative weights for each sub-criterion

Major Criterion : Education



Profiles

Single College Student

Couple without Kids

Couple with Kids

Retiree

High School Graduates	Four Year Graduates	MS-PHD Graduates	School Expenditures	Student Teach Ratio
0.31	0.22	0.14	0.12	0.2
0.32	0.15	0.12	0.19	0.23
0.12	0.11	0.18	0.28	0.32
0.09	0.26	0.35	0.12	0.18

Measurement 2 Cont. –

Relative weights for each sub-criterion

Major Criterion : Health



Profiles

Single College Student
Couple without Kids
Couple with Kids
Retiree

Health Cost Index	Physicians Per Capita	Water Quality	Air Quality
0.23	0.22	0.36	0.19
0.31	0.16	0.25	0.27
0.33	0.22	0.20	0.15
0.20	0.33	0.24	0.24

Measurement 2 Cont. –

Relative weights for each sub-criterion

Major Criterion : Housing



Profiles

Single College Student
Couple without Kids
Couple with Kids
Retiree

Median Home Cost	Home Appreciation	Property Tax Rate	Home Cost Index
0.30	0.12	0.33	0.25
0.31	0.21	0.21	0.27
0.33	0.24	0.20	0.22
0.30	0.18	0.19	0.33

Measurement 2 Cont. –

Relative weights for each sub-criterion

Major Criterion : Transportation



Profiles

Single College Student

Couple without Kids

Couple with Kids

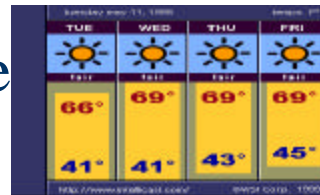
Retiree

Commute Time	Carpool	Mass Transit	Bike or Walk
0.28	0.14	0.25	0.33
0.21	0.16	0.15	0.48
0.31	0.16	0.19	0.34
0.30	0.24	0.34	0.12

Measurement 2 Cont. –

Relative weights for each sub-criterion

Major Criterion : Climate



Profiles

Single College Student

Couple without Kids

Couple with Kids

Retiree

Temperature	Rainfall	Sunny Days	Comfort Index
0.23	0.11	0.32	0.35
0.25	0.17	0.28	0.30
0.30	0.22	0.29	0.19
0.30	0.24	0.37	0.10

Measurement 2 Cont. – Relative weights for each sub-criterion

Major Criterion : Crime

Profiles



Single College Student

Couple without Kids

Couple with Kids

Retiree

Murder	Robbery	Burglary	Auto-Theft
0.25	0.4	0.19	0.16
0.35	0.22	0.20	0.23
0.36	0.24	0.23	0.17
0.48	0.20	0.22	0.10

Measurement 2 Cont. –

Relative weights for each sub-criterion

Major Criterion : Population



Profiles

Single College Student

Couple without Kids

Couple with Kids

Retiree

Population Range	Population Density	Population Change	Median Age
0.22	0.33	0.19	0.26
0.18	0.31	0.19	0.33
0.21	0.35	0.23	0.21
0.21	0.33	0.23	0.22

Example of Relative Values

Physicians per capita

The number of physicians in the county per 100,000 population.

Relative Value defined using ratio- scale measurements of 100 points

1-550+, 550+ to be best.

Physicians per capita	Relative Value
1-100	10
101-150	20
151-200	30
201-250	40
251-300	50
301-350	60
351-400	70
401-450	80
501-550	90
550+	100
US Average = 230	

How to normalize relative values

Every sub-criterion's relative value is normalized.

