

# Mapping the Genome: A Spatial Analysis of Gene Expression on the Mouse Chromosome

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# Genes and Chromosomes in the GIS

Distance (Mb) from beginning of chromosome



# The Questions

- How do genes respond differently in parous and nulliparous mice?
- Can GIS and spatial analysis be used in genetic research?
- Is there a spatial organization of gene expression based on biological experience ?

# Mapping the Mouse Genome

Chromosomes.mxd - ArcMap - ArcInfo

Table



FID	Shape *	Chrom	Start	End	Y	GeneID	Ratio	ID	Y1	ChromName	y2
14	Point ZM	1	132723271	132748377	1	18703	0.635269	15	1000000	1	10000000
15	Point ZM	1	135944511	135944738	1	14264	0.963892	16	1000000	1	10000000
16	Point ZM	1	136079053	136086608	1	12654	1.825004	17	1000000	1	10000000
17	Point ZM	1	153737977	153738979	1	69399	0.624608	18	1000000	1	10000000
18	Point ZM	1	1739451	153923377	1	1515234 (// 69399)	0.68871	19	1000000	1	10000000
19	Point ZM	1	161523308	16751115	1	1615234	0.161523	20	1000000	1	10000000
20	Point ZM	1	174153643	174157329	1	27222	-0.683757	21	1000000	1	10000000
21	Point ZM	1	180868682	180869330	1	320862	0.59634	22	1000000	1	10000000
22	Point ZM	1	188447313	188447313	1	21808	0.71743	23	1000000	1	10000000
23	Point ZM	1	188529868	188529868	1	21808	0.71743	24	1000000	1	10000000
24	Point ZM	1	188447313	188529868	1	21808	0.845098	25	1000000	1	10000000
25	Point ZM	1	192829710	192832334	1	226844	0.631068	26	1000000	1	10000000
26	Point ZM	1	193004536	193004536	1	226844	0.631068	27	1000000	1	10000000
27	Point ZM	1	193004536	193004536	1	226844	-0.630811	28	1000000	1	10000000
28	Point ZM	1	194332795	194334041	1	16510	1.27102	29	1000000	1	10000000
29	Point ZM	1	19467024	194677337	1	214791	0.873869	30	1000000	1	10000000
30	Point ZM	1	19467024	194677337	1	214791	0.622589	31	1000000	1	10000000
31	Point ZM	1	23373262	23390004	1	70155	0.60459	32	1000000	1	10000000
32	Point ZM	1	23373262	23390004	1	70155	0.818038	33	1000000	1	10000000
33	Point ZM	1	23373262	23390004	1	70155	0.818038	34	1000000	1	10000000
34	Point ZM	1	24184534	24258839	1	12839	0.892702	35	1000000	1	10000000
35	Point ZM	1	24202083	24259527	1	12839	1.912218	36	1000000	1	10000000
36	Point ZM	1	24202083	24259527	1	12839	0.88797	37	1000000	1	10000000
37	Point ZM	1	24202083	24259527	1	12839	0.88797	38	1000000	1	10000000
38	Point ZM	1	43787416	43799411	1	78896	2.787244	39	1000000	1	10000000
39	Point ZM	1	43799089	43799409	1	78896	1.067007	40	1000000	1	10000000
40	Point ZM	1	43799089	43799409	1	78896	3.390719	41	1000000	1	10000000
41	Point ZM	1	45964907	45982736	1	53945	1.334782	42	1000000	1	10000000
42	Point ZM	1	45964907	45982736	1	53945	1.354228	43	1000000	1	10000000
43	Point ZM	1	51358226	51358473	1	20324	-0.580666	44	1000000	1	10000000
44	Point ZM	1	59539439	59543799	1	14369	0.655985	45	1000000	1	10000000
45	Point ZM	1	66485979	66489157	1	17756	0.764477	46	1000000	1	10000000
46	Point ZM	1	72034443	72034443	1	45044	0.664830	47	1000000	1	10000000

