Example of Object Detection with Detectron 2 based on the tutorial from:

https://colab.research.google.com/drive/16jcaJoc6bCFAQ96jDe2HwtXj7BMD_-m5#scrollTo=b2bjrfb2LDeo (https://colab.research.google.com/drive/16jcaJoc6bCFAQ96jDe2HwtXj7BMD_-m5#scrollTo=b2bjrfb2LDeo)

---------- Environment Setup ----------

This was ran on a Standard NV6_Promo (6 vcpus, 56 GiB memory) Instance on Azure which includes GPU's

Requirements:

Python 3.6
GPU - cuda-drivers (418.87.00-1)

Step 1 - The Cuda Driver on the Istance is not up-to-date, so an update is requrired to the NV6_Promo instance (as of 2019-01-01)

To update the Cuda Driver issue the following command:

sudo apt-get install cuda-drivers

A Reboot of the linux host is then required:

sudo reboot

Step 2 - Install the python libraries for Detectron 2

cd /data/anaconda/envs/py36/bin
./pip install torch==1.3.0+cu92 torchvision==0.4.1+cu92 -f https://download.pytorch.org/whl/torch_stable.html (https://download.pytorch.org/whl/torch_stable.html)
./pip install git+https://github.com/facebookresearch/fvcore.git (https://github.com/facebookresearch/fvcore.git)
git clone https://github.com/facebookresearch/detectron2 (https://github.com/facebookresearch/detectron2) detectron2_repo
./pip install -e detectron2_repo
./pip install 'git+https://github.com/facebookresearch/fvcore (https://github.com/facebookresearch/fvcore)'
./pip install opencv-python
./pip install "git+https://github.com/philferriere/cocoapi.git#egg=pycocotools&subdirectory=PythonAPI (https://github.com/philferriere/cocoapi.git#egg=pycocotools&subdirectory=PythonAPI)"

If using Jupyter a restat of the kernel is necessary for the notebook to the new packages

Create Cell Dataset which will be used to for object detection, also create a project specific instance of the detectron2_repo by running the output of the next cell in the linux command line

In [1]:
```
import os
dirpath = os.getcwd()
print("cd %s" % dirpath)
print("git clone https://github.com/facebookresearch/detectron2 detectron2_repo")
```

```
cd /data/home/ben_dk_ds/notebooks/hw
git clone https://github.com/facebookresearch/detectron2 detectron2_repo
```

Need to unzip files on first pass

In [2]:
```
#import zipfile
#with zipfile.ZipFile("cell_obj_detection_images.zip", 'r') as zip_ref:
#    zip_ref.extractall("./")
```

In [3]:
```
# You may need to restart your runtime prior to this, to let your installation take effect
# Some basic setup
# Setup detectron2 logger
import detectron2
from detectron2.utils.logger import setup_logger
setup_logger()

# import some common libraries
import numpy as np
import cv2
#from google.colab.patches import cv2_imshow

# import some common detectron2 utilities
from detectron2.engine import DefaultPredictor
from detectron2.config import get_cfg
from detectron2.utils.visualizer import Visualizer
from detectron2.data import MetadataCatalog

import os
import numpy as np
import json
from detectron2.structures import BoxMode
import itertools
%matplotlib inline
```

In [4]:
```
# write a function that loads the dataset into detectron2's standard format
def get_cell_dicts(img_dir):
    json_file = os.path.join(img_dir, "via_region_data.json")
    with open(json_file) as f:
        imgs_anns = json.load(f)

    dataset_dicts = []
    for _, v in imgs_anns.items():
        record = {}

        filename = os.path.join(img_dir, v["filename"])
        height, width = cv2.imread(filename).shape[:2]

        record["file_name"] = filename
        record["height"] = height
        record["width"] = width

        annos = v["regions"]
        objs = []
        for _, anno in annos.items():
            assert not anno["region_attributes"]
            anno = anno["shape_attributes"]
            px = anno["all_points_x"]
            py = anno["all_points_y"]
            poly = [(x + 0.5, y + 0.5) for x, y in zip(px, py)]
            poly = list(itertools.chain.from_iterable(poly))

            obj = {
                "bbox": [np.min(px), np.min(py), np.max(px), np.max(py)],
                "bbox_mode": BoxMode.XYXY_ABS,
                "segmentation": [poly],
                "category_id": 0,
                "iscrowd": 0
            }
            objs.append(obj)
        record["annotations"] = objs
        dataset_dicts.append(record)
    return dataset_dicts
```

