line_Ps is a principal version of 1st-level 1D algorithm

```
Operations:
```

- Cross-compare consecutive pixels within each row of image, forming dert*: queue of derts, each a tuple of derivatives per pixel. dert* is then segmented into patterns Pms and Pds: contiguous sequences of pixels forming same-sign match or difference. Initial match is inverse deviation of variation: m = ave_|d| - |d|, rather than a minimum for directly defined match: albedo of an object doesn't correlate with its predictive value.

- Match patterns Pms are spans of inputs forming same-sign match. Positive Pms contain high-match pixels, which are likely to match more distant pixels. Thus, positive Pms are evaluated for cross-comp of pixels over incremented range.

- Difference patterns Pds are spans of inputs forming same-sign ds. d sign match is a precondition for d match, so only same-sign spans (Pds) are evaluated for cross-comp of constituent differences, which forms higher derivatives. (d match = min: rng+ comp value: predictive value of difference is proportional to its magnitude, although inversely so)

Both extended cross-comp forks are recursive: resulting sub-patterns are evaluated for deeper cross-comp, same as top patterns. These forks here are exclusive per P to avoid redundancy, but they do overlap in line_patterns_olp.

In [ ]:

```python
# add ColAlg folder to system path
import sys
from os.path import dirname, join, abspath

from numpy import int16, int32
sys.path.insert(0, abspath(join(dirname("CogAlg"), '..')))
import cv2
# import argparse
import pickle
from time import time
from matplotlib import pyplot as plt
from itertools import zip_longest
from frame_2D_alg.class_cluster import ClusterStructure, NoneType, comp_param
```

In [ ]:

```
class Cdert(ClusterStructure):
    i = int  # input for range_comp only
    p = int  # accumulated in rng
    d = int  # accumulated in rng
    m = int  # distinct in deriv_comp only
    mrdn = lambda: 1.0  # -> Rdn: rdn counter per P
```

In [ ]:

```
class CP(ClusterStructure):
    L = int
    I = int
    D = int
    M = int  # summed ave - abs(d), different from D
    Rdn = lambda: 1.0  # mrdn counter
    x0 = int
    dert_ = list  # contains (i, p, d, m, mrdn)
    subset = list  # 1st sublayer' rdn, rng, xsub_pmdertt_, _xsub_pddertt_, sub_Ppm_, sub_Ppd_
    # for layer-parallel access and comp, ~ frequency domain, composition: 1st: dert_, 2nd: sub_P_[ dert_], 3rd: sub
    sublayers = list  # multiple layers of sub_P_s from d segmentation or extended comp, nested to depth = sub_[n]
    subDertt_ = list  # m,d' [L,I,D,M] per sublayer, conditionally summed in line_PPs
    derDertt_ = list  # for subDertt_s compared in line_PPs
```

In [ ]:

```
verbose = False
# pattern filters or hyper-parameters: eventually from higher-level feedback, initialized here as constants:
ave = 15  # |difference| between pixels that coincides with average value of Pm
ave_min = 2  # for m defined as min |d|: smaller?
ave_M = 20  # min M for initial incremental-range comparison(t_), higher cost than der_comp?
ave_D = 5  # min |D| for initial incremental-derivation comparison(d_)
ave_nP = 5  # average number of sub_Ps in P, to estimate intra-costs? ave_rdn_inc = 1 + 1 / ave_nP # 1.2
ave_rdm = .5  # obsolete: average dm / m, to project bi_m = m * 1.5
ave_splice = 50  # to merge a kernel of 3 adjacent Ps
init_y = 501  # starting row, set 0 for the whole frame, mostly not needed
halt_y = 502  # ending row, set 999999999 for arbitrary image
```

Conventions:

- postfix 't' denotes tuple, multiple ts is a nested tuple

- postfix '_' denotes array name, vs. same-name elements
- prefix '_' denotes prior of two same-name variables
- prefix 'f' denotes flag
- 1-3 letter names are normally scalars, except for P and similar classes,
- capitalized variables are normally summed small-case variables,
- longer names are normally classes

