참고자료 : https://www.kaggle.com/pednt9/gwd-keras-unet-starter (https://www.kaggle.com/pednt9/gwd-keras-unet-starter)

해결 방향

train image + bounding box -> mask

test image -> mask -> bounding box

데이터 가져오기

Loading Libraries

In [1]:

```
import os
os.environ["CUDA_DEVICE_ORDER"]="PCI_BUS_ID"
os.environ["CUDA_VISIBLE_DEVICES"]="{}".format(2) # gpu idx
```

In [2]:

```
import os
import sys
import random
import warnings

import numpy as np
import pandas as pd

import matplotlib.pyplot as plt

from itertools import chain
from skimage.io import imread, imshow, imread_collection, concatenate_images
from skimage.transform import resize
from skimage.measure import label, regionprops
from PIL import Image, ImageDraw
from ast import literal_eval
from tqdm.notebook import tqdm

import tensorflow as tf

from keras.models import Model, load_model
from keras.layers import Input
from keras.layers.core import Dropout, Lambda
from keras.layers.convolutional import Conv2D, Conv2DTranspose
from keras.layers.pooling import MaxPooling2D
from keras.layers.merge import concatenate
from keras.callbacks import EarlyStopping
from keras import backend as K
```

```
/home/hyejoo/.venv/py367tf/lib/python3.6/site-packages/tensorflow/python/framewor
k/dtypes.py:516: FutureWarning: Passing (type, 1) or '1type' as a synonym of type
is deprecated; in a future version of numpy, it will be understood as (type, (1,))
/ '(1,)type'.
  _np_qint8 = np.dtype([("qint8", np.int8, 1)])
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k/dtypes.py:518: FutureWarning: Passing (type, 1) or '1type' as a synonym of type
is deprecated; in a future version of numpy, it will be understood as (type, (1,))
/ '(1,)type'.
  _np_qint16 = np.dtype([("qint16", np.int16, 1)])
/home/hyejoo/.venv/py367tf/lib/python3.6/site-packages/tensorflow/python/framewor
k/dtypes.py:519: FutureWarning: Passing (type, 1) or '1type' as a synonym of type
is deprecated; in a future version of numpy, it will be understood as (type, (1,))
/ '(1,)type'.
  _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
/home/hyejoo/.venv/py367tf/lib/python3.6/site-packages/tensorflow/python/framewor
k/dtypes.py:520: FutureWarning: Passing (type, 1) or '1type' as a synonym of type
is deprecated; in a future version of numpy, it will be understood as (type, (1,))
/ '(1,)type'.
  _np_qint32 = np.dtype([("qint32", np.int32, 1)])
/home/hyejoo/.venv/py367tf/lib/python3.6/site-packages/tensorflow/python/framewor
k/dtypes.py:525: FutureWarning: Passing (type, 1) or '1type' as a synonym of type
is deprecated; in a future version of numpy, it will be understood as (type, (1,))
/ '(1,)type'.
  np_resource = np.dtype([("resource", np.ubyte, 1)])
/home/hyejoo/.venv/py367tf/lib/python3.6/site-packages/tensorboard/compat/tensorfl
ow_stub/dtypes.py:541: FutureWarning: Passing (type, 1) or '1type' as a synonym of
type is deprecated; in a future version of numpy, it will be understood as (type,
(1,)) / '(1,)type'.
  _np_qint8 = np.dtype([("qint8", np.int8, 1)])
/home/hyejoo/.venv/py367tf/lib/python3.6/site-packages/tensorboard/compat/tensorfl
ow_stub/dtypes.py:542: FutureWarning: Passing (type, 1) or '1type' as a synonym of
type is deprecated; in a future version of numpy, it will be understood as (type,
(1,)) / '(1,)type'.
  _np_quint8 = np.dtype([("quint8", np.uint8, 1)])
/home/hyejoo/.venv/py367tf/lib/python3.6/site-packages/tensorboard/compat/tensorfl
ow_stub/dtypes.py:543: FutureWarning: Passing (type, 1) or '1type' as a synonym of
type is deprecated; in a future version of numpy, it will be understood as (type,
(1,)) / '(1,)type'.
  _np_qint16 = np.dtype([("qint16", np.int16, 1)])
/home/hyejoo/.venv/py367tf/lib/python3.6/site-packages/tensorboard/compat/tensorfl
ow_stub/dtypes.py:544: FutureWarning: Passing (type, 1) or '1type' as a synonym of
type is deprecated; in a future version of numpy, it will be understood as (type,
(1,)) / '(1,)type'.
  _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
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ow_stub/dtypes.py:545: FutureWarning: Passing (type, 1) or '1type' as a synonym of
type is deprecated; in a future version of numpy, it will be understood as (type,
(1,)) / '(1,)type'.
  _np_qint32 = np.dtype([("qint32", np.int32, 1)])
/home/hyejoo/.venv/py367tf/lib/python3.6/site-packages/tensorboard/compat/tensorfl
ow_stub/dtypes.py:550: FutureWarning: Passing (type, 1) or '1type' as a synonym of
type is deprecated; in a future version of numpy, it will be understood as (type,
(1,)) / '(1,)type'.
  np_resource = np.dtype([("resource", np.ubyte, 1)])
Using TensorFlow backend.
```

Reading data

In [3]:

```
# Set some parameters
IMG_WIDTH = 512
IMG_HEIGHT = 512

## '..'는 상위폴더로 가는 것
TRAIN_PATH = '../Wheat/train/'
TEST_PATH = '../Wheat/test/'
SC_FACTOR = int(1024 / IMG_WIDTH)

warnings.filterwarnings('ignore')
seed = 42
random.seed = seed
np.random.seed = seed
```

