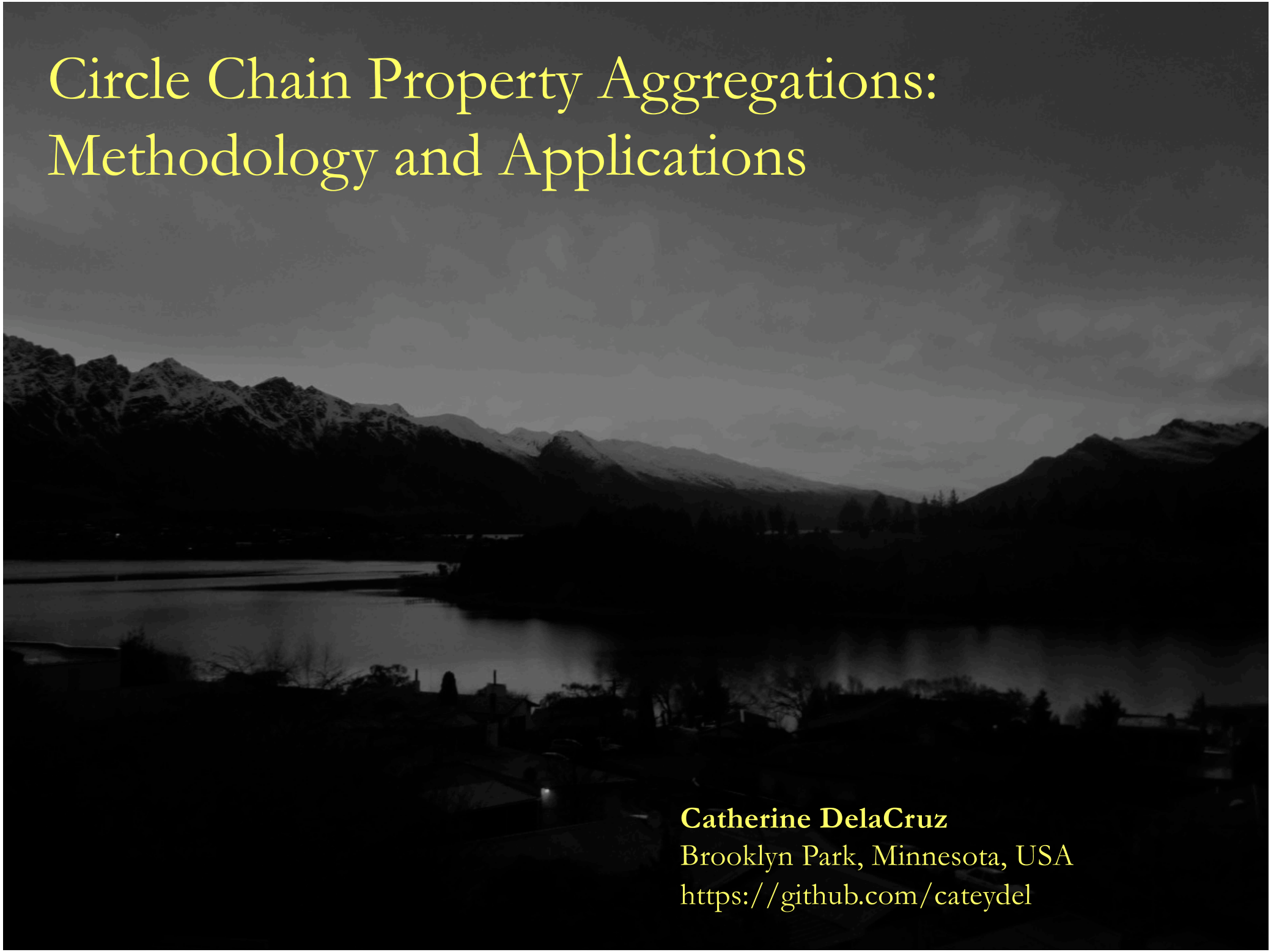
Circle Chain Property Aggregations: Methodology and Applications



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About the Presenter

Catherine (*Cate*) DelaCruz
Minneapolis-St Paul area

- 6 years portfolio management @ primary insurer
  Argo Group
  - Portfolio optimization and risk appetite advisory analysis

- 7 years CAT modeling @ reinsurance brokerages
  Guy Carpenter, Willis
  - Event scenario & reinsurance loss cost modeling
  - Property aggregation analysis
  - Natural CAT & terrorism perils

- 9 years actuarial analysis @ primary insurers
  Suncorp, Mutual Service Insurance, The St Paul

Exposure concentration analysis

Simplest and most common resolutions of analysis in P&C insurance:

- By political boundary (*e.g., county, ZIP code*)
- By latitude/longitude grid block (*e.g., coordinates rounded to the nearest 0.1°*)

Fundamental issue with traditional exposure summaries:

- What if the company's most important property concentrations don't fit easily into a political boundary or grid block?

