Image segmentation with CAMVID

```
%reload_ext autoreload
%autoreload 2
%matplotlib inline
```

```
from fastai.vision import *
from fastai.callbacks.hooks import *
from fastai.utils.mem import *
```

```
path = untar_data(URLs.CAMVID)
```

```
Downloading https://s3.amazonaws.com/fast-ai-imagelocal/camvid
```

```
path.ls()
```

```
[PosixPath('/root/.fastai/data/camvid/images'),
 PosixPath('/root/.fastai/data/camvid/valid.txt'),
 PosixPath('/root/.fastai/data/camvid/codes.txt'),
 PosixPath('/root/.fastai/data/camvid/labels')]
```

```
path_lbl = path/'labels'
path_img = path/'images'
```

```
fnames = get_image_files(path_img)
fnames[:3]
```

```
[PosixPath('/root/.fastai/data/camvid/images/0016E5_08159.png'),
 PosixPath('/root/.fastai/data/camvid/images/0016E5_05010.png'),
 PosixPath('/root/.fastai/data/camvid/images/0016E5_08580.png')]
```

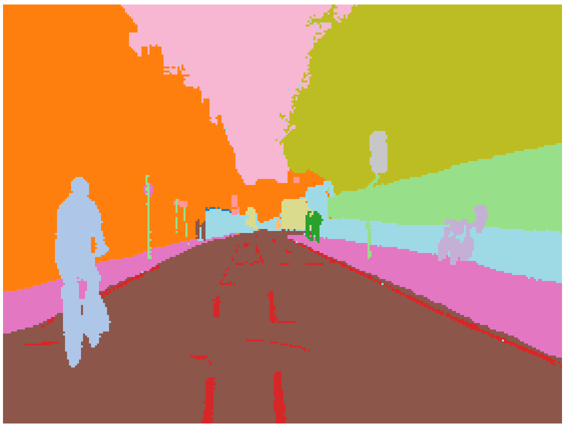
```
lbl_names = get_image_files(path_lbl)
lbl_names[:3]
```

```
[PosixPath('/root/.fastai/data/camvid/labels/0016E5_00720_P.png'),
 PosixPath('/root/.fastai/data/camvid/labels/0016E5_07560_P.png'),
 PosixPath('/root/.fastai/data/camvid/labels/0001TP_008760_P.png')]
```

```
img_f = fnames[0]
img = open_image(img_f)
img.show(figsize=(5,5))
```

```
# convert image file names to equivalent label file names
get_y_fn = lambda x: path_lbl/f'{x.stem}_P{x.suffix}'
```

```
mask = open_mask(get_y_fn(img_f))
mask.show(figsize=(5,5), alpha=1)
```



```
src_size = np.array(mask.shape[1:])
src_size,mask.data
```

```
(array([720, 960]), tensor([[[ 4,  4,  4,  ..., 26, 26, 26],
          [ 4,  4,  4,  ..., 26, 26, 26],
          [ 4,  4,  4,  ..., 26, 26, 26],
          ...,
          [17, 17, 17,  ..., 17, 17, 17],
          [17, 17, 17,  ..., 17, 17, 17],
          [17, 17, 17,  ..., 17, 17, 17]]]))
```

```
codes = np.loadtxt(path/'codes.txt', dtype=str); codes
```

```
array(['Animal', 'Archway', 'Bicyclist', 'Bridge', 'Building', 'Car', 'CartLuggagePra
       'Fence', 'LaneMkgsDriv', 'LaneMkgsNonDriv', 'Misc_Text', 'MotorcycleScooter',
       'Pedestrian', 'Road', 'RoadShoulder', 'Sidewalk', 'SignSymbol', 'Sky', 'SUVPic
       'TrafficLight', 'Train', 'Tree', 'Truck_Bus', 'Tunnel', 'VegetationMisc', 'Voi
```

```
size = src_size//2
```

```
free = gpu_mem_get_free_no_cache()
```

