Multi-Objective Decision Analysis for Personal Decisions

Eric Johnson, April 2024

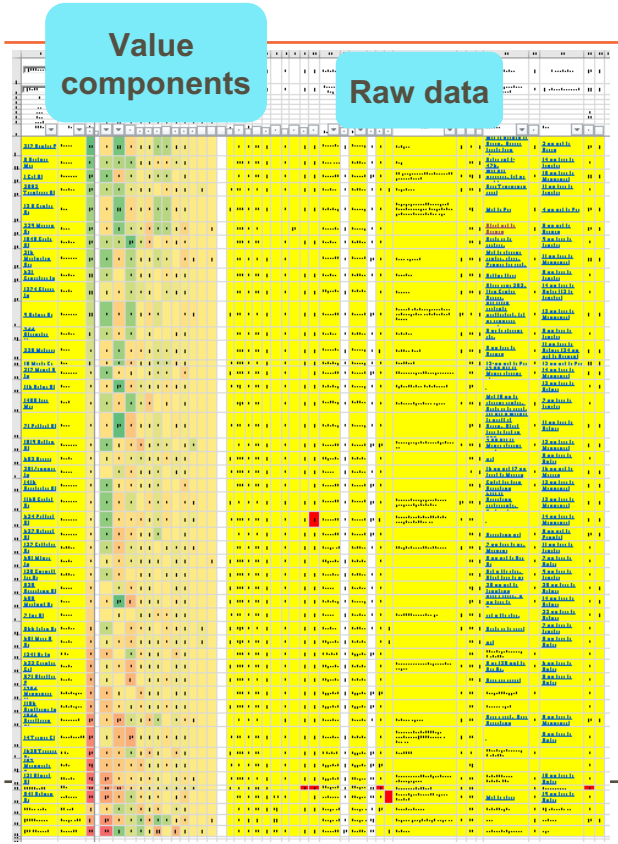
Multi-Objective Decision Analysis (MODA) can be useful for large personal decisions.

House	Car	Job
– School	– Fun	– Responsibilities
– Commute	– Price	– Salary
– Price	– Repair	– Colleagues
– Size	– Safety	– Location
– Neighborhood	– Gas	– Hours
– Safety	– Other	– Other
– Other		

Agenda

- Making sense of it
- Pressure-testing data
- Supporting revision
- Examples

Sort by score and color-code value components.



- This is main sheet of my 2020 decision about buying a house.
- Roughly 50 rows by 50 columns, including raw data and value calculations.
- Score is the leftmost color-coded column.
- Some value components have a lot of impact; others not so much.

Put the most important info at left and top (FreezePanes).

