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A NOVEL IMAGE SEGMENTATION AND CONTOUR DETECTION METHOD USING SUPER PIXEL AND MODULARITY

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Abstract - High-level image analysis tasks require image segmentation as an initial step in processing image pixels in substantial homogeneous regions so that the complication of further analysis reduced substantially. To concentrate on the predicament of segmenting an image; an efficient algorithm based on modularity optimization and super pixel is proposed. An over-segmented image that contains many undersized regions, proposed algorithm merges these homogeneous regions that construct the biggest increase in modularity index. Our algorithm is examined on the publicly accessible Berkeley Segmentation Data Set as properly as the semantic segmentation records set and in contrast with different famous algorithms. Experimental consequences have proven that our algorithm produces extensive segmentation, preserves repetitive patterns with attractive time complexity, and achieves object-level segmentation to some extent. Here in our work we are going to studied two images that are image of stone and image of a man for qualitative analysis purposes. For better user representations we are also create a graph chart for different images as discussed. The bar graph plotted for various images shows that Precision, Recall and F Measure are outperformed in our case.

1. INTRODUCTION

Image segmentation includes changing a photograph into a series of areas of pixels that are represented with the aid of a masks or a labeled image. By dividing a photograph into segments, you can technique solely the essential segments of the photo as an alternative of processing the complete image.
A frequent approach is to appear for unexpected discontinuities in pixel value, which usually point out edges that outline a region. Segmentation of Image is provided a significant measure in image processing, also a vital meadow of computer based visualization. Segmentation of Image is the procedure of extracting important characteristics or region of the picture. Some characteristics can be the novel characteristics of image, such as pixels gray value, colour, reflection characteristics and textures, etc. It may also spatial range, like histogram features. The rationale of image segmentation be to segregate the image into variety of non-intersecting Segmentation of Image is one among the foremost important problems in computer vision research. It's become a hot spot within the meadow of image [2] [3]. Consistent with the extent of user involvement, image segmentation algorithms are alienated into two classes which are automatic segmentation and semi-automatic segmentation. This lookup proposes a novel technique for efficient image segmentation on digital images. This new technique is named as "A Novel image segmentation and contour detection method using super pixel and modularity". A digital image is fed as input for the system and it performs the segmentation steps to target the segmented output image with higher accuracy.

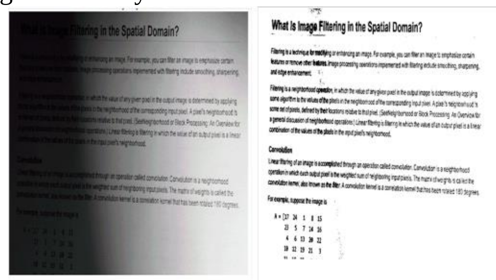

Figure 1: Using Segmentation a binary photograph to enhance the legibility of the textual content in an illustration

2. CONTOUR FORMATION AND SEGMENTATION

The discontinuities or the sharp changes in the image brightness existing at the above mentioned points are connected and form a curved line segment that is commonly termed as an edge. Hence an Edge could be defined as "An edge is a connected curved line segment connecting the pixels of rapid variation in the brightness of an image".
When the edges are detected, they are linked to shape a boundary enclosing vicinity of interest. A closed boundary so shaped is known as the contour. The contour succeeds in providing a meaningful segment of a picture as a unit/segment. Thus the manner of segmentation partitions the photograph underneath process, ensuing in the identification of the sizeable areas of activity and their background. The area of software for which the photo segmentation is achieved decides the stage to which the segmenting is to be done. In different phrases the segmenting degree varies from software to application. The accuracy of segmentation determines the success or failure of pc imaginative and prescient system. Therefore, segmentation is one of the quintessential steps that make the pc imaginative and prescient device to analyze and observe the objects of hobby successfully.
The Algorithms of Segmentation are based on tracking discontinuity and similarity among the pixels or groups of pixels in an image. The first approach considers the sharp and rapid variations in the intensity to detect and partition the image edge i.e. by finding edges. In the second approach, image pixels are grouped into different regions with similar pixel properties. The pixel properties are compared by using certain predefined similarity values relating to Euclidean distance, correlation etc.