In [4]:

```
PATH = "../Wheat/"
train_folder = os.path.join(PATH, "train")
test_folder = os.path.join(PATH, "test")
train_csv_path = os.path.join(PATH, "train.csv")
df = pd.read_csv(train_csv_path)
sample_sub = pd.read_csv(PATH + "sample_submission.csv")

df.head()
```

Out[4]:

	image_id	width	height	bbox	source
0	b6ab77fd7	1024	1024	[834.0, 222.0, 56.0, 36.0]	usask_1
1	b6ab77fd7	1024	1024	[226.0, 548.0, 130.0, 58.0]	usask_1
2	b6ab77fd7	1024	1024	[377.0, 504.0, 74.0, 160.0]	usask_1
3	b6ab77fd7	1024	1024	[834.0, 95.0, 109.0, 107.0]	usask_1
4	b6ab77fd7	1024	1024	[26.0, 144.0, 124.0, 117.0]	usask_1

In [5]:

```
train_ids = os.listdir(TRAIN_PATH)
test_ids = os.listdir(TEST_PATH)
```

In [6]:

```
print(os.listdir(TEST_PATH))
```

```
['aac893a91.jpg', '2fd875eaa.jpg', '348a992bb.jpg', '51f1be19e.jpg', '51b3e36ab.jp
g', 'cc3532ff6.jpg', 'f5a1f0358.jpg', 'cb8d261a3.jpg', '53f253011.jpg', '796707dd
7.jpg']
```

os.listdir() : path 경로의 파일명을 리스트에 저장.

경계 상자를 Mask로 변환

In [7]:

```
def make_polygon(coords):
    xm, ym, w, h = coords
    xm, ym, w, h = xm / SC_FACTOR, ym / SC_FACTOR, w / SC_FACTOR, h / SC_FACTOR   # scale values
if image was downsized
    return [(xm, ym), (xm, ym + h), (xm + w, ym + h), (xm + w, ym)]

masks = dict() # 모든 마스크를 포함하는 dictionnary

for img_id, gp in tqdm(df.groupby("image_id")):
    gp['polygons'] = gp['bbox'].apply(eval).apply(lambda x: make_polygon(x))

    img = Image.new('L', (IMG_WIDTH, IMG_HEIGHT), 0)
    for pol in gp['polygons'].values:
        ImageDraw.Draw(img).polygon(pol, outline=1, fill=1)

    mask = np.array(img, dtype=np.uint8)
    masks[img_id] = mask
```

<실행>

1. (for문) train 데이터 한 행의 bbox 값이 make_polygon(coords)이라는 함수에 의해 사각형의 4가지 좌표를 가지게 된다.
2. return 문으로 반환되어 gp['polygons']에 저장
3. Image.new()함수를 통해 512x512 이미지를 만들고 img에 저장(IMG_WIDTH = 512, IMG_HEIGHT = 512)
4. gp['polygons']를 img에 그림.
5. mask에 이미지 저장
6. masks 리스트에 img_id에 해당하는 mask저장

<함수>

- tqdm : for문의 상태바를 나타내주는 라이브러리
- groupby() : 집단, 그룹별로 데이터를 집계/요약
- lambda : 쓰고 버리는 일시적인 함수 x: --> x가 변수처럼 쓰임

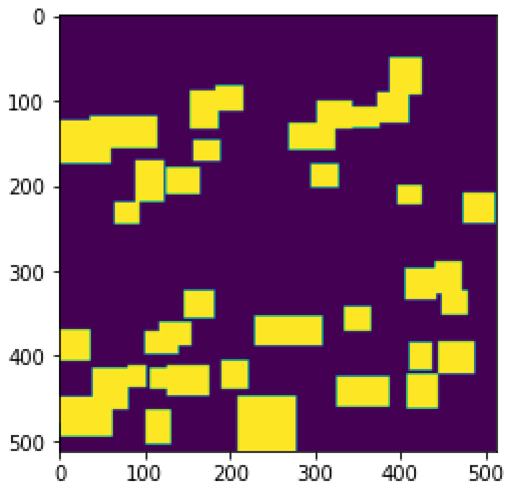
첫 번째 이미지의 마스크에 대한 간단한 예를 그려 봅시다.

In [8]:

```
im = Image.fromarray(masks[list(masks.keys())[3372]])
plt.imshow(im)
```

Out[8]:

```
<matplotlib.image.AxesImage at 0x7f83be431b00>
```



3373번째 사진의 마스크를 그려보았다.

#문제1 - 마스크에 해당하는 이미지 띄우기 (내가 작성해보기)

데이터셋 로드하기

train 이미지와 마스크 가져 오기 (+크기 조정)