R_i = Relative value of a city's actual value for a sub-criterion

n

$\sum_{i=1}^n R_i$: The sum of relative values

i

$n = 1, 2, 3, 4, 5, 6 ; i = 1$

Cities	Relative Values (R_i)	Normalized Values
New York, NY	R_1	$R_1 / \sum_{i=1}^n R_i$
Portland, OR	R_2	$R_2 / \sum_{i=1}^n R_i$
Los Angeles, CA	R_3	$R_3 / \sum_{i=1}^n R_i$
San Francisco, CA	R_4	$R_4 / \sum_{i=1}^n R_i$
Chicago, IL	R_5	$R_5 / \sum_{i=1}^n R_i$
Miami, FL	R_6	$R_6 / \sum_{i=1}^n R_i$
Total:	$\sum_{i=1}^n R_i$	$\sum_{i=1}^n \frac{R_i}{\sum_{i=1}^n R_i} = 1.00$

Example of Normalized Values

Physicians per capita

Cities	City Values	Relative Value	Normalized
New York, NY	273	50	0.13
Portland, OR	396	70	0.18
Los Angeles, CA	240	40	0.11
San Francisco, CA	564	100	0.26
Chicago, IL	328	60	0.16
Miami, FL	304	60	0.16
USA Average	230	? =380	? =1

Measurement 3 – Normalized relative values of each city

Major Criterion : Economic Conditions

	<u>NY</u>	<u>PO</u>	<u>LA</u>	<u>SF</u>	<u>CH</u>	<u>MI</u>
Cost of living	0.12	0.19	0.17	0.11	0.21	0.21
Low Sales + Income tax rate	0.04	0.24	0.12	0.12	0.2	0.28
Job Growth	0.14	0.21	0.16	0.16	0.14	0.19
Unemployment	0.15	0.15	0.15	0.15	0.15	0.25

Measurement 3 Cont. – Normalized relative values of each city

Major Criterion : Education

	<u>NY</u>	<u>PO</u>	<u>LA</u>	<u>SF</u>	<u>CH</u>	<u>MI</u>
High School Graduates	0.16	0.19	0.16	0.19	0.16	0.14
Four Year Graduates	0.12	0.2	0.16	0.24	0.16	0.12
MS. - PhD Graduates	0.19	0.16	0.16	0.19	0.16	0.14
School Expenditures	0.21	0.17	0.15	0.15	0.17	0.15
Student Teacher Ratio	0.17	0.23	0.1	0.17	0.23	0.1

Measurement 3 Cont. – Normalized relative values of each city

Major Criterion : Health

	<u>NY</u>	<u>PO</u>	<u>LA</u>	<u>SF</u>	<u>CH</u>	<u>MI</u>
Health Cost Index	0.11	0.17	0.18	0.14	0.19	0.21
Physicians per capita	0.13	0.18	0.11	0.26	0.16	0.16
Water Quality	0.12	0.19	0.19	0.19	0.12	0.19
Air Quality	0.22	0.22	0.11	0.22	0.11	0.11

Measurement 3 Cont. – Normalized relative values of each city

Major Criterion : Housing

	<u>NY</u>	<u>PO</u>	<u>LA</u>	<u>SF</u>	<u>CH</u>	<u>MI</u>
Median Home Cost	0.1	0.21	0.15	0.07	0.25	0.23
Home Appreciation	0.2	0.13	0.2	0.2	0.13	0.15
Property Tax Rate	0.13	0.16	0.25	0.22	0.13	0.12
Home Cost Index	0.1	0.21	0.15	0.07	0.25	0.23

Measurement 3 Cont. – Normalized relative values of each city

Major Criterion : Transportation

	<u>NY</u>	<u>PO</u>	<u>LA</u>	<u>SF</u>	<u>CH</u>	<u>MI</u>
Commute Time	0.22	0.13	0.16	0.16	0.19	0.16
Carpool	0.1	0.17	0.19	0.19	0.19	0.21
Mass Transit	0.33	0.11	0.06	0.06	0.17	0.11
Bike or Walk	0.23	0.15	0.12	0.12	0.15	0.12

Measurement 3 Cont. – Normalized relative values of each city

Major Criterion : Climate

	<u>NY</u>	<u>PO</u>	<u>LA</u>	<u>SF</u>	<u>CH</u>	<u>MI</u>
Temperature	0.11	0.11	0.21	0.16	0.05	0.37
Rainfall	0.12	0.15	0.27	0.27	0.15	0.04
Sunny Days	0.17	0.1	0.21	0.21	0.14	0.17
Comfort Index	0.15	0.23	0.19	0.23	0.15	0.04