- 21,000 genes on 21 chromosomes
- Starting and Ending Locations
- Used Cartesian Coordinate System
- X = starting location
- Y = chromosome # (for display)
- Mapped as points for analysis

chromosome

19



18



17



16



15



14



13



12



11



10



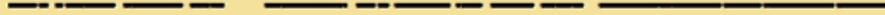
9



8



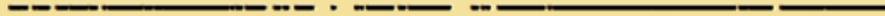
7



6



5



4



3



2



1



X



# Mapping the Mouse Genome

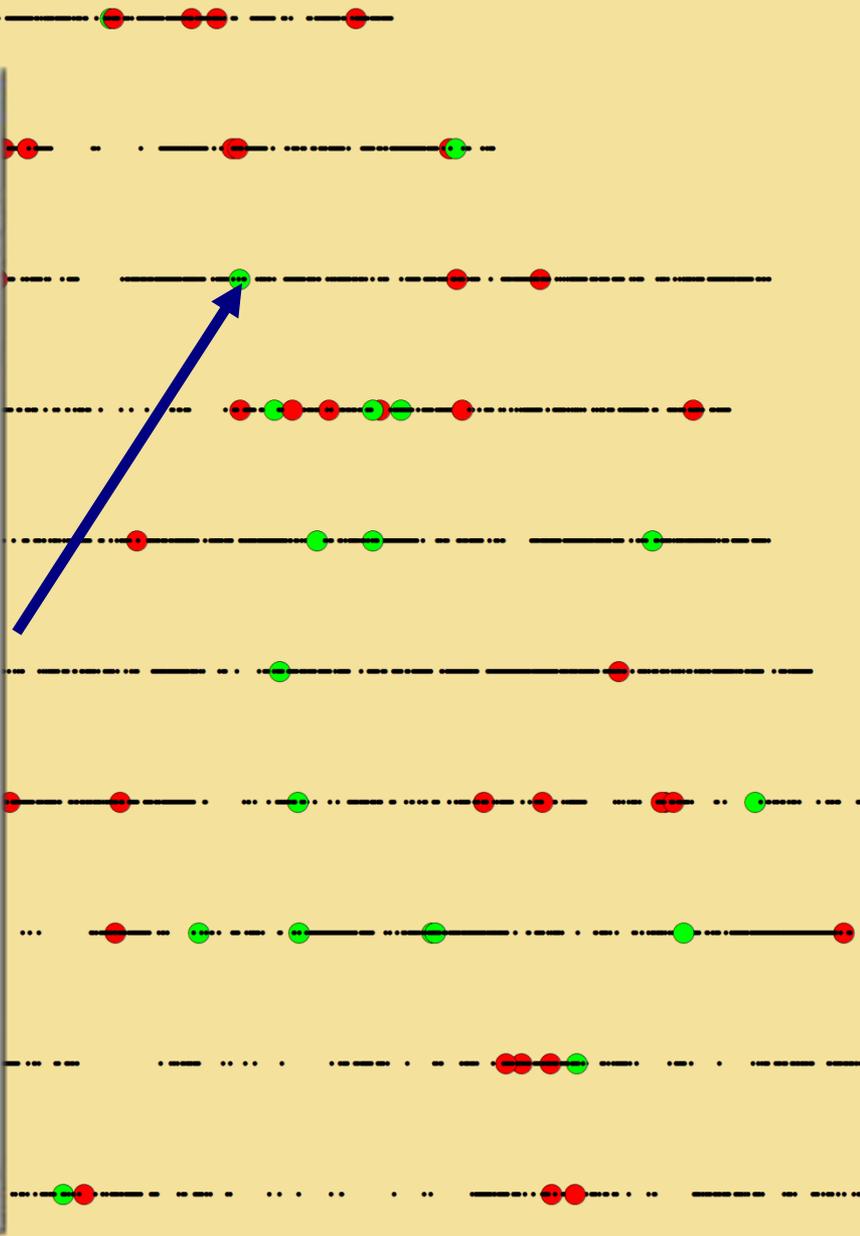
**Identify**

Identify from:  Parous vs Non-Parous Mice

Location: 58,054,170.322 180,335,640.139 Mb Units

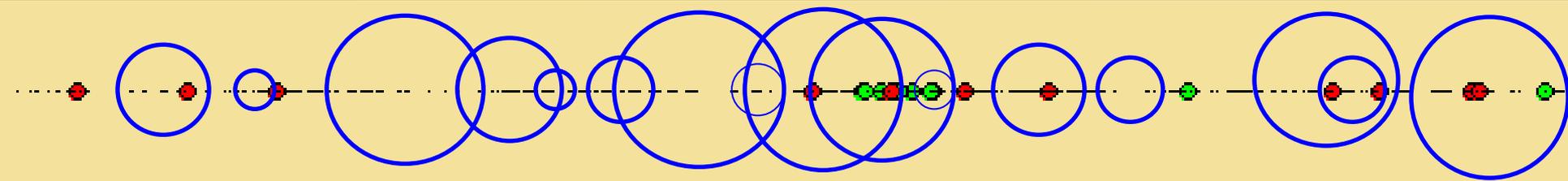
Field	Value
OBJECTID	1427
id	8891
Loc_ID	8891
Location	58250789
Chrom	18
NoIR_Ratio	-0.091171
noIR_Signif	
Group2	2
ProbeSet_ID	1433085_at
MouseGene_ID	77112
MouseGene_Symbol	5930427J20Rik
NnoIR_mean	4.684484
NnoIR_SD	0.167669
PnoIR_mean	4.593313
PnoIR_SD	0.125975
Y	180000000
Shape	Point

