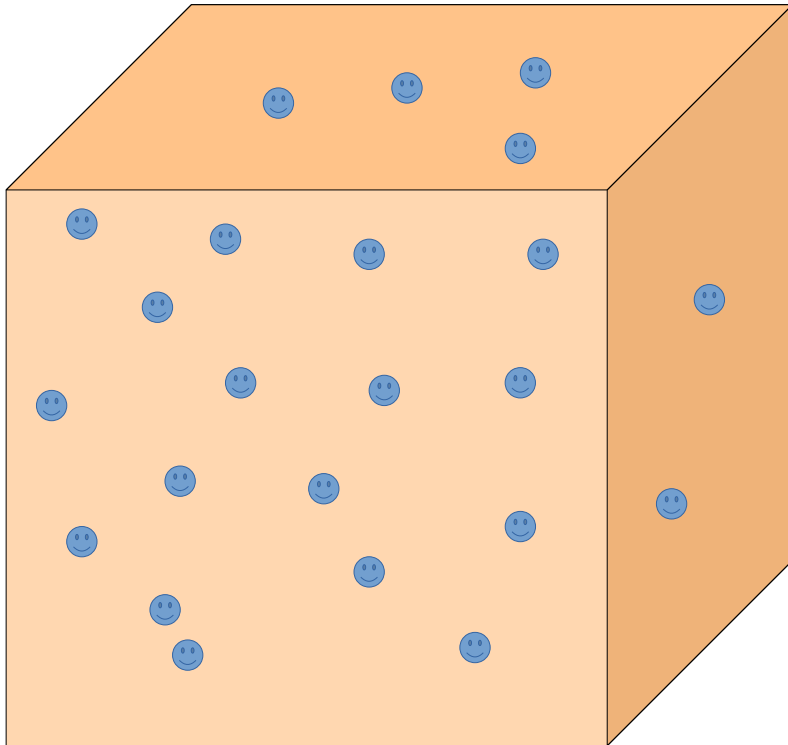


A fast (?) way to compute distances when you have a large dataset



N objects

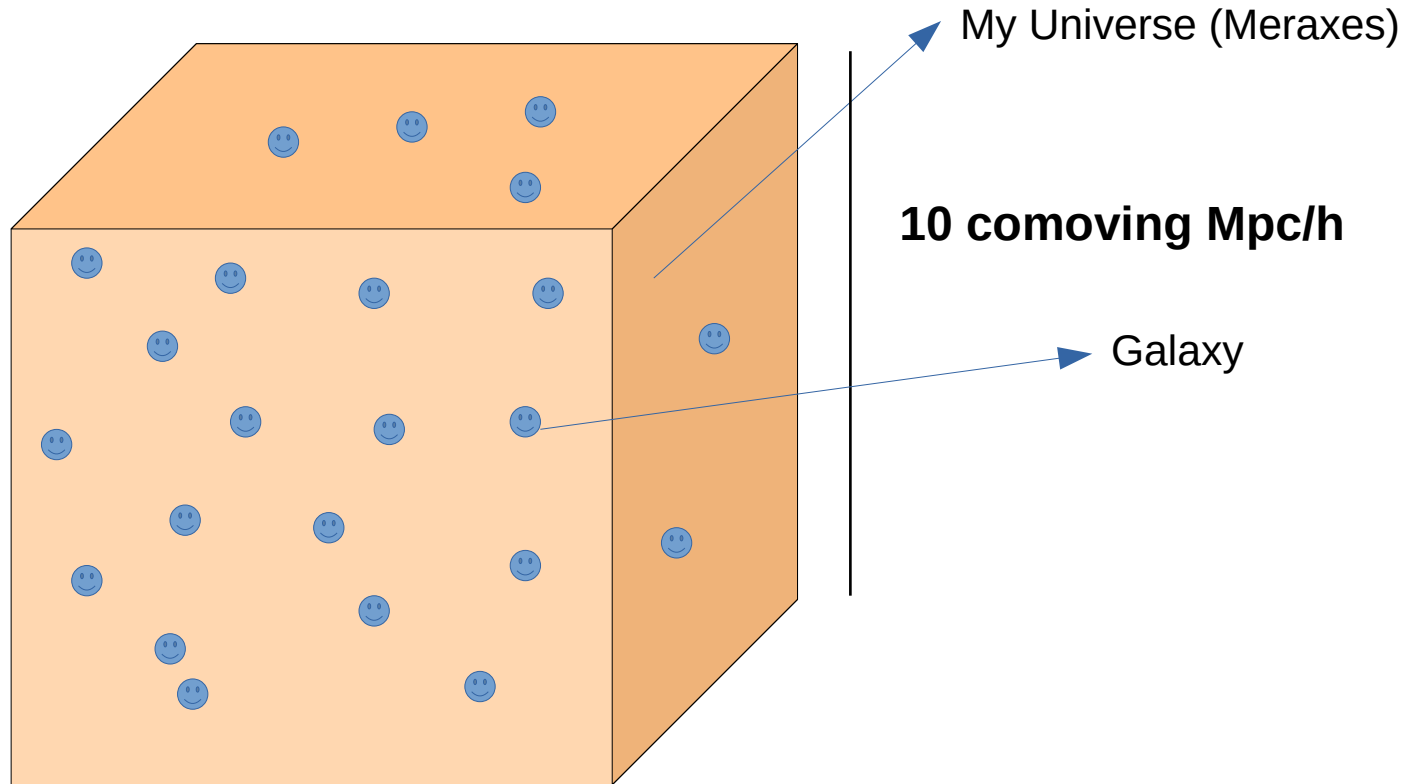


N-1 pairs

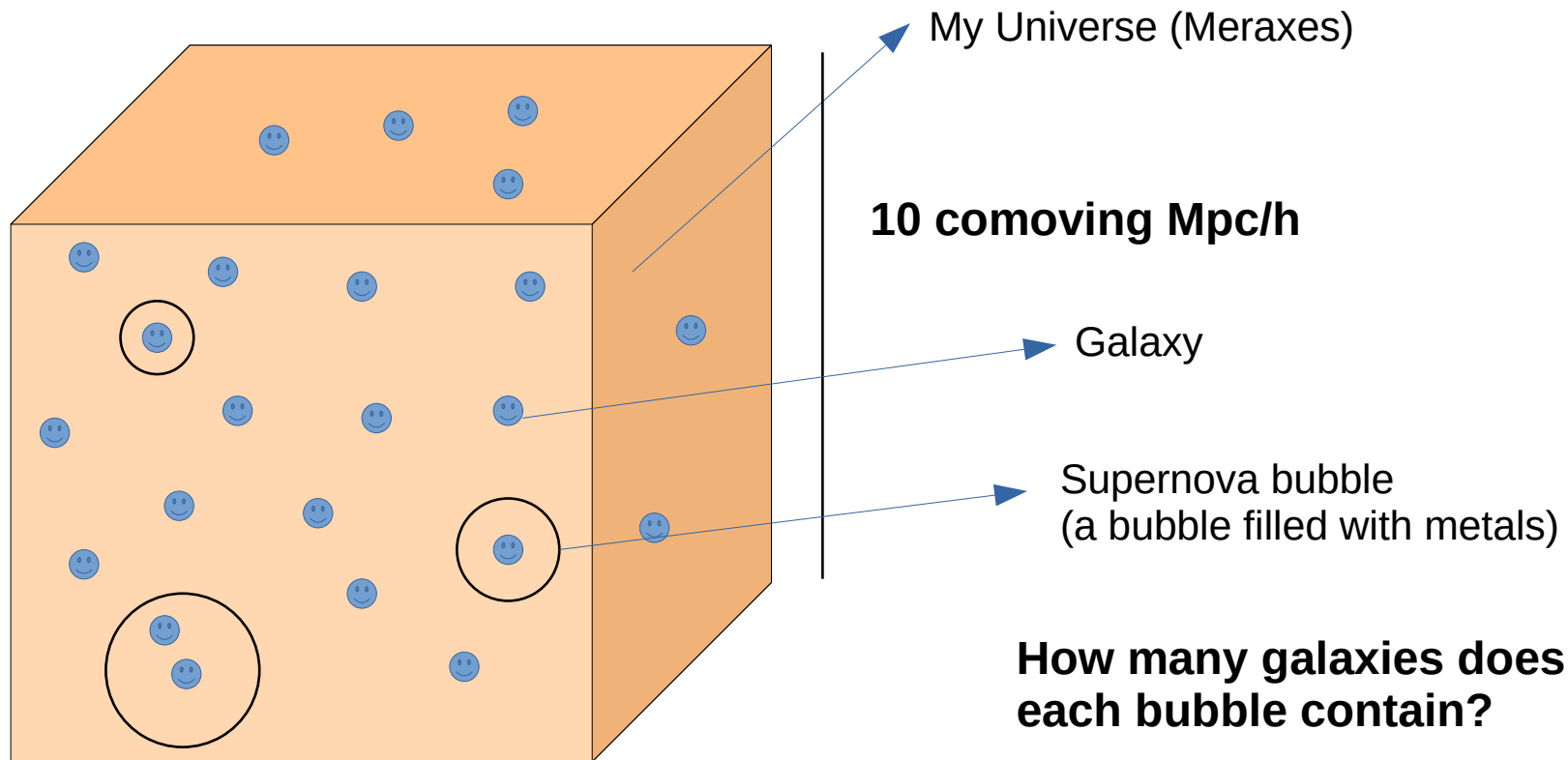


If N is large that's a lot!

A fast (?) way to compute distances when you have a large dataset



A fast (?) way to compute distances when you have a large dataset



Download GalMeraxes.dat



Catalog of galaxies inside the box at $z = 10$

10^6 galaxies

ID	x (cMpc/h)	y (cMpc/h)	z (cMpc/h)	R (pMpc/h)
32	9.39847183227539	9.311675071716309	6.563014984130859	0.004909333772957325
94	4.649499893188477	2.6379075050354004	2.507711887359619	0.008088280446827412
126	7.039572238922119	9.757633209228516	1.47855806350708	0.007576911710202694
159	9.06210708618164	1.946584939956665	9.584404945373535	0.006176112685352564
168	4.802731513977051	4.1556854248046875	0.41099879145622253	0.004963770043104887
