Video Object Detection

July 21, 2019

1 Preamble

L'objectif de ce document est de présenter un algorithme de détermination de l'angle d'une remorque à l'arrière d'un véhicule équipé d'une caméra vidéo.

2 import

Le programme écrit en python s'appuie sur plusieurs bibliothèques existantes standard.

```
In [1]: import cv2
        print(cv2.__version__)
        import matplotlib
        import matplotlib.pyplot as plt
        import numpy as np
        from numpy import pi
        import pandas as pd
        import os
        from numba import jit
        from scipy.signal import find_peaks
```

```
4.1.0
```

3 File selection

```
In [2]: path = "/Users/oliviermanette/Desktop/trailer detection challenge/data/P473_Arizona_Da
        os.chdir(path)
```

```
In [3]: pwd
```

```
Out[3]: '/Users/oliviermanette/Desktop/trailer detection challenge/data/P473_Arizona_Day_Asphal
```

```
In [4]: ls
```

```
P473_Arizona_Day_Asphalt_Close_To_Sunset_dry_Nominal_8300lx.avi*
P473_Arizona_Day_Asphalt_Close_To_Sunset_dry_Nominal_8300lx.dat_GT.csv*
```

```
In [5]: #fileName='W420_ES_Hi_Snow_Slush_Asphalt_28klux.avi'
        fileName = 'P473_Arizona_Day_Asphalt_Close_To_Sunset_dry_Nominal_8300lx.avi'
```

4 Test Video Loop

```
In [6]: cap = cv2.VideoCapture(fileName)  # load the video
        while (cap.isOpened()):  # play the video by reading frame by frame
            ret, frame = cap.read()
            if ret == True:
                # optional: do some image processing here
                cv2.imshow('frame', frame)
                # show the video
                if cv2.waitKey(1) & 0xFF == ord('q'):
                    #if 0xFF == ord('q'):
                    break
            else:
                break
        cap.release()
        cv2.destroyAllWindows()
```

5 Variables globales

Pour des raisons de lisibilité du code, l'ensemble des variables locales seront précédés du préfixe 'l' afin de les différencier des variables globales qui n'ont pas de préfixe. ## Type de données de position

```
In [7]: posType = np.dtype([('x', 'u1'), ('y', 'u2')])
```

5.1 Type de données de Neurones

5.1.1 Neurone sensoriel à champs récepteur

```
In [8]: NeuronType = np.dtype([('longueur', 'u1'), ('angle', 'f4'), ('weight', 'f4'),
                               ('precision', 'f4'), ('xPos', 'u1'), ('yPos', 'u2'),
                               ('groupID', 'u1'), ('layer', 'f4')])
```

5.2 Taille des champs récepteurs neuronaux

```
In [9]: tailleField = 7
```

6 Fonctions

6.1 Calcul d'un neurone champ moyen

A partir d'une liste de neurones, il retourne le neurone moyen

```
In [10]: def getAvgFieldNeuron(lNeuronList, typeList=NeuronType):
             lNeurons = np.zeros(1, dtype=typeList)
             lpNeurons = pd.DataFrame(lNeurons)
             lpNeurons['longueur'] = int(lNeuronList.longueur[0:1])
             lpNeurons['angle'] = float(
```

```
            np.sum((lNeuronList.angle * lNeuronList.weight) /
                   np.sum(lNeuronList.weight)))
        lpNeurons['weight'] = float(
            np.sum((lNeuronList.weight * lNeuronList.weight) /
                   np.sum(lNeuronList.weight)))
        lpNeurons['precision'] = float(
            np.sum((lNeuronList.precision * lNeuronList.weight) /
                   np.sum(lNeuronList.weight)))
        lpNeurons['xPos'] = np.around(
            np.sum((lNeuronList.xPos * lNeuronList.weight)) /
                   np.sum(lNeuronList.weight))
        lpNeurons['yPos'] = np.around(
            np.sum((lNeuronList.yPos * lNeuronList.weight)) /
                   np.sum(lNeuronList.weight))
        return lpNeurons
```

6.2 Matrice des directions

Afin de faciliter le calcul des angles des pixels, une matrice de poids est générée afin d'appliquer à chaque pixel centré sur un champs récepteur un poids correspondant à l'angle d'une ligne passant par ce centre. Voici comment les angles sont représentés IMAGE

```
In [11]: @jit(nopython=True, parallel=True)
         def fillAngleMat(lSize):
             lOutput = np.zeros((lSize, lSize))
             lOffset = int(np.floor(lSize / 2))
             for lX in range(0, lSize):
                 for lY in range(0, lSize):
                     if (lX - lOffset) == 0:
                         lOutput[lX, lY] = 90
                     else:
                         lOutput[lX, lY] = 0.01 + np.around(
                             np.arctan((lY - lOffset) / (lOffset - lX)) / pi * 180, 2)
             lOutput[lOffset, lOffset] = 0
             return lOutput
```

6.3 Fonction d'activation des neurones

Chaque neurone retourne une valeur comprise entre 0 et 255 qui reflète son niveau d'activation. Cette activation reflète le niveau de confiance que le neurone a sur le lien existant entre sa fonction de base et les pixels reçus dans son champs récepteur. Plus les pixels sont organisés de façon à former une ligne avec l'angle correspondant à la fonction de base du neurone et plus ce dernier sera activé. Comme on ne souhaite pas obtenir une activation de valeur infinie, on utilise donc une fonction sigmoide qui s'applique à l'écart-type des angles supposés.

```
In [12]: @jit(nopython=True, parallel=True)
         def sigmoidActivationFctN1(lActivationVector):
             lDenom = (1 + np.exp(0.1 * (np.abs(np.std(lActivationVector)) - 30)))
             return 255 / lDenom
```

6.4 Création d'une liste de neurones à champs récepteurs

```
In [736]: #@jit(nopython=True, parallel=True)
          def getNeuronActivationList(idxX,
                                      idxY,
                                      size,
                                      frameE,
                                      nbPixelPts,
                                      lNeuronType=NeuronType,
                                      lVerbose=False):
              #commencer par créer le tableau de neurones
              lCriterion = nbPixelPts >= size

              nbNeurons = sum(lCriterion)
              lNeurons = np.zeros(nbNeurons, dtype=lNeuronType)
              lpNeurons = pd.DataFrame(lNeurons)
              lpNeurons['longueur'] = size
              #lpNeurons['layer'] = layer

              lHalfL = int(np.floor(size / 2))
              lAngleMat = fillAngleMat(size)

              newX = idxX[lCriterion]
              newY = idxY[lCriterion]
              if lVerbose:
                  print("size :" + str(len(newX)))

                  print("newX")
                  print(np.min(newX))
                  print(np.max(newX))
                  print("newY")
                  print(np.min(newY))
                  print(np.max(newY))
                  print()
              pos = 0
              lnPos = 0
              for lintX in newX:
                  lintY = newY[pos]
                  if (lintX - lHalfL) < 0 or (lintY - lHalfL) < 0:
                      print("exceed the limit of the matrix")
                      pos += 1
                      continue

                  lNeuronFieldFrame = frameE[int(lintX - lHalfL):int(lintX + lHalfL + 1),
                                             int(lintY - lHalfL):int(lintY + lHalfL +
                                                                     1)] / 255

                  try:
```

```
            tmp = np.multiply(lAngleMat, lNeuronFieldFrame)
        except:
            print("error 10 : ")
            print("lAngleMat")
            print(lAngleMat)
            print("lNeuronFieldFrame")
            print(lNeuronFieldFrame)
            print("lintX")
            print(lintX)
            print("lintY")
            print(lintY)
            print("lHalfL")
            print(lHalfL)
            continue

        lNeuronFieldValues = tmp[np.nonzero(tmp)]
        if lVerbose:
            print("lNeuronFieldFrame :")
            print(lNeuronFieldFrame)
            print("np.multiply(lAngleMat, lNeuronFieldFrame)")
            print(tmp)
            print("lNeuronFieldValues")
            print(lNeuronFieldValues)
        if (np.mean(lNeuronFieldValues)) < 0:
            lNeuronFieldValues[lNeuronFieldValues > 89] = -90
        elif np.std(lNeuronFieldValues) > 45:
            lNeuronFieldValues[lNeuronFieldValues > 89] = -90
        if (lNeuronFieldValues.size > 0):
            lpNeurons.loc[pos, ['angle']] = np.mean(lNeuronFieldValues)
            lpNeurons.loc[pos, ['weight']] = sigmoidActivationFctN1(
                lNeuronFieldValues)
            lpNeurons.loc[pos, ['precision']] = np.std(lNeuronFieldValues)
            lpNeurons.loc[pos, ['xPos']] = lintX
            lpNeurons.loc[pos, ['yPos']] = lintY
            if (np.abs(np.mean(lNeuronFieldValues)) < 90):
                lpNeurons.loc[pos, ['layer']] = np.around(lintY +
                    np.sin(np.around(np.mean(lNeuronFieldValues)) / 180 * np.pi) *
                    lintX);
            else:
                lpNeurons.loc[pos, ['layer']] = frameE.shape[0] + lintX;
            lnPos += 1
        else:
            True  #print ("error it shouldn't be zero")
        pos += 1
    if lVerbose:
        print("nb de positions couvertes : " + str(lnPos) + " sur " + str(pos))

    return lpNeurons
```

6.5 Nombre de pixels actifs dans chaque champs récepteur

A partir des coordonnées des centres supposés de chaque champs récepteurs et de la taille du champs récepteur, recherche sur la frame bitmap passée en paramètres, retourne un tableau contenant le nombre de pixels allumés à l'intérieur de chacun de ces champs.

```
In [14]: @jit(nopython=True, parallel=True)
         def nbPixelField(lTableX, lTableY, lFrameEdge, lintTailleField=3):
             lIdx = 0
             lResults = np.zeros(lTableX.size)
             lRayon = np.floor(lintTailleField / 2)
             lTailleMaxX = lFrameEdge.shape[0]
             #lTailleMaxY = lFrameEdge.shape[1]
             lHalfX = lTailleMaxX / 3

             for lPosX in lTableX:
                 lPosY = lTableY[lIdx]
                 if lPosX > lHalfX and lPosX >= lRayon and (lPosX +
                                                           lRayon) < lTailleMaxX:
                     lResults[lIdx] = np.sum(
                         lFrameEdge[int(lPosX - lRayon):int(lPosX + lRayon + 1),
                                    int(lPosY - lRayon):int(lPosY + lRayon + 1)] / 255)
                 lIdx += 1
             return lResults

In [15]: #@jit(nopython=True, parallel=True)
         def getNonZero(LImg):
             return np.where(LImg != [0])
```

6.6 Coordonnées de la fonction de base (ligne)

```
In [16]: def getNFCoordinate(lNeurone,lVerbose=False):
             try:
                 lintDist = int(np.floor(lNeurone.longueur / 2))
             except:
                 lP1 = (0, 0)
                 lP2 = (0, 0)
                 return (lP1, lP2)
             if np.abs(lNeurone.angle) < 45:
                 lAlpha = lNeurone.angle / 180 * pi
                 lintY1 = np.around(lNeurone.yPos - lintDist * np.tan(lAlpha))
                 lintX1 = lNeurone.xPos + lintDist
                 lintY2 = np.around(lNeurone.yPos + lintDist * np.tan(lAlpha))
                 lintX2 = lNeurone.xPos - lintDist
             else:
                 lAlpha = (90 - lNeurone.angle) / 180 * pi
                 if lVerbose:
                     print("Angle : "+str(lNeurone.angle))
                     print("yPos = "+str(lNeurone.yPos)+"xPos = "+str(lNeurone.xPos))
```

```
            lintX1 = np.around(lNeurone.xPos - lintDist * np.tan(lAlpha))
            lintY1 = lNeurone.yPos + lintDist
            lintX2 = np.around(lNeurone.xPos + lintDist * np.tan(lAlpha))
            lintY2 = lNeurone.yPos - lintDist
        lP1 = (int(lintY1), int(lintX1))
        lP2 = (int(lintY2), int(lintX2))
        if lVerbose:
            print("point 1: "+str(lP1))
            print("point 2: "+str(lP2))
            print("")
        return lP1, lP2
```

6.7 Calcule la distance entre deux points

```
In [17]: def getDistance(lx1, ly1, lx2, ly2):
        return np.sqrt(
            np.power(np.abs(lx1 - lx2), 2) + np.power(np.abs(ly1 - ly2), 2))
```

6.8 Retourne les neurones les plus proches d'un point

```
In [18]: def closestFieldNeurons(lneuronList, lposX, lposY, ldistance):
        return lneuronList[(lneuronList.xPos >= lposX - ldistance)
                           & (lneuronList.xPos <= lposX + ldistance) &
                           (lneuronList.yPos >= lposY - ldistance) &
                           (lneuronList.yPos <= lposY + ldistance)]
```

6.9 Crée un neurone avec les paramètres passés

```
In [19]: def createNeuron(llong, langle, lXpos, lYpos, lweight=255, lprecis=0, lGroup=0, llayer
        lNeurons = np.zeros(1, dtype=lNType);
        lpNeurons = pd.DataFrame(lNeurons);
        lpNeurons['longueur'] = llong;
        lpNeurons['angle'] = langle;
        lpNeurons['weight'] = lweight;
        lpNeurons['precision'] = lprecis;
        lpNeurons['xPos'] = lXpos;
        lpNeurons['yPos'] = lYpos;
        lpNeurons['groupID'] = lGroup;
        lpNeurons['layer'] = llayer;
        return lpNeurons;
```

6.10 Dessine les fonctions de base des neurones sur un bitmap

```
In [547]: def drawFieldNeurons(lNeuronList,
                               lBitmap,
                               lVerbose=False,
                               lGroupMember=0,
                               lLayer=0,
```

```
                lLayerRange=0,
                lAngle=0,
                lAngleRange=0):
    lInitShow = 8
    if lVerbose:
        lInitShow = 0
    lIndexPassOver = lInitShow
    for index, lNeuron in lNeuronList.iterrows():
        if lGroupMember > 0:
            if lNeuron.groupID != lGroupMember:
                continue
        if lLayer != 0:
            if (lNeuron.layer < lLayer - lLayerRange) or (
                    lNeuron.layer > lLayer + lLayerRange):
                continue
        if lAngle != 0:
            if (lNeuron.angle < lAngle - lAngleRange) or (
                    lNeuron.angle > lAngle + lAngleRange):
                continue
        lCoord = getNFCoordinate(lNeuron, lVerbose)
        if lVerbose:
            print(lNeuron)
            print(lCoord)
        if lIndexPassOver > 7:
            lIndexPassOver = lInitShow
            try:
                cv2.line(
                    lBitmap,
                    lCoord[0],
                    lCoord[1],
                    #         (255, 255, 255), 1)
                    (int(lNeuron.weight), int(
                        lNeuron.weight), int(lNeuron.weight)),
                    1)
            except:
                True
        if lVerbose:
            lIndexPassOver += 1
    return lBitmap
```

6.11 Find neuronal groups

Un groupe neuronal est un ensemble de neurone dont les champs récepteurs sont complémentaires les uns des autres. Pour faire partie d'un champs récepteur, deux conditions doivent être réunies. (A compléter) ### Translation Retourne les coordonnées d'un point translaté d'une certaine distance avec un certain angle. Cette fonction demande un angle, une distance et les coordonnées d'un point de départ. Il retourne ensuite les coordonnées après translation.

```
In [21]: #@jit(nopython=True, parallel=True)
         def moveCoordDeg(langle, lstartX, lstartY, ldistance, lVerbose=False):
             if lVerbose:
                 ##DEBUG
                 print("* moveCoordDeg(" + str(float(langle)) + "," +
                       str(int(lstartX)) + "," + str(int(lstartY)) +
                       "," + str(int(ldistance))+")")
                 ##DEBUG
             ltipX = lstartX + ldistance * np.cos(langle / 180 * pi)
             ltipY = lstartY - ldistance * np.sin(langle / 180 * pi)
             if lVerbose:
                 print ("* coord ==> ("+str(ltipX)+","+str(ltipY))
             return ltipX, ltipY
```

Effectue le même calcul que la fonction moveCoordDeg mais prend comme paramètre un neurone. Il effectue la translation en prenant comme point de départ le centre du champs récepteur et effectue un déplacement de la taille de ce champs dans la direction de la fonction de base.

```
In [22]: def getNextPosition(lneuroneMoyen, lVerbose):
             return moveCoordDeg(float(lneuroneMoyen.angle), int(lneuroneMoyen.xPos),
                                 int(lneuroneMoyen.yPos), int(lneuroneMoyen.longueur), lVerbose
```

6.11.1 Calcul des groupes à partir d'une liste de neurones à champs récepteurs

```
In [23]: def findGroups(lneuronList, lVerbose=False):
             # Sélection d'un nouveau numéro de Groupe (GroupID)
             lintCurrentGroupID = 0
             lintNbGroups = 0
             lIndex = 0

             ##DEBUG
             lnbNeuron = 0
             ##DEBUG
             # liste des neurones sans groupe
             lNoGroupList = lneuronList[lneuronList.groupID == 0]

             while lNoGroupList.shape[0] > 0:

                 #Sélection d'un neurone dans la liste (ceux sans groupID ou groupID=0)
                 lMoyenNeuron = lNoGroupList.iloc[0]
                 lIndex = lNoGroupList.head().index.values[0]

                 while True:
                     #Assignation d'un nouveau numéro de GroupID en cours
                     lintNbGroups += 1
                     lintCurrentGroupID += 1
                     if lneuronList[lneuronList.groupID ==
                                    lintCurrentGroupID].shape[0] == 0:
```

```
            break

    lneuronList.loc[lIndex, ['groupID']] = lintCurrentGroupID

    #déplacement
    lnPos = getNextPosition(lMoyenNeuron, lVerbose)

    #recherche de neurones proches
    lClosestNeurons = closestFieldNeurons(
        lneuronList, lnPos[0], lnPos[1],
        int(np.floor(lMoyenNeuron.longueur / 2)))
    if lVerbose:
        print("")
        print("")
        print("Coordonnées en cours : (" + str(lnPos[0]) + "," +
              str(lnPos[1]) + ")")

        lnbNeuron += 1
        if lClosestNeurons.shape[0] == 0:
            print("Aucun neurone a proximité pour le neurone #" +
                  str(lnbNeuron) + " aux coordonnées : (" + str(lnPos[0]) +
                  "," + str(lnPos[1]) + str(") a la distance :") +
                  str(int(np.floor(lMoyenNeuron.longueur / 2))))

        #Oui ==> retour étape 1
        lNbFindGroup = 0

    while lClosestNeurons.shape[0] != 0:
        #recherche des groupID dans cette sous-sélection
        if lClosestNeurons[lClosestNeurons.groupID> 0].shape[0] == 0:
            #Non => Assigner à tous les neurones de la sous-sélection
            #le groupID en cours => aller directement à l'étape 7
            if lVerbose:
                print("Aucun neurone dans le groupe : " +
                      str(lintCurrentGroupID))

            for lintIdx in lClosestNeurons.head().index.values:
                lneuronList.loc[lintIdx, ['groupID']] = lintCurrentGroupID
        else:
            #Oui
            if lVerbose:
                ##DEBUG
                #lNbFindGroup += 1
                print("Trouvé " + str(lClosestNeurons[
                    lClosestNeurons.groupID > 0].shape[0]) +
                      " neurone(s) déja dans des groupes :")
                print("Groupe en cours : " + str(lintCurrentGroupID))
```

```
                #Récupération de la liste de tous les groupID utilisés
                #Sélection du groupID le plus petit
                #(en comparant aussi avec le groupID en cours)
                lintPreviousGroupID = lintCurrentGroupID
                lintCurrentGroupID = np.min(
                    lClosestNeurons[lClosestNeurons.groupID > 0].groupID)
                if lVerbose:
                    print("Change pour le groupe #" + str(lintCurrentGroupID))
                    print("-")
                #Assigner au neurone en cours le nouveau groupe
                lneuronList.loc[lIndex, ['groupID']] = lintCurrentGroupID
                #Assigner à tous les neurones de la sous-sélection ce nouveau groupID
                for lintIdx in lClosestNeurons.head().index.values:
                    lneuronList.loc[lintIdx, ['groupID']] = lintCurrentGroupID
                    #remplacer dans la liste globale,
                    #pour chaque groupID présent dans la liste par le nouveau groupID
                    for lintGroupID in lClosestNeurons[
                            lClosestNeurons.groupID > 0].groupID:
                        lneuronList.loc[lneuronList.groupID == lintGroupID,
                                        'groupID'] = lintCurrentGroupID
                if lintPreviousGroupID == lintCurrentGroupID:
                    #si tous les neurones
                    if lClosestNeurons[lClosestNeurons.groupID >
                                       0].shape[0] == lClosestNeurons[
                                           lClosestNeurons.groupID ==
                                           lintPreviousGroupID].shape[0]:
                        break  # sortie de la boucle while
            if lVerbose:
                #Calcul du neurone Field moyen
                print("Neurones trouvé :")
                print(lClosestNeurons)
            lMoyenNeuron = getAvgFieldNeuron(lClosestNeurons)
            if lVerbose:
                print("neurone Moyen")
                print(lMoyenNeuron)
            #déplacement
            lnPos = getNextPosition(lMoyenNeuron, lVerbose)

            #recherche de neurones proches
            lClosestNeurons = closestFieldNeurons(
                lneuronList, lnPos[0], lnPos[1],
                int(np.floor(lMoyenNeuron.longueur / 2)))

    lNoGroupList = lneuronList[lneuronList.groupID == 0]
return lneuronList
```