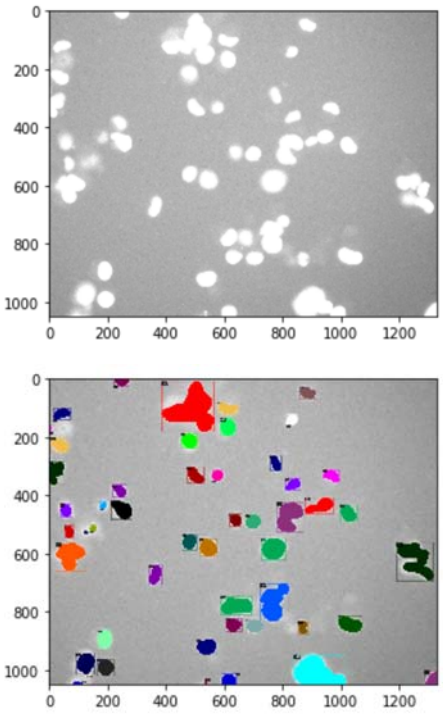
In [5]:
```
source_dir = "upload/"
train_dir = "%strain" % source_dir
valid_dir = "%svalid" % source_dir
from detectron2.data import DatasetCatalog, MetadataCatalog
for d in ["train", "valid"]:
    DatasetCatalog.register(source_dir + d, lambda d=d: get_cell_dicts(source_dir + d))
    MetadataCatalog.get(source_dir + d).set(thing_classes=["cell"])
cell_metadata = MetadataCatalog.get(train_dir)
```

In [6]:
```
dataset_dicts = get_cell_dicts(train_dir)
```

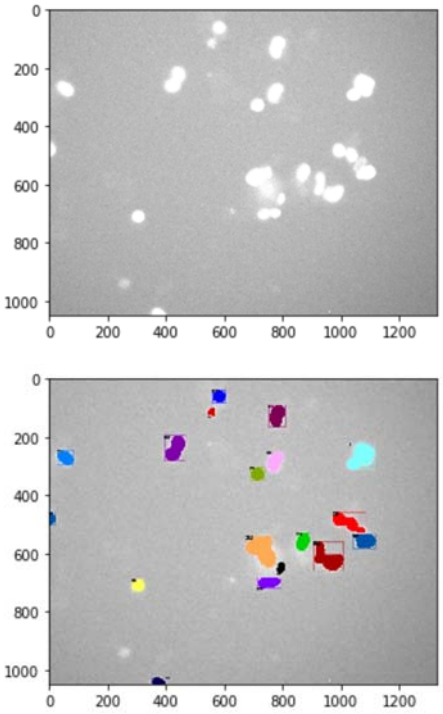
In [7]:
```
%pylab inline
import random
import matplotlib.pyplot as plt
import matplotlib.image as mpimg

dataset_dicts = get_cell_dicts(valid_dir)
for d in random.sample(dataset_dicts, 3):
    print(d["file_name"])
    img = cv2.imread(d["file_name"])
    implot = plt.imshow(img)
    plt.show()
    visualizer = Visualizer(img[:, :, ::-1], metadata=cell_metadata, scale=1)
    vis = visualizer.draw_dataset_dict(d)
    imgplot = plt.imshow(vis.get_image()[:, :, ::-1])
    plt.show()
```

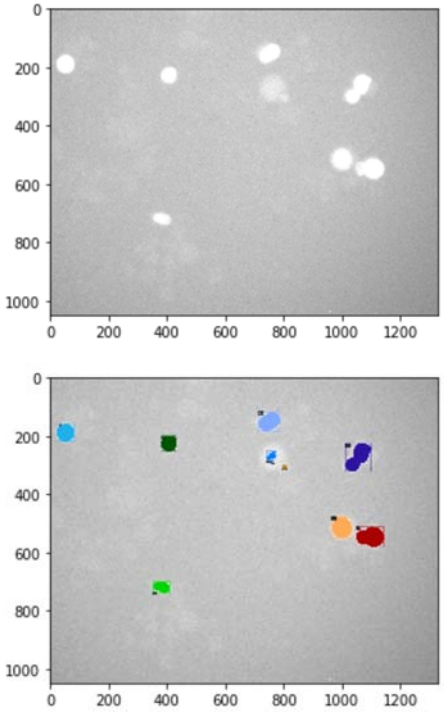
```
Populating the interactive namespace from numpy and matplotlib
upload/valid/p232_0_A06F00d2.jpg
```




```
upload/valid/p388_0_A04F00d2.jpg
```




```
upload/valid/p544_0_A04F00d2.jpg
```