3. BASIC TECHNIQUES OF IMAGE SEGMENTATION

3.1 EDGE DETECTION

Line detection, isolated point detection and edge detection are some part of image segmentation but it is the edge detection which is most important part of image segmentation. An edges [2],[133] can be well-defined as the set of linked pixels that form a border between two different regions.

Rendering to the line outline edges can be characterized as steep edge and ramp edge and their line outline is publicised in Figure 3-1

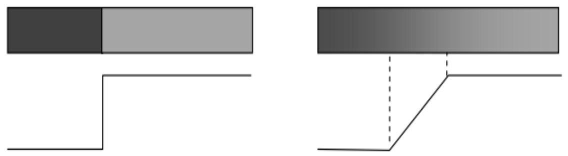

Figure 2: Line Profile of Steep edge and Ramp edge

Merely artificially produced images (like examination pattern) have such steep edges. The image of the real scene does not have steep edges due to the digitization of the optical image.

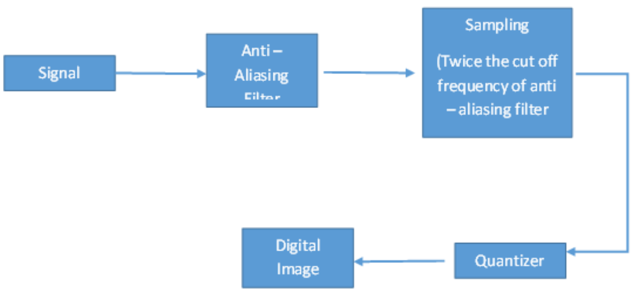

Figure 3: Block illustration of digitization Progression

As shown in Figure 3-2, in the digitization process, in order to meet the nyquist criterion, the original optical signal is passed through the anti-aliasing filter (a low pass filter) to remove the very high frequency component.

3.2 DETECTION OF EDGE

In any image, due to surface texture, lighting condition causes variation of brightness [2],[133]which give rise to an edge. In order to detect the edges in an image, a derivative approach is generally used. In derivative approach, computation of local derivative is carried out.

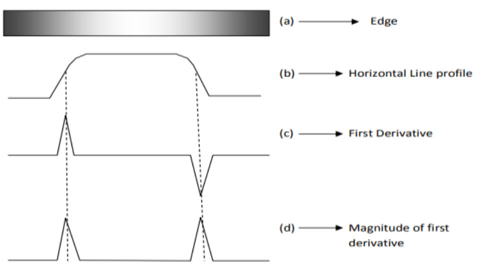

Figure 4 Line Profile of Edge

Figure 3-3(a), Figure 3-3(b) demonstrations the edge and its horizontal line outline. The first derivative line outline is constructive i.e positive at the principal edge of horizontal gray level profile, negative at the trailing edge and zero in constant gray level areas as shown in Figure 3-3(c).If we take the magnitude of first derivative then we get non negative values at the two edge and zero at non edge areas as shown by Figure 3-3(d). It is obvious that the edges can be detected by computing the derivative of the image.

4. IMAGE SEGMENTATION USING SUPER PIXEL AND MODULARITY

The algorithm can begin the aggregation manner by way of treating every single pixel as a community; however, it turns out that this will be too a whole lot time consuming, particularly for the first Louvain iteration. Fortunately, this is certainly no longer necessary, due to the fact no texture statistics is covered for single pixel. Therefore, instead, we begin with notable pixels, which can minimize the computational fee as nicely as seize the regularities. Super pixels are a set of very small and standardized regions of pixels. Initializing with super pixels can greatly reduce the time complexity without disturbing the segmentation performance. Hence, we first employ a pre-processing step to over-segment the image into a set of super pixels. This pre-processing step can be accomplished by simple K-means bunching algorithm (K is set to be a comparative large value, e.g., 200 or more) or other super pixels creating algorithms.
In our implementation, we have used a freely on hand code [31] to get the super pixel initialization. The super pixel generation step commonly offers extra than 200 over-segmented areas on average. This step can notably limit the complexity to solely think about 200 nodes in the first iteration for our algorithm. The segmentation end result given via our proposed algorithm, the place solely round ten harmonized areas with comparable ordinary patterns inner are left. This reality demonstrates that the segmentation effects are certainly the outcomes of our proposed algorithm as an alternative than the amazing pixel technology algorithm. To seize disparate traits of the color, a variety of shade areas are proposed in [32], such as RGB, L * a * b, YUV, HSV, and XYZ to acquire accurate segmentation performance.