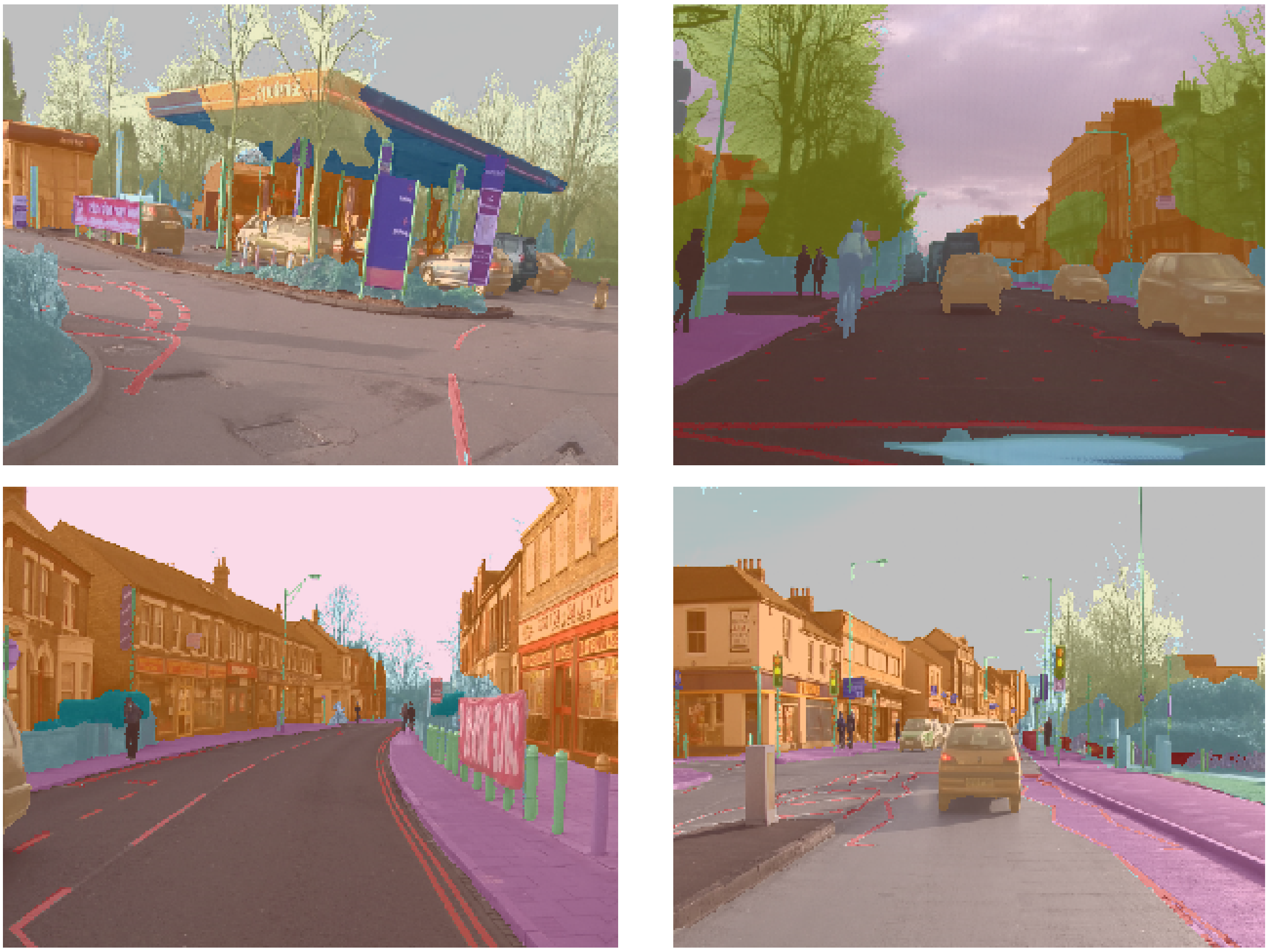
```
# the max size of bs depends on the available GPU RAM
if free > 8200: bs=8
else:           bs=4
print(f"using bs={bs}, have {free}MB of GPU RAM free")
```

```
using bs=8, have 16270MB of GPU RAM free
```