0
200
400
600
800
1000
0
200
400
600
800
1000
1200


0
200
400
600
800
1000
0
200
400
600
800
1000
1200

In [20]:
```
from detectron2.engine import DefaultTrainer
from detectron2.config import get_cfg

cfg = get_cfg()
cfg.merge_from_file("./detectron2_repo/configs/COCO-InstanceSegmentation/mask_rcnn_R_50_FPN_3x.yaml")
cfg.DATASETS.TRAIN = (train_dir,)
cfg.DATASETS.TEST = () # no metrics implemented for this dataset
cfg.DATALOADER.NUM_WORKERS = 2
cfg.MODEL.WEIGHTS = "detectron2://COCO-InstanceSegmentation/mask_rcnn_R_50_FPN_3x/137849600/model_final_f10
217.pkl"  # initialize from model zoo
cfg.SOLVER.IMS_PER_BATCH = 3
cfg.SOLVER.BASE_LR = 0.00025
cfg.SOLVER.MAX_ITER = 500    # 300 iterations seems good enough, but you can certainly train longer
cfg.MODEL.ROI_HEADS.BATCH_SIZE_PER_IMAGE = 256   # faster, and good enough for this toy dataset
cfg.MODEL.ROI_HEADS.NUM_CLASSES = 1  # only has one class (cell)
cfg.MODEL.MASK_ON = True

os.makedirs(cfg.OUTPUT_DIR, exist_ok=True)
trainer = DefaultTrainer(cfg)
trainer.resume_or_load(resume=False)
trainer.train()
```

```
WARNING [11/24 21:25:13 d2.config.compat]: Config './detectron2_repo/configs/COCO-InstanceSegmentation/ma
sk_rcnn_R_50_FPN_3x.yaml' has no VERSION. Assuming it to be compatible with latest v2.
[11/24 21:25:14 d2.engine.defaults]: Model:
GeneralizedRCNN(
  (backbone): FPN(
    (fpn_lateral2): Conv2d(256, 256, kernel_size=(1, 1), stride=(1, 1))
    (fpn_output2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (fpn_lateral3): Conv2d(512, 256, kernel_size=(1, 1), stride=(1, 1))
    (fpn_output3): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (fpn_lateral4): Conv2d(1024, 256, kernel_size=(1, 1), stride=(1, 1))
    (fpn_output4): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (fpn_lateral5): Conv2d(2048, 256, kernel_size=(1, 1), stride=(1, 1))
    (fpn_output5): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (top_block): LastLevelMaxPool()
    (bottom_up): ResNet(
      (stem): BasicStem(
        (conv1): Conv2d(
          3, 64, kernel_size=(7, 7), stride=(2, 2), padding=(3, 3), bias=False
          (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
        )
      )
      (res2): Sequential(
        (0): BottleneckBlock(
          (shortcut): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
          (conv1): Conv2d(
            64, 64, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv2): Conv2d(
            64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv3): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
        )
        (1): BottleneckBlock(
          (conv1): Conv2d(
            256, 64, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv2): Conv2d(
            64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv3): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
        )
        (2): BottleneckBlock(
          (conv1): Conv2d(
            256, 64, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv2): Conv2d(
            64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=64, eps=1e-05)
          )
          (conv3): Conv2d(
            64, 256, kernel_size=(1, 1), stride=(1, 1), bias=False
            (norm): FrozenBatchNorm2d(num_features=256, eps=1e-05)
          )
        )
      )
      (res3): Sequential(
        (0): BottleneckBlock(
          (shortcut): Conv2d(
            256, 512, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=512, eps=1e-05)
          )
          (conv1): Conv2d(
            256, 128, kernel_size=(1, 1), stride=(2, 2), bias=False