6.12 Get the Weighted Average of the group Angle (WAGA)

```
In [24]: def getWAGA(lNeuronList, lGroupID):
             lnl = lNeuronList[lNeuronList.groupID==lGroupID]
             return float(np.sum((lnl.angle * lnl.weight) /
                         np.sum(lnl.weight)))
```

6.13 Get two Neuron line spread

```
In [25]: def getTNLSpread(lNeuron1, lNeuron2):
             return 0;
```

7 Video Loop

```
In [26]: kernelSize = 21  # Kernel Bluring size

         # Edge Detection Parameter
         parameter1 = 20
         parameter2 = 40
         intApertureSize = 1

         #cap = cv2.VideoCapture(0)
         cap = cv2.VideoCapture(fileName)
         lCounter = 0
         while (cap.isOpened()):
             # Capture frame-by-frame
             ret, Cannyframe = cap.read()
             if ret == True:
                 # Our operations on the frame come here
                 if lCounter == 1:
                     Cannyframe = cv2.GaussianBlur(Cannyframe, (kernelSize, kernelSize), 0, 0)
                     Cannyframe = cv2.Canny(Cannyframe, parameter1, parameter2,
                                            intApertureSize)  # Canny edge detection
                     lCounter = 0
                     break
                 lCounter += 1

                 # Display the resulting frame
                 cv2.imshow('Edges Video', Cannyframe)
                 if cv2.waitKey(1) & 0xFF == ord('q'):  # press q to quit
                     break
             else:
                 break
         # When everything done, release the capture
         cap.release()
         cv2.destroyAllWindows()
```

8 Sandbox

8.1 Toy data Generator

```
In [373]: def generateToy(lType=1, lHauteur=80, lLargeur=128,lepaisseur=1):
              lFrame = 0
              if lType == 1:
                  lFrame = np.zeros((lHauteur, lLargeur))
                  lFrame[:, int((lLargeur-lepaisseur) / 2):int((lLargeur+lepaisseur) / 2)] = 25
              elif lType == 2:
                  lFrame = np.zeros((lHauteur, lLargeur))
                  lFrame[int((lHauteur-lepaisseur) / 2):int((lHauteur+lepaisseur)/2), :] = 255
              elif lType == 3:
                  lFrame = np.zeros((lHauteur, lLargeur))
                  cv2.line(lFrame, (int(lLargeur / 3), lHauteur),
                           (int(2 * lLargeur / 3), 0), (255, 255, 255), lepaisseur)
              elif lType == 4:
                  lFrame = np.zeros((lHauteur, lLargeur))
                  cv2.rectangle(lFrame,
                                (int(lLargeur / 128 * 10), int(lHauteur / 80 * 30)),
                                (int(lLargeur / 128 * 30), int(lHauteur / 80 * 50)),
                                (255, 255, 255), lepaisseur)
                  pts = np.array([[int(lLargeur / 128 *64),
                                   int(lHauteur / 80 * 30)],
                                  [int(lLargeur / 128 * 76),
                                   int(lHauteur / 80 * 50)],
                                  [int(lLargeur / 128 * 53),
                                   int(lHauteur / 80 *50)]], np.int32)
                  ts = pts.reshape((-1, 1, 2))
                  cv2.polylines(lFrame, [pts], True, (255, 255, 255), lepaisseur)
                  cv2.circle(lFrame,
                             (int(lLargeur / 128 * 107), int(lHauteur / 80 * 40)),
                             int(lHauteur / 80 * 10), (255, 255, 255), lepaisseur)
              elif lType == 5:
                  lFrame = np.zeros((lHauteur, lLargeur))
                  #createNeuron(llong, langle, lXpos, lYpos,
                  llN = int(lLargeur / 256 * 50)
                  llXTmp = int(lHauteur / 160 * 100)
                  lNeuronTest2 = createNeuron(llN, -75, llXTmp, int(lLargeur / 256 * 25))
                  drawFieldNeurons(lNeuronTest2, lFrame)
                  lNeuronTest2 = createNeuron(llN, -60, llXTmp, int(lLargeur / 256 * 75))
                  drawFieldNeurons(lNeuronTest2, lFrame)
                  lNeuronTest2 = createNeuron(llN, 0, llXTmp, int(lLargeur / 256 * 125))
                  drawFieldNeurons(lNeuronTest2, lFrame)
                  lNeuronTest2 = createNeuron(llN, 60, llXTmp, int(lLargeur / 256 * 175))
                  drawFieldNeurons(lNeuronTest2, lFrame)
                  lNeuronTest2 = createNeuron(llN, 75, llXTmp, int(lLargeur / 256 * 225))
                  drawFieldNeurons(lNeuronTest2, lFrame)
```

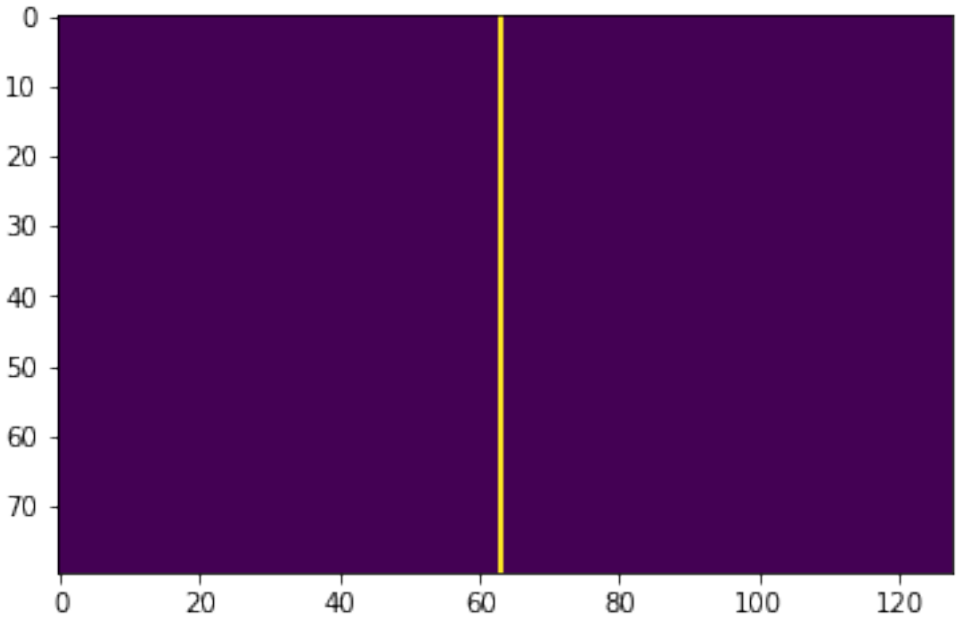
```
    elif lType == 6:
        lFrame = np.zeros((lHauteur, lLargeur))
        #createNeuron(llong, langle, lXpos, lYpos,
        llN = int(lLargeur / 256 * 50)
        llXTmp = int(lHauteur / 160 * 100)
        lNeuronTest2 = createNeuron(llN, 0, llXTmp, int(lLargeur / 256 * 25))
        drawFieldNeurons(lNeuronTest2, lFrame)
        lNeuronTest2 = createNeuron(llN, 0, llXTmp, int(lLargeur / 256 * 75))
        drawFieldNeurons(lNeuronTest2, lFrame)
        lNeuronTest2 = createNeuron(llN, 0, llXTmp, int(lLargeur / 256 * 125))
        drawFieldNeurons(lNeuronTest2, lFrame)
        lNeuronTest2 = createNeuron(llN, 0, llXTmp, int(lLargeur / 256 * 175))
        drawFieldNeurons(lNeuronTest2, lFrame)
        lNeuronTest2 = createNeuron(llN, 0, llXTmp, int(lLargeur / 256 * 225))
        drawFieldNeurons(lNeuronTest2, lFrame)
    elif lType == 7:
        lFrame = np.zeros((lHauteur, lLargeur))
        #createNeuron(llong, langle, lXpos, lYpos,
        llN = int(lLargeur / 256 * 50)
        llXTmp = int(lHauteur / 160 * 100)
        lNeuronTest2 = createNeuron(llN, 5, llXTmp, int(lLargeur / 256 * 25))
        drawFieldNeurons(lNeuronTest2, lFrame)
        lNeuronTest2 = createNeuron(llN, 5, llXTmp, int(lLargeur / 256 * 75))
        drawFieldNeurons(lNeuronTest2, lFrame)
        lNeuronTest2 = createNeuron(llN, 0, llXTmp+2, int(lLargeur / 256 * 125))
        drawFieldNeurons(lNeuronTest2, lFrame)
        lNeuronTest2 = createNeuron(llN, 0, llXTmp+2, int(lLargeur / 256 * 175))
        drawFieldNeurons(lNeuronTest2, lFrame)
        lNeuronTest2 = createNeuron(llN, 0, llXTmp+2, int(lLargeur / 256 * 225))
        drawFieldNeurons(lNeuronTest2, lFrame)
    else:
        lFrame = np.zeros((lHauteur, lLargeur))
        print("First parameter should be between 1 to 7")
    return lFrame
```

8.2 Playground

8.2.1 Test 1

Generate data of type 1

```
In [359]: frame = generateToy(1,80,128,1)
          imgplot = plt.imshow(frame)
```



Génération des neurones à champs récepteur

```
In [360]: indices = np.where(frame != [0])
          nbPixelsAll = nbPixelField(indices[0], indices[1], frame, tailleField)
          titi = getNeuronActivationList(indices[0], indices[1], tailleField, frame,
                                         nbPixelsAll)

In [361]: titi.describe()

Out[361]:        longueur         angle      weight  precision      xPos  yPos  groupID  \
          count      50.0  5.000000e+01   50.000000       50.0  50.00000  50.0     50.0
          mean        7.0  9.999996e-03  242.906311        0.0  51.50000  63.0      0.0
          std         0.0  3.763112e-09    0.000092        0.0  14.57738   0.0      0.0
          min         7.0  1.000000e-02  242.906403        0.0  27.00000  63.0      0.0
          25%         7.0  1.000000e-02  242.906403        0.0  39.25000  63.0      0.0
          50%         7.0  1.000000e-02  242.906403        0.0  51.50000  63.0      0.0
          75%         7.0  1.000000e-02  242.906403        0.0  63.75000  63.0      0.0
          max         7.0  1.000000e-02  242.906403        0.0  76.00000  63.0      0.0

                 layer
          count   50.0
          mean    63.0
          std      0.0
          min     63.0
          25%     63.0
          50%     63.0
```

```
75%     63.0
max     63.0
```

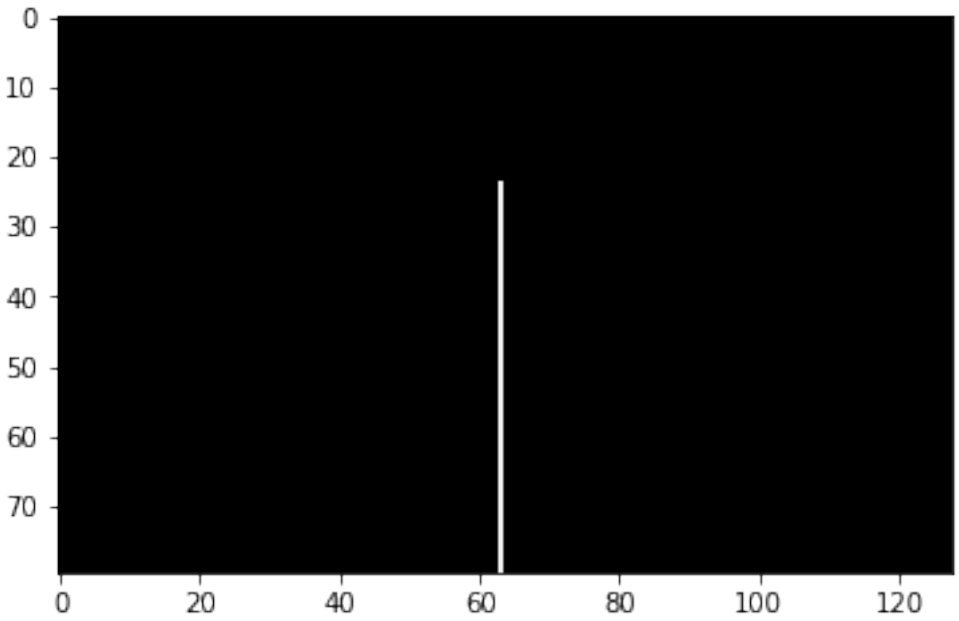
```
In [362]: titi[0:4]
```

Out[362]:

	longueur	angle	weight	precision	xPos	yPos	groupID	layer
0	7	0.01	242.906403	0.0	27	63	0	63.0
1	7	0.01	242.906403	0.0	28	63	0	63.0
2	7	0.01	242.906403	0.0	29	63	0	63.0
3	7	0.01	242.906403	0.0	30	63	0	63.0

Affichage graphique du champs récepteur des neurones

```
In [363]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
          testBitmap = drawFieldNeurons(titi, testBitmap)
          imgplot = plt.imshow(testBitmap)
```




```
In [364]: np.max(testBitmap)
```

```
Out[364]: 242
```

```
In [365]: lintI = 0
          while (lintI < 10):
              cv2.imshow('FRAME', frame)
              if cv2.waitKey(1) & 0xFF == ord('q'):  # press q to quit
                  break
              lintI += 1
```

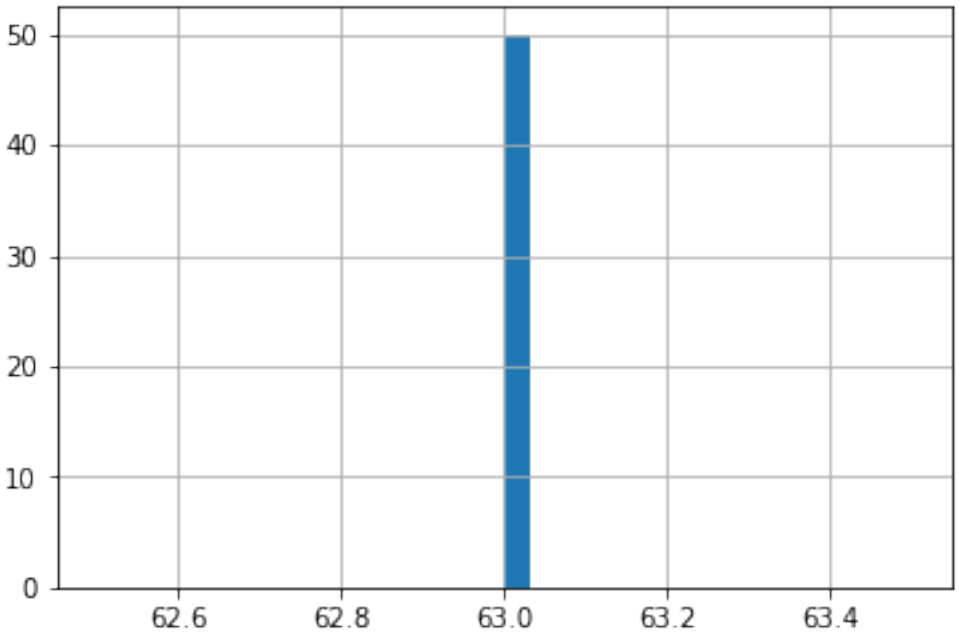
Simplification des neurones

```
In [366]: np.sum(titi.memory_usage())
```

```
Out[366]: 2130
```

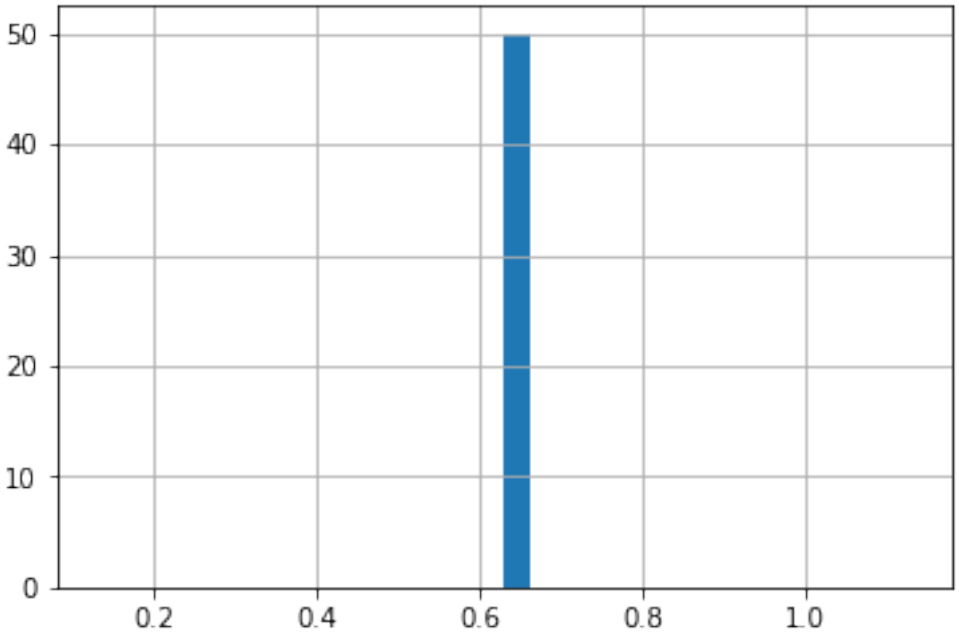
```
In [367]: titi.layer.hist(bins=32)
```

```
Out[367]: <matplotlib.axes._subplots.AxesSubplot at 0x138b4c710>
```