In [9]:

```
#X_train -> 사진 데이터, Y_train -> 마스크 데이터
X_train = np.zeros((len(train_ids), IMG_HEIGHT, IMG_WIDTH, 3), dtype=np.uint8)
Y_train = np.zeros((len(train_ids), IMG_HEIGHT, IMG_WIDTH, 1), dtype=np.bool)
print('Getting and resizing train images and masks... ')
sys.stdout.flush()

for n, id_ in tqdm(enumerate(train_ids[:]), total=len(train_ids)):
    path = TRAIN_PATH + id_
    img = imread(path)
    img = resize(img, (IMG_HEIGHT, IMG_WIDTH), mode='constant', preserve_range=True)
    X_train[n] = img #크기가 조정된 이미지 저장
    mask = np.zeros((IMG_HEIGHT, IMG_WIDTH, 1), dtype=np.bool)#이해x

    id_clean = id_.split('.')[0]#아이디만 분리해서 저장
    if id_clean in masks.keys():
        Y_train[n] = masks[id_clean][:, :, np.newaxis]#아이디에 해당하는 mask저장

# test이미지 가져오기/크기조정
X_test = np.zeros((len(test_ids), IMG_HEIGHT, IMG_WIDTH, 3), dtype=np.uint8)
sizes_test = list()
print('Getting and resizing test images...')
sys.stdout.flush()

for n, id_ in tqdm(enumerate(test_ids), total=len(test_ids)):
    path = TEST_PATH + id_
    img = imread(path)
    sizes_test.append([img.shape[0], img.shape[1]])#이미지 크기 조정
    img = resize(img, (IMG_HEIGHT, IMG_WIDTH), mode='constant', preserve_range=True)
    X_test[n] = img

print('Done!')
```

```
Getting and resizing train images and masks...

Getting and resizing test images...

Done!
```

- X_train, X_test -> 사진데이터 저장 공간, 3은 사진의 색을 표현하는 rgb 세 개의 값을 넣는 곳.
- Y_train -> 마스크데이터 저장 공간, 1은 마스크의 색을 표현하는 0과 1의 값을 넣는 곳.
- [:]리스트 전체
- resize() : 사진 크기를 다시 설정

In [10]:

```
X_train.shape, Y_train.shape
```

Out[10]:

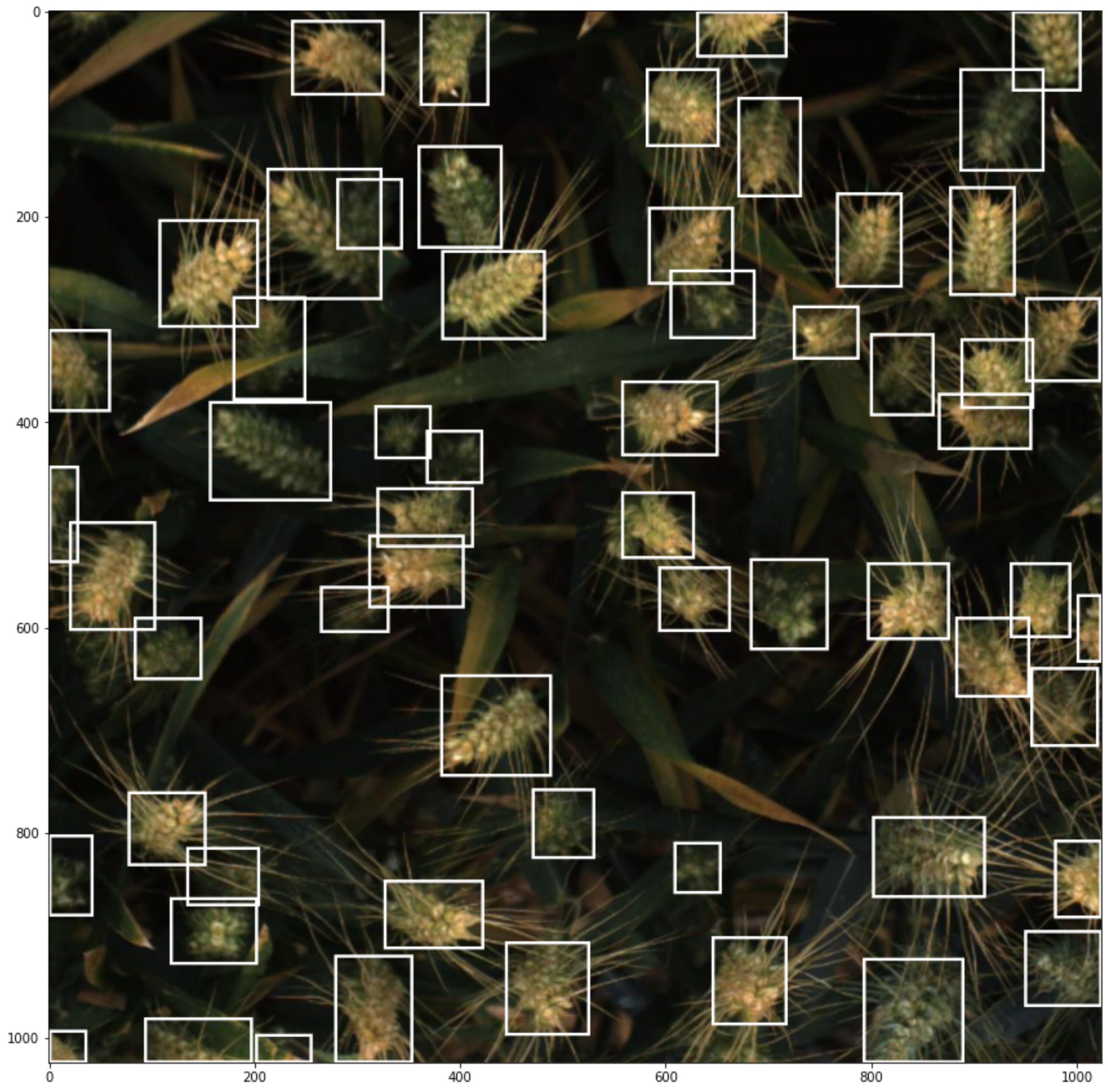
```
((3422, 512, 512, 3), (3422, 512, 512, 1))
```