Identity

Summary score

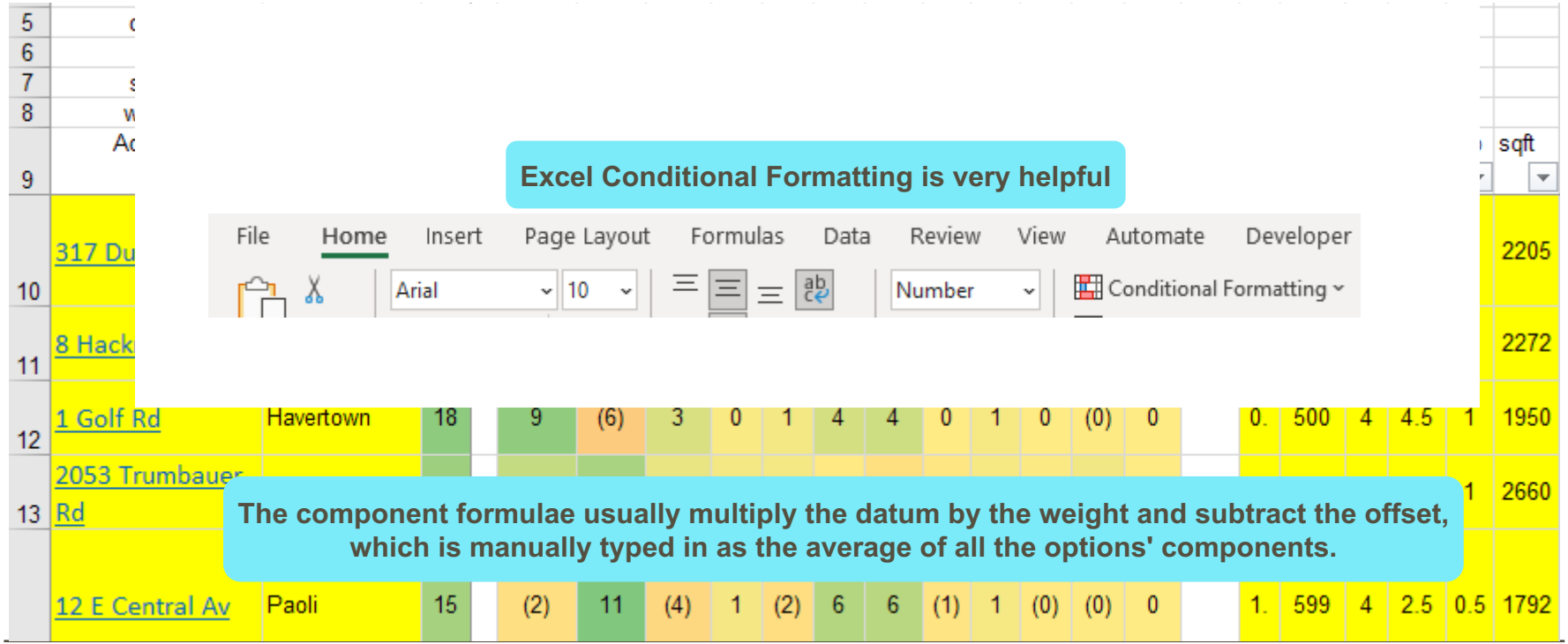
Value components

Supporting data

9	Address	Town	Net	school	commute	price	tax	rooms	transit	walk to	crime	garage	extra	pool	cenA/C		avail	price	br	bath	rooms	sqft
10	317 Dundee Pl	Devon	22	(2)	11	(4)	1	1	6	6	1	1	0	(0)	0		0.	600	4	2.5	1	2205
11	8 Hackney Way	Harleysville	20	5	6	7	1	1	(2)	(2)	2	1	(0)	(0)	0		0.	445	5	2.5	1	2272
12	1 Golf Rd	Havertown	18	9	(6)	3	0	1	4	4	0	1	0	(0)	0		0.	500	4	4.5	1	1950
13	2053 Trumbauer Rd	Lansdale	16	5	7	2	1	1	(0)	(2)	(1)	1	0	1	0		0.5	520	4	3.	1	2660
	12 E Central Av	Paoli	15	(2)	11	(4)	1	(2)	6	6	(1)	1	(0)	(0)	0		1.	599	4	2.5	0.5	1792

Sorted with best on top and most important on the left.

Center each value component on zero, so that we can color code all the components.



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If you score dimensions without explicitly defining a scale, put the verbal description right next to the score.

Hyperlink to source data

Extras score is $k/yr equiv. It's right next to the description of the extras.

Hyperlink to Google maps next to neighborhood score

1: lively
0: meh

0-15, per time to walk to station and ride downtown

Address	Town	Net	pool	Notes	extra	commut	x	Location	w to k	Transit	
317 Dundee Pl	Devon	22	0	Brick patio.	10	20	1	Walk to Berwyn or Devon. Across tracks from shopping	1	3 min walk to Devon	13
8 Hackney Way	Harleysville	20	0	siding.		26	1	Hotels and I-476.	0	14 min drive to Lansdale	7
1 Golf Rd	Havertown	18	0	3 br+garage loft office. Whole house standby generator. Piano?	6	41	1	Map not impressive, but we loved it.	0.8	10 min drive to Wynnewood	11
2053 Trumbauer Rd	Lansdale	16	1	Huge house	10	25	1	Near Towamencin creek	0	11 min drive to Lansdale	8
12 E Central Av	Paoli	15	0	Huge gorgeous tree. Thin office porch. Piano barely fits in living room. Dining table has to go downstairs. Only one bathroom		21		Walk to Paoli	1	4 min walk to Paoli	13

Carving out parts of the problem allows them to be carefully considered ... on a different sheet.