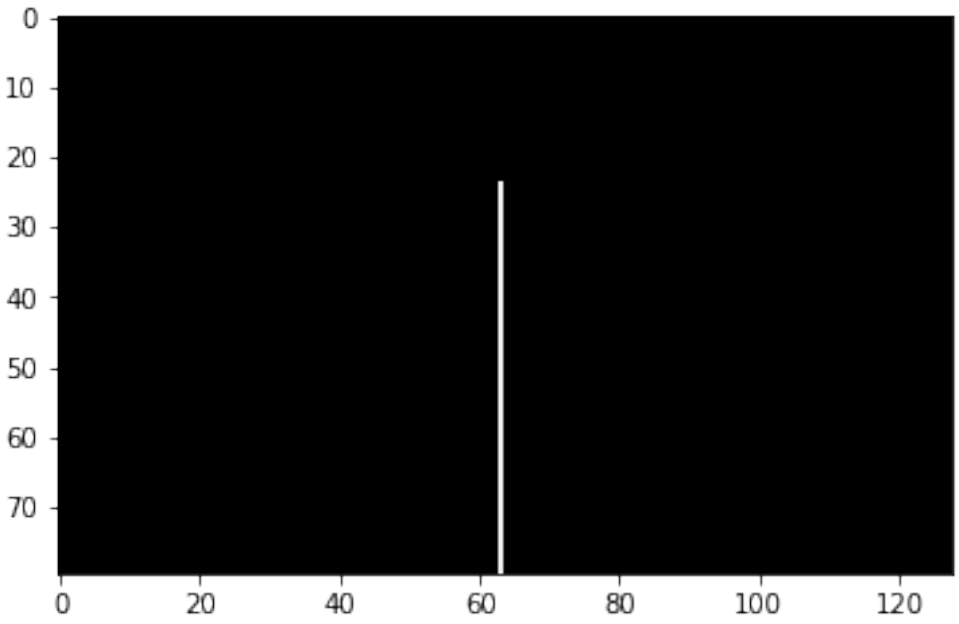



```
In [368]: toto = titi.angle*titi.layer
          toto.hist(bins=32)
```

```
Out[368]: <matplotlib.axes._subplots.AxesSubplot at 0x13889b400>
```



In [371]:
```
testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
testBitmap = drawFieldNeurons(titi, testBitmap,0,0,60,5)
imgplot = plt.imshow(testBitmap)
```



Génération des groupes

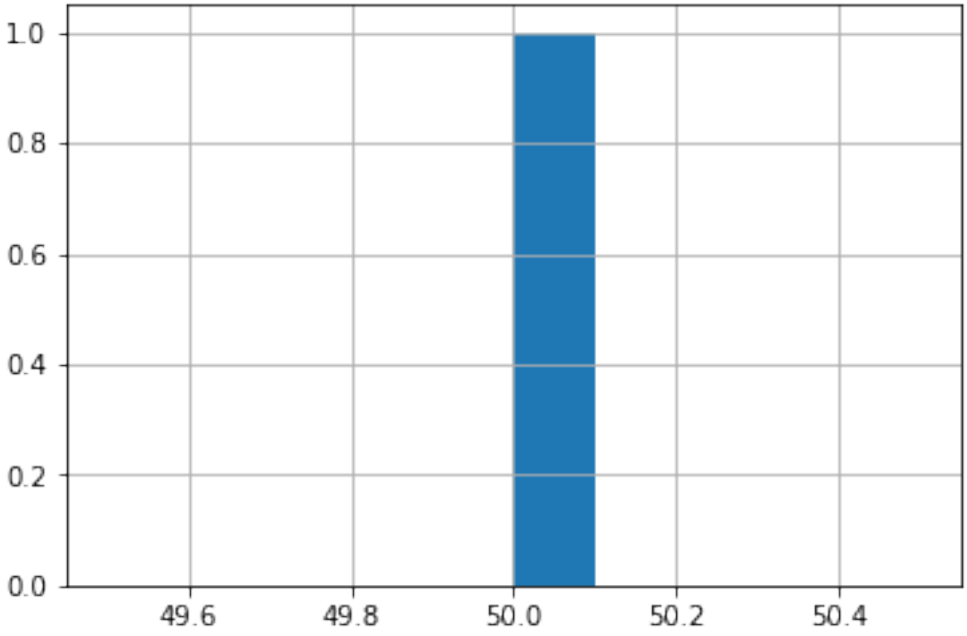
```
In [35]: findGroups(titi);
```

```
In [36]: titi.groupby('groupID').agg(['mean', 'count'])[0:5]
```

```
Out[36]:          longueur       angle            weight       precision        xPos  \
                      mean count  mean count        mean count      mean count  mean
          groupID
          1              7    50  0.01    50  242.906403    50       0.0    50  51.5

                       yPos       layer
                 count mean count  mean count
          groupID
          1           50   63    50   0.0    50
```

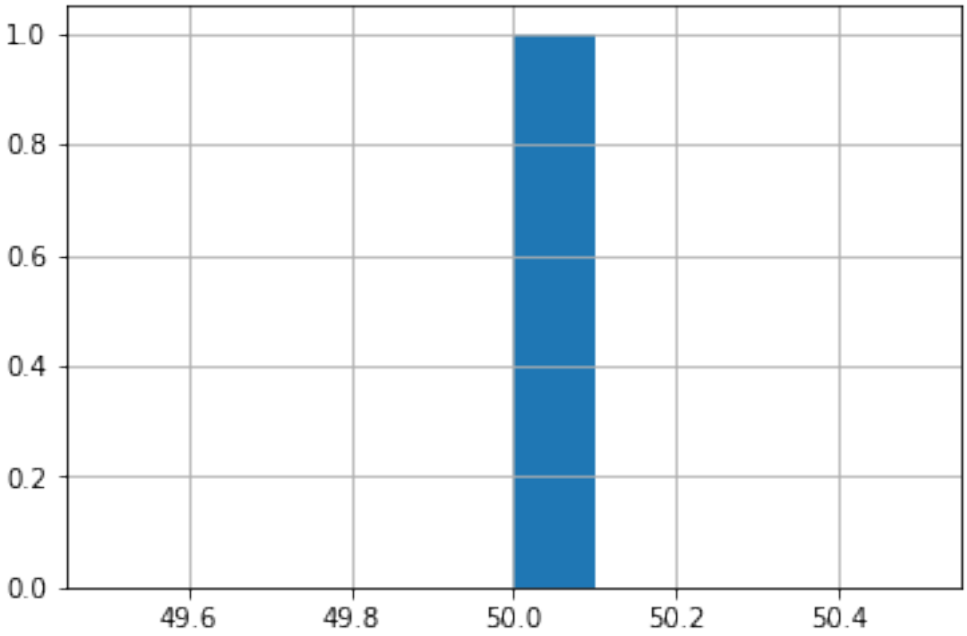
```
In [37]: titi.groupby('groupID').size().hist()
```

```
Out[37]: <matplotlib.axes._subplots.AxesSubplot at 0x123b2c470>
```




```
In [38]: resultGroup = titi.groupby('groupID').size()
         resultGroup[resultGroup>10].hist()
```

```
Out[38]: <matplotlib.axes._subplots.AxesSubplot at 0x124135a90>
```




```
In [39]: titi.describe()
```

Out[39]:

	longueur	angle	weight	precision	xPos	yPos	groupID	layer
count	50.0	5.000000e+01	50.000000	50.0	50.00000	50.0	50.0	50.0
mean	7.0	9.999996e-03	242.906311	0.0	51.50000	63.0	1.0	0.0
std	0.0	3.763112e-09	0.000092	0.0	14.57738	0.0	0.0	0.0
min	7.0	1.000000e-02	242.906403	0.0	27.00000	63.0	1.0	0.0
25%	7.0	1.000000e-02	242.906403	0.0	39.25000	63.0	1.0	0.0
50%	7.0	1.000000e-02	242.906403	0.0	51.50000	63.0	1.0	0.0
75%	7.0	1.000000e-02	242.906403	0.0	63.75000	63.0	1.0	0.0
max	7.0	1.000000e-02	242.906403	0.0	76.00000	63.0	1.0	0.0

```
In [369]: titi[0:4]
```

Out[369]:

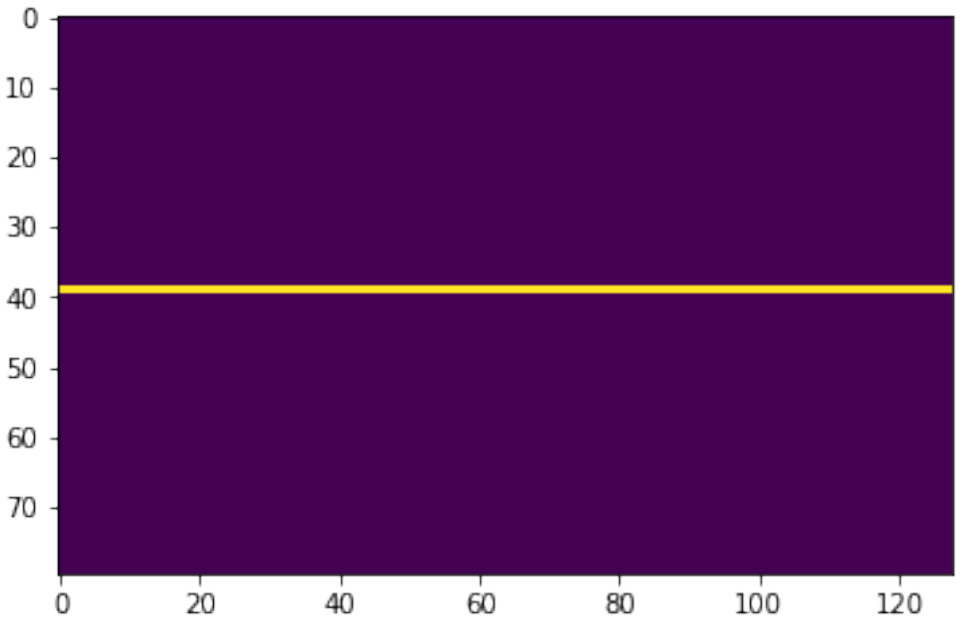
	longueur	angle	weight	precision	xPos	yPos	groupID	layer
0	7	0.01	242.906403	0.0	27	63	0	63.0

1	7	0.01	242.906403	0.0	28	63	0	63.0
2	7	0.01	242.906403	0.0	29	63	0	63.0
3	7	0.01	242.906403	0.0	30	63	0	63.0

8.2.2 Test 2

Generate data of type 2

```
In [42]: frame = generateToy(2,80,128,1)
         imgplot = plt.imshow(frame)
```



Génération des neurones à champs récepteur

```
In [43]: indices = np.where(frame != [0])
         nbPixelsAll = nbPixelField(indices[0], indices[1], frame, tailleField)
         titi = getNeuronActivationList(indices[0], indices[1], tailleField, frame,
                                        nbPixelsAll)
```

```
exceed the limit of the matrix
exceed the limit of the matrix
exceed the limit of the matrix
error 10 :
lAngleMat
[[-4.499e+01 -3.368e+01 -1.842e+01  1.000e-02  1.844e+01  3.370e+01
   4.501e+01]
 [-5.630e+01 -4.499e+01 -2.656e+01  1.000e-02  2.658e+01  4.501e+01
   5.632e+01]
```

```
 [-7.156e+01 -6.342e+01 -4.499e+01  1.000e-02  4.501e+01  6.344e+01
   7.158e+01]
 [ 9.000e+01  9.000e+01  9.000e+01  0.000e+00  9.000e+01  9.000e+01
   9.000e+01]
 [ 7.158e+01  6.344e+01  4.501e+01  1.000e-02 -4.499e+01 -6.342e+01
  -7.156e+01]
 [ 5.632e+01  4.501e+01  2.658e+01  1.000e-02 -2.656e+01 -4.499e+01
  -5.630e+01]
 [ 4.501e+01  3.370e+01  1.844e+01  1.000e-02 -1.842e+01 -3.368e+01
  -4.499e+01]]
lNeuronFieldFrame
[[0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]
 [1. 1. 1. 1. 1. 1.]
 [0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]]
lintX
39
lintY
125
offsetField
3
error 10 :
lAngleMat
[[-4.499e+01 -3.368e+01 -1.842e+01  1.000e-02  1.844e+01  3.370e+01
   4.501e+01]
 [-5.630e+01 -4.499e+01 -2.656e+01  1.000e-02  2.658e+01  4.501e+01
   5.632e+01]
 [-7.156e+01 -6.342e+01 -4.499e+01  1.000e-02  4.501e+01  6.344e+01
   7.158e+01]
 [ 9.000e+01  9.000e+01  9.000e+01  0.000e+00  9.000e+01  9.000e+01
   9.000e+01]
 [ 7.158e+01  6.344e+01  4.501e+01  1.000e-02 -4.499e+01 -6.342e+01
  -7.156e+01]
 [ 5.632e+01  4.501e+01  2.658e+01  1.000e-02 -2.656e+01 -4.499e+01
  -5.630e+01]
 [ 4.501e+01  3.370e+01  1.844e+01  1.000e-02 -1.842e+01 -3.368e+01
  -4.499e+01]]
lNeuronFieldFrame
[[0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]
 [1. 1. 1. 1. 1. 1.]
 [0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]]
```

```
lintX
39
lintY
125
offsetField
3
error 10 :
lAngleMat
[[-4.499e+01 -3.368e+01 -1.842e+01  1.000e-02  1.844e+01  3.370e+01
   4.501e+01]
 [-5.630e+01 -4.499e+01 -2.656e+01  1.000e-02  2.658e+01  4.501e+01
   5.632e+01]
 [-7.156e+01 -6.342e+01 -4.499e+01  1.000e-02  4.501e+01  6.344e+01
   7.158e+01]
 [ 9.000e+01  9.000e+01  9.000e+01  0.000e+00  9.000e+01  9.000e+01
   9.000e+01]
 [ 7.158e+01  6.344e+01  4.501e+01  1.000e-02 -4.499e+01 -6.342e+01
  -7.156e+01]
 [ 5.632e+01  4.501e+01  2.658e+01  1.000e-02 -2.656e+01 -4.499e+01
  -5.630e+01]
 [ 4.501e+01  3.370e+01  1.844e+01  1.000e-02 -1.842e+01 -3.368e+01
  -4.499e+01]]
lNeuronFieldFrame
[[0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]
 [1. 1. 1. 1. 1. 1.]
 [0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]
 [0. 0. 0. 0. 0. 0.]]
lintX
39
lintY
125
offsetField
3
```

```
In [44]: titi.describe()
```

Out[44]:

	longueur	angle	weight	precision	xPos	yPos	\
count	128.0	128.000000	128.000000	128.0	128.000000	128.000000	
mean	7.0	85.781250	231.520050	0.0	37.171875	60.523438	
std	0.0	19.098122	51.545200	0.0	8.275863	37.053901	
min	7.0	0.000000	0.000000	0.0	0.000000	0.000000	
25%	7.0	90.000000	242.906403	0.0	39.000000	28.750000	
50%	7.0	90.000000	242.906403	0.0	39.000000	60.500000	
75%	7.0	90.000000	242.906403	0.0	39.000000	92.250000	

```
max         7.0    90.000000  242.906403        0.0    39.000000  124.000000
```

```
       groupID  layer
count    128.0  128.0
mean       0.0    0.0
std        0.0    0.0
min        0.0    0.0
25%        0.0    0.0
50%        0.0    0.0
75%        0.0    0.0
max        0.0    0.0
```

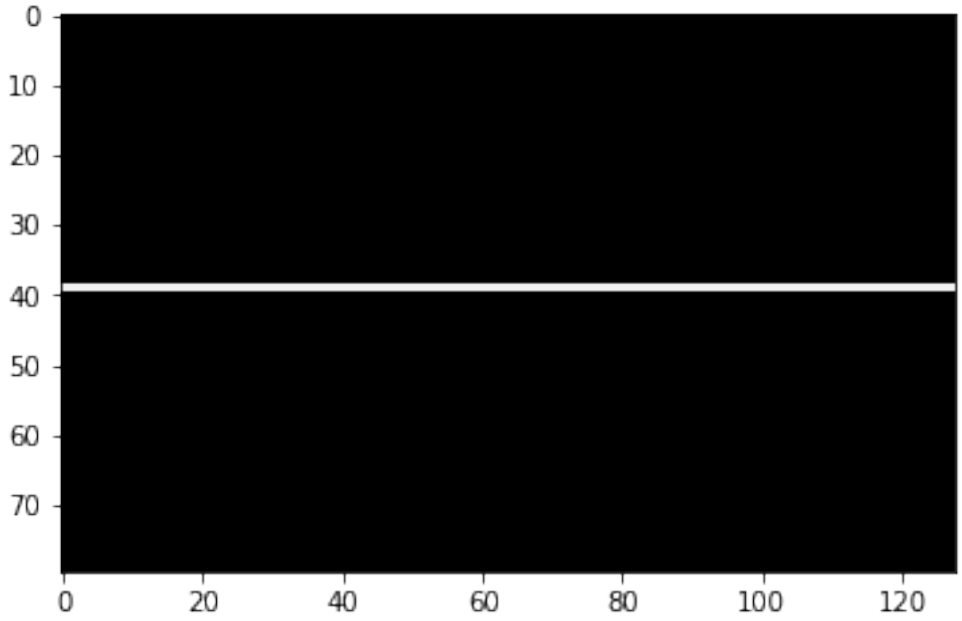
```
In [45]: titi[0:4]
```

Out[45]:

	longueur	angle	weight	precision	xPos	yPos	groupID	layer
0	7	0.0	0.000000	0.0	0	0	0	0.0
1	7	0.0	0.000000	0.0	0	0	0	0.0
2	7	0.0	0.000000	0.0	0	0	0	0.0
3	7	90.0	242.906403	0.0	39	3	0	0.0

Affichage graphique du champs récepteur des neurones

```
In [46]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
         testBitmap = drawFieldNeurons(titi, testBitmap)
         imgplot = plt.imshow(testBitmap)
```



Génération des groupes

```
In [47]: findGroups(titi);
```

```
In [48]: titi.groupby('groupID').agg(['mean', 'count'])[0:5]
```

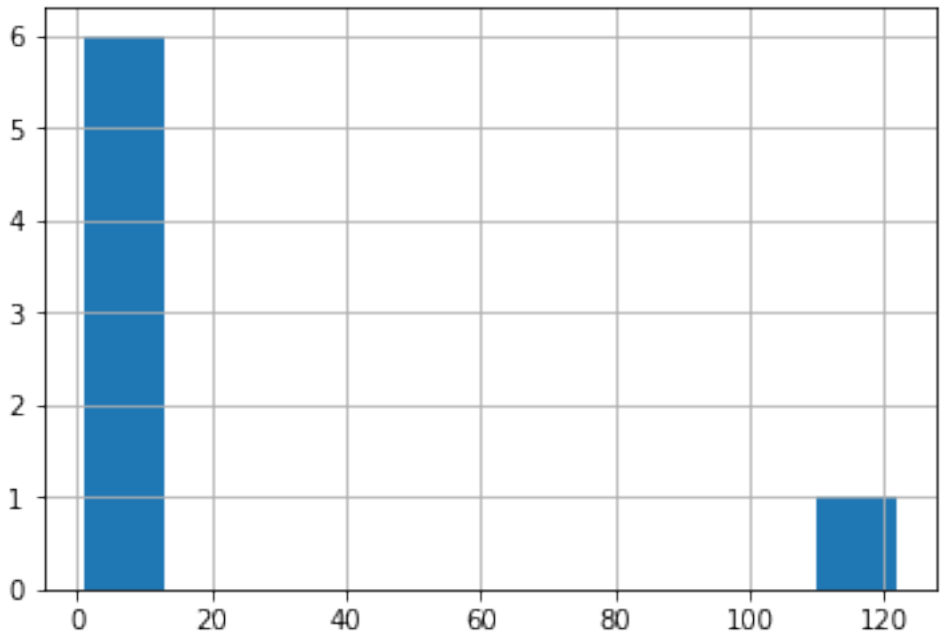
Out[48]:

	longueur		angle		weight		precision		xPos	
	mean	count	mean	count	mean	count	mean	count	mean	
groupID										
1	7	1	0.0	1	0.000000	1	0.0	1	0	
2	7	1	0.0	1	0.000000	1	0.0	1	0	
3	7	1	0.0	1	0.000000	1	0.0	1	0	
4	7	122	90.0	122	242.906403	122	0.0	122	39	
5	7	1	0.0	1	0.000000	1	0.0	1	0	

	yPos		layer	
count	mean	count	mean	count
groupID				
1	1	0.0	1	0.0	1
2	1	0.0	1	0.0	1
3	1	0.0	1	0.0	1
4	122	63.5	122	0.0	122
5	1	0.0	1	0.0	1

```
In [49]: titi.groupby('groupID').size().hist()
```

```
Out[49]: <matplotlib.axes._subplots.AxesSubplot at 0x1235eb320>
```



```
In [50]: titi[0:4]
```