            (norm): FrozenBatchNorm2d(num_features=128, eps=1e-05)
          )
          (conv2): Conv2d(
```

```
'roi_heads.box_predictor.cls_score.weight' has shape (81, 1024) in the checkpoint but (2, 1024) in the mo
del! Skipped.
'roi_heads.box_predictor.cls_score.bias' has shape (81,) in the checkpoint but (2,) in the model! Skippe
d.
'roi_heads.box_predictor.bbox_pred.weight' has shape (320, 1024) in the checkpoint but (4, 1024) in the m
odel! Skipped.
'roi_heads.box_predictor.bbox_pred.bias' has shape (320,) in the checkpoint but (4,) in the model! Skippe
d.
'roi_heads.mask_head.predictor.weight' has shape (80, 256, 1, 1) in the checkpoint but (1, 256, 1, 1) in
the model! Skipped.
'roi_heads.mask_head.predictor.bias' has shape (80,) in the checkpoint but (1,) in the model! Skipped.
```

```
[11/24 21:25:22 d2.engine.train_loop]: Starting training from iteration 0
[11/24 21:25:45 d2.utils.events]: eta: 0:09:24  iter: 19  total_loss: 5.742  loss_cls: 0.659  loss_box_re
g: 0.634  loss_mask: 0.690  loss_rpn_cls: 3.072  loss_rpn_loc: 0.620  time: 1.1619  data_time: 0.0365  l
r: 0.000005  max_mem: 3792M
[11/24 21:26:08 d2.utils.events]: eta: 0:08:56  iter: 39  total_loss: 3.520  loss_cls: 0.614  loss_box_re
g: 0.675  loss_mask: 0.683  loss_rpn_cls: 0.935  loss_rpn_loc: 0.590  time: 1.1527  data_time: 0.0311  l
r: 0.000010  max_mem: 3792M
[11/24 21:26:30 d2.utils.events]: eta: 0:08:24  iter: 59  total_loss: 2.659  loss_cls: 0.575  loss_box_re
g: 0.689  loss_mask: 0.670  loss_rpn_cls: 0.150  loss_rpn_loc: 0.535  time: 1.1381  data_time: 0.0300  l
r: 0.000015  max_mem: 3792M
[11/24 21:26:52 d2.utils.events]: eta: 0:07:55  iter: 79  total_loss: 2.398  loss_cls: 0.519  loss_box_re
g: 0.694  loss_mask: 0.654  loss_rpn_cls: 0.111  loss_rpn_loc: 0.419  time: 1.1262  data_time: 0.0301  l
r: 0.000020  max_mem: 3792M
[11/24 21:27:15 d2.utils.events]: eta: 0:07:33  iter: 99  total_loss: 2.429  loss_cls: 0.467  loss_box_re
g: 0.680  loss_mask: 0.636  loss_rpn_cls: 0.117  loss_rpn_loc: 0.501  time: 1.1270  data_time: 0.0309  l
r: 0.000025  max_mem: 3792M
[11/24 21:27:38 d2.utils.events]: eta: 0:07:12  iter: 119  total_loss: 2.233  loss_cls: 0.441  loss_box_r
eg: 0.660  loss_mask: 0.618  loss_rpn_cls: 0.107  loss_rpn_loc: 0.407  time: 1.1300  data_time: 0.0316  l
r: 0.000030  max_mem: 3792M
[11/24 21:28:01 d2.utils.events]: eta: 0:06:51  iter: 139  total_loss: 2.254  loss_cls: 0.420  loss_box_r
eg: 0.663  loss_mask: 0.603  loss_rpn_cls: 0.102  loss_rpn_loc: 0.450  time: 1.1342  data_time: 0.0306  l
r: 0.000035  max_mem: 3792M
[11/24 21:28:23 d2.utils.events]: eta: 0:06:27  iter: 159  total_loss: 2.194  loss_cls: 0.394  loss_box_r
eg: 0.640  loss_mask: 0.592  loss_rpn_cls: 0.088  loss_rpn_loc: 0.489  time: 1.1319  data_time: 0.0309  l
r: 0.000040  max_mem: 3792M
[11/24 21:28:46 d2.utils.events]: eta: 0:06:04  iter: 179  total_loss: 2.099  loss_cls: 0.367  loss_box_r
eg: 0.648  loss_mask: 0.574  loss_rpn_cls: 0.089  loss_rpn_loc: 0.406  time: 1.1326  data_time: 0.0316  l
r: 0.000045  max_mem: 3792M
[11/24 21:29:09 d2.utils.events]: eta: 0:05:41  iter: 199  total_loss: 2.122  loss_cls: 0.358  loss_box_r
eg: 0.664  loss_mask: 0.562  loss_rpn_cls: 0.078  loss_rpn_loc: 0.441  time: 1.1326  data_time: 0.0303  l
r: 0.000050  max_mem: 3792M
[11/24 21:29:31 d2.utils.events]: eta: 0:05:18  iter: 219  total_loss: 1.974  loss_cls: 0.340  loss_box_r
eg: 0.633  loss_mask: 0.551  loss_rpn_cls: 0.086  loss_rpn_loc: 0.373  time: 1.1322  data_time: 0.0313  l
r: 0.000055  max_mem: 3792M