Look up the data for crime (by township) and school (by district)

9	Address	Town	Net	Crime Lookup	cri n	School Looku	scho
10	317 Dundee Pl	Devon	22	Easttown T	1	Conestog	-5
11	8 Hackney Way	Harleysville	20	Towamenci	0	North Per	7
12	1 Golf Rd	Havertown	18	Haverford T	2	Haverford	14
13	2053 Trumbauer Rd	Lansdale	16	Lansdale	3	North Per	7
	12 E Central Av	Paoli	15	Tredyffrin T	3	Conestog	-5

– The scores for crime and school are lookups from sheets that address those issues.

The analysis of schools integrates many sources.

Identity, score | **Value components** | **Intermediate calculations** | **Raw data**

freq	School	school score	Avg cost	extras	Niche	Great	Bkg dCk	USN WR	T/S		Niche avg	GS avg	T/S	Avg cost	N Acad 2	N Teach 2	N C Prep 2	N safe 2	GS CR	GS SP	Website	GS College Readiness	GS Student Progress	GS T/S	N Aca-demics
10	Haverford	14	1	13	0	-1	1	0	0		4.1	9.0	14.5	0	4	4	4	4.3	10.0	8.0	haverf	10	8	14	A
0	Radnor	12	1	5	1	-3	1	3	4		4.2	8.5	12	0	4.3	4	4.3	4.3	10.0	7.0	rtsd.org	10	7	11	A+
0	Harriton	6	1	-3	2	-1	0	1	5		4.3	9.0	11	0	4.3	4.3	4.3	4.3	10.0	8.0	lmsd.or	10	8	11	A+
9	North Penn	7	1	9	-2	4	-1	-2	-2	1	3.9	10.0	16	0	4	4	4	3.7	10.0	10.0	nphs.np	10	10	17	A
0	Strath Haven	1	1	-7	1	1	-1	2	3		4.2	9.5	12.5	0	4.3	4.3	4.3	4.0	10.0	9.0	wssd.or	10	9	12	A+
7	Wissahickon	0	1	-11	0	4	0	2	4		4.2	10.0	12	0	4.3	4.3	4.3	3.7	10.0	10.0	wsdweb	10	10	11	A+

Freq of reference

Crime drill-down is similar to school drill-down.