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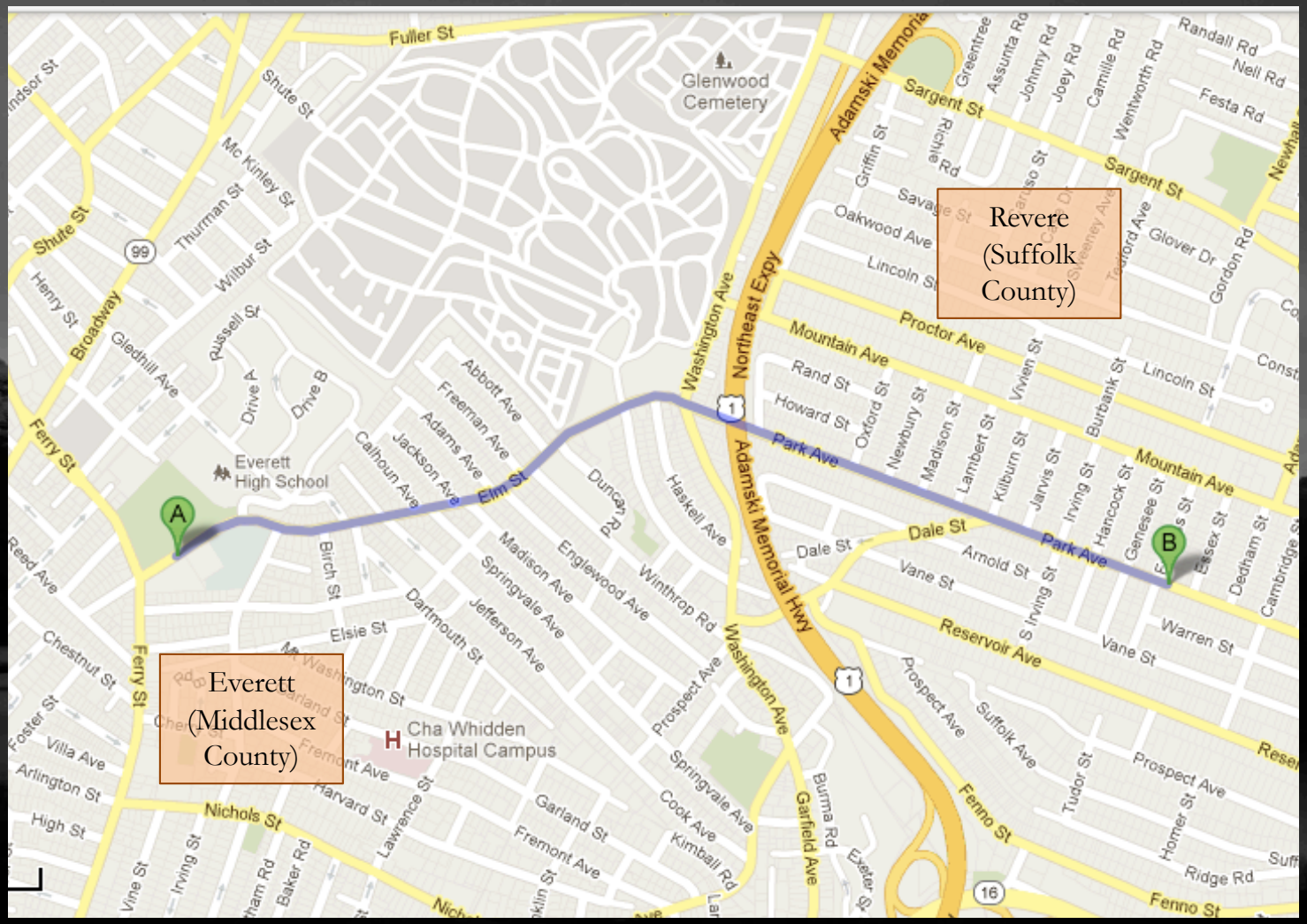