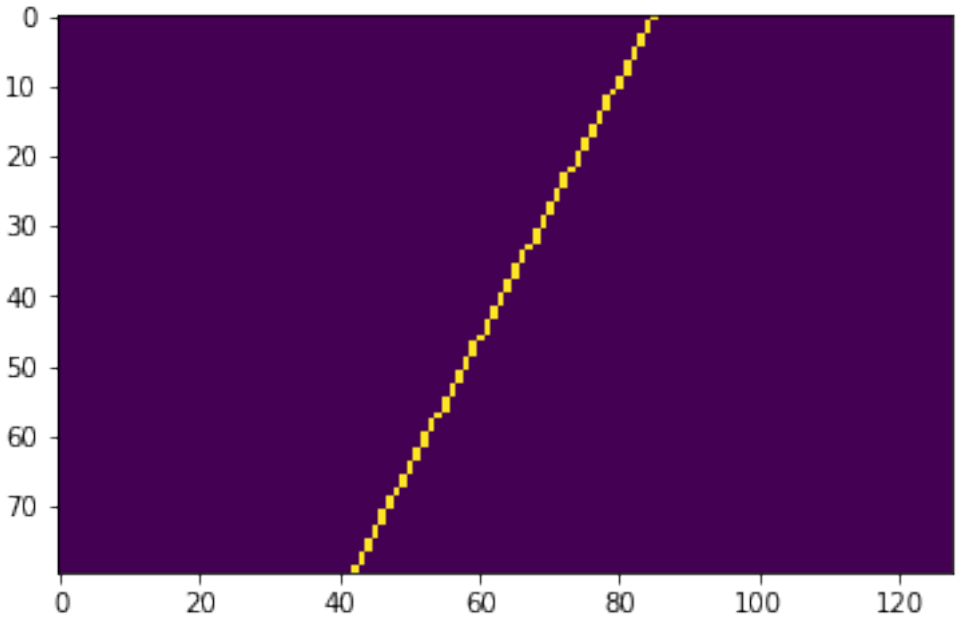
Out[50]:

	longueur	angle	weight	precision	xPos	yPos	groupID	layer
0	7	0.0	0.000000	0.0	0	0	1	0.0
1	7	0.0	0.000000	0.0	0	0	2	0.0
2	7	0.0	0.000000	0.0	0	0	3	0.0
3	7	90.0	242.906403	0.0	39	3	4	0.0

8.2.3 Test 3

Generate data of type 3

```
In [51]: frame = generateToy(3,80,128,1)
         imgplot = plt.imshow(frame)
```



Génération des neurones à champs récepteur

```
In [52]: indices = np.where(frame != [0])
         nbPixelsAll = nbPixelField(indices[0], indices[1], frame, tailleField)
         titi = getNeuronActivationList(indices[0], indices[1], tailleField, frame,
                                        nbPixelsAll)
```

```
In [53]: titi.describe()
```

Out[53]:

	longueur	angle	weight	precision	xPos	yPos	\
count	50.0	50.000000	50.000000	50.000000	50.00000	50.000000	
mean	7.0	26.755207	213.043991	13.634507	51.50000	56.980000	

```
std          0.0    2.806284    5.832972    1.934354   14.57738    7.924362
min          7.0   25.053333  205.570328    7.588554   27.00000   44.000000
25%          7.0   25.053333  212.746216   13.835940   39.25000   50.250000
50%          7.0   25.053333  212.746216   13.835940   51.50000   57.000000
75%          7.0   27.596666  212.746216   13.835940   63.75000   63.750000
max          7.0   35.096668  230.490402   15.747627   76.00000   70.000000
```

```
       groupID  layer
count     50.0   50.0
mean       0.0    0.0
std        0.0    0.0
min        0.0    0.0
25%        0.0    0.0
50%        0.0    0.0
75%        0.0    0.0
max        0.0    0.0
```

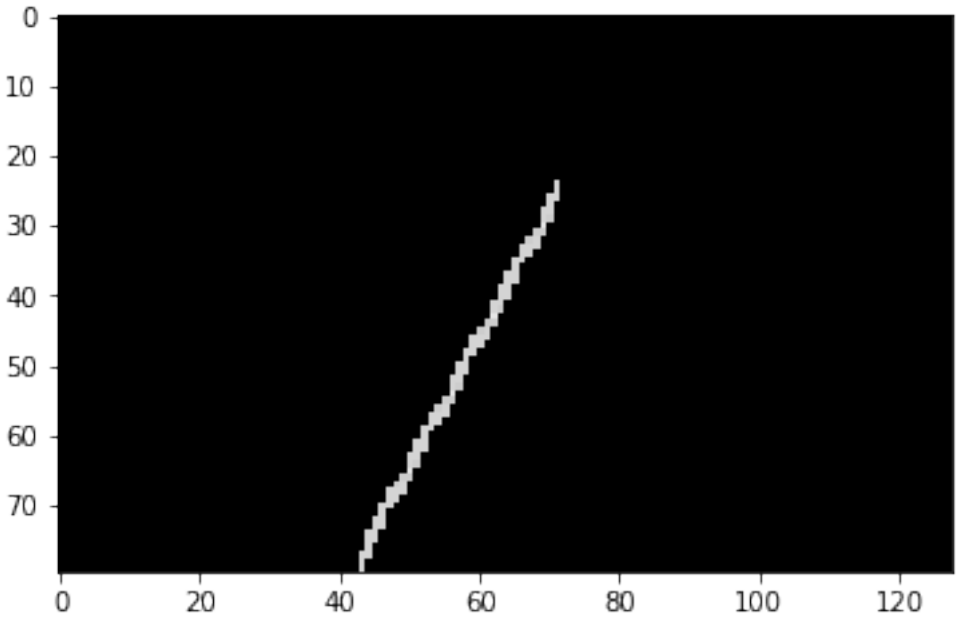
In [54]:
```
titi[0:4]
```

Out[54]:

	longueur	angle	weight	precision	xPos	yPos	groupID	layer
0	7	25.053333	212.746216	13.83594	27	70	0	0.0
1	7	25.053333	212.746216	13.83594	28	70	0	0.0
2	7	25.053333	212.746216	13.83594	29	69	0	0.0
3	7	25.053333	212.746216	13.83594	30	69	0	0.0

Affichage graphique du champs récepteur des neurones

In [55]:
```
testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
testBitmap = drawFieldNeurons(titi, testBitmap)
imgplot = plt.imshow(testBitmap)
```



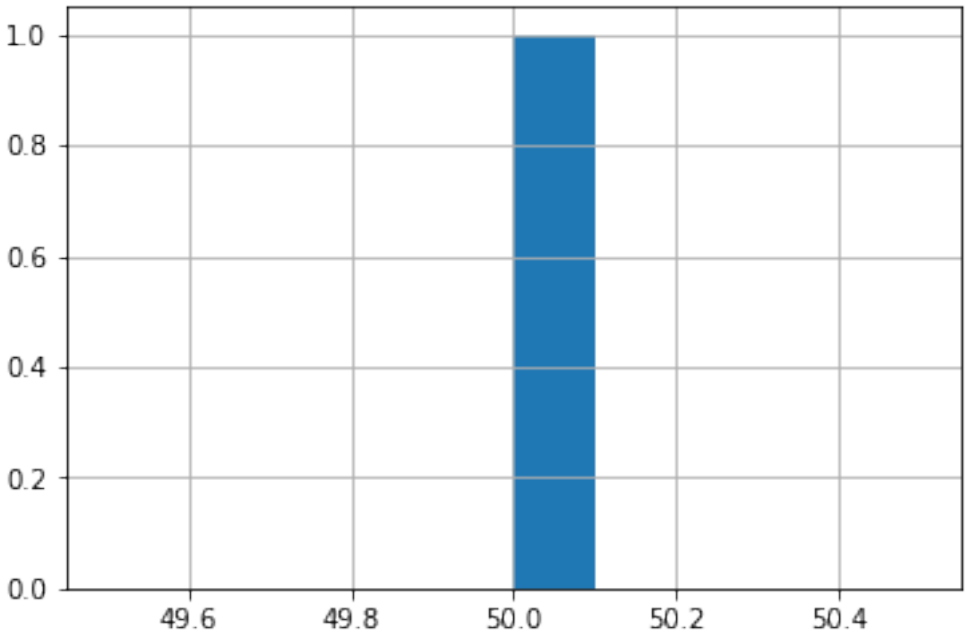
Génération des groupes

```
In [56]: findGroups(titi);

In [57]: titi.groupby('groupID').agg(['mean', 'count'])[0:5]
```

Out[57]:

groupID	longueur		angle		weight		precision		xPos		yPos		layer	
	mean	count	mean	count	mean	count	mean	count	mean	count	mean	count	mean	count
1	7	50	26.755199	50	213.044052	50	13.634507	50	51.5	50	56.98	50	0.0	50

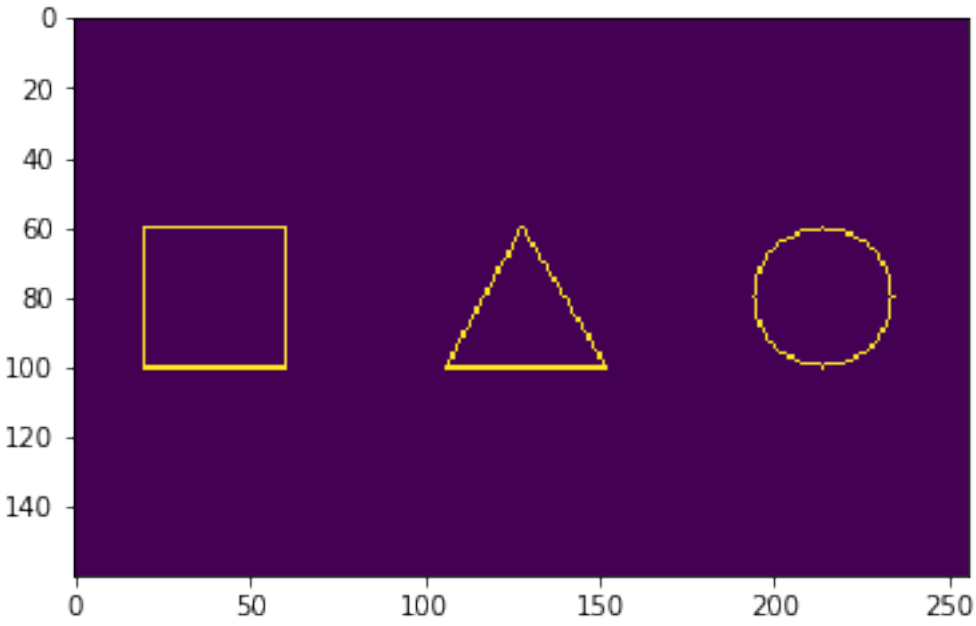
```
In [58]: titi.groupby('groupID').size().hist()

Out[58]: <matplotlib.axes._subplots.AxesSubplot at 0x123634f60>
```



8.2.4 Test 4

Generate data of type 4

```
In [737]: frame = generateToy(4,160,256,1)
          imgplot = plt.imshow(frame)
```



Génération des neurones à champs récepteur

```
In [738]: indices = np.where(frame != [0])
          nbPixelsAll = nbPixelField(indices[0], indices[1], frame, tailleField)
          titi = getNeuronActivationList(indices[0], indices[1], tailleField, frame,
                                         nbPixelsAll)

In [739]: titi.describe()

Out[739]:        longueur       angle      weight   precision        xPos        yPos  \
          count      398.0  398.000000  398.000000  398.000000  398.000000  398.000000
          mean         7.0   22.983759  214.483398    9.913938   82.311558  117.037688
          std          0.0   52.803646   44.123013   11.387993   15.140764   72.832620
          min          7.0  -86.926666   10.970448    0.000000   60.000000   20.000000
          25%          7.0   -7.785227  205.570328    0.000000   67.000000   50.000000
          50%          7.0   13.627500  230.490402    7.588554   84.000000  120.000000
          75%          7.0   90.000000  242.906403   15.747627   99.000000  195.000000
          max          7.0   90.000000  242.906403   61.020844  100.000000  234.000000

                 groupID       layer
          count    398.0  398.000000
          mean       0.0  161.944717
          std        0.0   90.397964
```

```
min         0.0  -75.000000
25%         0.0   94.000000
50%         0.0  160.500000
75%         0.0  260.000000
max         0.0  317.000000
```

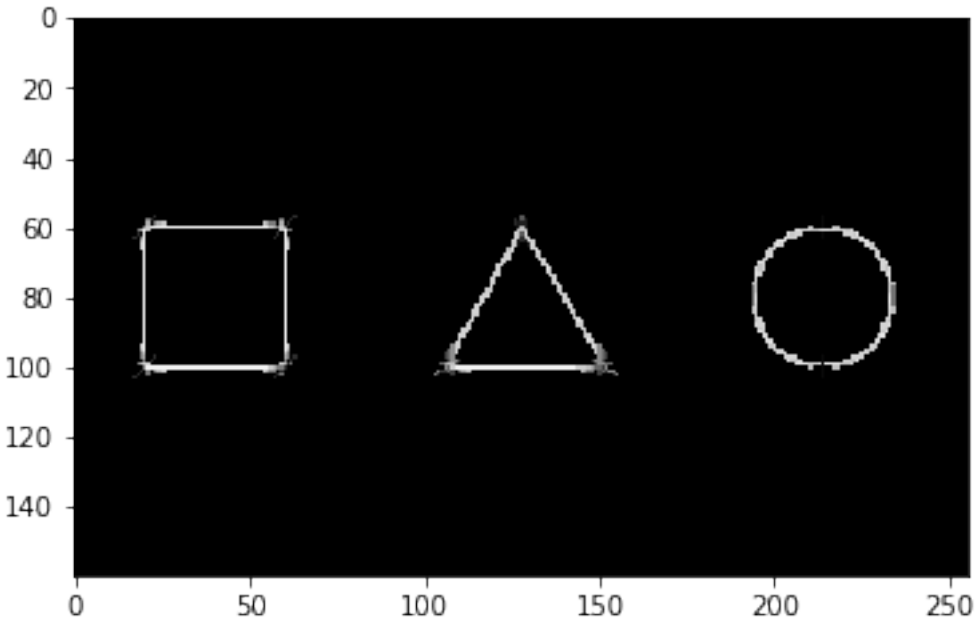
```
In [740]: titi[0:4]
```

Out[740]:

	longueur	angle	weight	precision	xPos	yPos	groupID	layer
0	7	45.005001	46.537529	44.994999	60	20	0	62.0
1	7	64.290001	123.892136	30.566092	60	21	0	75.0
2	7	74.018753	176.191147	21.954557	60	22	0	80.0
3	7	79.212219	202.501602	16.500349	60	23	0	82.0

Affichage graphique du champs récepteur des neurones

```
In [741]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
          testBitmap = drawFieldNeurons(titi, testBitmap)
          imgplot = plt.imshow(testBitmap)
```

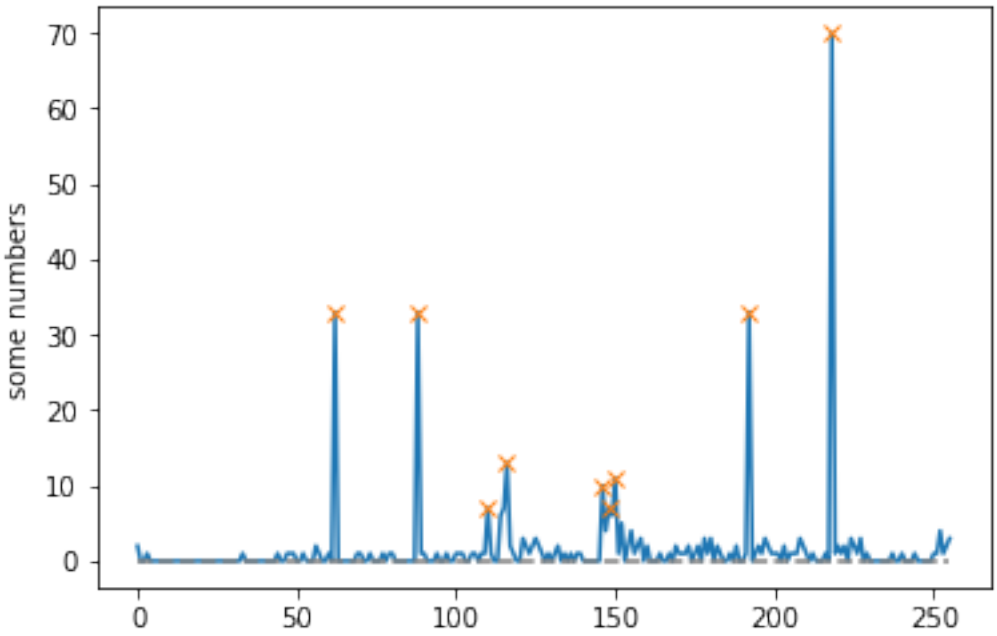


Simplification

Layer

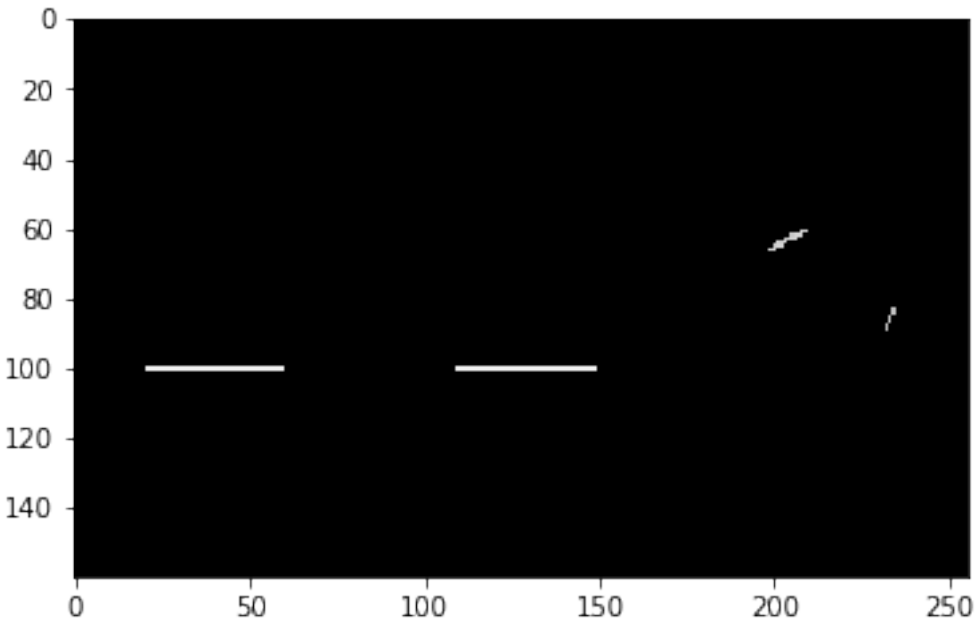
```
In [742]: lvhist = (titi['layer']
           .pipe(lambda s: pd.Series(np.histogram(s,  bins=512)))
           .pipe(lambda s: pd.Series(s[0], index=s[1][:-1]))
          )
```

```
In [744]: lvhist = (titi['layer']
           .pipe(lambda s: pd.Series(np.histogram(s,  bins=256)))
           .pipe(lambda s: pd.Series(s[0], index=s[1][:-1]))
          )
          peaks,ldict = find_peaks(lvhist, height=7)
          ser = lvhist.to_numpy()
          plt.plot(ser)
          plt.plot(peaks, ser[peaks], "x")
          plt.plot(np.zeros_like(ser), "--", color="gray")
          plt.ylabel('frequency')
          plt.show()
```