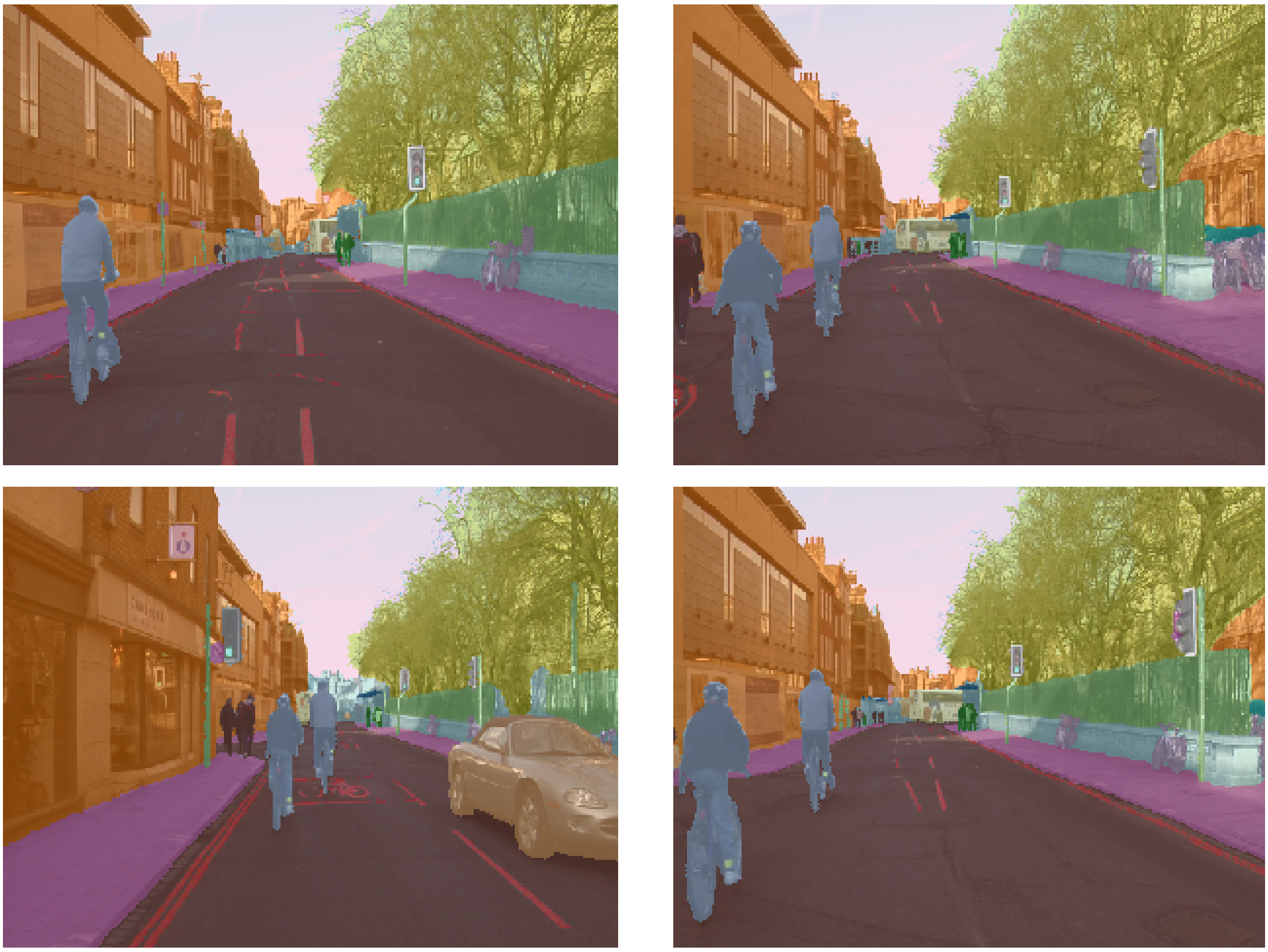
```
src = (SegmentationItemList.from_folder(path_img)
       .split_by_fname_file('../valid.txt')
       .label_from_func(get_y_fn, classes=codes))
```

```
data = (src.transform(get_transforms(), size=size, tfm_y=True)
        .databunch(bs=bs)
        .normalize(imagenet_stats))
```

```
data.show_batch(2, figsize=(10,7))
```



```
data.show_batch(2, figsize=(10,7), ds_type=DatasetType.Valid)
```