Measurement 3 Cont. – Normalized relative values of each city

Major Criterion : Crime

	<u>NY</u>	<u>PO</u>	<u>LA</u>	<u>SF</u>	<u>CH</u>	<u>MI</u>
Murder	0.24	0.11	0.18	0.25	0.09	0.13
Robbery	0.16	0.28	0.2	0.17	0.11	0.09
Burglary	0.26	0.12	0.24	0.19	0.13	0.07
Auto-Theft	0.26	0.15	0.2	0.17	0.12	0.09

Measurement 3 Cont. – Normalized relative values of each city

Major Criterion : Population

	<u>NY</u>	<u>PO</u>	<u>LA</u>	<u>SF</u>	<u>CH</u>	<u>MI</u>
Population Range	0.39	0.09	0.22	0.09	0.17	0.04
Population Density	0.07	0.22	0.2	0.17	0.17	0.17
Population Change	0.2	0.16	0.12	0.16	0.2	0.16
Median Age	0.15	0.15	0.23	0.09	0.23	0.15

Preference Function Results For Health Criterion

(S1)	(S2)	(S2)	(S4)
0.20	0.33	0.24	0.24

A

X

	IIV	PO	LA	SF	CH	MI
S1	0.11	0.17	0.18	0.14	0.19	0.21
S2	0.22	0.22	0.11	0.22	0.11	0.11
S3	0.13	0.18	0.11	0.26	0.16	0.16
S4	0.12	0.19	0.19	0.19	0.12	0.19

B

S1	Health Cost Index
S2	Physicians per capita
S3	Water Quality
S4	Air Quality

=

0.2	0.33	0.24	0.24	0.2	0.33
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C

Measurement 4 – Results : Decision of the Retiree

(S1)	(S2)	(S3)	(S4)	(S5)	(S6)	(S7)	(S8)
0.09	0.10	0.06	0.21	0.09	0.14	0.18	0.15



X

	New York	Portland	Los Angeles	San Francisco	Chicago	Miami
S1	0.11	0.20	0.16	0.12	0.19	0.22
S2	0.17	0.19	0.15	0.19	0.17	0.13
S3	0.19	0.16	0.19	0.13	0.19	0.14
S4	0.15	0.20	0.14	0.21	0.14	0.16
S5	0.12	0.19	0.18	0.12	0.21	0.19
S6	0.23	0.14	0.13	0.18	0.18	0.15
S7	0.14	0.14	0.21	0.20	0.11	0.20
S8	0.23	0.15	0.20	0.21	0.11	0.10



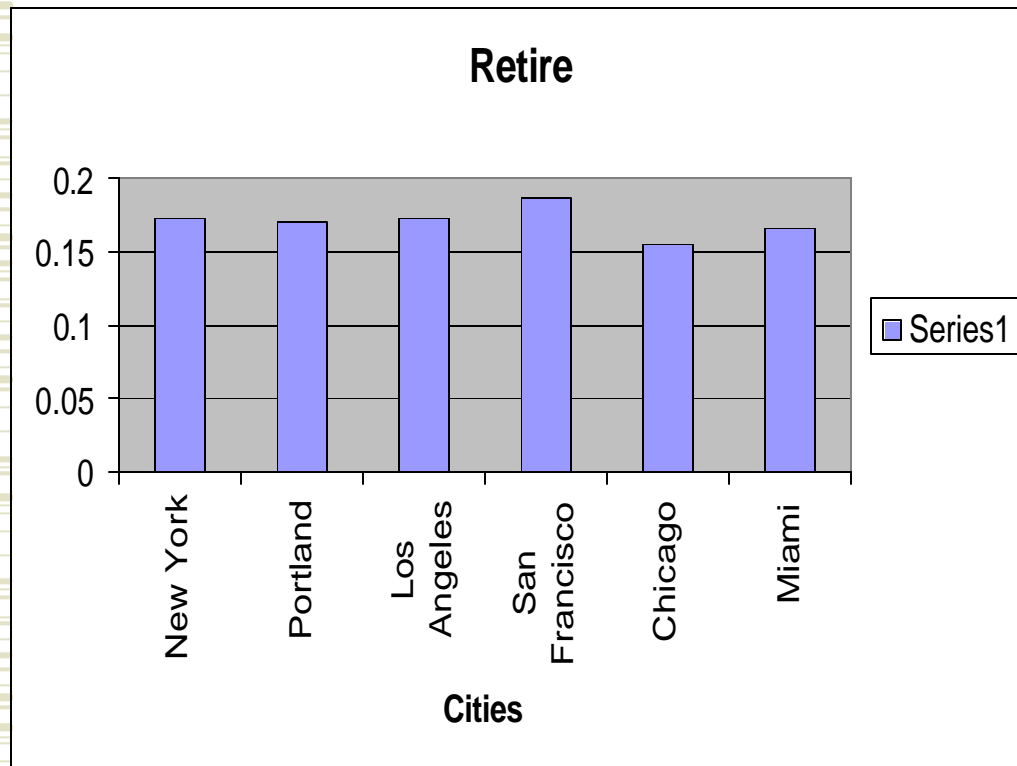
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Los Angeles	0.17256
Portland	0.17038
Miami	0.17266
San Francisco	0.18722
New York	0.15549
Chicago	0.16562