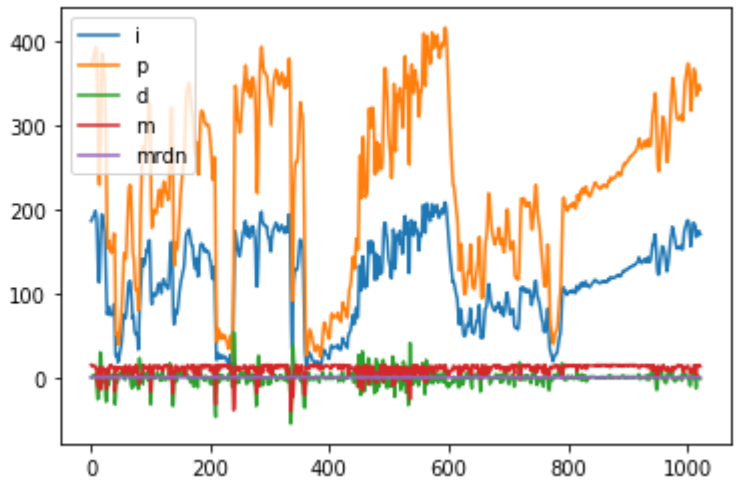
In [ ]:

```python
def line_Ps_root(pixel_):  # Ps: patterns, converts frame_of_pixels to frame_of_patterns, each pattern may be nested
    dert_ = []  # line-wide i_, p_, d_, m_, mrdn_
    _i = pixel_[0]
    # cross_comparison:
    for i in pixel_[1:]:  # pixel i is compared to prior pixel _i in a row:
        d = i - _i  # accum in rng
        p = i + _i  # accum in rng
        m = ave - abs(d)  # for consistency with deriv_comp output, else redundant
        mrdn = m + ave < abs(d)
        dert_.append( Cdert( i=i, p=p, d=d, m=m, mrdn=mrdn) )
        _i = i

    # form patterns, evaluate them for rng+ and der+ sub-recursion of cross_comp:
    # Pm_ = form_P_(None, dert_, rdn=1, rng=1, fPd=False)  # rootP=None, eval intra_P_ (calls form_P_)
    # Pd_ = form_P_(None, dert_, rdn=1, rng=1, fPd=True)
    if logging:
        with open("layer0_log.csv", "a") as csvFile:
            write = csv.writer(csvFile, delimiter=",")
            for id, val in enumerate(dert_):
                write.writerow([id, val.i, val.p, val.d, val.m, val.mrdn])

    if render:
        i_, p_, d_, m_, mrdn_ = [], [], [], [], []
        for id, val in enumerate(dert_):
            i_.append(val.i), p_.append(val.p), d_.append(val.d), m_.append(val.m), mrdn_.append(val.mrdn)
        plt.plot(i_, label = 'i')
        plt.plot(p_, label = 'p')
        plt.plot(d_, label = 'd')
        plt.plot(m_, label = 'm')
        plt.plot(mrdn_, label = 'mrdn')
        plt.legend(), plt.show()

    return [dert_]  # input to 2nd level
```

This jupyter notebook was created to compare Python and Julia implementations of CogAlg code. Currently only one line from the input image is processed and only line_Ps_root function has almost done. Functionality for logging and plotting output data has been added for easy comparison.

In [ ]:

```
render = 1
fline_PPs = 0
frecursive = 0
logging = 1  # logging of local functions variables

if logging: #  log dert_
    import csv
    with open("layer0_log.csv", "w") as csvFile:
        write = csv.writer(csvFile, delimiter=",")
        parameter_names = [" ", "i=", "p=", "d=", "m=", "mrdn="]
        write.writerow(parameter_names)

start_time = time()
image = cv2.imread('raccoon.jpg', 0).astype(int)  # manual load pix-mapped image
assert image is not None, "No image in the path"

if render:
    plt.figure(); plt.imshow(image, cmap='gray'); plt.show()  # show the image below in gray

# Main
Y, X = image.shape  # Y: frame height, X: frame width
frame = []
for y in range(init_y, min(halt_y, Y)):  # y is index of new row pixel_, we only need one row, use init_y=0, halt_y=
    line = line_Ps_root( image[y,:])  # line = [Pm_, Pd_]
    # frame.append(line)  # if fline_PPs: line is root CPp, else [Pm_, Pd_]

end_time = time() - start_time
print(end_time)
```



```
1.0089528560638428
```

```
In [ ]:
```