1010000000016	9.057523727416992	2.0408332347869873	9.344897270202637	0.003722317749634385
1010000000087	5.652709484100342	1.819104790687561	3.944387435913086	0.005807896610349417
2020000000001	1.117898941040039	2.6639058589935303	8.207464218139648	0.006554874125868082
2020000000151	8.420601844787598	9.846256256103516	6.694880485534668	0.009225325658917427
2020000000189	6.446775913238525	3.1694858074188232	3.0488383769989014	0.005887812469154596
2020000000286	8.042474746704102	3.713752269744873	7.519839763641357	0.004339142702519894
3030000000038	9.115301132202148	2.040675401687622	9.486834526062012	0.0065930974669754505
3030000000073	9.734993934631348	4.872226715087891	0.44379758834838867	0.009590666741132736
3030000000074	9.845823287963867	4.813952922821045	0.4330946207046509	0.005115066654980183
3030000000266	8.022832870483398	3.6731903553009033	7.533663272857666	0.007251090835779905
3030000000279	7.046058654785156	9.750727653503418	1.47841477394104	0.007914470508694649
40400000000231	9.254473686218262	4.721994400024414	0.1771562695503235	0.004658902995288372
40400000000310	7.038017272949219	9.758456230163574	1.4803993701934814	0.00912009458988905
40400000000434	9.116314888000488	2.034564733505249	9.490520477294922	0.006015545688569546
40400000000473	7.065565586090088	9.771013259887695	1.481566071510315	0.002825746312737465
40400000000483	7.348927974700928	7.704824447631836	9.512716293334961	0.004256140440702438
50500000000460	7.159983158111572	9.751408576965332	1.569387435913086	0.006184363272041082

- How many galaxies are contained by each bubble?
- Can you plot it?
- How many galaxies are polluted by at least one bubble?
- What is the fraction of the Universe filled with metals?

Multiply this by $(1+z = 11)$

Very difficult: bubble might overlap