ALGORITHM FOR IMAGE SEGMENTATION AND CONTOUR DETECTION USING SUPER PIXEL AND MODULARITY

Step – 1: load features of the image
Given a color image I and its oversegmented initialization with a set of superpixles $R = \{R1, \dots, Rn\}$
Step – 2: get the super-pixels
Reconstruct the neighbourhood system for each region in R.
it is just a wrapper around Stella Yu's cncut code. The super-

pixel will be computed as following steps –

a. Number of superpixels coarse/fine.

In our code we use - N_sp=200; N_sp2=1000; and Number of eigenvectors. N_ev=40;

b. Get n_cut parameters for superpixel computation

c. Intervening contour

Step – 3: choose proper color space and transform the data for similarity construction and estimate the distribution of the color feature for each region.

Step – 4: compute the modularity

Calculate the modularity enhance caused by merging region R_i with any of its neighboring regions and discover the neighboring region R_j, which provide the most important modularity increase in the midst of all of the neighboring regions of R_i .

Step – 5: get super pixel image

a. Merge regions R_i and R_j by setting the labels of pixels in these two regions to be of the same label,
b. The set of image segments R.
c. Create set of ME four points scale

Step – 6: Get segmented image

The set of image segments R.

i. CHOICE OF COLOR SPACE

The picking of redden/colour space is especially significant. Among all redden/colour space spaces, the L ∗ a ∗ b color space is identified to be in accordance with human being visual system and perceptually uniform; hence the image demonstration in this color space has been widely used within field of image processing and computer vision. Because of this aspect, all of our considerations of the algorithm are within the L ∗ a ∗ b color space. Later, in the experimental calculation section, we have also validated that the segmentation performance in L ∗ a ∗ b redden/colour space is much better than that within the RGB redden/colour space.

ii. NEIGHBOURHOOD SYSTEM CONSTRUCTION

Dissimilar from normal networks, such as social networks or citation networks, images have self-contained spatial a prior information, that is, spatial coherent regions are more expected to be observed as a single segment, while regions far away from each other are additional likely to go to different segments. So, different from Louvain method where two regions are deliberated to be neighbors as long as the similarity heaviness between them are nonzero, we have as an alternative constructed a different neighborhood system by incorporating this spatial a earlier information of images. To be definite, we solely think about the opportunity of merging neighboring areas in the photograph all thru every aggregation method.

To accomplish this, for each region in the image, we only consider the adjacent regions of this region to be its neighbors and increase its neighbouring regions using an adjacent list. The adjacent regions are defined to be the regions that share at least one pixel with the current region. In the following methods for the likeness matrix construction and aggregation, we only consider the current region and the regions in its neighbourhood system.

iii. FEATURES FOR SIMILARITY

Colour is the most straight forward and important feature for segmentation, so we use the pixel value in the L ∗ a ∗ b color space as one of the features for computing the similarity.

However, the coloration characteristic alone can't acquire precise segmentation performance, due to the fact it does now not consider the repetitive patterns of specific colorings in some homogeneous object. The black and white stripe regularities on zebra would be treated as a whole part according to human's observation. Simply using color feature will break down these regularities into different segments. To tackle this problem, we not only employ the color feature, but we have also proposed a novel texture feature to capture the regularities in the image. Our proposed texture depicter is motivated by the Histogram of Oriented Gradients (HoG) [33] for pedestrian detection; however, instead of constructing a histogram of gradients.

5. RESULT ANAYLSIS AND DISCUSSION

Results and Analysis is a process of evaluating a single or multiple methods in an attempt to measure its intrinsic value, by examining related economic, complex, accuracy and other qualitative and quantitative factors. The final goal of comparative analysis is to produce a quantitative value that a research method with existing versions of the same category to indicate whether his/her proposed research method is undervalued or overvalued.

This thesis announces its research contribution on image segmentation in the form of the proposed method namely "A Novel image segmentation and contour detection method using super pixel and modularity".