C = DECISION

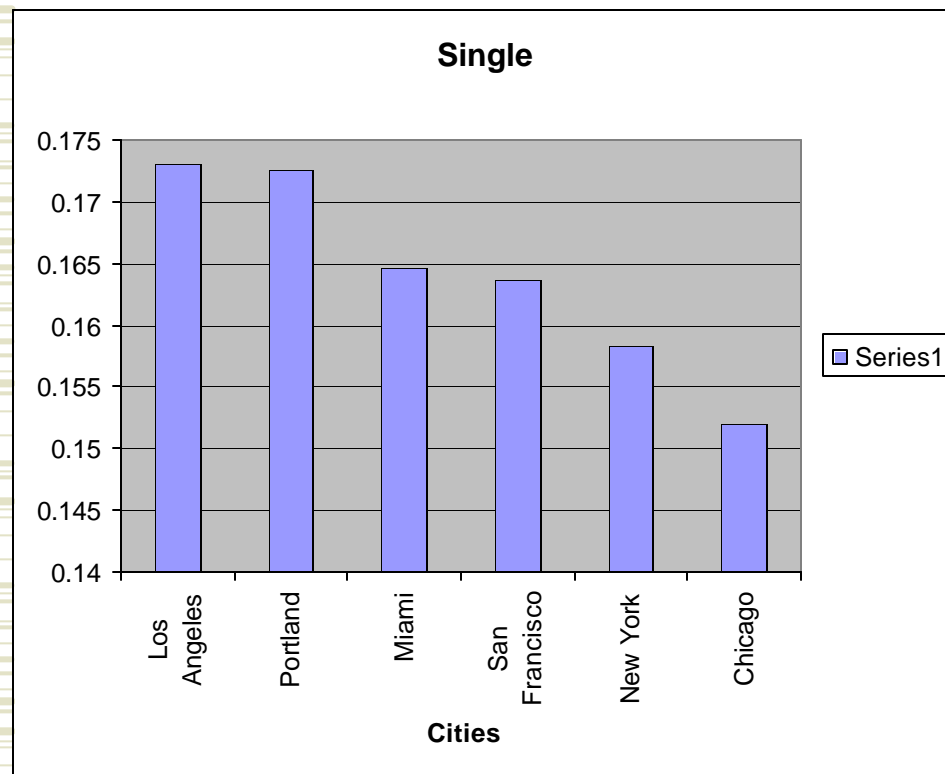
S1	Economic Conditions
S2	Education
S3	Population
S4	Health
S5	Housing
S6	Transportation
S7	Climate
S8	Crime

Results : Decision of the Retiree



Los Angeles	0.17256
Portland	0.17038
Miami	0.17266
San Francisco	0.18722
New York	0.15549
Chicago	0.16562