[11/24 21:29:54 d2.utils.events]: eta: 0:04:56  iter: 239  total_loss: 1.994  loss_cls: 0.322  loss_box_r
eg: 0.591  loss_mask: 0.529  loss_rpn_cls: 0.083  loss_rpn_loc: 0.396  time: 1.1350  data_time: 0.0333  l
r: 0.000060  max_mem: 3792M
[11/24 21:30:17 d2.utils.events]: eta: 0:04:33  iter: 259  total_loss: 1.905  loss_cls: 0.318  loss_box_r
eg: 0.600  loss_mask: 0.512  loss_rpn_cls: 0.073  loss_rpn_loc: 0.403  time: 1.1346  data_time: 0.0305  l
r: 0.000065  max_mem: 3792M
[11/24 21:30:40 d2.utils.events]: eta: 0:04:10  iter: 279  total_loss: 1.840  loss_cls: 0.308  loss_box_r
eg: 0.597  loss_mask: 0.487  loss_rpn_cls: 0.072  loss_rpn_loc: 0.394  time: 1.1336  data_time: 0.0308  l
r: 0.000070  max_mem: 3792M
[11/24 21:31:02 d2.utils.events]: eta: 0:03:47  iter: 299  total_loss: 1.735  loss_cls: 0.286  loss_box_r
eg: 0.559  loss_mask: 0.471  loss_rpn_cls: 0.073  loss_rpn_loc: 0.349  time: 1.1329  data_time: 0.0306  l
r: 0.000075  max_mem: 3792M
[11/24 21:31:25 d2.utils.events]: eta: 0:03:25  iter: 319  total_loss: 1.751  loss_cls: 0.292  loss_box_r
eg: 0.541  loss_mask: 0.449  loss_rpn_cls: 0.069  loss_rpn_loc: 0.394  time: 1.1344  data_time: 0.0308  l
r: 0.000080  max_mem: 3792M
[11/24 21:31:48 d2.utils.events]: eta: 0:03:03  iter: 339  total_loss: 1.707  loss_cls: 0.284  loss_box_r
eg: 0.507  loss_mask: 0.423  loss_rpn_cls: 0.080  loss_rpn_loc: 0.434  time: 1.1360  data_time: 0.0328  l
r: 0.000085  max_mem: 3792M
[11/24 21:32:11 d2.utils.events]: eta: 0:02:40  iter: 359  total_loss: 1.571  loss_cls: 0.262  loss_box_r
eg: 0.477  loss_mask: 0.414  loss_rpn_cls: 0.057  loss_rpn_loc: 0.323  time: 1.1348  data_time: 0.0304  l
r: 0.000090  max_mem: 3792M
[11/24 21:32:34 d2.utils.events]: eta: 0:02:17  iter: 379  total_loss: 1.553  loss_cls: 0.273  loss_box_r
eg: 0.447  loss_mask: 0.390  loss_rpn_cls: 0.068  loss_rpn_loc: 0.372  time: 1.1364  data_time: 0.0315  l
r: 0.000095  max_mem: 3792M
[11/24 21:32:57 d2.utils.events]: eta: 0:01:55  iter: 399  total_loss: 1.435  loss_cls: 0.252  loss_box_r
eg: 0.398  loss_mask: 0.380  loss_rpn_cls: 0.055  loss_rpn_loc: 0.327  time: 1.1376  data_time: 0.0321  l
r: 0.000100  max_mem: 3792M
[11/24 21:33:20 d2.utils.events]: eta: 0:01:32  iter: 419  total_loss: 1.435  loss_cls: 0.253  loss_box_r
eg: 0.408  loss_mask: 0.369  loss_rpn_cls: 0.070  loss_rpn_loc: 0.318  time: 1.1374  data_time: 0.0301  l
r: 0.000105  max_mem: 3792M
[11/24 21:33:43 d2.utils.events]: eta: 0:01:09  iter: 439  total_loss: 1.312  loss_cls: 0.232  loss_box_r
eg: 0.348  loss_mask: 0.373  loss_rpn_cls: 0.060  loss_rpn_loc: 0.294  time: 1.1372  data_time: 0.0313  l
r: 0.000110  max_mem: 3792M
[11/24 21:34:05 d2.utils.events]: eta: 0:00:46  iter: 459  total_loss: 1.389  loss_cls: 0.250  loss_box_r
eg: 0.370  loss_mask: 0.363  loss_rpn_cls: 0.056  loss_rpn_loc: 0.344  time: 1.1368  data_time: 0.0305  l
r: 0.000115  max_mem: 3792M
[11/24 21:34:28 d2.utils.events]: eta: 0:00:23  iter: 479  total_loss: 1.335  loss_cls: 0.229  loss_box_r
eg: 0.341  loss_mask: 0.361  loss_rpn_cls: 0.064  loss_rpn_loc: 0.335  time: 1.1377  data_time: 0.0313  l
r: 0.000120  max_mem: 3792M
[11/24 21:34:52 d2.utils.events]: eta: 0:00:01  iter: 499  total_loss: 1.305  loss_cls: 0.221  loss_box_r
eg: 0.336  loss_mask: 0.357  loss_rpn_cls: 0.046  loss_rpn_loc: 0.295  time: 1.1374  data_time: 0.0314  l
r: 0.000125  max_mem: 3792M
[11/24 21:34:55 d2.engine.hooks]: Overall training speed: 497 iterations in 0:09:26 (1.1397 s / it)
[11/24 21:34:55 d2.engine.hooks]: Total training time: 0:09:31 (0:00:04 on hooks)
```

