

Making Mangle Masks for DES

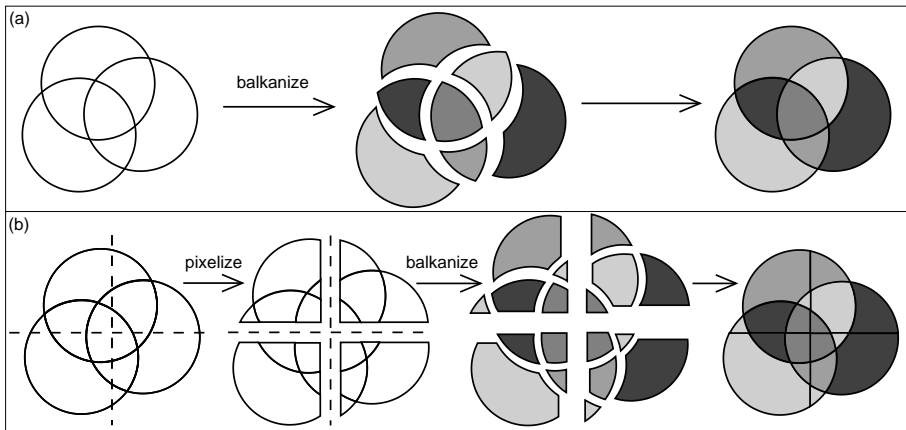
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What is mangle?

- Mangle “polygon” files encode functions that are piecewise-constant on a sphere:
 - Completeness
 - Magnitude limit
 - etc.
- A polygon is an intersection of spherical caps
- Mangle tasks:
 - Take input polygons (e.g. a set of overlapping DES tiles) and split into non-overlapping regions
 - Given an (RA, dec), output what polygons it is in
 - Make random samples with varying weight in each region
 - Convert polygons to HEALPix format
 - And more!

Balkanizing masks with mangle



- Balkanize: resolve mask into non-overlapping polygons
- Pixelize: method to speed up balkanization

For more details:

<http://space.mit.edu/home/tegmark/mangle>

Mangle inputs from database

To make a mask with mangle for a DES coadd, extract from each reduced image:

- 4 RA/Dec corners of CCD
- Mean background noise σ_{sky} (skysigma in image header)
- Zeropoint
- (not yet!) positions of regions masked for bright stars, bleed trails, etc.

Code by Tony Darnell pulls this info from DESDM database
Then:

- Make a polygon for each CCD
- Weighted by inverse variance $1/\sigma_{\text{sky}}^2$
- Balkanize with mangle to make one mask for each band

Calculating magnitude limit

- Combine noise from overlapping coadd regions appropriately (see SWarp manual)
- Weighted average means that $1/\sigma_{\text{sky}}^2$ weights can just be added together to get the final weight
- Define limiting magnitude as magnitude of the flux in an aperture (e.g. 2'') that is equal to $10\sigma_{\text{tot}}^2$

$$\sigma_{\text{tot}}^2 = \left[\sum_i \frac{1}{p_i^2 \sigma_i^2} \right]^{-1}$$

σ_i is σ_{sky} for image i , p_i is zeropoint calibration factor

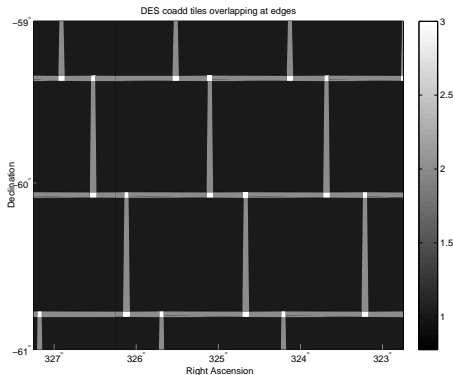
- **Magnitude limit:**

$$m_{\text{limit}} = m_{\text{ZPcal}} - 2.5 \log \left(10 \sqrt{\pi \frac{(D/2)^2}{.27^2} \sigma_{\text{tot}}} \right)$$

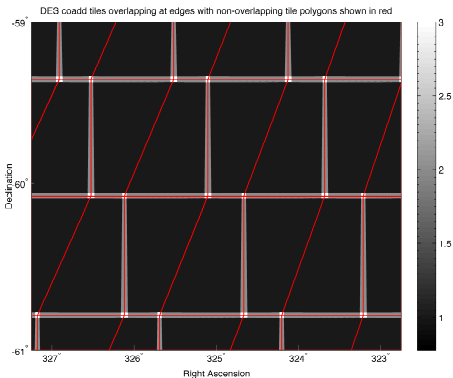
D is diameter of aperture in arcsec

Managing coadd tiles

- DES coadd images and catalogs done in $0.75^\circ \times 0.75^\circ$ tiles that overlap by $\sim 2'$ on the edges
- Duplicate images in overlap regions must be filtered out
- Want a single mask for whole sky for LSS, not per tile
- Solution: process mask in units of *tile polygons*