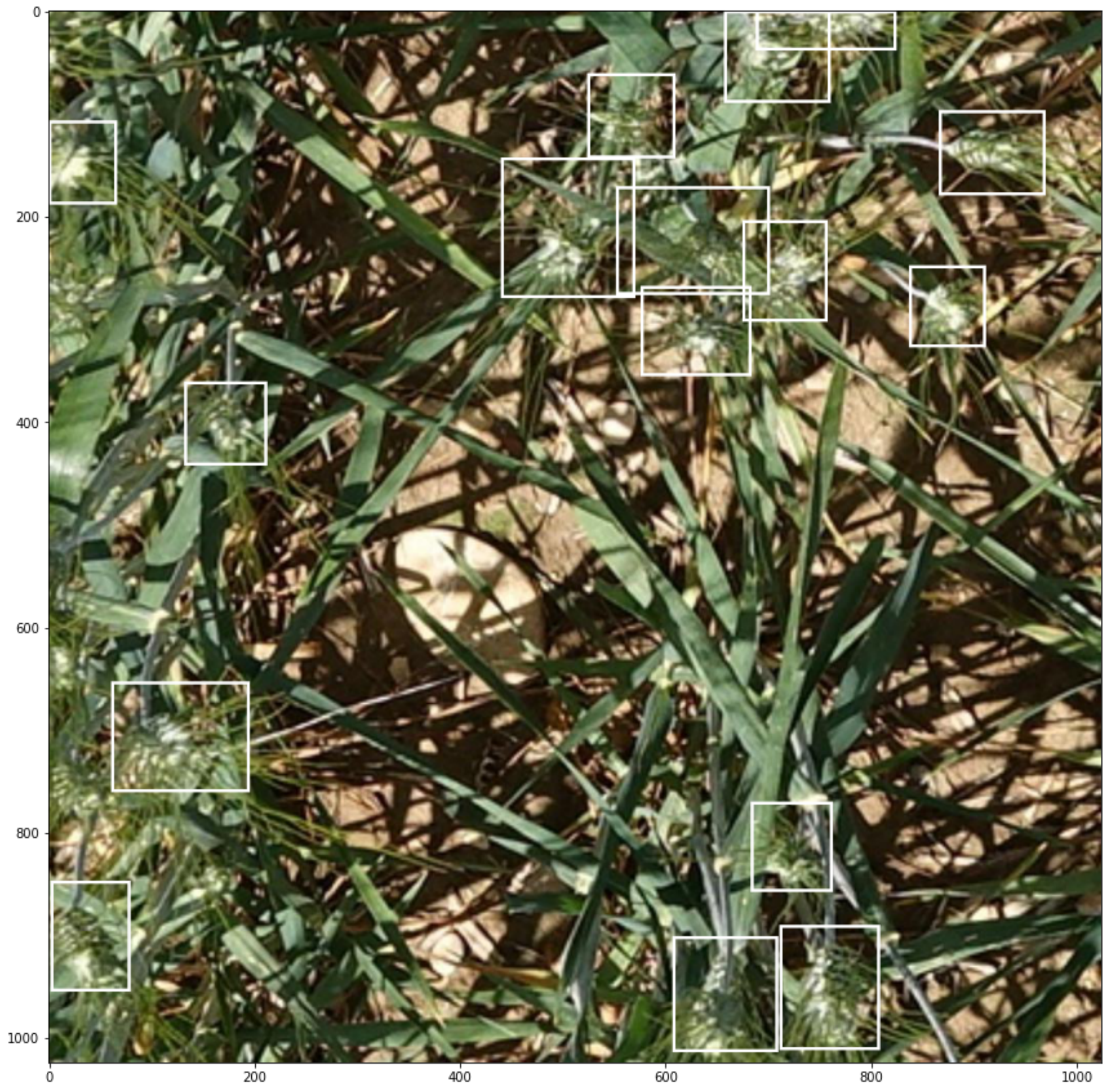
X_train -> 3422개의 사진, 512x512 크기, rgb색(3겹)

Y_train -> 3422개의 마스크, 512x512 크기, 0 1로 이루어진 색(1겹)

In [11]:

```
def show_images(images, num=2):

    images_to_show = np.random.choice(images, num)

    for image_id in images_to_show:

        image_path = os.path.join(train_folder, image_id + ".jpg")
        image = Image.open(image_path)

        # get all bboxes for given image in [xmin, ymin, width, height]
        bboxes = [literal_eval(box) for box in df[df['image_id'] == image_id]['bbox']]

        # visualize them
        draw = ImageDraw.Draw(image)
        for bbox in bboxes:
            draw.rectangle([bbox[0], bbox[1], bbox[0] + bbox[2], bbox[1] + bbox[3]], width=3)

        plt.figure(figsize = (15,15))
        plt.imshow(image)
        plt.show()


unique_images = df['image_id'].unique()
show_images(unique_images)
```