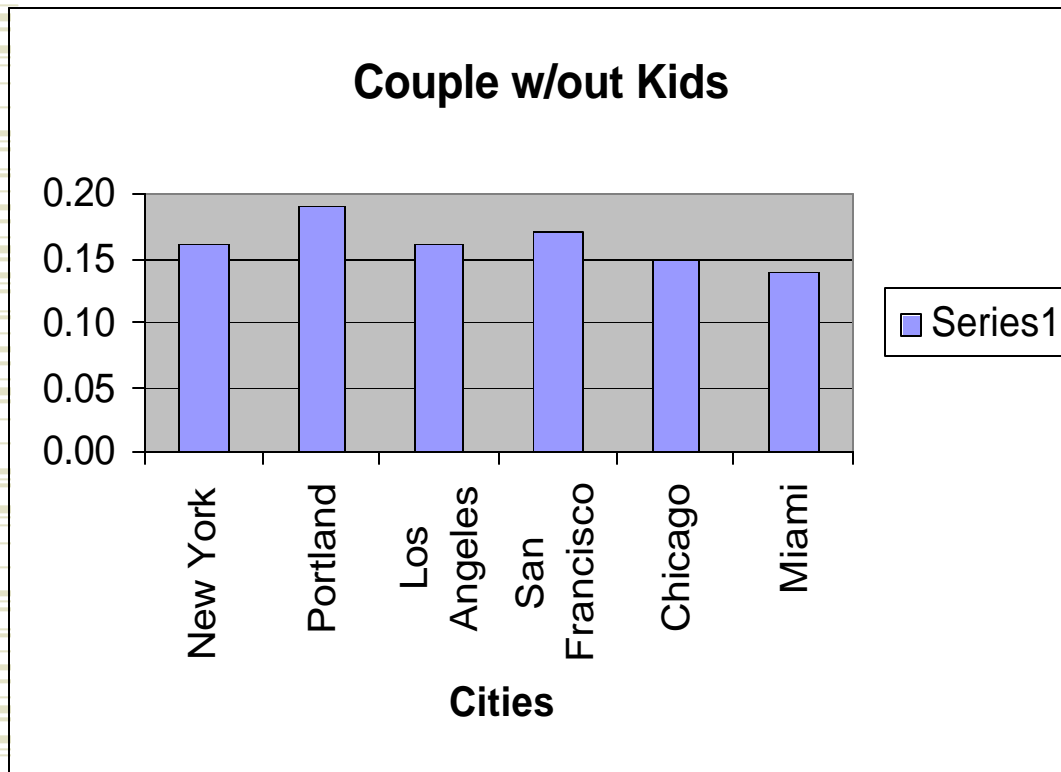
Results : Decision of the Single College Student



Los Angeles	0.17304
Portland	0.17262
Miami	0.16456
San Francisco	0.16364
New York	0.1583
Chicago	0.15194

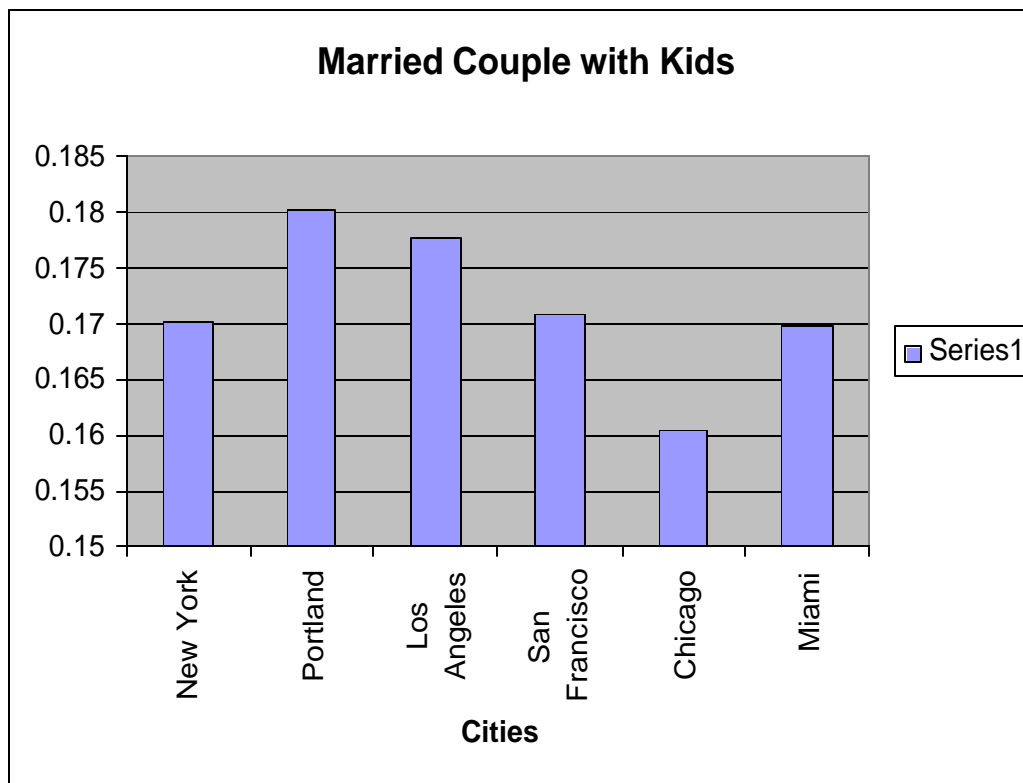
Results :