Identity, score

Value components

Intermediate calculations

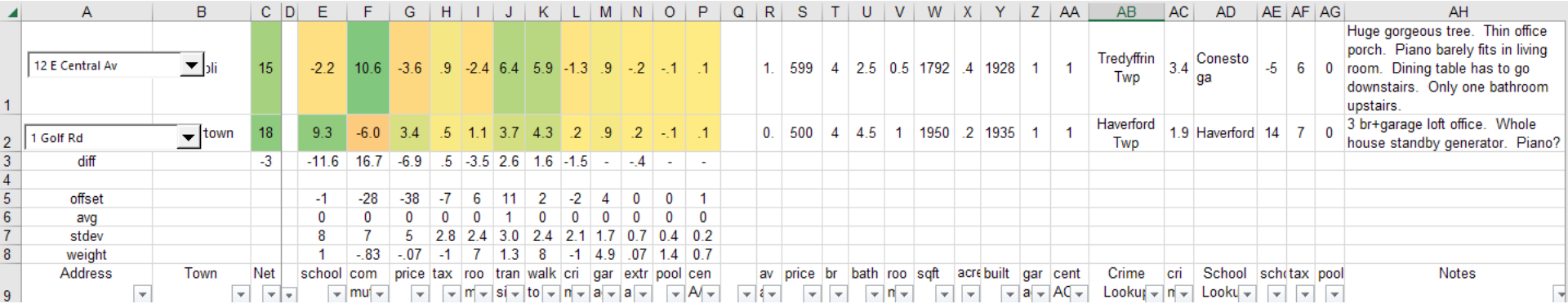
Raw data

2	https://www.cityrating.com/			10000	2000	100	3					v	p	v	v		
3	freq	town	impact $k/y	x	murder manslaugher	rape	aggravated assault	larceny theft	x	our share	pop 100ks	imputed rape	aggravated assault	larceny theft	murder manslaugher	rape	prop incidents	prop inc/100k
4	1	Abington Twp	.5		0.0	0.1	0.3	0.2		.0001	.6	1.0	52	1037	0	1	1258	2200
6	0	Chester Twp	1.8		0.0	0.7	1.0	0.1		.0003	.1	1.0	30	55	0	1	95	1,100
7	0	Collegeville	2.0		0.0	1.7	0.2	0.1		.0009	.0	1.0	2	33	0	1	45	1,300
8	0	Doylestown	7.0		3.5	2.9	0.4	0.2		.0004	.1	4.1	12	148	1		179	2,100
9	3	Easttown Twp	1.2		0.0	0.1	0.0	0.1	1	.0004	.1	.1	1	84	0		98	1300
10	0	Frazer Twp	2.1		0.0	1.6	0.0	0.5		.0008	.0	1.0	0	224	0	1	228	6,000
11	1	Hatfield Twp	1.9		0.0	0.7	0.1	0.1	1	.0002	.2	2.0	6	184	0	2	216	1300
12	0	Hatboro	.1		0.0	0.0	0.0	0.1		.0005	.1	.0	0	60	0		75	1,300
13	10	Haverford Twp	1.9		0.0	0.7	0.1	0.1	1	.0001	.4	5.0	10	605	0	5	696	1700
15	5	Lansdale	3.0		0.0	1.6	0.3	0.1	1	.0003	.1	3.0	12	173	0	3	196	1700

Freq of reference

– I had to do the math to make the data per-capita.

Allowing pairwise comparisons of options supports pressure-testing of attribute weights



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1	12 E Central Av	oli	15		-2.2	10.6	-3.6	.9	-2.4	6.4	5.9	-1.3	.9	-.2	-.1	.1		1.	599	4	2.5	0.5	1792	.4	1928	1	1	Tredyffrin Twp	3.4	Conestoga	-5	6	0	Huge gorgeous tree. Thin office porch. Piano barely fits in living room. Dining table has to go downstairs. Only one bathroom upstairs.
2	1 Golf Rd	town	18		9.3	-6.0	3.4	.5	1.1	3.7	4.3	.2	.9	.2	-.1	.1		0.	500	4	4.5	1	1950	.2	1935	1	1	Haverford Twp	1.9	Haverford	14	7	0	3 br+garage loft office. Whole house standby generator. Piano?
3	diff		-3		-11.6	16.7	-6.9	.5	-3.5	2.6	1.6	-1.5	-	-.4	-	-																		
4																																		
5	offset				-1	-28	-38	-7	6	11	2	-2	4	0	0	1																		
6	avg				0	0	0	0	0	1	0	0	0	0	0	0																		
7	stdev				8	7	5	2.8	2.4	3.0	2.4	2.1	1.7	0.7	0.4	0.2																		
8	weight				1	-.83	-.07	-1	7	1.3	8	-1	4.9	.07	1.4	0.7																		
9	Address	Town	Net		school	com mu	price	tax	roo m	tran si	walk to	cri n	gar a	extr a	pool	cen A		av a	price	br	bath	roo n	sqft	acre	built	gar a	cent AC	Crime Lookup	cri n	School Lookup	sch	tax	pool	Notes

- The drop-downs let you select any two options and compare them right at the top of the spreadsheet.
- Do I really believe that this one is better than that one?
- Or am I over/under valuing one of the attributes?