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


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

In [12]:

```
def castF(x):
    return K.cast(x, K.floatx())

def castB(x):
    return K.cast(x, bool)

def iou_loss_core(true,pred):  #this can be used as a loss if you make it negative
    intersection = true * pred
    notTrue = 1 - true
    union = true + (notTrue * pred)

    return (K.sum(intersection, axis=-1) + K.epsilon()) / (K.sum(union, axis=-1) + K.epsilon())

def competitionMetric2(true, pred):

    tresholds = [0.5 + (i * 0.05)  for i in range(5)]

    #flattened images (batch, pixels)
    true = K.batch_flatten(true)
    pred = K.batch_flatten(pred)
    pred = castF(K.greater(pred, 0.5))

    #total white pixels - (batch,)
    trueSum = K.sum(true, axis=-1)
    predSum = K.sum(pred, axis=-1)

    #has mask or not per image - (batch,)
    true1 = castF(K.greater(trueSum, 1))
    pred1 = castF(K.greater(predSum, 1))

    #to get images that have mask in both true and pred
    truePositiveMask = castB(true1 * pred1)

    #separating only the possible true positives to check iou
    testTrue = tf.boolean_mask(true, truePositiveMask)
    testPred = tf.boolean_mask(pred, truePositiveMask)

    #getting iou and threshold comparisons
    iou = iou_loss_core(testTrue,testPred)
    truePositives = [castF(K.greater(iou, tres)) for tres in tresholds]

    #mean of thressholds for true positives and total sum
    truePositives = K.mean(K.stack(truePositives, axis=-1), axis=-1)
    truePositives = K.sum(truePositives)

    #to get images that don't have mask in both true and pred
    trueNegatives = (1-true1) * (1 - pred1) # = 1 -true1 - pred1 + true1*pred1
    trueNegatives = K.sum(trueNegatives)

    return (truePositives + trueNegatives) / castF(K.shape(true)[0])
```

