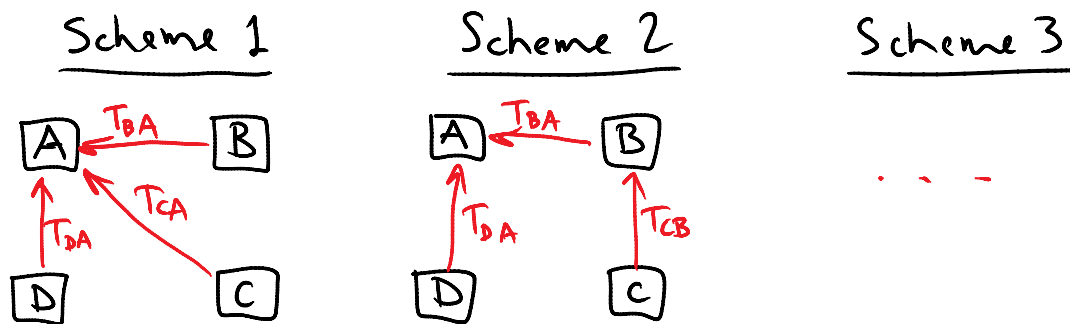


Image-Group Registration

L 35

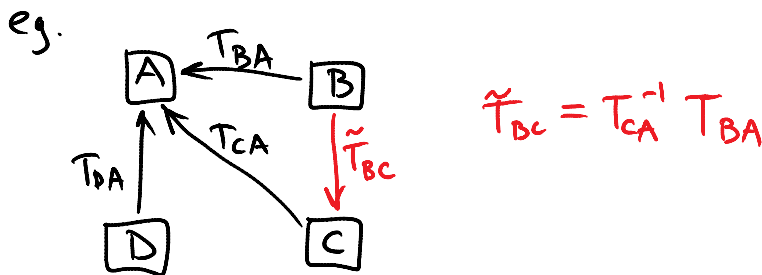
Goal: How can we register a whole group of images together?

Suppose you have 3 or more images that you want to register. How do you go about it?



To encode the relative transformations among a set of E images, you need $E-1$ transformations.

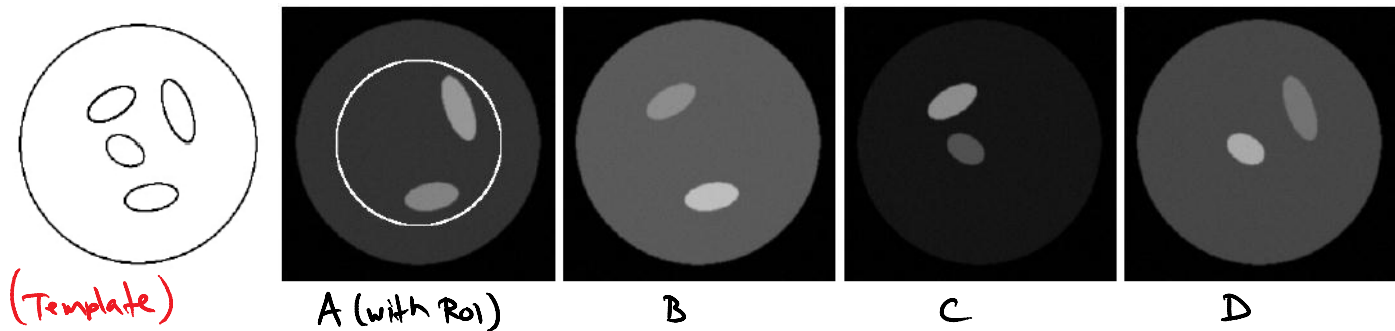
Then, we can derive the transformation between any two images.



That's fine and dandy. Now, what happens if we register B to C? We get another estimate of T_{BC} . It's highly unlikely that \tilde{T}_{BC} is exactly the same as T_{BC} . Which is more accurate? Which scheme should we use? What about all the other transforms that might bring up similar inconsistencies?