Modelling

```
name2id = {v:k for k,v in enumerate(codes)}
void_code = name2id['Void']

def acc_camvid(input, target):
    target = target.squeeze(1)
    mask = target != void_code
    return (input.argmax(dim=1)[mask]==target[mask]).float().mean()
```

```
metrics=acc_camvid
# metrics=accuracy
```

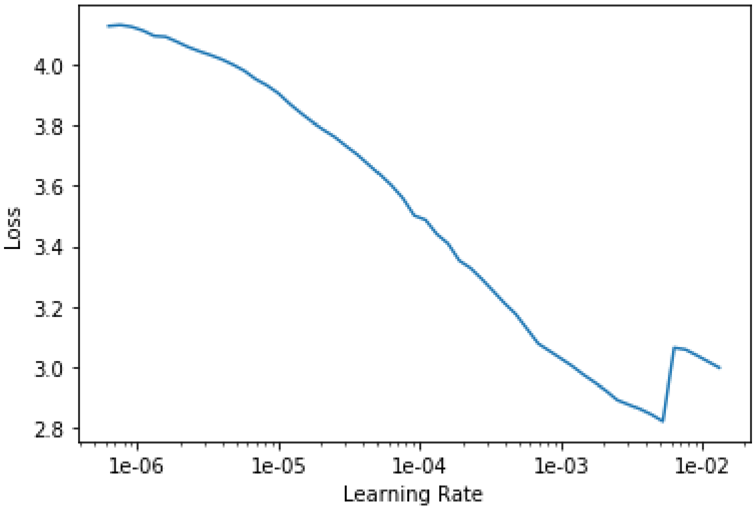
```
wd=1e-2
```

```
learn = unet_learner(data, models.resnet34, metrics=metrics, wd=wd)
```

```
Downloading: "https://download.pytorch.org/models/resnet34-333f7ec4.pth" to /root/.ca
100%|██████████| 83.3M/83.3M [00:00<00:00, 328MB/s]
```

```
lr_find(learn)
learn.recorder.plot()
```

```
0.00% [0/2 00:00<00:00]
epoch  train_loss  valid_loss  acc_camvid  time
92.00% [69/75 00:51<00:04 10.4677]
LR Finder is complete, type {learner_name}.recorder.plot() to see the graph.
```



```
lr=3e-3
```

```
learn.fit_one_cycle(10, slice(lr), pct_start=0.9)
```