In [13]:

```
# Build U-Net model
inputs = Input((IMG_HEIGHT, IMG_WIDTH, 3))
s = Lambda(lambda x: x / 255) (inputs)  # rescale inputs

c1 = Conv2D(16, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (s)
c1 = Dropout(0.1) (c1)
c1 = Conv2D(16, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (c1)
p1 = MaxPooling2D((2, 2)) (c1)

c2 = Conv2D(32, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (p1)
c2 = Dropout(0.1) (c2)
c2 = Conv2D(32, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (c2)
p2 = MaxPooling2D((2, 2)) (c2)

c3 = Conv2D(64, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (p2)
c3 = Dropout(0.2) (c3)
c3 = Conv2D(64, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (c3)
p3 = MaxPooling2D((2, 2)) (c3)

c4 = Conv2D(128, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (p3)
c4 = Dropout(0.2) (c4)
c4 = Conv2D(128, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (c4)
p4 = MaxPooling2D(pool_size=(2, 2)) (c4)

c5 = Conv2D(256, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (p4)
c5 = Dropout(0.3) (c5)
c5 = Conv2D(256, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (c5)

u6 = Conv2DTranspose(128, (2, 2), strides=(2, 2), padding='same') (c5)
u6 = concatenate([u6, c4])
c6 = Conv2D(128, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (u6)
c6 = Dropout(0.2) (c6)
c6 = Conv2D(128, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (c6)

u7 = Conv2DTranspose(64, (2, 2), strides=(2, 2), padding='same') (c6)
u7 = concatenate([u7, c3])
c7 = Conv2D(64, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (u7)
c7 = Dropout(0.2) (c7)
c7 = Conv2D(64, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (c7)

u8 = Conv2DTranspose(32, (2, 2), strides=(2, 2), padding='same') (c7)
u8 = concatenate([u8, c2])
c8 = Conv2D(32, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (u8)
c8 = Dropout(0.1) (c8)
c8 = Conv2D(32, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (c8)

u9 = Conv2DTranspose(16, (2, 2), strides=(2, 2), padding='same') (c8)
u9 = concatenate([u9, c1], axis=3)
c9 = Conv2D(16, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (u9)
c9 = Dropout(0.1) (c9)
c9 = Conv2D(16, (3, 3), activation='elu', kernel_initializer='he_normal', padding='same') (c9)

outputs = Conv2D(1, (1, 1), activation='sigmoid') (c9)

model = Model(inputs=[inputs], outputs=[outputs])
model.compile(optimizer='adam', loss='binary_crossentropy', metrics=[competitionMetric2])
model.summary()
```

```
WARNING: Logging before flag parsing goes to stderr.
W0727 23:22:02.119865 140208691042112 deprecation_wrapper.py:119] From /home/hyejo
o/.venv/py367tf/lib/python3.6/site-packages/keras/backend/tensorflow_backend.py:7
4: The name tf.get_default_graph is deprecated. Please use tf.compat.v1.get_defaul
t_graph instead.

W0727 23:22:02.131398 140208691042112 deprecation_wrapper.py:119] From /home/hyejo
o/.venv/py367tf/lib/python3.6/site-packages/keras/backend/tensorflow_backend.py:51
7: The name tf.placeholder is deprecated. Please use tf.compat.v1.placeholder inst
ead.

W0727 23:22:02.135936 140208691042112 deprecation_wrapper.py:119] From /home/hyejo
o/.venv/py367tf/lib/python3.6/site-packages/keras/backend/tensorflow_backend.py:41
85: The name tf.truncated_normal is deprecated. Please use tf.random.truncated_nor
mal instead.

W0727 23:22:02.143796 140208691042112 deprecation_wrapper.py:119] From /home/hyejo
o/.venv/py367tf/lib/python3.6/site-packages/keras/backend/tensorflow_backend.py:13
3: The name tf.placeholder_with_default is deprecated. Please use tf.compat.v1.pla
ceholder_with_default instead.

W0727 23:22:02.148512 140208691042112 deprecation.py:506] From /home/hyejoo/.venv/
py367tf/lib/python3.6/site-packages/keras/backend/tensorflow_backend.py:3445: call
ing dropout (from tensorflow.python.ops.nn_ops) with keep_prob is deprecated and w
ill be removed in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_p
rob`.
W0727 23:22:02.164993 140208691042112 deprecation_wrapper.py:119] From /home/hyejo
o/.venv/py367tf/lib/python3.6/site-packages/keras/backend/tensorflow_backend.py:39
76: The name tf.nn.max_pool is deprecated. Please use tf.nn.max_pool2d instead.

W0727 23:22:02.259210 140208691042112 deprecation_wrapper.py:119] From /home/hyejo
o/.venv/py367tf/lib/python3.6/site-packages/keras/backend/tensorflow_backend.py:41
38: The name tf.random_uniform is deprecated. Please use tf.random.uniform instea
d.

W0727 23:22:02.427242 140208691042112 deprecation_wrapper.py:119] From /home/hyejo
o/.venv/py367tf/lib/python3.6/site-packages/keras/optimizers.py:790: The name tf.t
rain.Optimizer is deprecated. Please use tf.compat.v1.train.Optimizer instead.

W0727 23:22:02.440721 140208691042112 deprecation.py:323] From /home/hyejoo/.venv/
py367tf/lib/python3.6/site-packages/tensorflow/python/ops/nn_impl.py:180: add_disp
atch_support.<locals>.wrapper (from tensorflow.python.ops.array_ops) is deprecated
and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
```

```
__________________________________________________________________________________
________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================
================
input_1 (InputLayer)            (None, 512, 512, 3)  0
__________________________________________________________________________________
________________
lambda_1 (Lambda)               (None, 512, 512, 3)  0           input_1[0][0]
__________________________________________________________________________________
________________
conv2d_1 (Conv2D)               (None, 512, 512, 16) 448         lambda_1[0][0]
__________________________________________________________________________________
________________
dropout_1 (Dropout)             (None, 512, 512, 16) 0           conv2d_1[0][0]
__________________________________________________________________________________
________________
conv2d_2 (Conv2D)               (None, 512, 512, 16) 2320        dropout_1[0][0]
__________________________________________________________________________________
________________
max_pooling2d_1 (MaxPooling2D)  (None, 256, 256, 16) 0           conv2d_2[0][0]
__________________________________________________________________________________
________________
conv2d_3 (Conv2D)               (None, 256, 256, 32) 4640        max_pooling2d_1
[0][0]
__________________________________________________________________________________
________________
dropout_2 (Dropout)             (None, 256, 256, 32) 0           conv2d_3[0][0]
__________________________________________________________________________________
________________
conv2d_4 (Conv2D)               (None, 256, 256, 32) 9248        dropout_2[0][0]
__________________________________________________________________________________
________________
max_pooling2d_2 (MaxPooling2D)  (None, 128, 128, 32) 0           conv2d_4[0][0]
__________________________________________________________________________________
________________
conv2d_5 (Conv2D)               (None, 128, 128, 64) 18496       max_pooling2d_2
[0][0]
__________________________________________________________________________________
________________
dropout_3 (Dropout)             (None, 128, 128, 64) 0           conv2d_5[0][0]
__________________________________________________________________________________
________________
conv2d_6 (Conv2D)               (None, 128, 128, 64) 36928       dropout_3[0][0]
__________________________________________________________________________________
________________
max_pooling2d_3 (MaxPooling2D)  (None, 64, 64, 64)   0           conv2d_6[0][0]
__________________________________________________________________________________
________________
conv2d_7 (Conv2D)               (None, 64, 64, 128)  73856       max_pooling2d_3
[0][0]
__________________________________________________________________________________
________________
dropout_4 (Dropout)             (None, 64, 64, 128)  0           conv2d_7[0][0]
__________________________________________________________________________________
________________
conv2d_8 (Conv2D)               (None, 64, 64, 128)  147584      dropout_4[0][0]
__________________________________________________________________________________
________________
max_pooling2d_4 (MaxPooling2D)  (None, 32, 32, 128)  0           conv2d_8[0][0]
__________________________________________________________________________________
```

```
________________
conv2d_9 (Conv2D)               (None, 32, 32, 256)  295168      max_pooling2d_4
[0][0]
__________________________________________________________________________________
________________
dropout_5 (Dropout)             (None, 32, 32, 256)  0           conv2d_9[0][0]
__________________________________________________________________________________
________________
conv2d_10 (Conv2D)              (None, 32, 32, 256)  590080      dropout_5[0][0]
__________________________________________________________________________________
________________
conv2d_transpose_1 (Conv2DTrans (None, 64, 64, 128)  131200      conv2d_10[0][0]
__________________________________________________________________________________
________________
concatenate_1 (Concatenate)     (None, 64, 64, 256)  0           conv2d_transpose_
1[0][0]
                                                                 conv2d_8[0][0]
__________________________________________________________________________________
________________
conv2d_11 (Conv2D)              (None, 64, 64, 128)  295040      concatenate_1[0]
[0]
__________________________________________________________________________________
________________
dropout_6 (Dropout)             (None, 64, 64, 128)  0           conv2d_11[0][0]
__________________________________________________________________________________
________________
conv2d_12 (Conv2D)              (None, 64, 64, 128)  147584      dropout_6[0][0]
__________________________________________________________________________________
________________
conv2d_transpose_2 (Conv2DTrans (None, 128, 128, 64) 32832       conv2d_12[0][0]
__________________________________________________________________________________
________________
concatenate_2 (Concatenate)     (None, 128, 128, 128 0           conv2d_transpose_
2[0][0]
                                                                 conv2d_6[0][0]
__________________________________________________________________________________
________________
conv2d_13 (Conv2D)              (None, 128, 128, 64) 73792       concatenate_2[0]
[0]
__________________________________________________________________________________
________________
dropout_7 (Dropout)             (None, 128, 128, 64) 0           conv2d_13[0][0]
__________________________________________________________________________________
________________
conv2d_14 (Conv2D)              (None, 128, 128, 64) 36928       dropout_7[0][0]
__________________________________________________________________________________
________________
conv2d_transpose_3 (Conv2DTrans (None, 256, 256, 32) 8224        conv2d_14[0][0]
__________________________________________________________________________________
________________
concatenate_3 (Concatenate)     (None, 256, 256, 64) 0           conv2d_transpose_
3[0][0]
                                                                 conv2d_4[0][0]
__________________________________________________________________________________
________________
conv2d_15 (Conv2D)              (None, 256, 256, 32) 18464       concatenate_3[0]
[0]
__________________________________________________________________________________
________________
dropout_8 (Dropout)             (None, 256, 256, 32) 0           conv2d_15[0][0]
__________________________________________________________________________________
```

```
________________
conv2d_16 (Conv2D)              (None, 256, 256, 32) 9248        dropout_8[0][0]
__________________________________________________________________________________
________________
conv2d_transpose_4 (Conv2DTrans (None, 512, 512, 16) 2064        conv2d_16[0][0]
__________________________________________________________________________________
________________
concatenate_4 (Concatenate)     (None, 512, 512, 32) 0           conv2d_transpose_
4[0][0]
                                                                 conv2d_2[0][0]
__________________________________________________________________________________
________________
conv2d_17 (Conv2D)              (None, 512, 512, 16) 4624        concatenate_4[0]
[0]
__________________________________________________________________________________
________________
dropout_9 (Dropout)             (None, 512, 512, 16) 0           conv2d_17[0][0]
__________________________________________________________________________________
________________
conv2d_18 (Conv2D)              (None, 512, 512, 16) 2320        dropout_9[0][0]
__________________________________________________________________________________
________________
conv2d_19 (Conv2D)              (None, 512, 512, 1)  17          conv2d_18[0][0]
==================================================================================
================
Total params: 1,941,105
Trainable params: 1,941,105
Non-trainable params: 0
__________________________________________________________________________________
________________
```