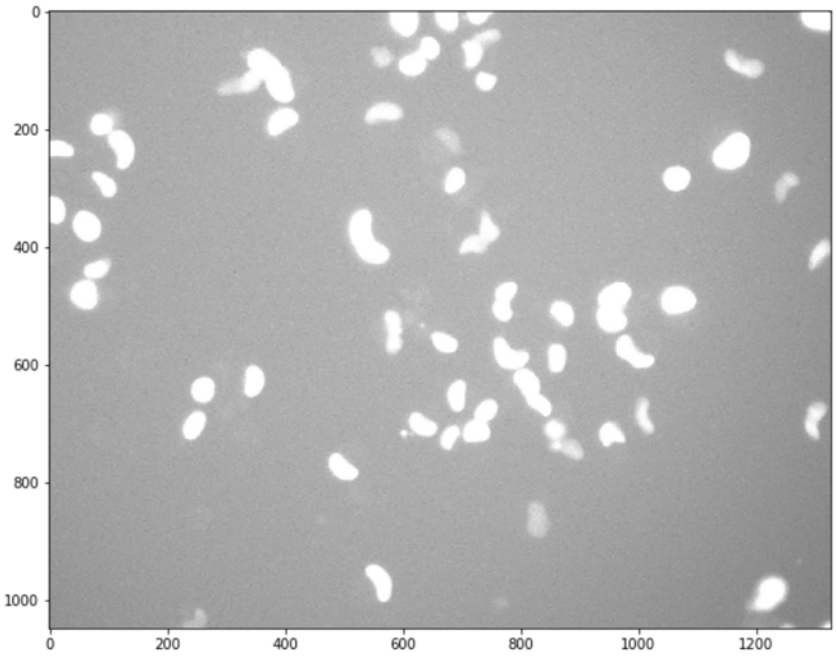
```
Out[20]: OrderedDict()
```

In [21]:
```
cfg.MODEL.WEIGHTS = os.path.join(cfg.OUTPUT_DIR, "model_final.pth")
cfg.MODEL.ROI_HEADS.SCORE_THRESH_TEST = 0.7   # set the testing threshold for this model
cfg.DATASETS.TEST = (valid_dir, )
predictor = DefaultPredictor(cfg)
```