Example 1 (political boundary counterexample, Massachusetts):

- Boston's NE Expressway & a county line separate Everett and Revere
- Company P classifies the cities together in underwriting and pricing

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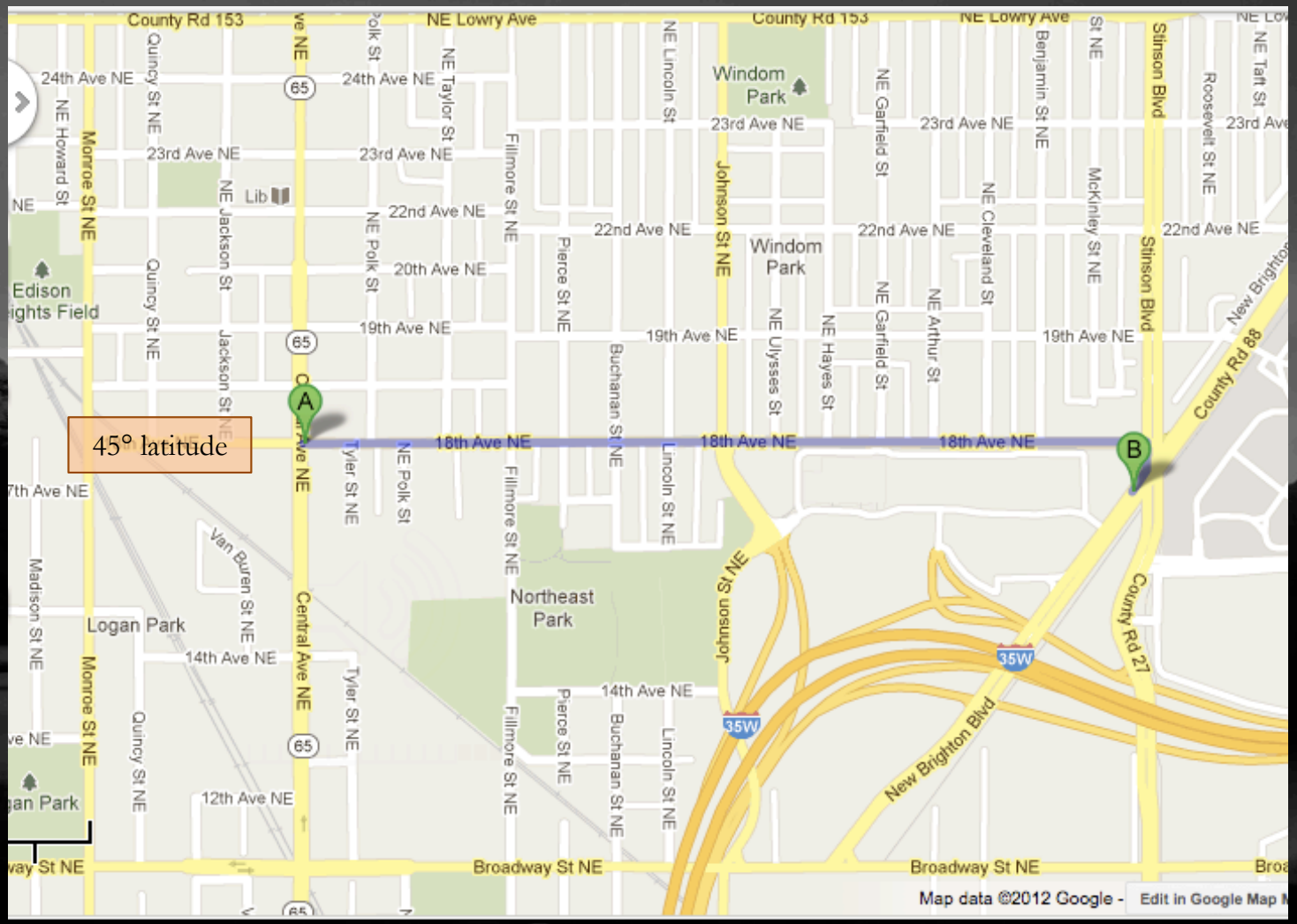

Example 2 (coordinate grid block counterexample, Minnesota):