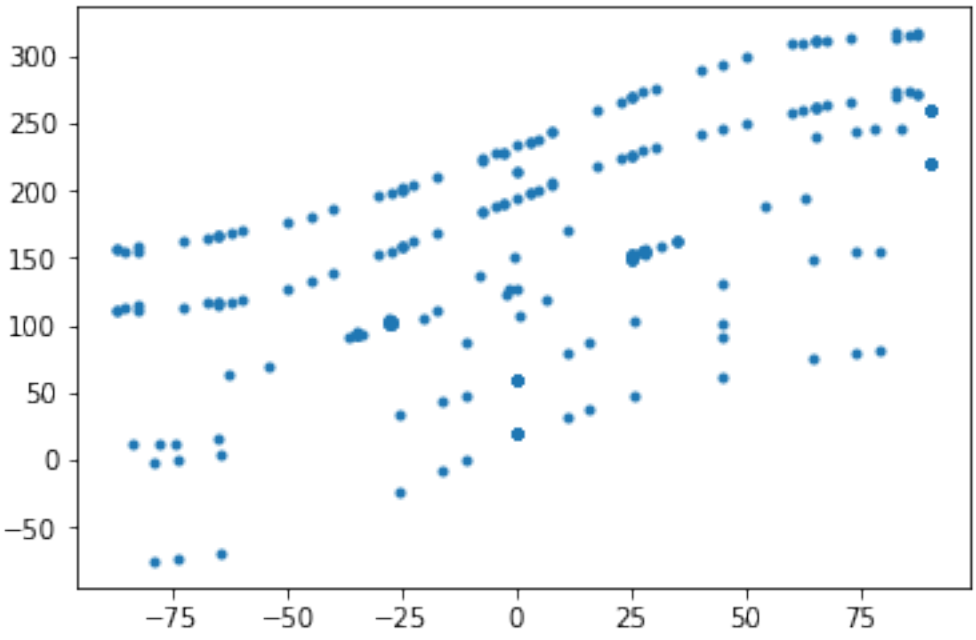



```
In [745]: lidx2 = peaks[np.argmax(ldict['peak_heights'])]
          lLayerPic = lvhist.index.values[lidx2:lidx2+1][0]
```

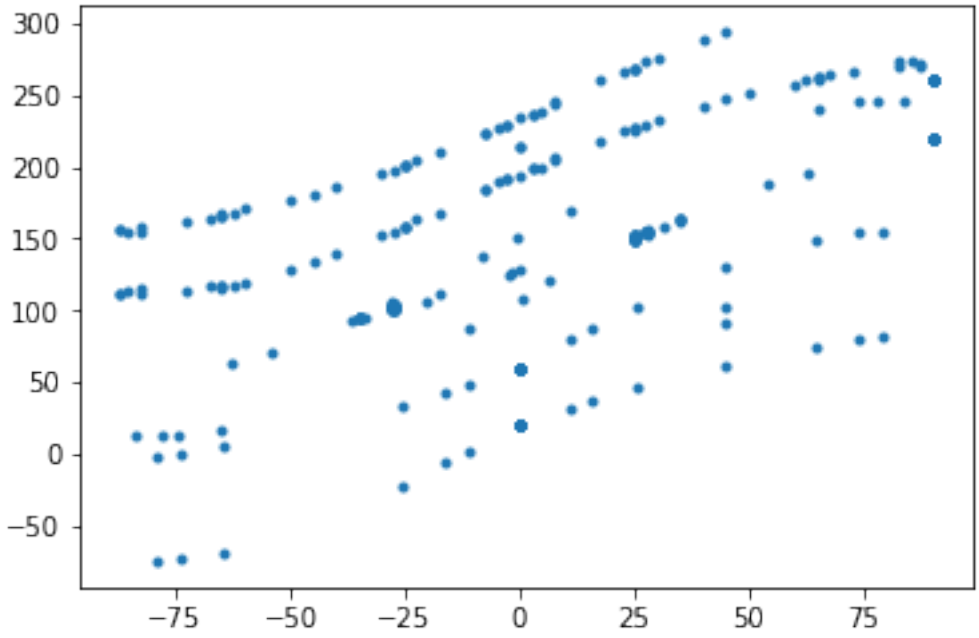
```
In [752]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
          testBitmap = drawFieldNeurons(titi, testBitmap,0,0,lLayerPic,5)
          imgplot = plt.imshow(testBitmap)
```



In [753]:
```
plt.plot(titi.angle,titi.layer,'.')
plt.show()
```



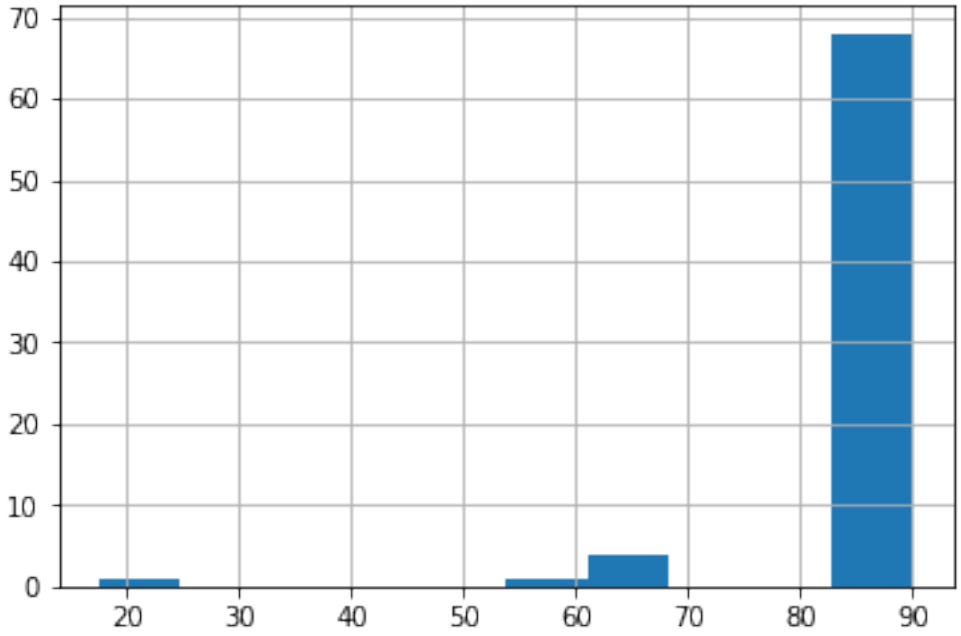
In [754]:
```
plt.plot(titi.angle[np.abs(titi.layer)<300],titi.layer[np.abs(titi.layer)<300],'.')
plt.show()
```



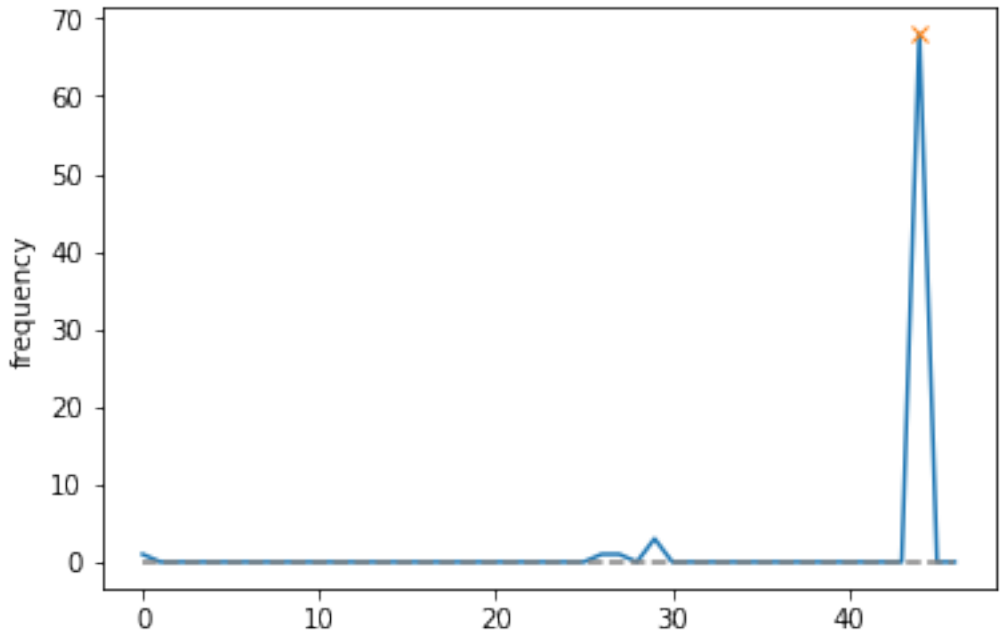
Angle

```
In [755]: lNeuronTopLayer = titi[(titi.layer>=(lLayerPic-5)) &(titi.layer<=(lLayerPic+5))]
          lNeuronTopLayer.angle.hist()
```

```
Out[755]: <matplotlib.axes._subplots.AxesSubplot at 0x146525b70>
```

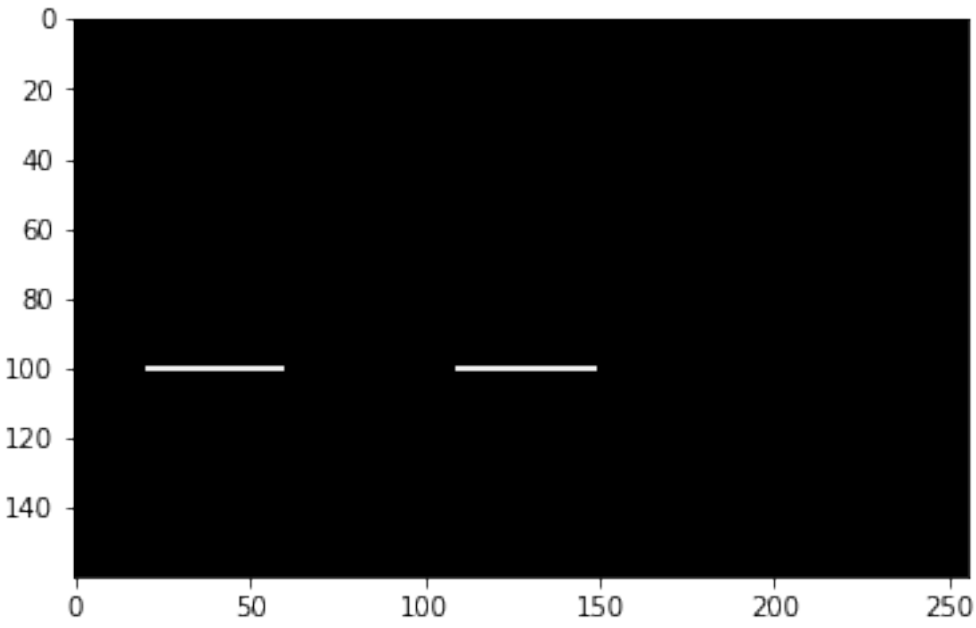


```
In [775]: lvhist = (lNeuronTopLayer['angle']
           .pipe(lambda s: pd.Series(np.histogram(s,  bins=45)))
           .pipe(lambda s: pd.Series(s[0], index=s[1][:-1]))
          )
          lvhist = lvhist.append(pd.Series([0, 0]))
          peaks,ldict = find_peaks(lvhist, height=7)
          ser = lvhist.to_numpy()
          plt.plot(ser)
          plt.plot(peaks, ser[peaks], "x")
          plt.plot(np.zeros_like(ser), "--", color="gray")
          plt.ylabel('frequency')
          plt.show()
```




```
In [777]: lidx2 = peaks[np.argmax(ldict['peak_heights'])]
          lAnglePic = lvhist.index.values[lidx2:lidx2+1][0]
```

```
In [779]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
          testBitmap = drawFieldNeurons(titi, testBitmap,0,0,lLayerPic,5,lAnglePic,5)
          imgplot = plt.imshow(testBitmap)
```

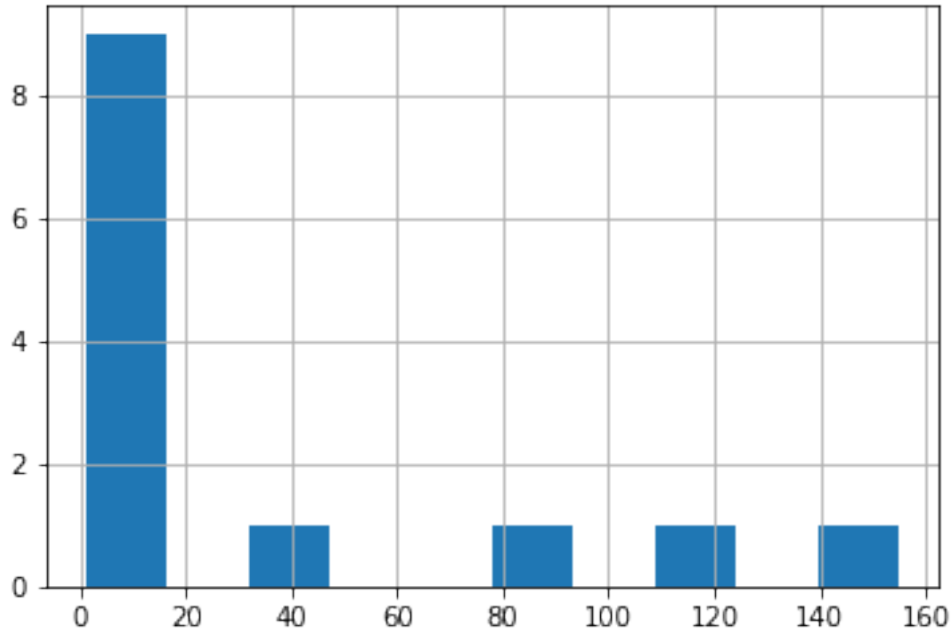


Génération des groupes

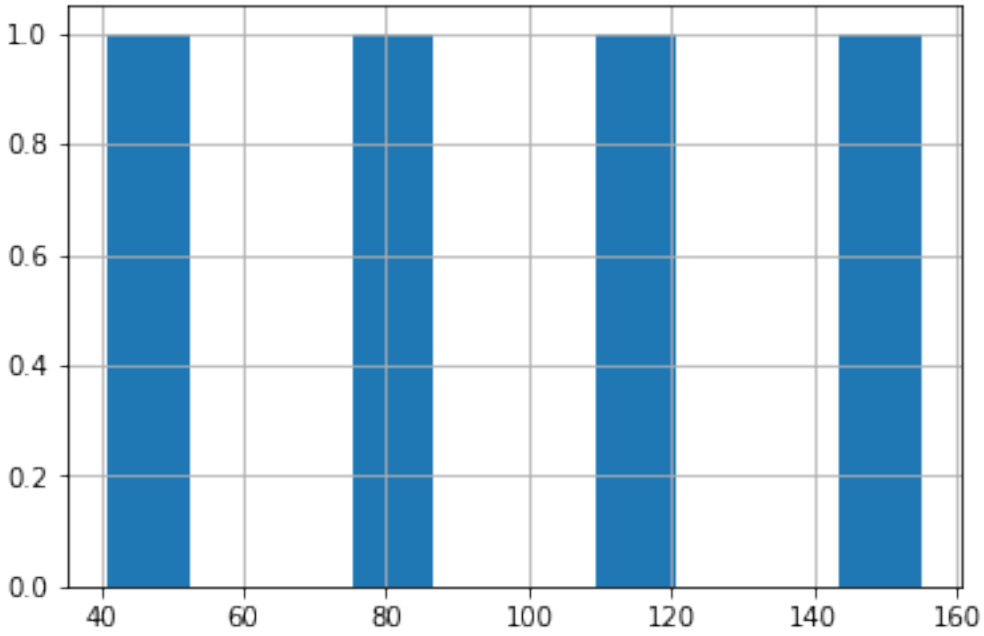
```
In [64]: findGroups(titi);
```

```
In [65]: titi.groupby('groupID').size().hist()
```

```
Out[65]: <matplotlib.axes._subplots.AxesSubplot at 0x1240b6198>
```

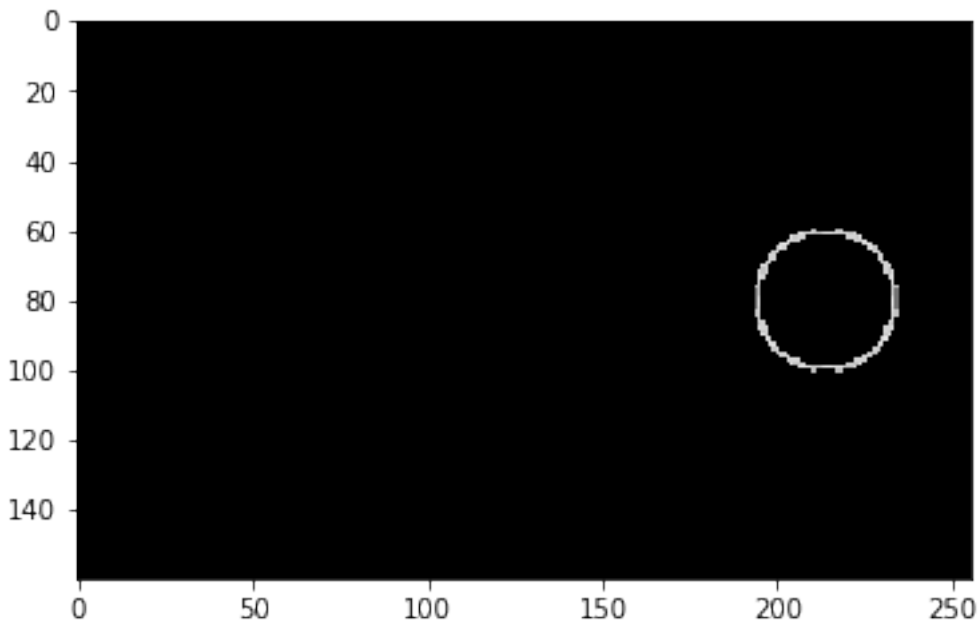


```
In [66]: resultGroup = titi.groupby('groupID').size()
         resultGroup[resultGroup>10].hist()

Out[66]: <matplotlib.axes._subplots.AxesSubplot at 0x123c11208>
```




```
In [67]: titi.groupby('groupID').agg(['mean', 'count'])[resultGroup>10]

Out[67]:         longueur            angle            weight        precision        \
                     mean count       mean count        mean count       mean count
         groupID
         1              7   155  40.768021   155  229.658386   155   3.791248   155
         6              7    83  48.416748    83  211.846710    83  10.593689    83
         9              7    41 -21.370747    41  187.712830    41  18.333818    41
         10             7   110   0.008000   110  214.484055   110  12.641945   110

                      xPos             yPos       layer
                      mean count       mean count  mean count
         groupID
         1        80.638710   155  39.393548   155   0.0   155
         6        90.156627    83  122.337349    83   0.0    83
         9        80.902439    41  140.390244    41   0.0    41
         10       80.000000   110  214.000000   110   0.0   110
```