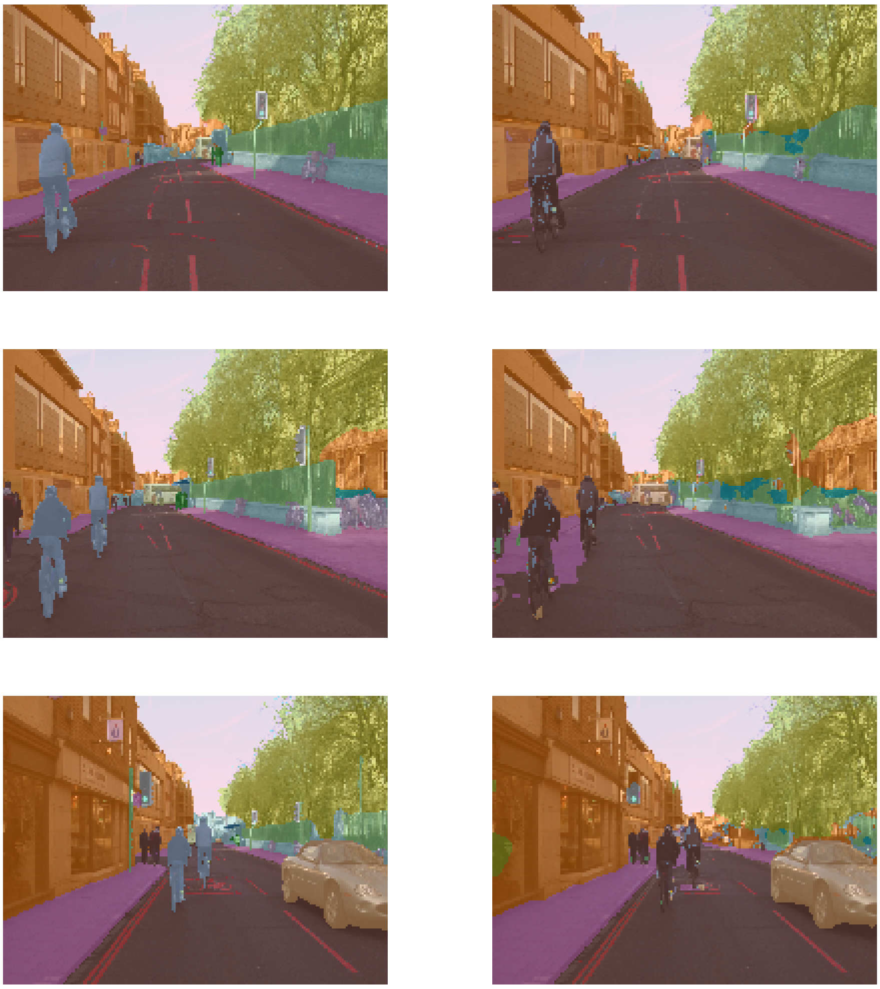
epoch	train_loss	valid_loss	acc_camvid	time
0	1.196258	0.769203	0.827455	00:54
1	0.818703	0.693821	0.826269	00:51
2	0.722321	0.534580	0.856703	00:51
3	0.634283	0.617080	0.850598	00:51
4	0.629293	0.527589	0.858258	00:51
5	0.582632	0.510770	0.871061	00:51
6	0.636059	0.532386	0.857269	00:51
7	0.674969	0.444165	0.872903	00:51
8	0.575881	0.645875	0.839219	00:51
9	0.489502	0.363996	0.895137	00:51

```
learn.save('stage-1')
```

```
learn.load('stage-1');
```

```
learn.show_results(rows=3, figsize=(8,9))
```

Ground truth/Predictions



```
learn.unfreeze()
```

```
lrs = slice(lr/400,lr/4)
```

```
learn.fit_one_cycle(12, lrs, pct_start=0.8)
```

epoch	train_loss	valid_loss	acc_camvid	time
0	0.418384	0.350688	0.897273	00:53
1	0.406504	0.350110	0.895977	00:52
2	0.394534	0.334460	0.906691	00:52
3	0.381445	0.317356	0.907634	00:52
4	0.366837	0.315390	0.911705	00:53
5	0.353838	0.299530	0.918435	00:53
6	0.347749	0.296001	0.914528	00:53
7	0.330103	0.309215	0.910542	00:53
8	0.322873	0.292945	0.912567	00:53
9	0.314060	0.287867	0.922294	00:53
10	0.286326	0.286936	0.920011	00:53
11	0.262034	0.264440	0.925488	00:53

```
learn.save('stage-2');
```

```
learn.destroy()

size = src_size

free = gpu_mem_get_free_no_cache()
# the max size of bs depends on the available GPU RAM
if free > 8200: bs=3
else:           bs=1
print(f"using bs={bs}, have {free}MB of GPU RAM free")
```

```
this Learner object self-destroyed - it still exists, but no longer usable
using bs=3, have 15565MB of GPU RAM free
```

```
data = (src.transform(get_transforms(), size=size, tfm_y=True)
        .databunch(bs=bs)
        .normalize(imagenet_stats))
```

```
learn = unet_learner(data, models.resnet34, metrics=metrics, wd=wd)
```