Agenda

- Making sense of it
- Pressure-testing data
- Supporting revision
- Examples

Using MODA is an evolutionary process, and the tools we use must support this evolution.

Kinds of Evolution

- Definitions of criteria evolve.
- Weights of criteria evolve.
  - commute time, sq ft
- Options get added.
- We gather information about the options.

Examples of Evolving Definitions

- Car age => reliability
- Nature of work => capturing expertise in a model, decision process, doing other stuff
- Home location => commute time, walk to commerce & transit
- Home size => rooms
- Home: add safety & groundskeeping
- Home view => nature, water, distance

Let yourself get the structure right.

- Be willing to move rows or columns around to make a tool that lets you do the kind of thinking you need to do.
- Use robust spreadsheet techniques:
  - =INDEX(dataColumn, MATCH(item, keyColumn, 0))
    rather than VLOOKUP, so that you can rearrange columns if needed.
  - When summing across a group of columns (e.g. value components), put little empty columns to left and right, and sum from these. This way, if you move the first or last data column into the middle, your SUM still picks up all the columns.

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- Making sense of it
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Cars

	model	year	value	x	fun	price	repair	safe	gas	extra	row	repair	fun	safe	eff age	price	odo	mpg	extra	Source	
6	Infiniti G	2010	7.5		5.2	-3.0	1.7	.2	1.8	1.5		4.0	1.0	4.5		22.0	36	18	2.7		G37 X 4d sed premium pkg, seats, Bose s steering whee
15	Mazda 6	2010	5.8		-6.3	1.9	3.1	4.1	3.1	-.2		4.2	.4	4.8		15.0	11	21	1		4D sedan. sport pkg, 4 cy
	Difference		1.7		11.5	-4.9	-1.5	-3.8	-1.3	1.7											
	offset				14	-12.4	-8	57	-11	1											
	av															17.8	63				
	std															4.1	29				
	par																				
1	Nissan Z	2006	12.0		5.2	1.2	3.0	.2	1.8	.5	14	4.9	1.0	4.5	11.8	16.0	79	18	1.7	http://w	350Z touring 2 CD changer, p heated leather
2	Ford Mustang	2008	8.9		5.2	1.9	1.0	1.5	.6	-1.4	7	4.0	1.0	4.6	8.8	15.0	31	16	-.2	http://w	2d coupe.V6 4
3	Nissan Z	2007	8.7		5.2	.1	2.1	.2	2.3	-1.3	14	4.5	1.0	4.5	10.0	17.6	48	19	-.1	http://w	350Z enthusia
4	Infiniti G	2008	8.4	x	5.2	-.2	-.7	1.5	1.2	1.3	10	4.(	1.0	4.6	10.8	18.0	80	17	2.5	http://w	G35 X 4d sed nav system, h sunroof, Bose