Identified 13 features



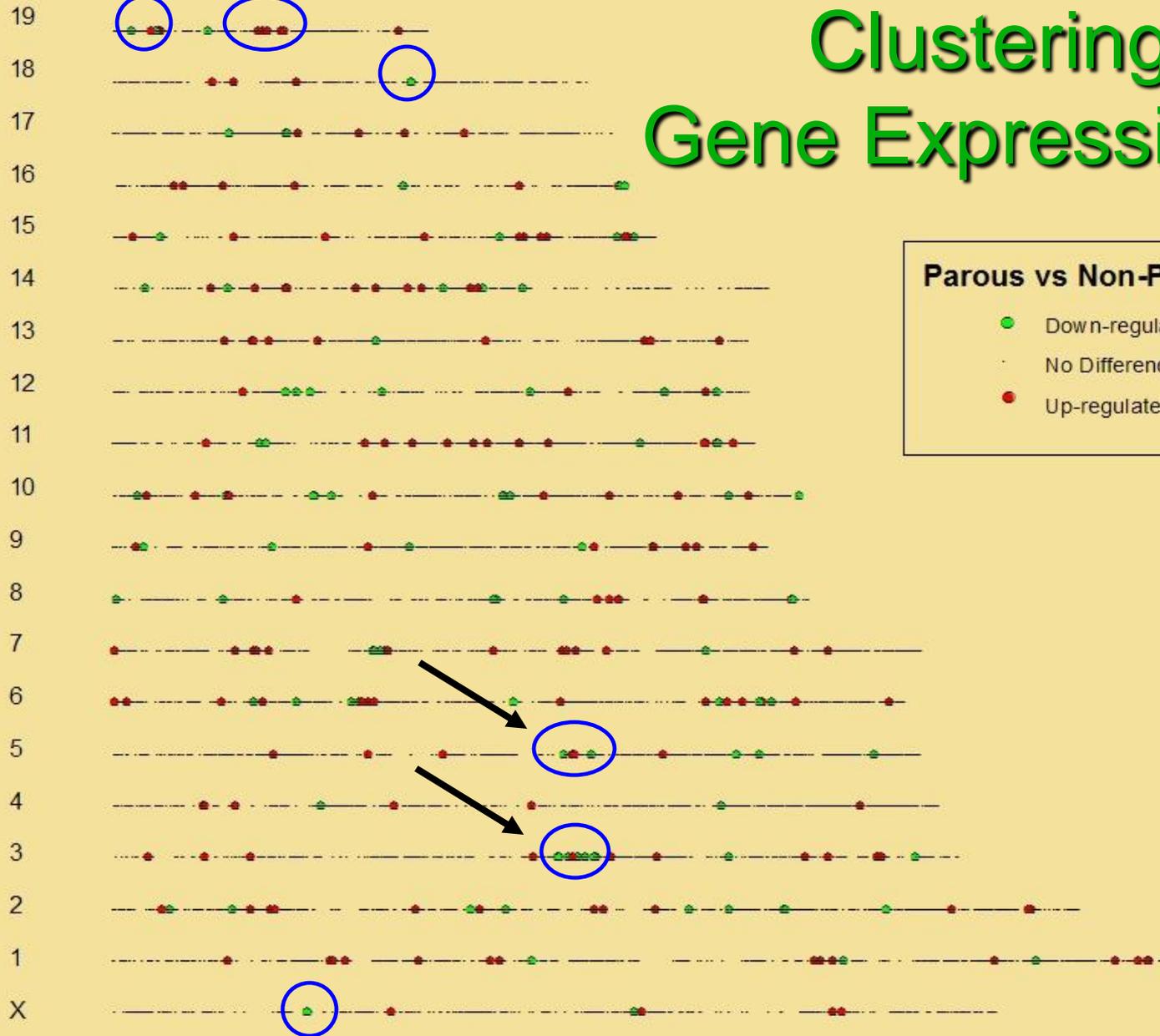
# The Spatial Scan Statistic

## *Spatial Autocorrelation*



chromosome

# Clustering of Gene Expression



## Parous vs Non-Parous

- Down-regulated
- No Difference
- Up-regulated

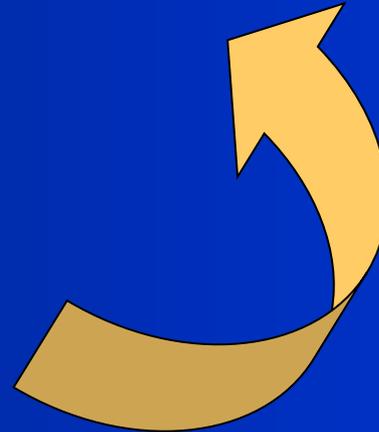
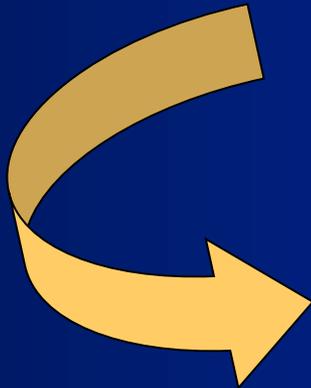
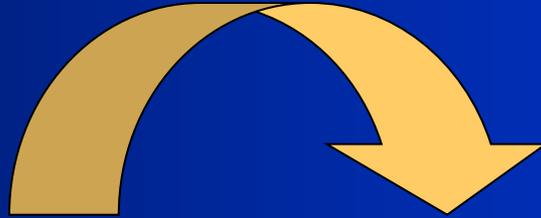
# Conclusions

- Mapping the gene in a GIS is now possible
- Clustering of up-or down-regulated genes in response to parity
- Genes exhibit coordinated expression based on their spatial location
- Mechanism for protective effect of parity

# Next Steps

- What are the functions of the individual genes in clusters?
- Are they related to disruption of oncogenesis?
- Examine the differential response of parity to radiation

# Collaboration



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Thank you

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# Problems with Spatial analysis of Gene Expression levels

- relative gene location on the chromosome at equally spaced intervals
- Pre-defined region of the chromosome
- False Discovery

# Resolves Statistical Issues with Previous Studies

- Analyzes actual distance
- Not Limited to one scale
- Controls for multiple tests
- Gene locations analyzed at actual location rather than at regularly space intervals