In [22]:
```
%pylab inline
import random
import matplotlib.pyplot as plt
import matplotlib.image as mpimg

from detectron2.utils.visualizer import ColorMode
dataset_dicts = get_cell_dicts(valid_dir)
for d in random.sample(dataset_dicts, 3):
    im = cv2.imread(d["file_name"])
    fig = plt.figure(figsize=(10,10))
    imgplot = plt.imshow(im)
    plt.show()
    outputs = predictor(im)
    v = Visualizer(im[:, :, ::-1],
                   metadata=cell_metadata,
                   scale=3,
                   instance_mode=ColorMode.IMAGE_BW   # remove the colors of unsegmented pixels
    )
    #print(outputs["instances"].get_fields()) #['pred_masks'])
    v = v.draw_instance_predictions(outputs["instances"].to("cpu"))
    print(d["file_name"])
    fig = plt.figure(figsize=(10,10))
    imgplot = plt.imshow(v.get_image()[:, :, ::-1])
    plt.show()
```

```
Populating the interactive namespace from numpy and matplotlib
```

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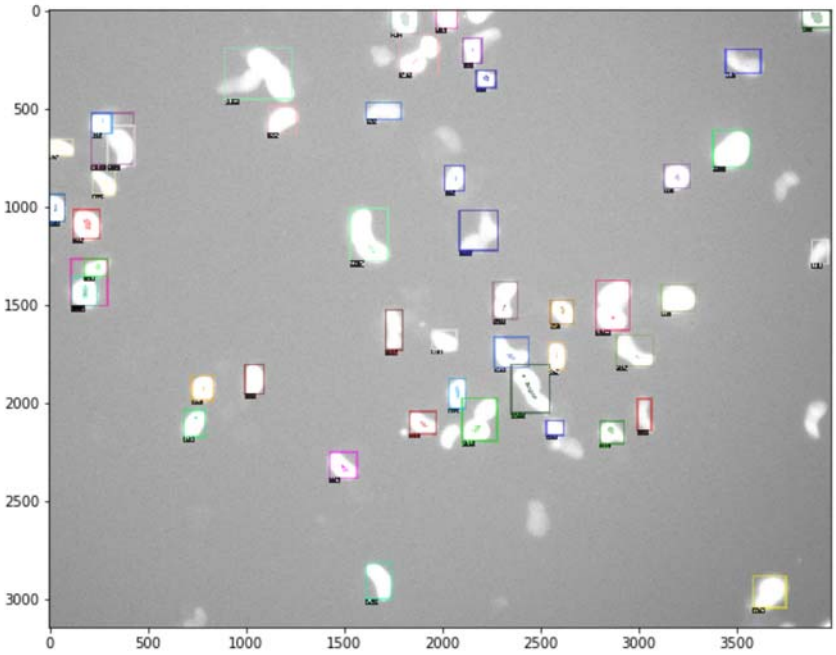