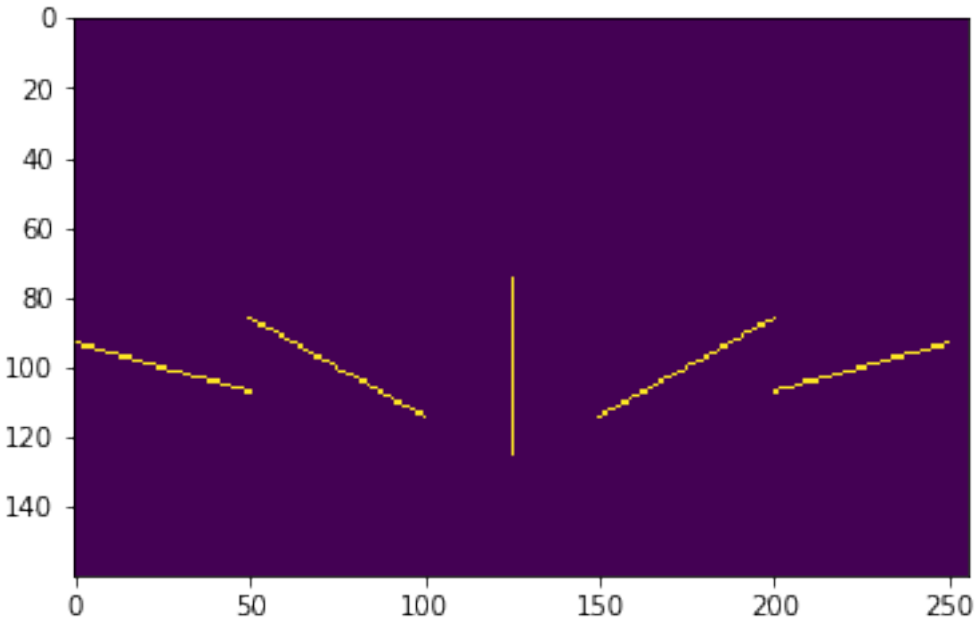
```
In [68]: for lidx, langle in titi.groupby('groupID').count().sort_values('angle', ascending=Fa
             print (lidx)

1
10
6
9
2
3
4
5
7
8
11
12
13


In [69]: getWAGA(titi,6)

Out[69]: 54.005035400390625

In [70]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
         testBitmap = drawFieldNeurons(titi, testBitmap,0,10)
         imgplot = plt.imshow(testBitmap)
```



8.2.5 Test 5

Generate data of type 5

```
In [345]: frame = generateToy(5,160,256,1)
          imgplot = plt.imshow(frame)
```



Génération des neurones à champs récepteur

```
In [346]: indices = np.where(frame != [0])
          nbPixelsAll = nbPixelField(indices[0], indices[1], frame, tailleField)
          titi = getNeuronActivationList(indices[0], indices[1], tailleField, frame,
                                         nbPixelsAll)

In [347]: titi.describe()
```

Out[347]:

	longueur	angle	weight	precision	xPos	yPos	\
count	225.0	225.000000	225.000000	225.000000	225.000000	225.000000	
mean	7.0	0.007630	218.586960	10.958316	100.000000	125.000000	
std	0.0	62.412056	14.312121	5.934726	7.781044	71.818223	
min	7.0	-79.423332	200.650269	0.000000	78.000000	3.000000	
25%	7.0	-64.948334	206.338470	10.909474	95.000000	64.000000	
50%	7.0	0.010000	212.899750	13.792321	100.000000	125.000000	
75%	7.0	64.964996	222.082733	15.553707	105.000000	186.000000	
max	7.0	79.433334	242.906403	16.938763	122.000000	247.000000	

	groupID	layer

```
count    225.0   225.000000
mean       0.0   125.000000
std        0.0   751.482971
min        0.0 -1226.000000
25%        0.0  -418.000000
50%        0.0   125.000000
75%        0.0   668.000000
max        0.0  1476.000000
```

In [348]:
```
titi.groupby('angle').agg(['mean', 'count'])
```

Out[348]:

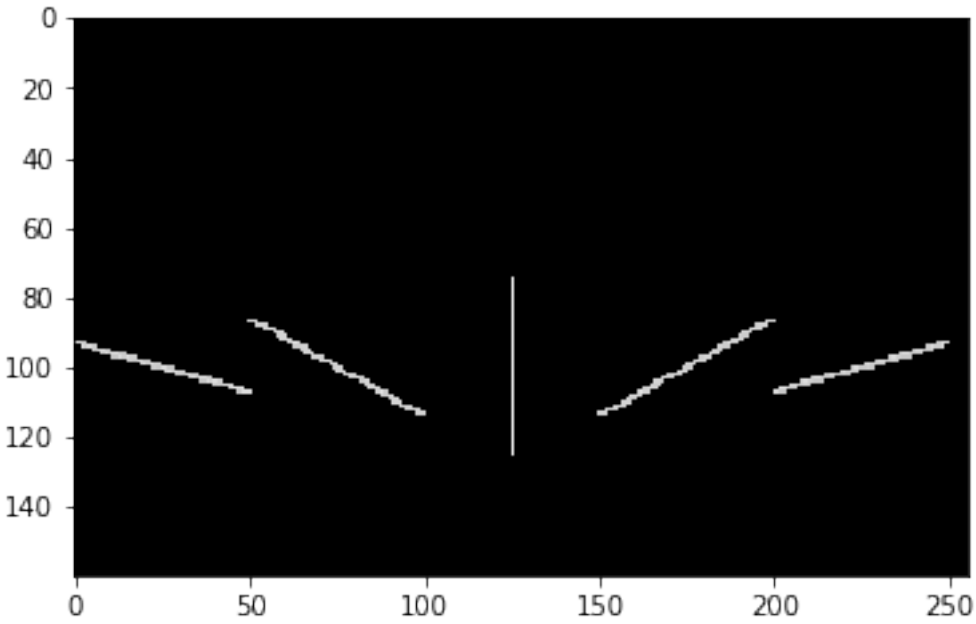
	longueur		weight		precision		xPos		yPos	
	mean	count	mean	count	mean	count	mean	count	mean	
angle										
-79.423332	7	16	222.054947	16	10.919160	16	100	16	25	
-74.995003	7	14	200.650269	14	16.938763	14	100	14	25	
-74.993332	7	5	221.475922	5	11.119500	5	100	5	25	
-71.921669	7	10	206.338470	10	15.553707	10	100	10	25	
-64.948334	7	20	212.735580	20	13.838958	20	100	20	75	
-62.404999	7	10	212.899750	10	13.792321	10	100	10	75	
-61.876667	7	10	205.558472	10	15.750603	10	100	10	75	
-54.903332	7	5	230.490402	5	7.588554	5	100	5	75	
0.010000	7	45	242.906403	45	0.000000	45	100	45	125	
54.923332	7	5	230.490402	5	7.588554	5	100	5	175	
61.893333	7	10	205.582184	10	15.744652	10	100	10	175	
62.421665	7	10	212.923187	10	13.785652	10	100	10	175	
64.964996	7	20	212.756851	20	13.832924	20	100	20	175	
71.934998	7	10	206.368973	10	15.545959	10	100	10	225	
75.004997	7	14	200.688141	14	16.929905	14	100	14	225	
75.006668	7	5	221.502106	5	11.110503	5	100	5	225	
79.433334	7	16	222.082733	16	10.909474	16	100	16	225	

	groupID		layer	
	count	mean	count	mean	count
angle					
-79.423332	16	0	16	-1175.000000	16
-74.995003	14	0	14	-846.000000	14
-74.993332	5	0	5	-845.599976	5
-71.921669	10	0	10	-693.000000	10
-64.948334	20	0	20	-425.000000	20
-62.404999	10	0	10	-363.799988	10
-61.876667	10	0	10	-363.799988	10
-54.903332	5	0	5	-258.200012	5
0.010000	45	0	45	125.000000	45
54.923332	5	0	5	508.200012	5
61.893333	10	0	10	613.799988	10
62.421665	10	0	10	613.799988	10
64.964996	20	0	20	675.000000	20

```
71.934998    10       0    10   943.000000    10
75.004997    14       0    14  1096.000000    14
75.006668     5       0     5  1095.599976     5
79.433334    16       0    16  1425.000000    16
```

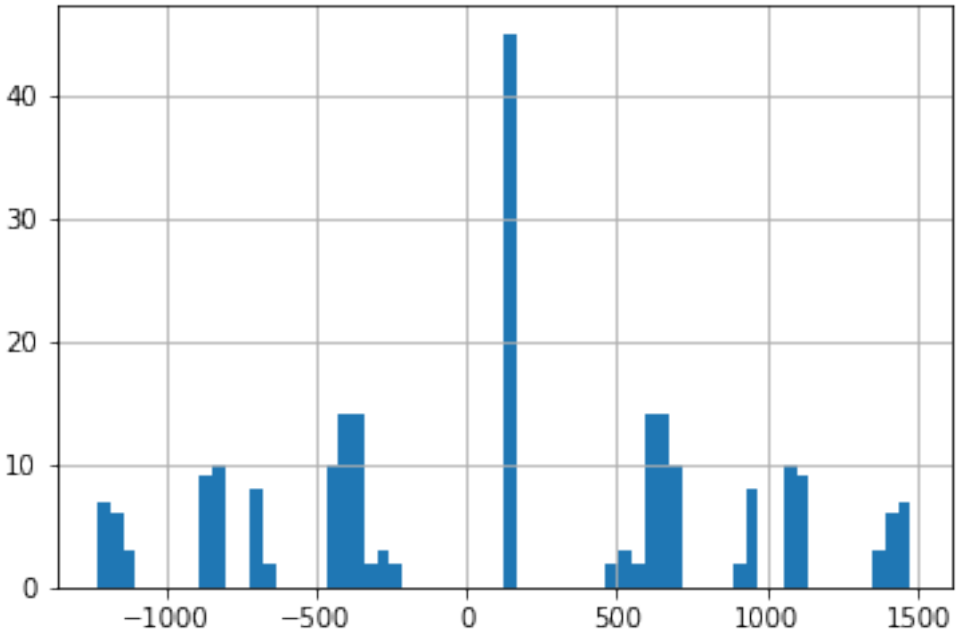
Affichage graphique du champs récepteur des neurones

```
In [349]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
          testBitmap = drawFieldNeurons(titi, testBitmap)
          imgplot = plt.imshow(testBitmap)
```



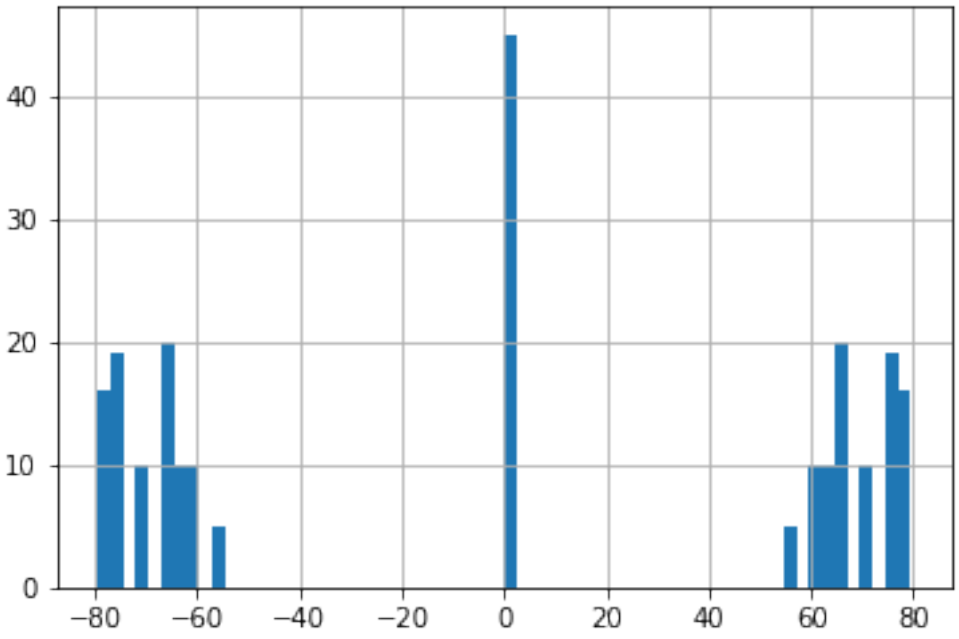
Simplification

```
In [350]: titi.layer.hist(bins=64)

Out[350]: <matplotlib.axes._subplots.AxesSubplot at 0x13d36db70>
```



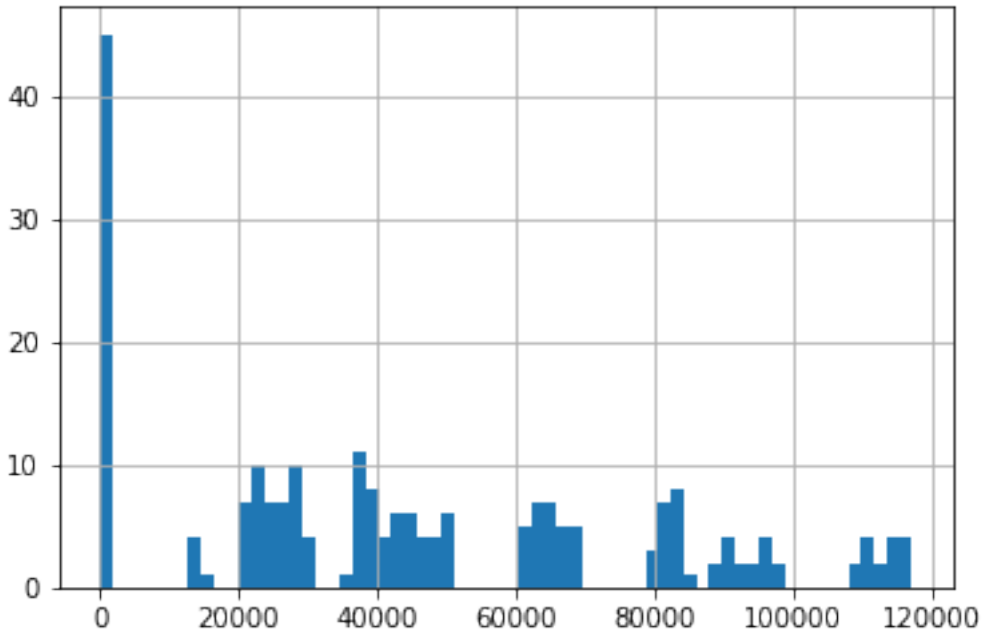

```
In [351]: titi.angle.hist(bins=64)
```

```
Out[351]: <matplotlib.axes._subplots.AxesSubplot at 0x13873d8d0>
```

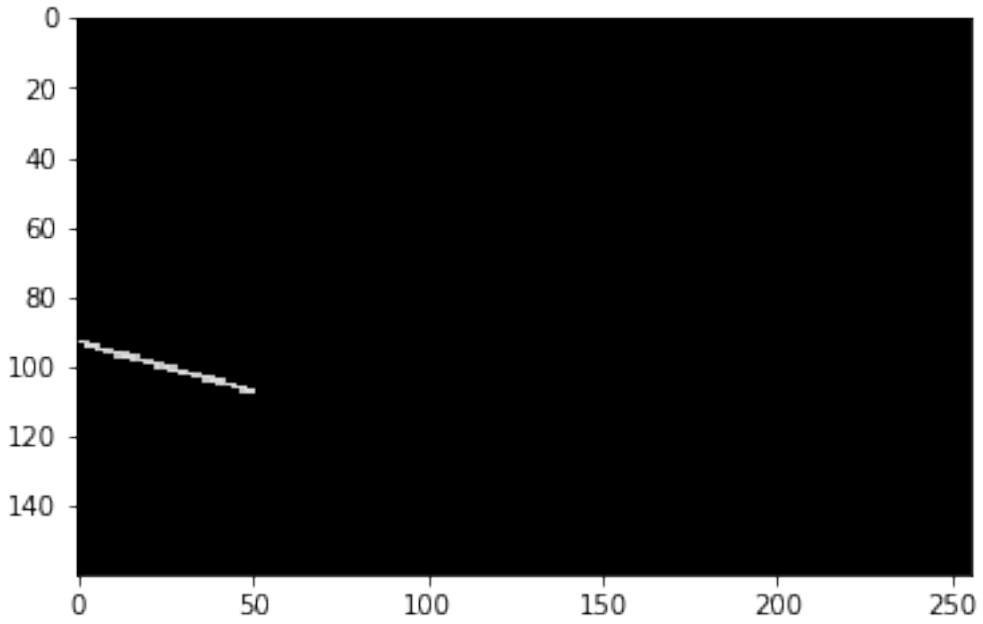


```
In [358]: toto = titi.angle*titi.layer
          toto.hist(bins=64)
```

```
Out[358]: <matplotlib.axes._subplots.AxesSubplot at 0x132f938d0>
```

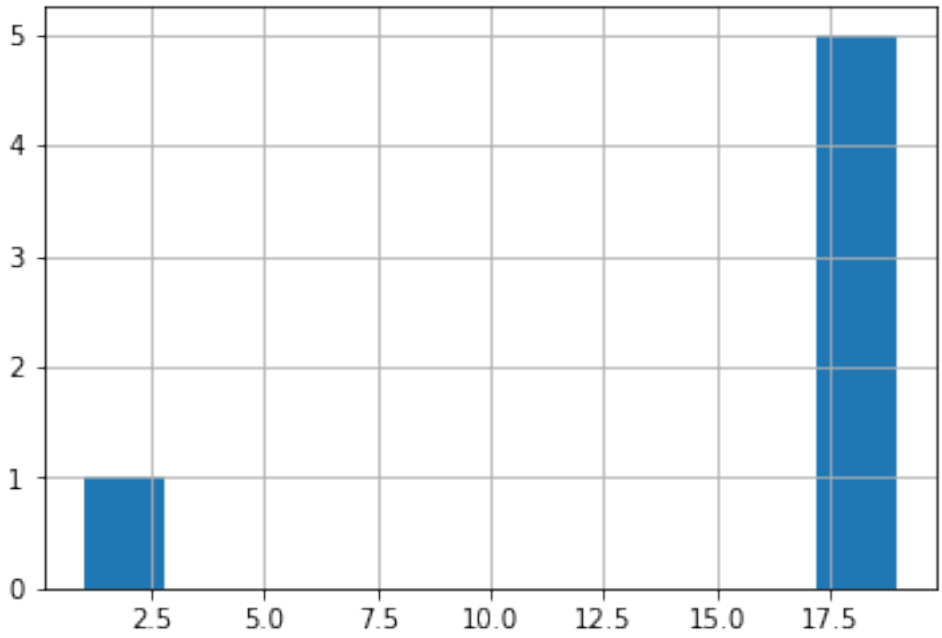



```
In [357]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
          testBitmap = drawFieldNeurons(titi, testBitmap,0,0,-1300,500)
          imgplot = plt.imshow(testBitmap)
```

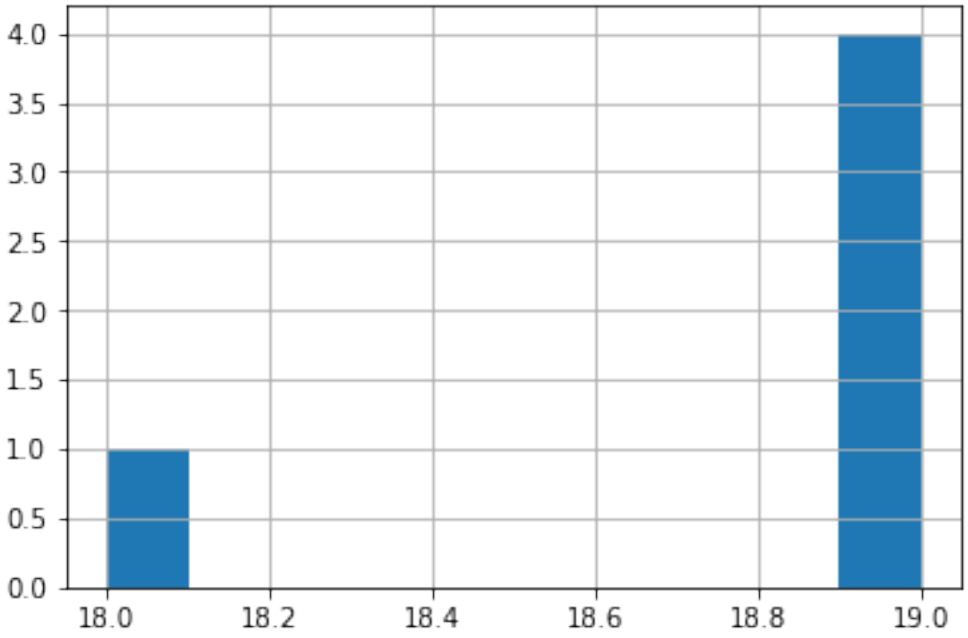


Génération des groupes

```
In [76]: findGroups(titi);

In [77]: titi.groupby('groupID').size().hist()

Out[77]: <matplotlib.axes._subplots.AxesSubplot at 0x1239cac50>
```




```
In [78]: resultGroup = titi.groupby('groupID').size()
         resultGroup[resultGroup>10].hist()

Out[78]: <matplotlib.axes._subplots.AxesSubplot at 0x1235a3cc0>
```