- 45° latitude line bisects northeast Minneapolis at 18th Ave NE
- Company Q's portfolio spans both sides in heavy concentrations

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An unscientific solution

- Use high-resolution political boundaries or grid blocks
- Then combine them manually
- (Combinations can vary from analyst to analyst)

A scientific solution

- Group properties together based on one statistic – their distance from each other
- State a distance e.g., $x = 1$ mile
- If any two properties are within x of each other, place them in the same group

Visualizing the scientific solution

- Imagine a circle of diameter x centered around each property
- Properties are grouped together when they form chains of overlapping circles
  - i.e., **circle chains**

Characteristics of circle chains

- Chains aren't constrained to any one shape
- Metro area chains tend to be larger than exurban chains
- All chains end where properties begin to disperse

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Origin Point	Latitude	Longitude	Distance to Destination Point (Miles)																										
			ß	Z	Y	X	W	V	U	T	S	R	Q	P	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A
A	37.7796	-122.4190	1.65	4.18	1.73	5.41	2.68	3.90	2.85	3.79	3.80	1.73	3.78	4.15	2.30	1.45	4.43	1.08	1.75	4.29	1.69	2.07	0.94	1.04	1.66	1.50	1.24	0.63	
B	37.7731	-122.4110	1.10	3.72	2.12	5.41	2.59	3.98	3.44	3.74	3.20	2.35	4.10	4.61	2.80	1.76	4.59	1.67	1.71	4.03	1.85	1.62	1.49	1.30	1.05	1.42	1.36		
C	37.7915	-122.4020	1.55	5.02	0.98	6.65	3.88	2.67	3.52	5.01	4.26	1.96	4.94	5.14	3.29	2.66	5.66	1.95	2.96	5.39	0.49	2.97	1.04	0.33	1.88	0.48			
D	37.7886	-122.3940	1.24	4.89	1.40	6.82	4.01	2.58	3.98	5.15	3.99	2.44	5.28	5.55	3.69	2.95	5.92	2.36	3.11	5.41	0.72	2.92	1.51	0.80	1.65				
E	37.7648	-122.3950	0.47	3.28	2.83	5.79	2.97	4.10	4.48	4.09	2.37	3.35	4.92	5.56	3.79	2.65	5.22	2.72	2.29	4.03	2.32	1.51	2.42	2.00					
F	37.7918	-122.4080	1.72	5.01	0.85	6.44	3.71	2.88	3.19	4.82	4.36	1.65	4.66	4.82	2.97	2.40	5.41	1.64	2.79	5.28	0.66	2.93	0.72						
G	37.7931	-122.4210	2.25	5.12	0.92	6.07	3.48	3.37	2.47	4.52	4.68	0.98	4.07	4.14	2.32	1.96	4.92	1.01	2.55	5.16	1.25	3.01							
H	37.7498	-122.4150	1.96	2.11	3.74	4.33	1.60	5.48	4.31	2.65	2.04	3.71	3.93	4.84	3.35	2.10	3.95	2.77	1.28	2.54	3.46								
I	37.7982	-122.3990	1.94	5.50	0.76	7.10	4.35	2.22	3.66	5.47	4.68	2.03	5.29	5.39	3.57	3.06	6.07	2.24	3.43	5.88									
J	37.7205	-122.4430	4.49	1.70	6.02	2.35	1.78	7.99	5.46	1.39	3.20	5.56	3.72	4.99	4.35	3.47	2.92	4.53	2.63										
K	37.7581	-122.4360	2.61	2.98	3.44	3.70	0.93	5.63	3.17	2.04	3.30	2.95	2.70	3.56	2.14	0.95	2.94	1.92											
L	37.7859	-122.4370	2.72	4.80	1.88	5.17	2.77	4.38	1.77	3.71	4.70	1.03	3.07	3.19	1.34	1.10	3.95												
M	37.7446	-122.4870	5.55	4.46	5.83	1.57	2.35	8.27	3.82	1.61	5.60	4.78	1.27	2.48	2.94	3.00													
N	37.7707	-122.4430	2.84	3.93	2.88	4.11	1.69	5.27	2.23	2.61	4.14	2.11	2.36	2.91	1.25														
O	37.7819	-122.4610	3.90	5.09	3.12	4.36	2.64	5.65	1.11	3.21	5.39	1.89	1.86	1.86															
P	37.7799	-122.4950	5.71	6.17	4.87	4.04	3.63	7.38	1.99	3.62	6.84	3.53	1.30																
Q	37.7629	-122.4850	5.16	5.00	4.93	2.83	2.52	7.44	2.60	2.34	5.84	3.74																	
R	37.8008	-122.4360	3.21	5.78	1.38	6.10	3.80	3.86	1.65	4.70	5.53																		
S	37.7312	-122.3860	2.75	1.64	5.20	5.50	3.33	6.25	6.33	4.05																			
T	37.7354	-122.4600	4.49	2.85	5.43	1.70	1.15	7.67	4.30																				
U	37.7974	-122.4660	4.49	6.15	3.04	5.33	3.74	5.48																					
V	37.8207	-122.3700	3.63	7.37	2.52	9.31	6.54																						
W	37.7462	-122.4440	3.36	2.55	4.37	2.84																							
X	37.7219	-122.4860	6.19	4.05	6.99																								
Y	37.8038	-122.4110	2.53	5.84																									
Z	37.7193	-122.4120	3.74																										
ß	37.7708	-122.3910																											