Here is an extreme (pathological) example:

Consider registering these four images,



Each image contains two of 4 small ellipses. How would you register A to C? Or B to D?

Of course, those are all rhetorical questions designed to set the stage for my next brilliant idea.

Ensemble Registration

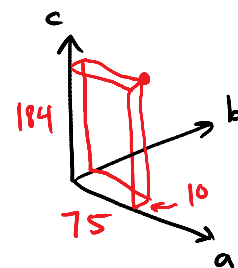
The problem with the above scenarios is that registration is treated as a pairwise operation; it always takes the form of **"Register X to Y"**.

But what if we could simultaneously register multiple images?

Let's consider registering 3 images: *a, b and c.*

We can populate the joint intensity scatter plot, but this time the JISP is 3D.

$$\text{i.e. } \left. \begin{array}{l} a_{ij} = 75 \\ b_{ij} = 10 \\ c_{ij} = 184 \end{array} \right\} (75, 10, 184)$$



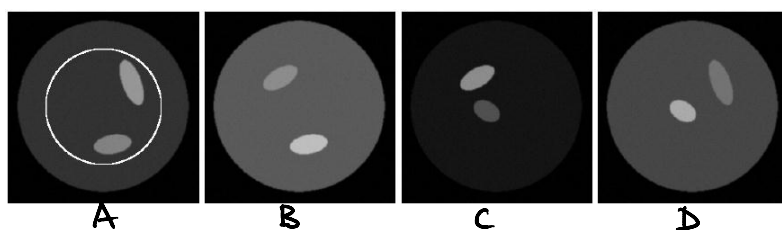
Now we place regressors in this 3D JISP, and do the same clustering process.

(video demo)



Results

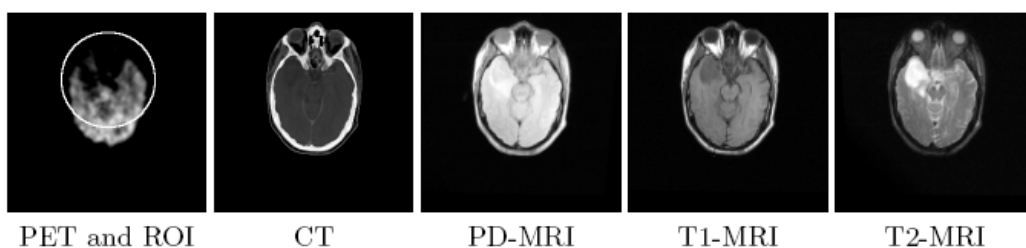
Case I:



Average Pixel
Displacement
(big=bad)

Method	A-B	A-C	A-D	B-C	B-D	C-D	Mean
NMI (pairwise)	0.59	4.1	0.31	0.83	7.2	4.2	2.87
Ensemble	0.54	0.67	0.32	0.31	0.53	0.64	0.50

Case II:



Method	CT- PET	CT- PD	CT- T1	CT- T2	PET- PD	PET- T1	PET- T2	PD- T1	PD- T2	T1- T2	Mean
NMI (pairwise)	6.1	7.7	2.6	8.2	7.6	5.9	6.7	6.0	4.9	7.7	6.34
Ensemble (pairwise)	1.9	0.80	1.1	1.2	2.6	2.9	2.6	0.93	1.4	2.0	1.73
Ensemble (full)	1.9	0.74	0.87	0.72	1.8	1.7	1.4	0.50	0.73	0.92	1.13

Case III:



Method	F1- F2	F1- F3	F1- F4	F1- F5	F2- F3	F2- F4	F2- F5	F3- F4	F3- F5	F4- F5	Mean
NMI (pairwise)	33	96	10	41	64	89	34	49	99	15	54.6
Ensemble (pairwise)	18	21	12	15	20	21	17	17	25	14	18.0
Ensemble (full)	0.46	0.97	1.8	1.8	1.1	2.1	2.0	1.7	2.1	0.44	1.45