5.1 SOFTWARE IMPLEMENTATION

Object detection and characteristic extraction are active lookup areas in video processing and laptop vision, many of modern purposes extending over specific fields inclusive of clinical industrial and surveillance make use of these techniques, most of these functions require distinct needs involving power, size, weight and actual time computational capability. Moving object detection is frequently carried out by using segmentation, the place, the shifting object or the object of activity is remote from the background.

Multitude of software program algorithms that operate segmentation and characteristic extraction have been proposed and carried out however their computational complexity and their lack of actual time compatibility makes their use impracticable in most applications. Software implementation of object detection and function extraction walking on widespread reason computer systems are confined to small photograph decision and body rates.

This work offers a software implementation carrying out on an image for contour detector, focusing on the anticipated segmentation processing as well as contour extraction the use of "A Novel image segmentation and contour detection method using super pixel and modularity".

5.2 DESCRIPTION ON TEST IMAGES

The Berkeley Segmentation Data Set 500 (BSDS500) is used to analyze the image segmentation performance and the Fig. 5.1 refers the sample Test-images which are used to compose analysis.

Figure 5. Test Images used in the algorithm

5.3 QUALITATIVE ANALYSIS

Full results present three measures. The optimal image scale (OIS) is the F-Measure score obtained using the optimal threshold on each image. The last measure is the average precision (AP) and corresponds to the area under the precision-recall curves of Fig.

The user manually defines a rough contour and the algorithm aims at extracting an accurate contour path from it. First, all the pixels that do not belong to the rough contour are considered forbidden. Then, taking advantage of the user interaction, we consider that the rough contour path is ordered and follows the true contour. Thus, intermediate control points regions are automatically spread at regular intervals within the rough contour. Using the rough contour tool has several advantages

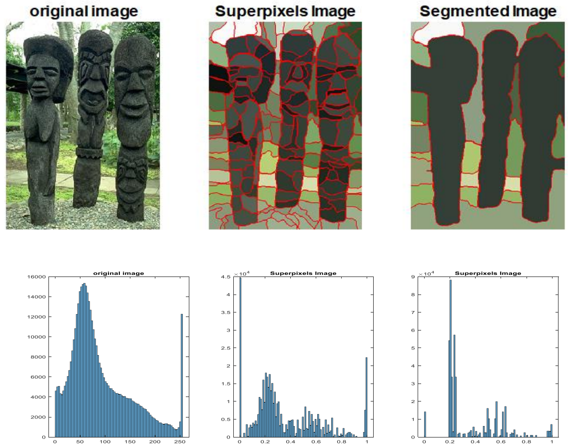

Figure 6: Experimental results
(a) The contour detector by previous method
(b) Contour detector by proposed method

First, the extraction process is efficient since the space problem is constrained. Second, it is certainly more convenient for the user since, unlike the first two tools that often result in a trial-and-error procedure; this one only needs one simple fast interaction.

In an image processing context, the histogram of an image normally refers to a histogram of the pixel intensity values. This histogram is a graph showing the number of pixels in an image at each different intensity value found in that image.

The x axis of the histogram shows the range of pixel values. Since its an 8 bpp image, that means it has 256 levels of gray or shades of gray in it. That's why the range of x axis starts from 0 and end at 255 with a gap of 50. Whereas on the y axis, is the count of these intensities.

As you can see from the graph, that most of the bars that have high frequency lies in the first half portion which is the darker portion. That means that the image we have got is darker. And this can be proved from the image too.

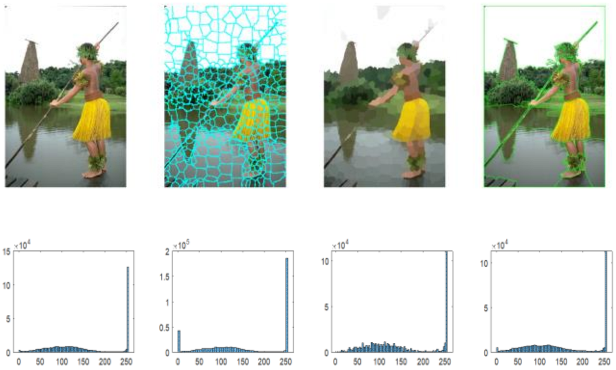

Figure 7: Experimental results for Mans Image
(a) The Original Image
(b)Super Pixel Image by proposed method
(c) Segmented Image and
(d) Contour Image

The analysis of a man's image which are taking from data of BSDS-300 project is described by Fig.5.4. The Fig.5.4.a shows the input original image DB-BSD-Mountain and Fig.5.4.b, Fig.5.4.c, Fig.5.4.d and Fig.5.4.e show the outputs of the segmentation method "A Novel image segmentation and contour detection method using super pixel and modularity". The segmentation output quality of the method proves that the outcome is having with much accuracy and highly meaningful for the Images.