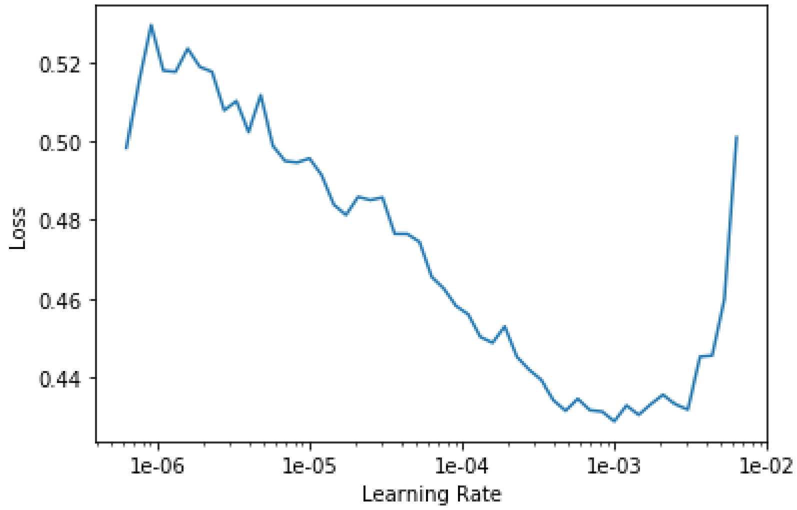
```
learn.load('stage-2');
```

```
lr_find(learn)
learn.recorder.plot()
```

```
0.00% [0/1 00:00<00:00]
```

epoch	train_loss	valid_loss	acc_camvid	time

```
32.50% [65/200 01:15<02:36 0.7413]
LR Finder is complete, type {learner_name}.recorder.plot() to see the graph.
```



```
lr=1e-3
```

```
learn.fit_one_cycle(10, slice(lr), pct_start=0.8)
```

epoch	train_loss	valid_loss	acc_camvid	time
0	0.373758	0.313761	0.915802	03:38
1	0.336631	0.314733	0.914408	03:35
2	0.333394	0.287228	0.921204	03:35
3	0.343204	0.303790	0.913903	03:35
4	0.341679	0.291435	0.922916	03:35
5	0.344433	0.350833	0.911346	03:35
6	0.328087	0.298650	0.916003	03:35
7	0.318760	0.306280	0.920618	03:35
8	0.278263	0.275225	0.932161	03:35
9	0.240248	0.240807	0.934117	03:35

```
learn.save('stage-1-big')
```

```
learn.load('stage-1-big');
```

```
learn.unfreeze()
```

```
lrs = slice(1e-6,lr/10)
```

```
learn.fit_one_cycle(10, lrs)
learn.fit_one_cycle(10, lrs)
```

epoch	train_loss	valid_loss	acc_camvid	time
0	0.224188	0.246791	0.934003	03:42
1	0.213088	0.256830	0.932385	03:41
2	0.218712	0.234583	0.936125	03:41
3	0.218922	0.249010	0.932935	03:42
4	0.219142	0.230402	0.937171	03:41
5	0.204338	0.242721	0.935733	03:42
6	0.196909	0.241375	0.936009	03:42
7	0.199717	0.235098	0.937353	03:42
8	0.191846	0.234249	0.937417	03:42
9	0.193807	0.240966	0.936277	03:42

```
learn.save('stage-2-big')
```

```
learn.load('stage-2-big');
```

```
learn.show_results(rows=3, figsize=(10,10))
```

Ground truth/Predictions