Exhibit A: 27 properties in San Francisco County, $x = 1$ mile

- Pairs of properties within x of each other are highlighted and will form circle chains

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	Circle chain formation, by algorithm iteration								
Point	#1	#2	#3	#4	#5	#6	#7	#8	#9
A	1	1	1	1	1	1	1	1	1
B	-	1	1	1	1	1	1	1	1
C	-	-	1	1	1	1	1	1	1
D	-	-	1	1	1	1	1	1	1
E	-	-	-	-	2	2	2	2	2
F	-	-	1	1	1	1	1	1	1
G	-	1	1	1	1	1	1	1	1
H	-	-	-	-	-	-	-	-	-
I	-	-	1	1	1	1	1	1	1
J	-	-	-	-	-	-	-	-	-
K	-	-	-	-	-	-	3	3	3
L	-	-	-	-	-	-	-	-	-
M	-	-	-	-	-	-	-	-	-
N	-	-	-	-	-	-	-	3	3
O	-	-	-	-	-	-	-	-	-
P	-	-	-	-	-	-	-	-	-
Q	-	-	-	-	-	-	-	-	-
R	-	-	1	1	1	1	1	1	1
S	-	-	-	-	-	-	-	-	-
T	-	-	-	-	-	-	-	-	-
U	-	-	-	-	-	-	-	-	-
V	-	-	-	-	-	-	-	-	-
W	-	-	-	-	-	-	-	3	3
X	-	-	-	-	-	-	-	-	-
Y	-	-	1	1	1	1	1	1	1
Z	-	-	-	-	-	-	-	-	-
ß	-	-	-	-	-	2	2	2	2

Exhibit B: iterative formation of circle chains

- Start with the first point that's within x of another point, but not in a chain yet
- Join points into the chain from the highlighted pairs on the previous slide

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Exhibit C: circle chain center points

- Unchained points in purple
- Circles to be rendered around points in later version of presentation

Business applications

Competitive strategy

- Define metro areas & city subareas
- Assess loss potential with CAT models and claim history
- Focus on most profitable areas/subareas

Risk selection

- Estimate marginal CAT costs of new policies by area/subarea & key property characteristics

Ratemaking margins

- Set contingency loads based on contributions to scenarios in which PHS < RBC ACL or similar

Caveats

Distance criterion (x) selection

- If x is too large, largest chain > ½ the portfolio
- If x is too small, many properties go unchained
-  Start with a moderate x_1, then drill down into the largest chains with $x_2 < x_1$

Chains change as business exits / enters the portfolio

-  Hold chains constant for multiple periods (*e.g., 3 years*)

Be careful to consider geography & hazard characteristics

- Topography, distance to coast / from fault line, etc.

Conclusions

Circle chains can supplement existing property aggregation analyses

- **Not meant to be a substitute** for sophisticated tools (e.g., **ArcGIS**, **ESRI**), but a starting point for dialogue
- **No single approach** fits all companies or strategies
- Companies with heavy concentrations across borders stand to benefit most from circle chain analyses

Circle chains are objective & (fairly) easy to explain

Algorithm can be implemented in several applications

- SQL, MS Access, R, etc.

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