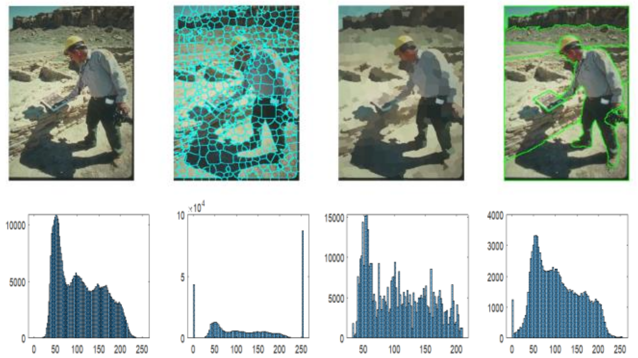

Figure 8: Experimental results for Engineers Image
(a) The Original Image
(b)Super Pixel Image by proposed method
(c) Segmented Image and
(d) Contour Image

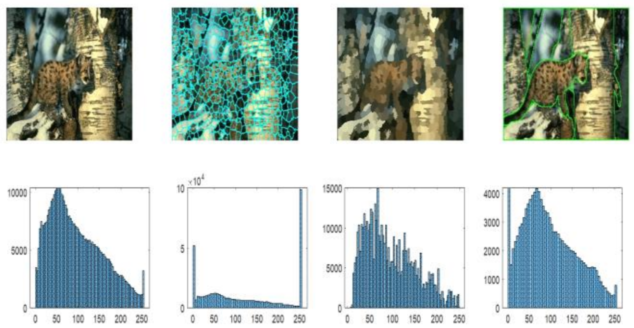

Figure 5.5: Experimental results for Cats Image
(a) The Original Image
(b)Super Pixel Image by proposed method
(c) Segmented Image and
(d) Contour Image

The proposed method is the higher performance provider for the three datasets which indicates the superior segmentation performance of the proposed method among the concerned algorithms.
The histogram of original image has most density in left hand side and it has most frequency distributed at 50 and gradual after this. The frequency distribution of super pixel's image shows great reduction in intensity and it is almost constant from 10 onwards and has one highest peak at around 250. The histogram of contour's image is almost distributed as original image but it has some more zig – zag in nature. The intensity level of the contour image reduces greatly to and below the level of 4000.

5.4 PERFORMANCE PARAMETER

We also calculate the performance using the standard boundary-based method established in [39]. This composition first gets the optimal boundary corresponding between the testing segmentation and the ground-truth, and then calculates the results from two phases: Precision and Recall. Given the testing segmentation C_{test} and the ground truth segmentationC_{gt}, the Precision measures the fraction of identified boundary pixels that match the ground-truth boundaries, and is well-defined as

$$\text{Precision} = \frac{|C_{test}| \cap |C_{gt}|}{|C_{test}|} \qquad (5.1)$$

Where $|C|$ is the number of boundary pixels in the segmentationC. Similarly, the Recall is defined as

$$\text{Recall} = \frac{|C_{test}| \cap |C_{gt}|}{|C_{gt}|} \qquad (5.2)$$

Which measures the fraction of ground-truth boundary pixels that are detected to encapsulate these two indexes, the global Fα-measure, defined in (6.3), is used to measure the harmonic mean of the Precision and Recall. We set $\alpha = 0.5$ and use it for all the experiments

$$F\alpha = \frac{\text{Precision} \cdot \text{Recall}}{(1-\alpha)\cdot \text{Recall} + \alpha \cdot \text{Precision}} \quad . \qquad (5.3)$$

5.5 QUANTITATIVE ANALYSIS

In this section we will discuss some more features of our methods,
The Precision and Recall values for altered algorithms underneath the same settings as the region level evaluation. It can be seen that our system obtains the highest precision with a value of 0.785, demonstrating that furthermost of our produced boundaries contest the ground-truth segmentation manually formed by human matters. Nevertheless, the result booms the lowest recall value for our algorithms than other methods, which frontrunners to a moderately lower. F measure compared with others, this is perhaps as the Recall is profound to underneath segmentation. In our algorithm, we encrypt the HoS feature into the likeness matrix to preserve regularities.
Table 5.1 lists the Precision and Recall values for different algorithms under the same settings as the region level evaluation. Here we are going to studied two images that are image of stone and image of a man. The table 5.1 presented parameter for stone image, here Precision, Recall and F Measure are better in our case. For better user representations we are also create a graph chart with same values.