Options

Value components

Intermediate calcs

Raw data

There were a lot of cars, so the pairwise comparison was important

Lookups from Consumer Reports data

Drill-down data for Cars

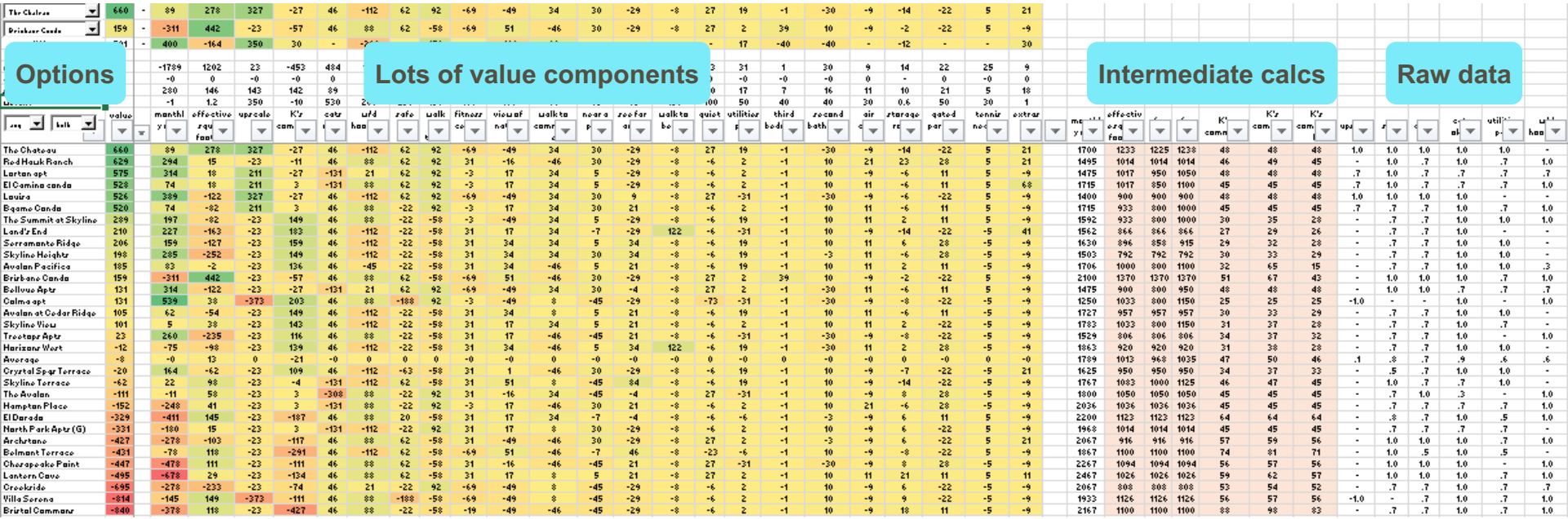
		Safety											Repair								
	notes	2006	2007	2008	2009	2010	2011	2012	2013	2014	fun	Road test	2006	2007	2008	2009	2010	2011	2012	2013	2014
Acura T		4.6	4.6	4.6	4.7	4.7	4.1	3.7	3.7	3.7	0.5		4.4	4.4	3.8	3.4	3.8	4.8	4.6	4.0	4.4
Audi A4		4.2	4.2	4.2	4.8	4.8	4.0	4.0	4.6	4.6	0.5		3.0	3.0	3.0	3.0	3.0	3.0	3.0	5.0	4.0
Audi S4		4.2	4.2	4.2	4.8	4.8	4.0	4.0	4.8	4.8	1		3.0	3.0	3.0	3.0	3.0	3.0	3.0	5.0	4.0
Cadillac CTS		4.2	4.2	4.6	4.4	4.4	4.4	4.8	4.8	4.8	1		3.0	3.0	3.0	3.5	3.5	4.0	3.0	3.0	3.0
Ford Focus	sedan	3.8	4.0	4.2	4.2	4.2	4.2	4.4	4.4	4.4	0.4	74	4.0	3.0	4.0	4.0	4.0	4.0	1.0	1.0	1.0
Ford Mustang	V8	4.2	4.2	4.6	4.6	4.8	4.2	4.2	4.2	4.2	1	83	4.0	5.0	4.0	3.5	3.0	3.0	2.0	4.0	3.0
Honda Accord	V6	4.4	4.4	4.4	4.5	4.5	4.5	4.5	4.3	4.3	0.4		4.1	4.1	3.2	3.1	3.2	4.2	4.9	4.0	4.0
Hyundai Sonata	V6	4.8	4.8	4.6	4.8	4.8	4.6	4.6	4.6	4.6	0	80	3.0	4.0	3.0	4.0	2.0	2.5	2.5	2.5	2.5
Infiniti G	sedan	4.0	4.0	4.6	4.5	4.5	4.0	4.0	4.0	4.0	1		4.1	4.0	4.0	4.0	4.0	4.5	4.9	4.9	4.9
Lexus IS	V8	4.0	4.0	4.2	4.2	4.2	4.0	4.0	4.2	4.2	0.2		4.0	3.0	4.0	5.0	5.0	4.0	5.0	5.0	5.0
Mazda 3		3.6	3.6	3.6	3.8	4.6	4.0	4.0	4.0	4.0	0.3	78	3.0	3.0	4.0	4.0	4.0	5.0	5.0	4.0	4.0
Mazda 6		4.2	4.4	4.4	4.8	4.8	4.0	4.0	4.0	4.0	0.4	85	3.0	3.0	4.0	4.0	4.2	4.2	4.2	4.5	4.0
Nissan Z		4.5	4.5	4.7	4.1	4.1	4.0	4.0	4.0	4.0	1	86	4.9	4.5	4.5	4.5	5.0	4.5	4.6	4.6	4.6
Subaru Impreza	sedan	4.2	4.2	4.6	4.6	4.6	4.0	4.0	4.6	4.6	0.2	82	3.0	3.0	3.0	3.0	4.0	4.0	4.0	5.0	4.0
Toyota Camry	SE	4.2	4.8	4.8	4.8	4.8	4.6	4.6	4.6	4.6	0		5.0	4.0	4.0	4.0	4.0	5.0	4.0	3.0	3.0
VW GTI	~Golf	4.0	4.4	4.4	4.4	4.4	4.0	4.0	4.0	4.0	1		3.0	3.0	3.0	2.5	2.0	1.0	1.0	2.0	2.0