Decision of the Married Couple w/out Kids



Los Angeles	0.16
Portland	0.19
Miami	0.14
San Francisco	0.17
New York	0.16
Chicago	0.15

Results : Decision of the Married Couple w/ Kids



Los Angeles	0.1777
Portland	0.1803
Miami	0.1697
San Francisco	0.1708
New York	0.1702
Chicago	0.1604

Key Learning

- ◆ People are subjective to values so it is hard to quantify
- ◆ Model does not fit all scenarios/situations
- ◆ Lack of tools for numerous calculations and integration of model (except PCM)
- ◆ Learned how to employ HDM, PCM, and matrix calculation model to create a decision model for any situation

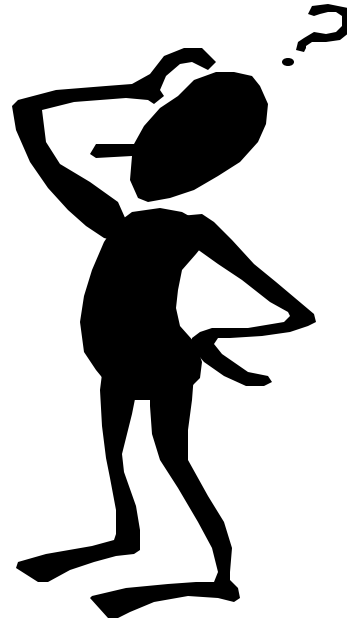
Model Improvements

- ◆ Increase the number of decision alternatives
- ◆ Present a questionnaire /survey to gather better criteria selection
- ◆ Expand the model with additional data such as Fine Art, Recreation, Culture etc.
- ◆ Have more up-to-date Data

Conclusion

- ◆ Our model is limited
- ◆ General assumptions
- ◆ Pair-wise comparisons take into considerations of user preferences
- ◆ Two level criteria approach produces more accurate results

Questions & Discussions





Backup Slides





ECONOMIC CONDITIONS

- 1. Cost of living:** Places are awarded higher points for a lower cost of living, which is derived from Bureau of the Census CPI Index and the ACCRA Cost of Living Index. To find the normalized value of each city for the cost of living criteria, we will use the $100/\text{cost value}$.
- 2. Low Sale Income & Tax Rate:** The total of the local, county, and state taxes. We like to use the total value of sales and income taxes since some states have only sales or income taxes. We believe the sum of both taxes will give a better feeling about that city.
- 3. Job Growth:** The past income and job growth is based on reports from the Bureau of Labor Statistics and covers the most recent calendar year. We believe we should use both recent and future job growth numbers to have a better figure about the city. Therefore, we took the average of both numbers for each city as a job growth number.
- 4. Unemployment Rate:** The percentage of the population that commutes using mass transit, including bus, light rail, subway, and ferry.

EDUCATION



1. **High School Graduates:** The percentage of the area's population over the age of 25 with high school diplomas or high school equivalency degrees (GEDs).
2. **4 year College Graduates:** The percentage of the area's population over the age of 25 with a bachelor's degree or other 4-year college degree.
3. **Highly Educated People (MS-PhD Graduates):** The percentage of the area's population over the age of 25 with a master's degree, Ph.D. or other advanced college degree.
4. **School Expenditures:** The dollar amount that the local school district spends on each of its students.
- 5- **Student/Teacher Ratio:** The number of students for each teacher. For example, 17.7 means there are 17.7 pupils for each teacher in the school.