In [14]:

```
#from keras.utils import plot_model
#plot_model(model, to_file='model.png', show_shapes=True)
#from IPython.display import Image
#Image('model.png')
```

In [15]:

```
#Fit model


earlystop = EarlyStopping(patience=10, verbose=1, restore_best_weights=True)

model.fit(X_train,
          Y_train,
          validation_split=0.1,
          batch_size=16,
          epochs=10,
          callbacks=[earlystop],
         )
```

```
Train on 3079 samples, validate on 343 samples
Epoch 1/10
3079/3079 [==============================] - 80s 26ms/step - loss: 0.4855 - compet
itionMetric2: 0.0555 - val_loss: 0.3874 - val_competitionMetric2: 0.1883
Epoch 2/10
3079/3079 [==============================] - 76s 25ms/step - loss: 0.3434 - compet
itionMetric2: 0.3623 - val_loss: 0.2989 - val_competitionMetric2: 0.4122
Epoch 3/10
3079/3079 [==============================] - 77s 25ms/step - loss: 0.2804 - compet
itionMetric2: 0.5797 - val_loss: 0.2722 - val_competitionMetric2: 0.5971
Epoch 4/10
3079/3079 [==============================] - 77s 25ms/step - loss: 0.2438 - compet
itionMetric2: 0.6959 - val_loss: 0.2470 - val_competitionMetric2: 0.6968
Epoch 5/10
3079/3079 [==============================] - 76s 25ms/step - loss: 0.2233 - compet
itionMetric2: 0.7658 - val_loss: 0.2111 - val_competitionMetric2: 0.7942
Epoch 6/10
3079/3079 [==============================] - 76s 25ms/step - loss: 0.2095 - compet
itionMetric2: 0.8110 - val_loss: 0.2049 - val_competitionMetric2: 0.8233
Epoch 7/10
3079/3079 [==============================] - 76s 25ms/step - loss: 0.2009 - compet
itionMetric2: 0.8357 - val_loss: 0.2010 - val_competitionMetric2: 0.8437
Epoch 8/10
3079/3079 [==============================] - 77s 25ms/step - loss: 0.1937 - compet
itionMetric2: 0.8595 - val_loss: 0.1828 - val_competitionMetric2: 0.8723
Epoch 9/10
3079/3079 [==============================] - 77s 25ms/step - loss: 0.1870 - compet
itionMetric2: 0.8776 - val_loss: 0.1792 - val_competitionMetric2: 0.8985
Epoch 10/10
3079/3079 [==============================] - 77s 25ms/step - loss: 0.1816 - compet
itionMetric2: 0.8887 - val_loss: 0.1809 - val_competitionMetric2: 0.8927
```