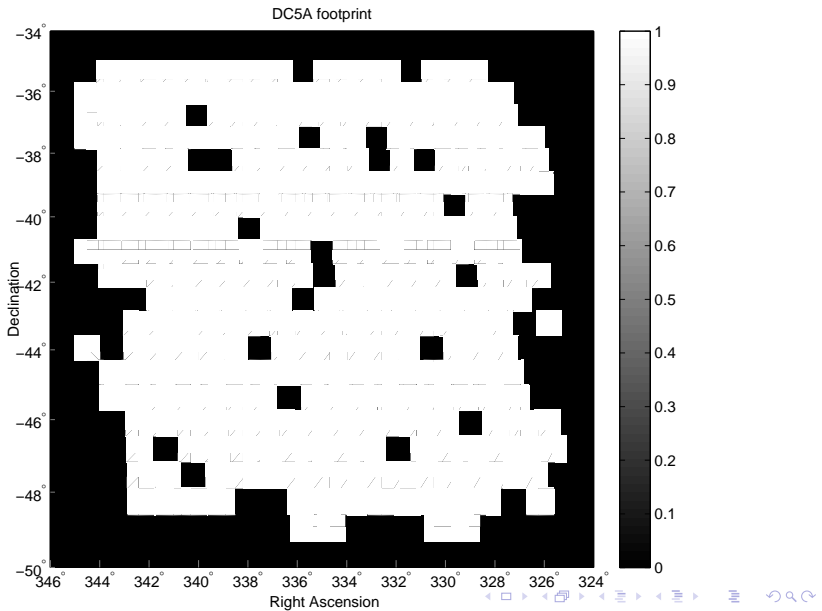
Tile polygons



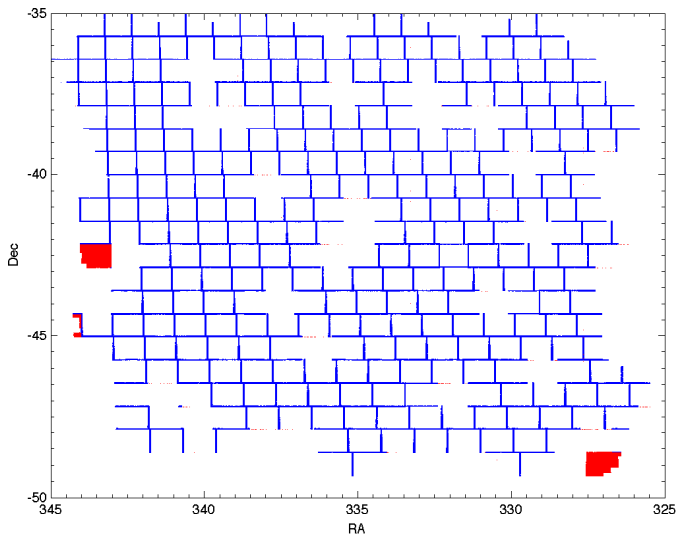
Process mask within *tile polygons*:

- Non-overlapping
- Perfectly abutting
- Covers inner region of each tile (excludes $\sim 1'$ at edges)
- Filter duplicates by requiring `coadd_tile_id = tile_polygon_id`