POPULATION



1. **Population Range:** City population, 1999, from the Census Bureau.
2. **Population Density:** The number of residents per square mile of area.
3. **Population Change:** The percent change in the city's population since 1990. Negative percentages represent a decrease in population.
4. **Median Age:** The median age of all residents of the city. Median is the middle value, when all possible values are listed in order. Median is not the same as Average (or Mean).

HEALTH



- 1. Air Quality:** The Air Quality index is based on annual reports from the EPA. Higher values are better. The number of ozone alert days is used as an indicator of air quality, as are the amounts of seven pollutants including particulates, carbon monoxide, sulfur dioxide, lead, and volatile organic chemicals.
- 2. Water Quality:** A measure of the quality of an area's water supply as rated by the EPA. Higher values are better. The EPA has a complex method of measuring the watershed quality, using 15 indicators such as pollutants, turbidity, sediments, and toxic discharges.
- 3. Physicians Per Capita:** The number of physicians in the county per 100,000 population.
- 4. Health Cost Index:** The Cost of Health Care Index is calculated using the standard daily rate for a hospital room, and the costs of a doctor's office visit and a dental checkup. Patterned after the Cost of Living index, the national average is 100.

HOUSING



- 1. Median Home Cost:** This is the value of the year's most recent home sales data (January to December, 2000). It's important to note that this is not the average (or arithmetic mean). The median home price is the middle value when you arrange all the sales prices of homes from lowest to highest. This is a better indicator than the average, because the median is not changed as much by a few unusually high or low values.
- 2. Home Appreciation:** The average percentage change in the value of the area's homes, in 2000.
- 3. Property Tax Rate:** The property tax rate shown here is the rate per \$1,000 of home value. If the tax rate is \$14.00 and the home value is \$250,000, the property tax would be $\$14.00 \times (\$250,000/1000)$, or \$3500. This is the 'effective' tax rate.
- 4. Home Cost Index:** The overall Cost of Housing Index, which includes home cost, apartment rents, and property tax. Patterned after the Cost of Living index, the national average is 100. An index of 150 would mean a housing cost 50% higher than the national average.

TRANSPORTATION



1. **Commute Time:** The average number of minutes that residents of an area require for a one-way commute to work.
2. **Carpool:** The percentage of the working population which commutes to work in a carpool.
3. **Mass Transit:** The percentage of the population that commutes using mass transit, including bus, light rail, subway, and ferry.
4. **Bike or Walk:** The percentage of the population that commutes to work by bicycle or by walking.

CLIMATE



1. **Temperature:** Average temperature.
2. **Rainfall:** The annual rainfall in inches.
3. **Sunny Days:** The average number of days per year that are predominantly sunny.
4. **Comfort Index:** Higher values indicate a more comfortable climate. The Comfort Index measure recognizes that humidity by itself isn't the problem. The Comfort Index uses a combination of afternoon summer temperature and humidity to closely predict the effect that the humidity will have on people.

CRIME



- 1. Murder:** Murder and no negligent manslaughter, as defined by the FBI, is the willful (no negligent) killing of one human being by another. Not included in the count for this offense classification are deaths caused by negligence, suicide, or accident; justifiable homicides; and attempts to murder or assaults to murder, which are scored as aggravated assaults (crimes per 100,000 population).
- 2. Robbery:** Robbery is the taking or attempting to take anything of value from the care, custody, or control of a person or persons by force or threat of force or violence and/or by putting the victim in fear.
- 3. Burglary:** The FBI defines Burglary as the unlawful entry of a structure to commit a felony or theft. The use of force to gain entry is not required to classify an offense as burglary.
- 4. Auto-Theft:** Motor Vehicle Theft is defined as the theft or attempted theft of a motor vehicle. This category includes the stealing of automobiles, trucks, buses, motorcycles, motor scooters, snowmobiles, etc.