Out[15]:

```
<keras.callbacks.History at 0x7f83bce3f860>
```

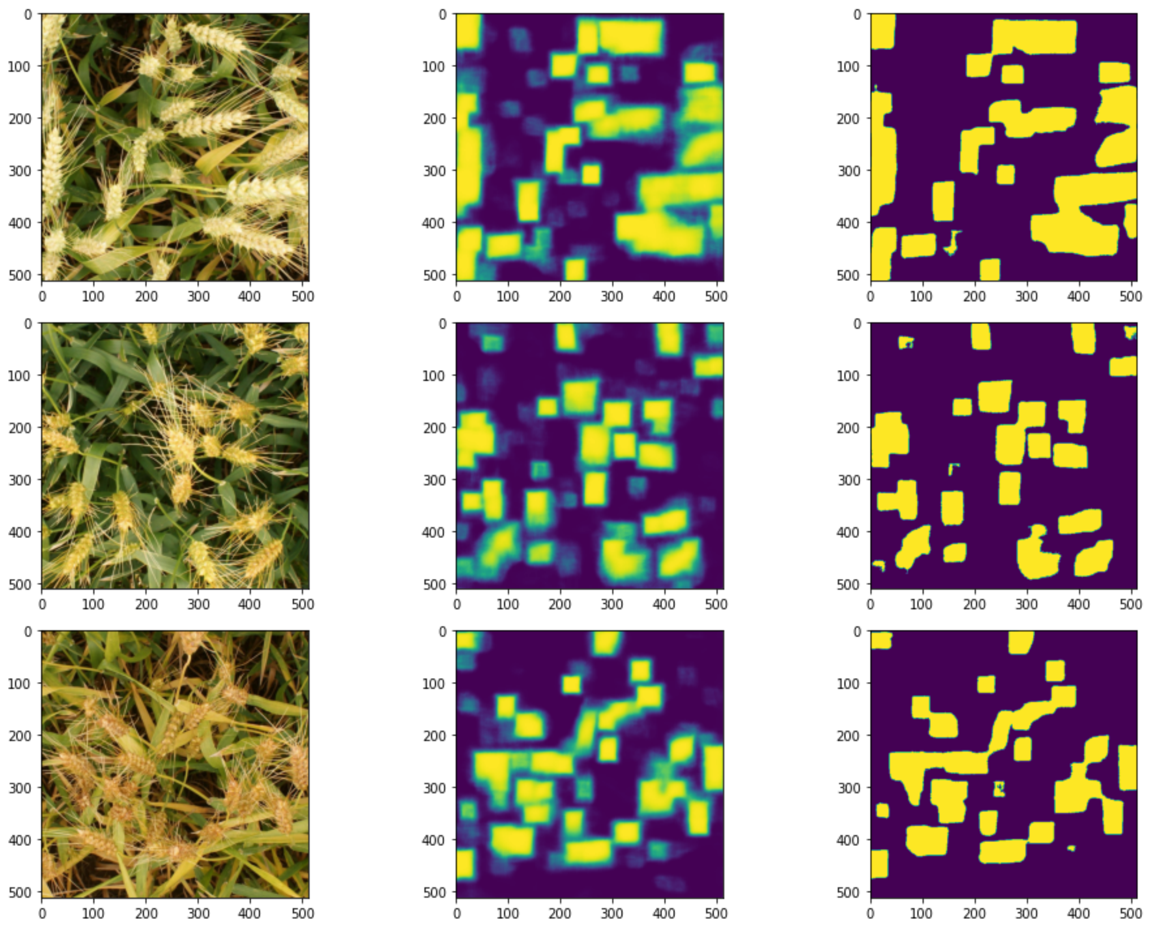
Predicition

In [16]:

```
THRESH = 0.65

preds = model.predict(X_test)[:, :, :, 0]
masked_preds = preds > THRESH
```

In [17]:

```
n_rows = 3
f, ax = plt.subplots(n_rows, 3, figsize=(14, 10))

for j, idx in enumerate([4,5,6]):
    for k, kind in enumerate(['original', 'pred', 'masked_pred']):
        if kind == 'original':
            img = X_test[idx]
        elif kind == 'pred':
            img = preds[idx]
        elif kind == 'masked_pred':
            masked_pred = preds[idx] > THRESH
            img = masked_pred
        ax[j, k].imshow(img)

plt.tight_layout()
```



In [18]:

```
def get_params_from_bbox(coords, scaling_factor=1):
    xmin, ymin = coords[1] * scaling_factor, coords[0] * scaling_factor
    w = (coords[3] - coords[1]) * scaling_factor
    h = (coords[2] - coords[0]) * scaling_factor

    return xmin, ymin, w, h
```

In [19]:

```
# Allows to extract bounding boxes from binary masks
bboxes = list()

for j in range(masked_preds.shape[0]):
    label_j = label(masked_preds[j, :, :])
    props = regionprops(label_j)   # that's were the job is done
    bboxes.append(props)
```

In [20]:

```
# Here we format the bboxes into the required format
output = dict()

for i in range(masked_preds.shape[0]):
    bboxes_processed = [get_params_from_bbox(bb.bbox, scaling_factor=SC_FACTOR) for bb in bboxe
s[i]]
    formated_boxes = ['1.0 ' + ' '.join(map(str, bb_m)) for bb_m in bboxes_processed]

    output[sample_sub["image_id"][i]] = " ".join(formated_boxes)
```

In [21]:

```
sample_sub["PredictionString"] = output.values()
```

In [22]:

```
sample_sub
```

Out[22]:

	image_id	PredictionString
0	aac893a91	1.0 178 0 68 76 1.0 550 0 72 50 1.0 252 56 156...
1	51f1be19e	1.0 0 0 218 108 1.0 232 0 92 58 1.0 426 10 124...
2	f5a1f0358	1.0 142 38 112 86 1.0 540 38 70 92 1.0 660 44 ...
3	796707dd7	1.0 20 0 90 66 1.0 780 20 140 142 1.0 612 94 1...
4	51b3e36ab	1.0 0 0 98 140 1.0 366 24 426 222 1.0 874 186 ...
5	348a992bb	1.0 770 0 94 128 1.0 386 4 78 106 1.0 972 18 5...
6	cc3532ff6	1.0 528 0 100 92 1.0 0 4 86 70 1.0 670 114 76 ...
7	2fd875eaa	1.0 594 42 180 234 1.0 440 124 96 70 1.0 312 1...
8	cb8d261a3	1.0 18 36 246 156 1.0 770 50 52 46 1.0 312 68 ...
9	53f253011	1.0 334 0 100 58 1.0 628 34 164 116 1.0 956 88...

In [23]:

```
sample_sub.to_csv('submission.csv', index=False)
```