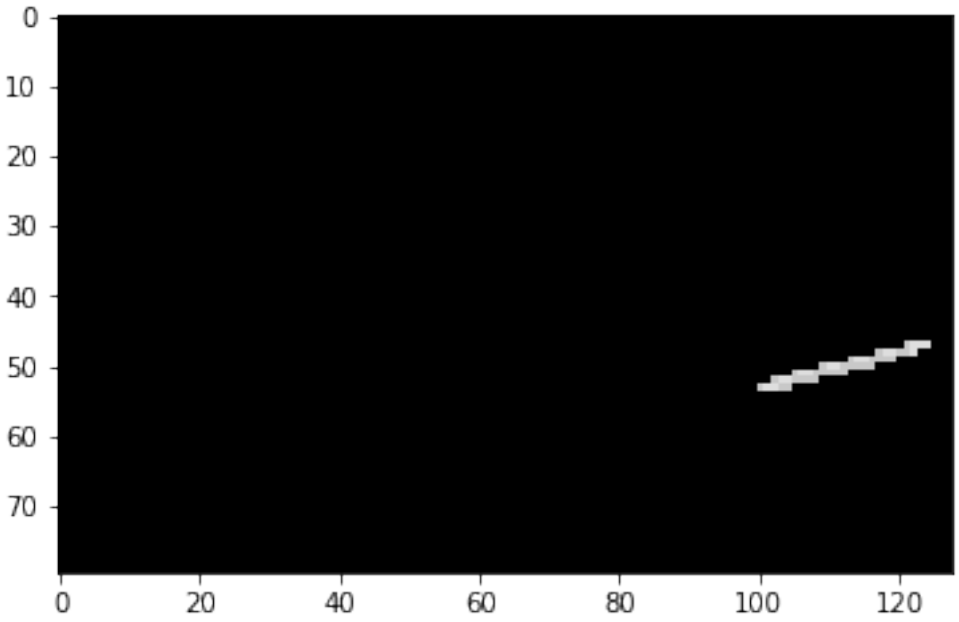

```
In [79]: titi.groupby('groupID').agg(['mean', 'count'])[resultGroup>10]
```

Out[79]:

	longueur		angle		weight		precision		\
	mean	count	mean	count	mean	count	mean	count	
groupID									
1	7	19	0.010000	19	242.906403	19	0.000000	19	
2	7	19	-61.589123	19	213.324356	19	13.441002	19	
3	7	18	61.419720	18	213.376328	18	13.413681	18	
4	7	19	-77.325699	19	211.915894	19	13.770551	19	
5	7	19	77.335701	19	211.948456	19	13.761257	19	

	xPos		yPos		layer	
	mean	count	mean	count	mean	count
groupID						
1	50.000000	19	62.000000	19	0.0	19
2	49.947368	19	37.000000	19	0.0	19
3	49.777778	18	87.444444	18	0.0	18
4	49.894737	19	12.000000	19	0.0	19
5	50.105263	19	112.000000	19	0.0	19

```
In [80]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
         testBitmap = drawFieldNeurons(titi, testBitmap,0,5)
         imgplot = plt.imshow(testBitmap)
```



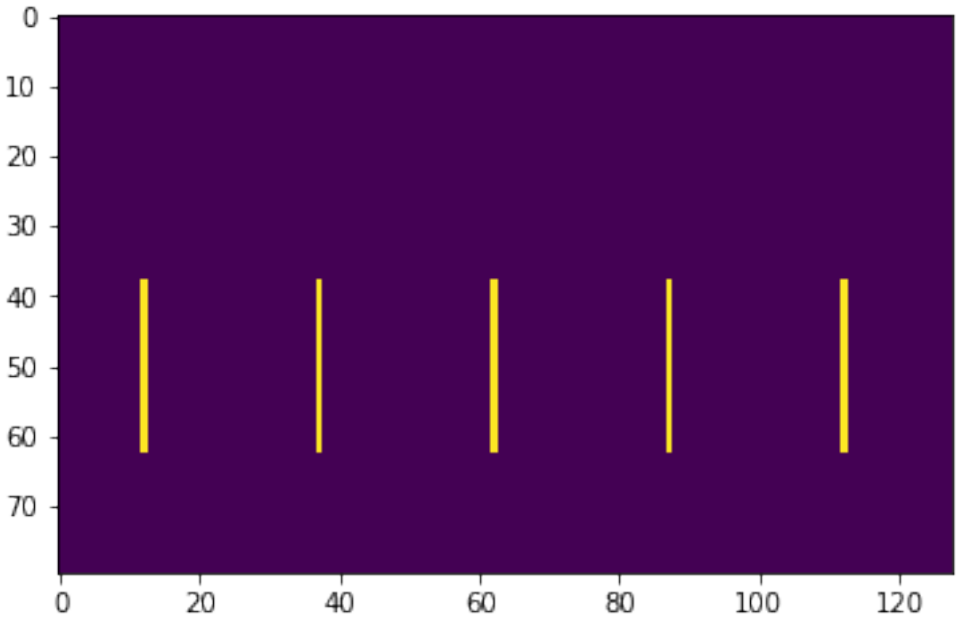

```
In [81]: getWAGA(titi,5)
```

```
Out[81]: 77.44712829589844
```

8.2.6 Test 6

Generate data of type 6

```
In [82]: frame = generateToy(6,80,128,1)
         imgplot = plt.imshow(frame)
```

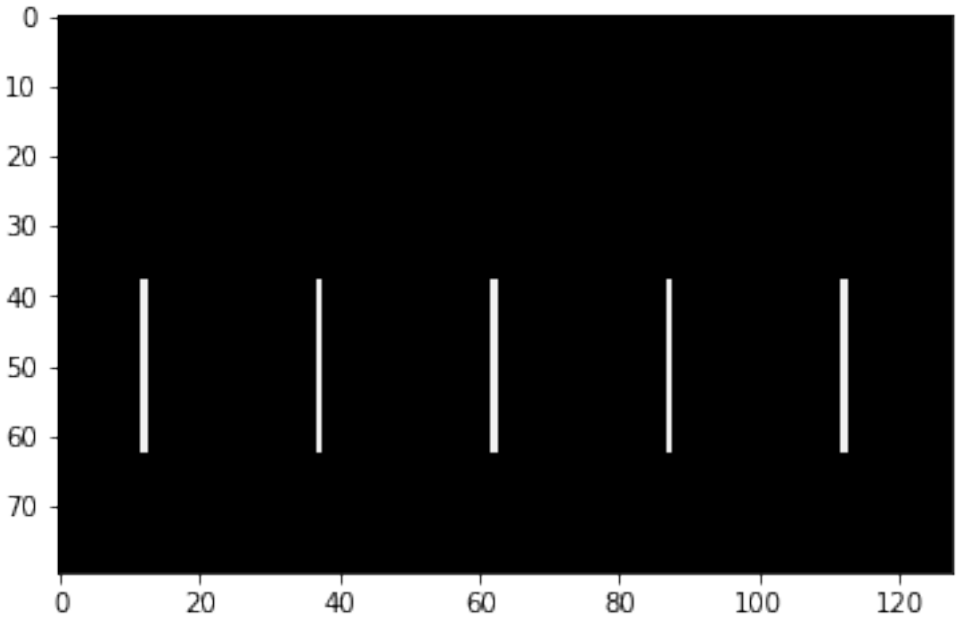


Génération des neurones à champs récepteur

```
In [83]: indices = np.where(frame != [0])
         nbPixelsAll = nbPixelField(indices[0], indices[1], frame, tailleField)
         titi = getNeuronActivationList(indices[0], indices[1], tailleField, frame,
                                        nbPixelsAll)

In [84]: titi.groupby('angle').agg(['mean', 'count'])

Out[84]:       longueur            weight       precision       xPos       yPos        \
                   mean count        mean count      mean count mean count mean count
         angle
         0.01         7    95  242.906403    95       0.0    95   50    95   62    95

               groupID       layer
                  mean count  mean count
         angle
         0.01        0    95   0.0    95
```

Affichage graphique du champs récepteur des neurones

```
In [85]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
         testBitmap = drawFieldNeurons(titi, testBitmap)
         imgplot = plt.imshow(testBitmap)
```

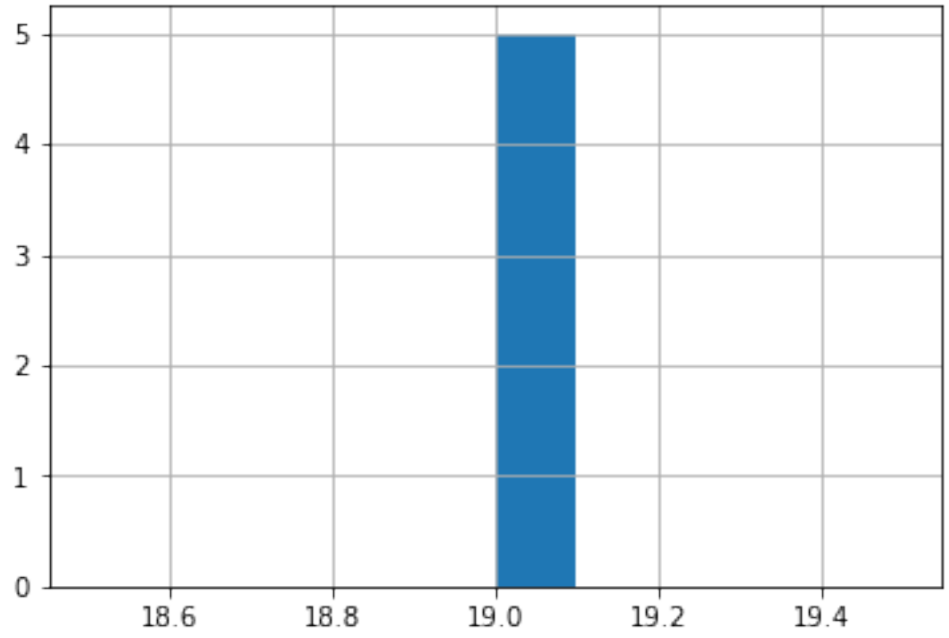


Génération des groupes

```
In [86]: findGroups(titi);
```

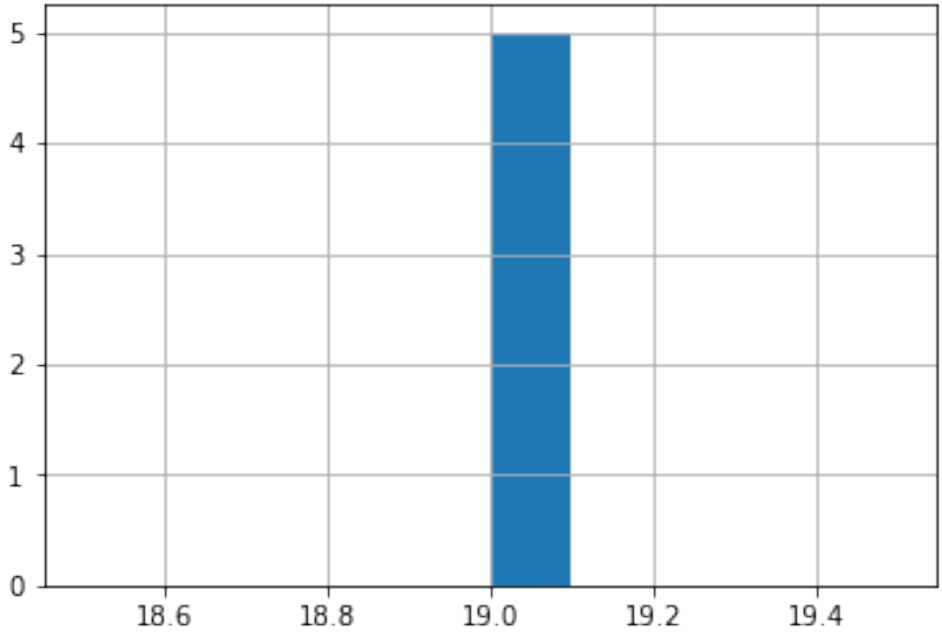
```
In [87]: titi.groupby('groupID').size().hist()
```

```
Out[87]: <matplotlib.axes._subplots.AxesSubplot at 0x1239ffcc0>
```



```
In [88]: resultGroup = titi.groupby('groupID').size()
         resultGroup[resultGroup>10].hist()
```

```
Out[88]: <matplotlib.axes._subplots.AxesSubplot at 0x1241dd320>
```



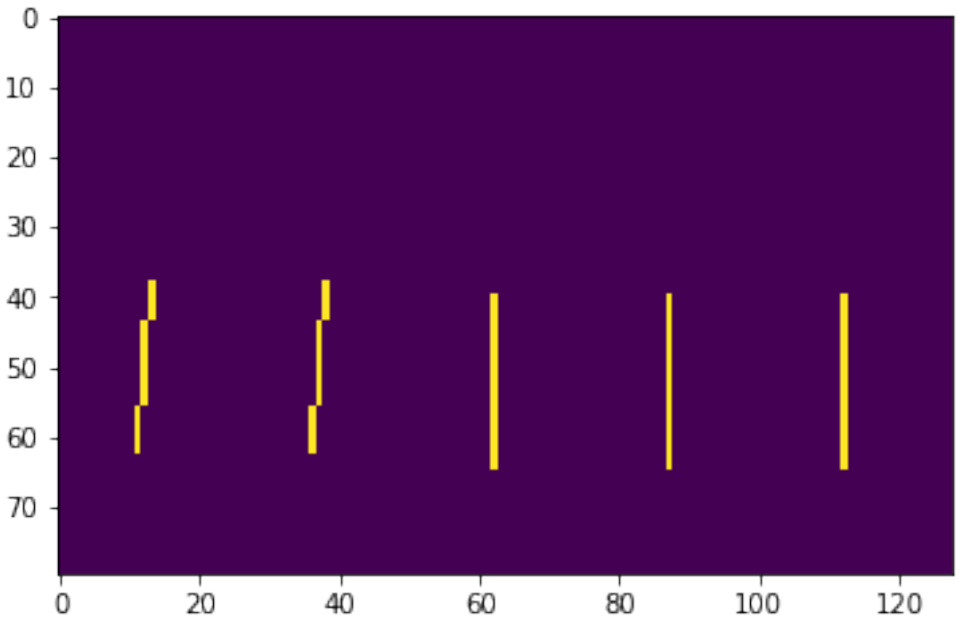

```
In [89]: titi.groupby('groupID').agg(['mean', 'count'])[resultGroup>10]
```

```
Out[89]:          longueur       angle             weight       precision       xPos  \
                      mean count  mean count        mean count      mean count mean
         groupID
         1               7    19  0.01    19  242.906403    19       0.0    19   50
         2               7    19  0.01    19  242.906403    19       0.0    19   50
         3               7    19  0.01    19  242.906403    19       0.0    19   50
         4               7    19  0.01    19  242.906403    19       0.0    19   50
         5               7    19  0.01    19  242.906403    19       0.0    19   50

                     yPos       layer
                    count mean count  mean count
         groupID
         1             19   12    19   0.0    19
         2             19   37    19   0.0    19
         3             19   62    19   0.0    19
         4             19   87    19   0.0    19
         5             19  112    19   0.0    19
```

8.2.7 Test 7

Generate data of type 7

```
In [90]: frame = generateToy(7,80,128,1)
         imgplot = plt.imshow(frame)
```



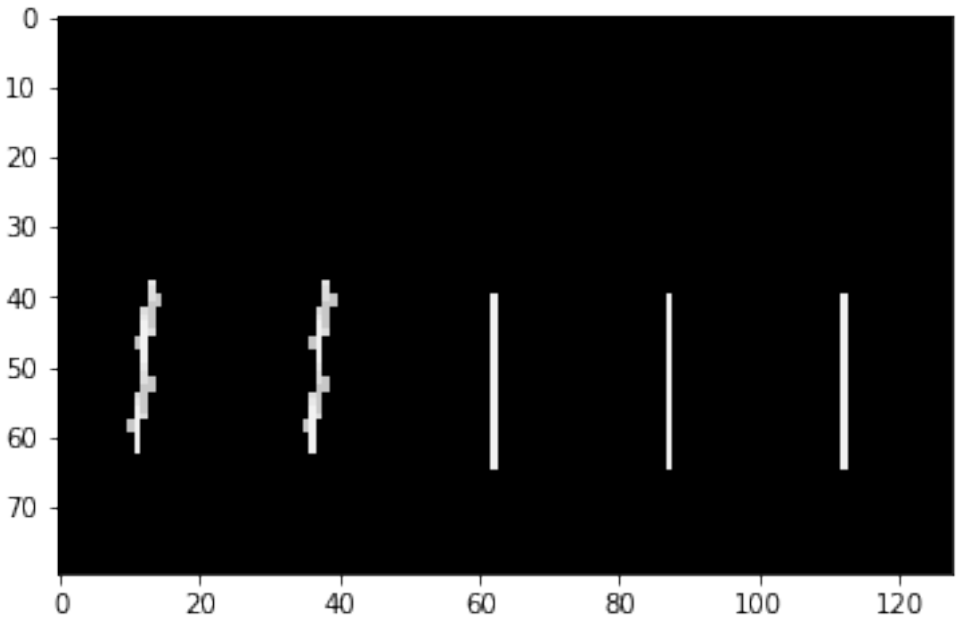
Génération des neurones à champs récepteur

```
In [91]: indices = np.where(frame != [0])
         nbPixelsAll = nbPixelField(indices[0], indices[1], frame, tailleField)
         titi = getNeuronActivationList(indices[0], indices[1], tailleField, frame,
                                        nbPixelsAll)

In [92]: titi.groupby('angle').agg(['mean', 'count'])

Out[92]:           longueur            weight        precision             xPos        \
                       mean count        mean count       mean count       mean count
         angle
         0.010000         7    71  242.906403    71   0.000000    71  51.774648    71
         3.081667         7     8  232.039963     8   6.868455     8  49.500000     8
         7.510000         7     8  222.213516     8  10.863776     8  49.500000     8
         15.010000        7     8  200.669205     8  16.934334     8  49.500000     8

                        yPos       groupID       layer
                        mean count    mean count  mean count
         angle
```

```
0.010000   74.647887    71       0    71   0.0    71
3.081667   24.500000     8       0     8   0.0     8
7.510000   24.500000     8       0     8   0.0     8
15.010000  24.500000     8       0     8   0.0     8
```

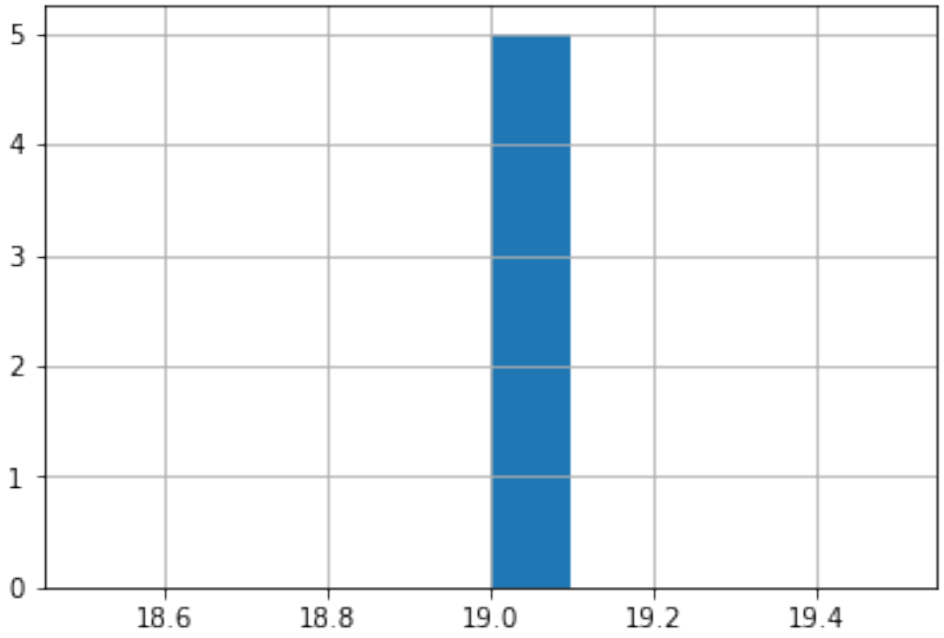
Affichage graphique du champs récepteur des neurones

```
In [93]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
         testBitmap = drawFieldNeurons(titi, testBitmap)
         imgplot = plt.imshow(testBitmap)
```