Table 5. 1 Parameter comparison for stone image

Methods	Precision	Recall	F_{α} Measure
Previous Method	0.733	0.508	0.60
Proposed Method	0.785	0.505	0.63

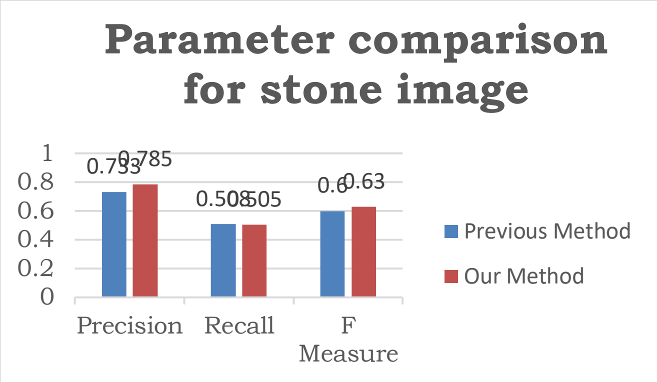

Figure 5.6 Bar graph for stone image

Table 5. 2 shows the comparison parameters in which the precision is improved recall rate is approximate same. Figure 5.7 shows the bar graph for mans image for better representation. As shown clearly in the bar graph Precision, Recall and F Measure are outperformed.

Table 5.2 Parameter comparison for man image

Methods	**Precision**	**Recall**	F_α **Measure**
Previous Method	0.813	0.518	0.61
Proposed Method	0.819	0.512	0.62

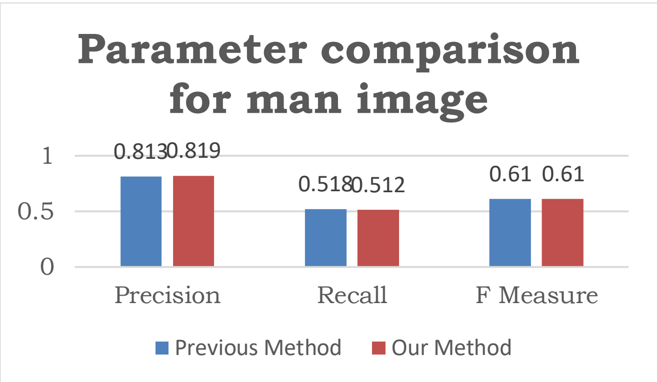

Figure 5.7 Bar graph for man's image

6. CONCLUSION

In this presented work of image segmentation techniques, various image segmentation techniques are detailed described and compared. These all techniques are suitable for many image applications. These techniques can be used for object recognition and detection. Due to the need of image segmentation in many applications, it has a challenging future. In the work, we have proposed an efficient picture segmentation algorithm taking benefits of the scalability of modularity optimization and the inherent properties of images. Adopting the bottom-up framework, the proposed algorithm automatically detects the wide variety of segments in the image, and by using the coloration function as nicely as the proposed HoS texture feature, it adaptively constructs the similarity matrix amongst extraordinary regions, optimizes the modularity, and aggregates the neighboring areas iteratively.

The optimal segmentation is done when no modularity expand occurs by aggregating any neighboring regions. Results of massive experiments have validated that the proposed algorithm gives marvelous qualitative segmentation results; besides, it is reported that the new algorithm achieves the first-class performance among all the experimented famous techniques in phrases of VOI and Precision on BSDS500. Because the algorithm aims to avoid over segmentation, it produces low Recall value. In addition, it is proven that the new algorithm can preserve regularities in the object and obtain the pleasant overall performance from the semantic stage on SSDS. Furthermore, our proposed algorithm affords attractive time complexity and runs constantly quicker than CTM and TBES below the same experiment

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