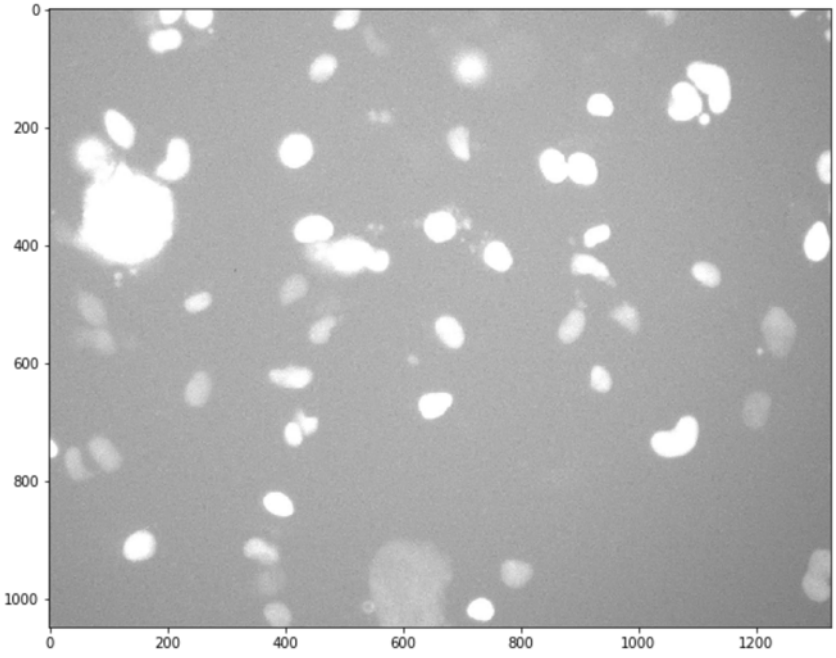


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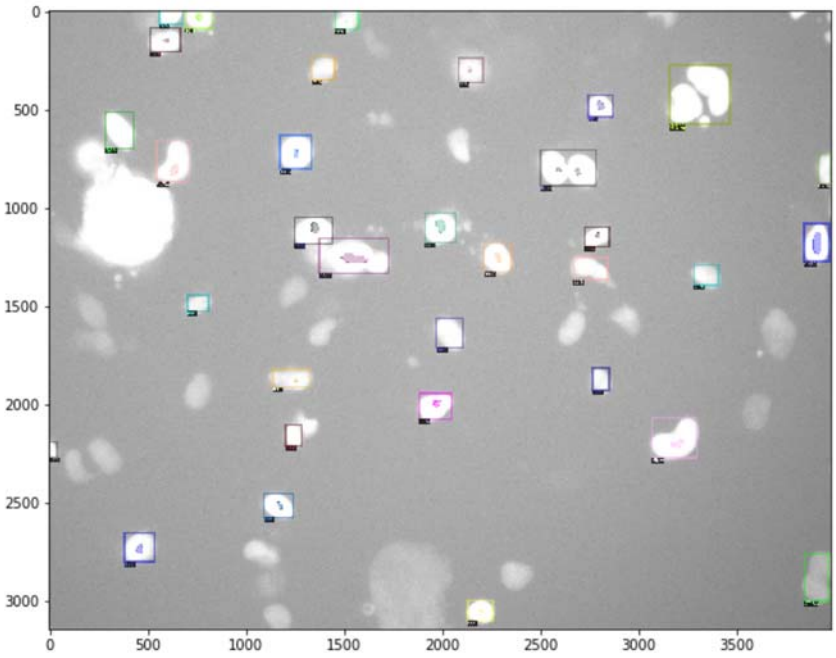

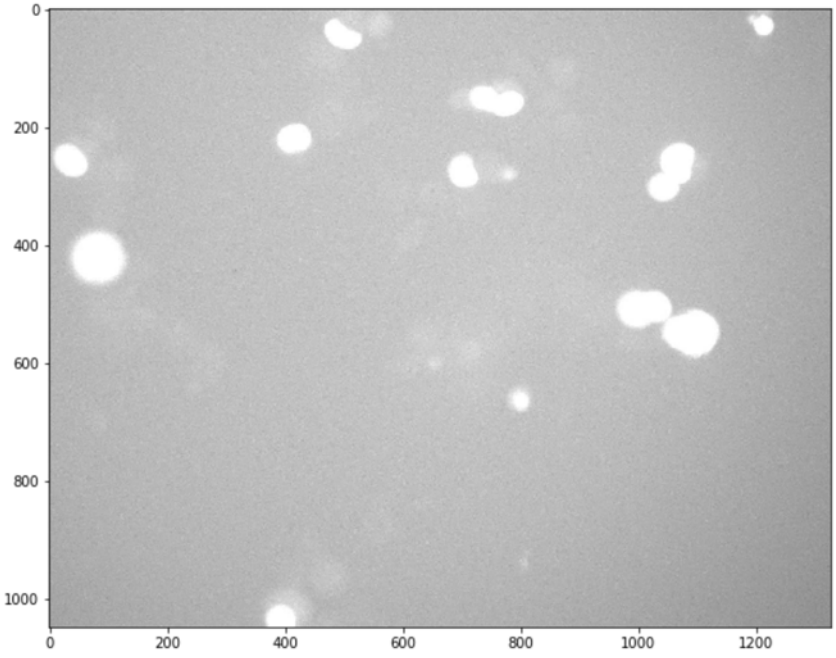


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