Jobs

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	offset			102	22	-2	-20	-1											
2	avg			-	-0	0	-0	-											
3	stdev	28		23	15	9	7	3											
4				1				5						80	50				-.4
5																			
6		total value		salary	hours	foster rationality	town	colleagues		housing cost	town quality	rat'l score		salary	hours	foster rationality	town	colleagues	c score
7	Pharsight CPDP	35		18	14	11	-6	-1		30	.5	.6		120	45	decision ent system	Bay Area	name1	0
8	Pharsight	35		18	2	17	-6	5		30	.5	1.0		120	50	development strategy	Bay Area	name2	.8
9	AEP	22		-12	26	-3	10	1		15	.7	-.3		90	40	power gen strat	Dallas	name4	.0
10	Aventis	12		8	2	-6	9	-1		18	.9	-.5		110		project mgmt	Jersey		
11	Pfizer	5		8	2	2	-5	-1		25	.0	.0		110	50	pharmaco-economics	New York	name5	-.4
12	Schering	1		28	-22	-13	9	-1		18	.9	-1.0		130	60	same old	Jersey	name7	-.4
13	Abt	-16		18	-22	-3	-5	-4		25	.1	-.3		120	60	smartCRO	Boston	name6	-1.0
14	Covance	-19		-22	2	-3	4	-0		18	.3	-.3				smartCRO	Washington	name9	-.2
15	Brattle	-26		-22	2	-3	-5	2		25	.1	-.3				smartCRO	Boston	name8	.2
16	NECM	-51		-42	-10	2	-5	4		25	.1	.0		60	55	pharmaco-economics	Boston	name10	.6

Options **Value components** **Intermediate calcs** **Raw data**

Apartments


Options
Lots of value components
Intermediate calcs
Raw data

Summary: Ways to use MODA for Personal Decisions

- FreezePanes and color coding helps you make sense of data.
- Juxtaposing scores with supporting data helps pressure-test scores.
- Comparing pairs of options helps you pressure-test weights.
- Drill-down sheets handle important sub-issues in an orderly way.
- Using border-row summations and index/match lookups makes spreadsheet evolution straightforward.