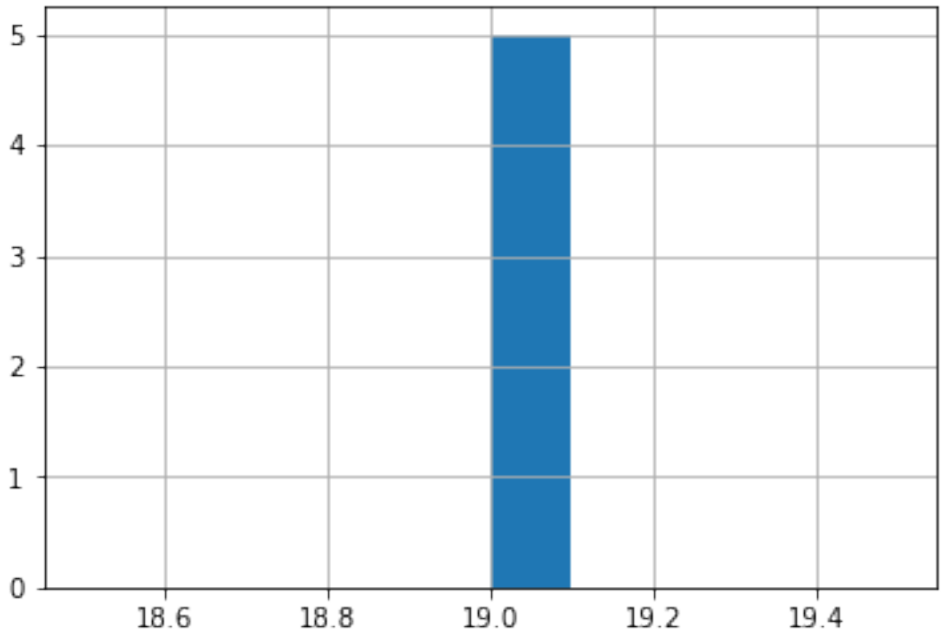
Génération des groupes

```
In [94]: findGroups(titi);

In [95]: titi.groupby('groupID').size().hist()

Out[95]: <matplotlib.axes._subplots.AxesSubplot at 0x123648278>
```




```
In [96]: resultGroup = titi.groupby('groupID').size()
         resultGroup[resultGroup>10].hist()
```

```
Out[96]: <matplotlib.axes._subplots.AxesSubplot at 0x12362d6d8>
```



```
In [97]: titi.groupby('groupID').agg(['mean', 'count'])[resultGroup>10]
```

Out[97]:

	longueur		angle		weight		precision		xPos	\
	mean	count	mean	count	mean	count	mean	count	mean	
groupID										
1	7	19	5.393509	19	227.370285	19	7.298224	19	50	
2	7	19	5.393509	19	227.370285	19	7.298224	19	50	
3	7	19	0.010000	19	242.906403	19	0.000000	19	52	
4	7	19	0.010000	19	242.906403	19	0.000000	19	52	
5	7	19	0.010000	19	242.906403	19	0.000000	19	52	

	yPos		layer	
count	mean	count	mean	count
groupID				
1	19	11.947368	19	0.0	19
2	19	36.947368	19	0.0	19
3	19	62.000000	19	0.0	19
4	19	87.000000	19	0.0	19
5	19	112.000000	19	0.0	19

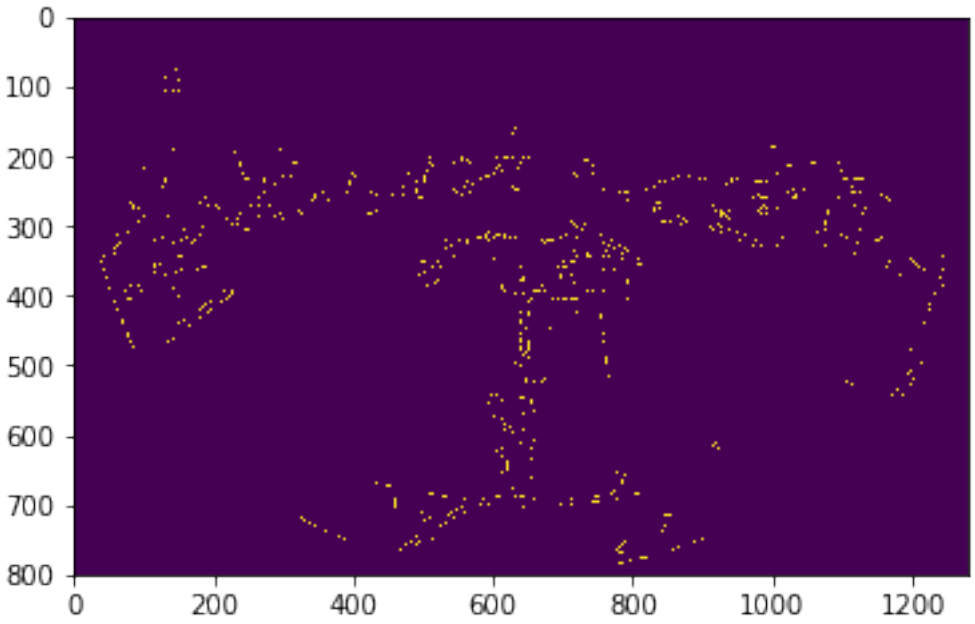
```
In [98]: getWAGA(titi,2)
```

Out[98]: 5.000133991241455

8.2.8 Test 8 : video frame

Get Video frame

```
In [99]: frame = Cannyframe
         imgplot = plt.imshow(frame)
```



Génération des neurones à champs récepteur

```
In [100]: indices = np.where(frame != [0])
          nbPixelsAll = nbPixelField(indices[0], indices[1], frame, tailleField)
          titi = getNeuronActivationList(indices[0], indices[1], tailleField, frame,
                                         nbPixelsAll)
```

```
In [101]: titi.describe()
```

Out[101]:

	longueur	angle	weight	precision	xPos	yPos	groupID	layer
count	6452.0	6452.000000	6452.000000	6452.000000	6452.000000	6452.000000	6452.0	6452.0
mean	7.0	4.998969	157.106003	24.906563	445.457688	650.464197	0.0	0.0
std	0.0	50.678619	72.648529	16.812843	153.752807	297.094736	0.0	0.0
min	7.0	-87.365715	2.718763	0.000000	267.000000	39.000000	0.0	0.0
25%	7.0	-34.992499	120.865974	14.346698	325.000000	523.000000	0.0	0.0
50%	7.0	0.010000	182.490227	20.770247	388.500000	653.000000	0.0	0.0
75%	7.0	48.726250	210.914810	31.041572	549.000000	789.000000	0.0	0.0
max	7.0	90.000000	242.906403	75.303673	784.000000	1246.000000	0.0	0.0

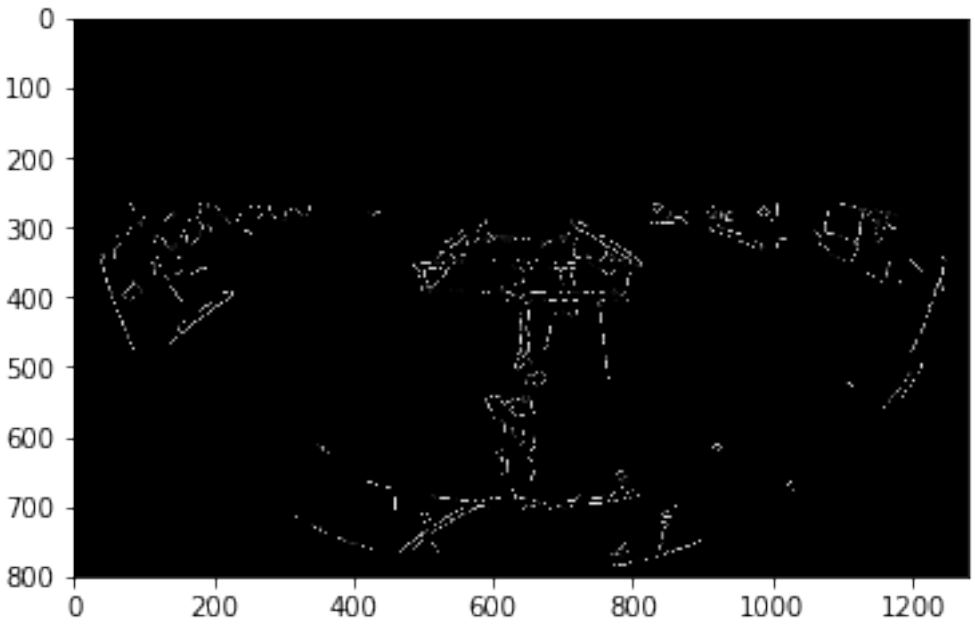
```
In [102]: titi[0:4]
```

Out[102]:

	longueur	angle	weight	precision	xPos	yPos	groupID	layer
0	7	-14.990000	200.669205	16.934334	267	82	0	0.0
1	7	-21.908571	169.895966	23.086880	267	180	0	0.0
2	7	-40.563332	112.282188	32.398540	267	191	0	0.0
3	7	23.696667	157.390488	25.222450	267	281	0	0.0

Affichage graphique du champs récepteur des neurones

```
In [103]: testBitmap = np.zeros((frame.shape[0],frame.shape[1],3), np.uint8)
          testBitmap = drawFieldNeurons(titi, testBitmap)
          imgplot = plt.imshow(testBitmap)
```



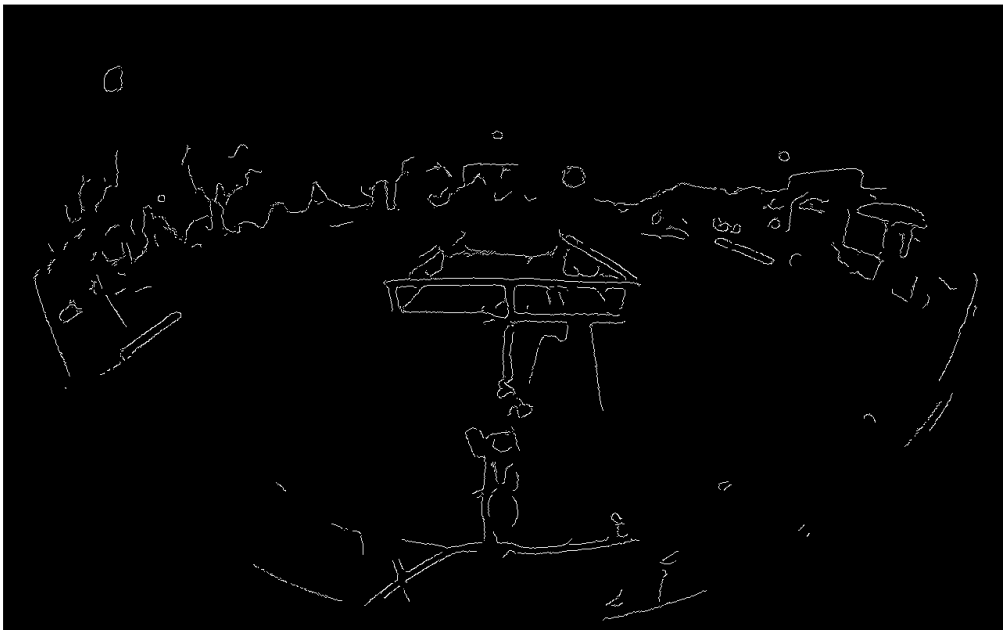

```
In [104]: lintI = 0
          while (lintI < 10):
              cv2.imshow('testBitmap', testBitmap)
              if cv2.waitKey(1) & 0xFF == ord('q'): # press q to quit
                  break
              lintI += 1
```

Affichage de la frame :

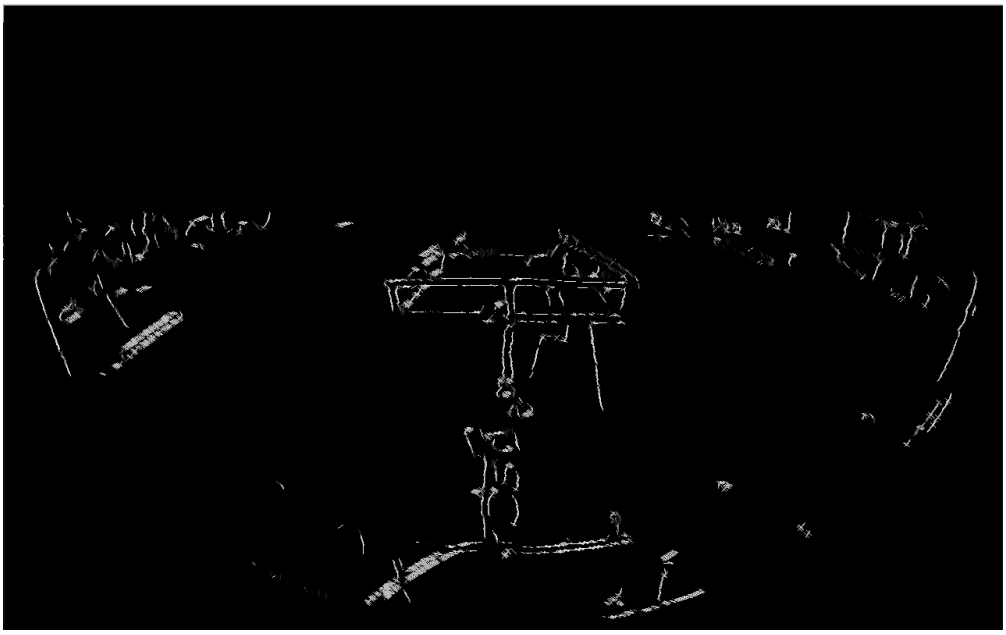
Affichage des champs récepteurs des neurones

Génération des groupes

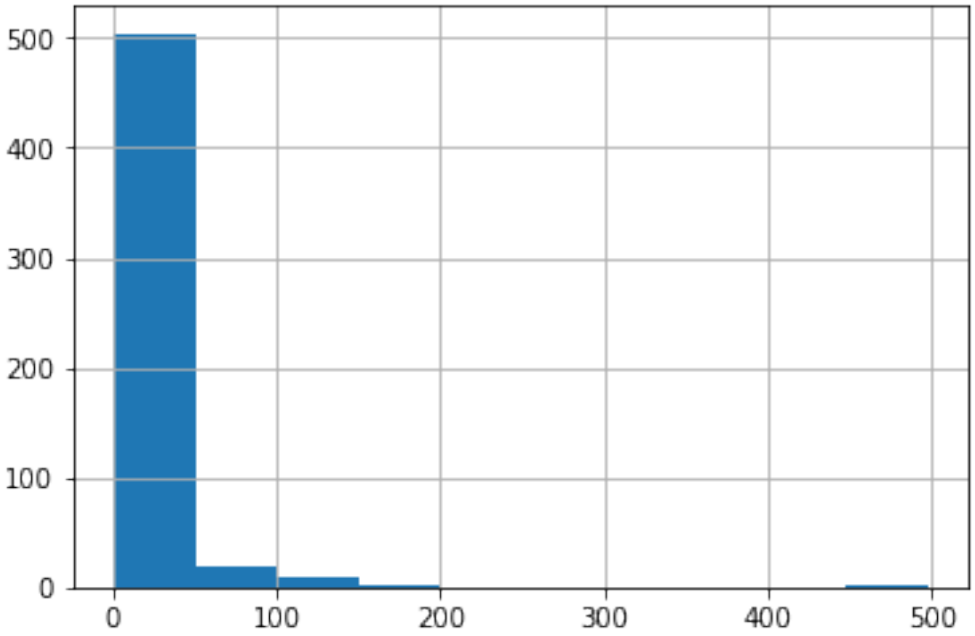
```
In [105]: findGroups(titi);

In [106]: titi.groupby('groupID').size().hist()

Out[106]: <matplotlib.axes._subplots.AxesSubplot at 0x129411320>
```



Edge detection frame image, with the Canny Algorithm

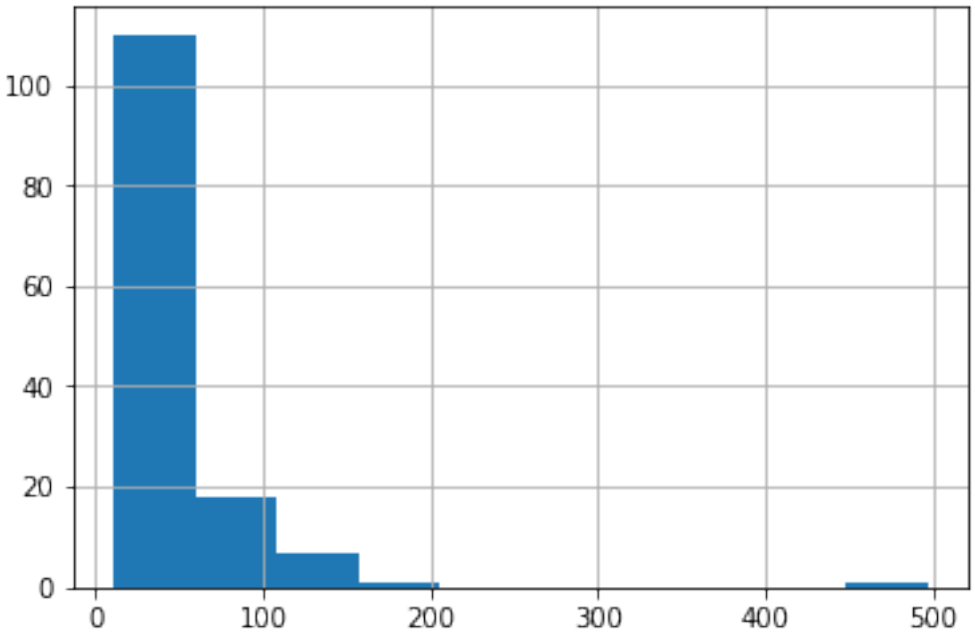


NeuronField Image : Le niveau de gris correspond au niveau d'activation du neurone




```
In [107]: resultGroup = titi.groupby('groupID').size()
          resultGroup[resultGroup>10].hist()
```

```
Out[107]: <matplotlib.axes._subplots.AxesSubplot at 0x124023be0>
```



```
In [108]: titi.groupby('groupID').agg(['mean', 'count'])[resultGroup>130]
```

Out[108]:

groupID	longueur		angle		weight		precision		\
	mean	count	mean	count	mean	count	mean	count	
136	7	497	26.611830	497	174.087921	497	19.788208	497	
201	7	151	12.489170	151	182.971664	151	18.340914	151	
203	7	149	-15.760202	149	174.091461	149	21.210890	149	
211	7	152	18.596670	152	175.904434	152	21.124544	152	
443	7	181	63.175495	181	197.623657	181	15.064166	181	

groupID	xPos		yPos		layer	
	mean	count	mean	count	mean	count
136	361.372233	497	574.227364	497	0.0	497
201	354.079470	151	765.158940	151	0.0	151
203	406.140940	149	59.134228	149	0.0	149
211	407.828947	152	1226.342105	152	0.0	152
443	691.972376	181	731.281768	181	0.0	181

9 Errors list

9.1 Error 10

Problème dans la fonction Section **??**

```
In [ ]:
```