DC5A tile polygons

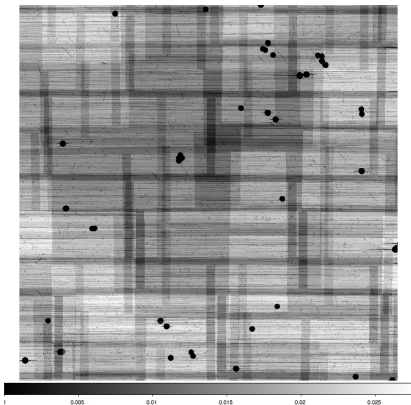


DC5A duplicate object flagging

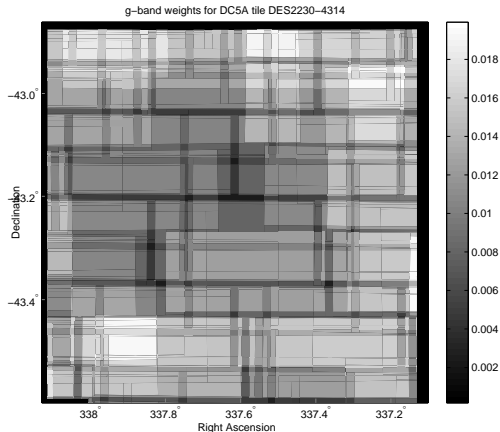


Test 1: Visual comparison with weight map

Fits weight map



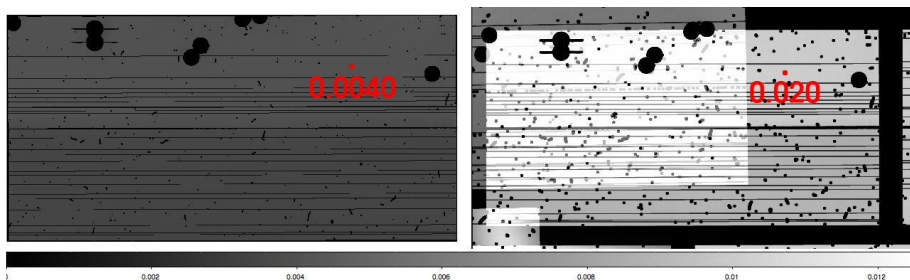
Mangle mask



Bad columns and bright stars not included yet

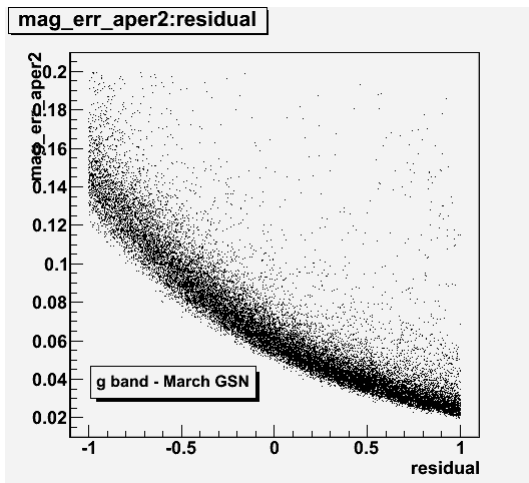
Test 2: Examine coadd near edges

- Compare remap weight map and coadd weight map



- Weights disagree by factor of 4. Worse than before!!
(b/c of PSF homogenization?)

Test 3: matching magnitude errors



Magnitude error at magnitude limit should be 0.1
GSN2: error at magnitude limit ~ 0.065 (Nacho Sevilla)

Using the mangle mask

With this mask, mangle can:

- Take any point on the sky and tell you which non-overlapping region it's in
- For each region, tell you which DES tile(s) observed it

Key DES mask tasks:

- Generate random object catalog for LSS studies
- Look up the corresponding magnitude limit, completeness, etc. for observed objects and randoms
- Find which reduced images targeted a given coadd object
- Your task here? Let us know!

Getting DC5A mangle masks

Available at

<http://deslogin.cosmology.illinois.edu/~mswanson/>

- Masks in mangle polygon format
 - Tile polygons
 - CCD polygons (polygon id = image id)
 - Coadded, balkanized polygons (weight=magnitude limit)
- New object catalog
 - Match DC5ACATALOG_2.5GB.fits (~15 million objects)
 - Tile edge duplicates flagged
 - Magnitude limits attached
- Random angular catalog
 - ~150 million objects over DC5A area
 - Magnitude limits attached
 - Mag limits + luminosity func. to generate z's

Mask info in DESDM

- Mangle generates a *polygon file* containing the mask
- Mask generation should be part of coadd pipeline
- For every coadd catalog (with given selection cuts), there are 5 corresponding masks (one for each band)
- Can use mask to generate matching random catalog
- Will include some mask info in database for each coadd
- Polygon files themselves saved and separately available

New database structures for mask

New table: 1 per band per coadd containing mask info:

$\text{mask}_{\text{ID}}^i$	m_{lim} for $2''$	σ_{tot}	list of reduced image IDs contributing to coadd	other?
0	23.69	14.61	6657, 6968, 6232, 6046, 6404, 7278	...
1	23.74	13.96	6519, 6657, 6968, 6232, 6046, 6404, 7278	...
2	23.82	13.01	6519, 6657, 6462, 6968, 6232, 6046, 6404, 7278	...
\vdots	\vdots	\vdots	\vdots	\vdots

New info in coadd object catalog table:

coadd_objects_id	...	$\text{mask}_{\text{ID}}^g$	$\text{mask}_{\text{ID}}^r$	$\text{mask}_{\text{ID}}^i$	$\text{mask}_{\text{ID}}^z$	$\text{mask}_{\text{ID}}^y$
47086410	...	607	706	866	845	388
47086411	...	368	716	991	760	314
\vdots	\vdots	\vdots	\vdots	\vdots		

Also make coadd random catalog with mask IDs attached

DES science with the mask

What LSS wants

- Magnitude limit at every point in survey area
- Random catalog with selection matching data catalog

What weak lensing wants

- List of images that go into each point
- Means to easily look up info for each image
- Binary mask in complicated color space (photo-z's)

What clusters want

- Binary mask for magnitude limit
- Means to find completeness over cluster regions

To Do

- Figure out issues with magnitude limit matching
- Add in masked regions due to bright stars, bleed trails, etc
- Integrate mask making into coadd pipeline
- Create database structures containing mask info
- Build masks of full DES area to create larger simulated catalogs for blind cosmology challenge, survey strategy
- Build mangle tools for Brazil portal, REST tool