In this competition, you are asked to develop a model that can automatically grade 20000 hand-written calculus quizzes which contains seven different integrals:

- $\int xdx$
- $\int x^2dx$
- $\int x^3dx$
- $\int x^4dx$
- $\int 2xdx$
- $\int 3x^2dx$
- $\int 4x^3dx$

The grading rules are:

10 points

- $\int xdx = \frac{1}{2}x^2 + C$ or $\int xdx = \frac{x^2}{2} + C$
- $\int x^2dx = \frac{1}{3}x^3 + C$ or $\int xdx = \frac{x^3}{3} + C$
- $\int x^3dx = \frac{1}{4}x^4 + C$ or $\int xdx = \frac{x^4}{4} + C$
- $\int x^4dx = \frac{1}{5}x^5 + C$ or $\int xdx = \frac{x^5}{5} + C$
- $\int 2xdx = x^2 + C$
- $\int 3x^2dx = x^3 + C$
- $\int 4x^3dx = x^4 + C$

9 points

- $\int xdx = \frac{1}{2}x^2$ or $\int xdx = \frac{x^2}{2}$
- $\int x^2dx = \frac{1}{3}x^3$ or $\int xdx = \frac{x^3}{3}$
- $\int x^3dx = \frac{1}{4}x^4$ or $\int xdx = \frac{x^4}{4}$
- $\int x^4dx = \frac{1}{5}x^5$ or $\int xdx = \frac{x^5}{5}$
- $\int 2xdx = x^2$
- $\int 3x^2dx = x^3$
- $\int 4x^3dx = x^4$

5 points

- $\int xdx = \frac{1}{2}t^2 + C$ or $\int xdx = \frac{t^2}{2} + C$
- $\int x^2dx = \frac{1}{3}t^3 + C$ or $\int xdx = \frac{t^3}{3} + C$
- $\int x^3dx = \frac{1}{4}t^4 + C$ or $\int xdx = \frac{t^4}{4} + C$
- $\int x^4dx = \frac{1}{5}t^5 + C$ or $\int xdx = \frac{t^5}{5} + C$

2 points

- $\int x^2dx = 2x + C$
- $\int x^3dx = 3x^2 + C$
- $\int x^4dx = 4x^3 + C$

1 point

- $\int x^2dx = 2x$
- $\int x^3dx = 3x^2$
- $\int x^4dx = 4x^3$

0 point

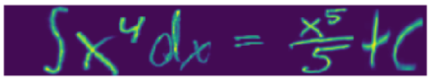
- For all the remaining cases.

Test Set

The test set is a list of length 20000. For each item in a list is a numpy array of the shape 64×384, which is a grey-scale image of a mathematical expression like

In [11]:
```
import numpy as np
from matplotlib import pyplot as plt

Sample=np.load('Sample.npy')
plt.imshow(Sample)
plt.axis('off')
plt.show()
```



The symbols besides blank space used in each expression are from the following set
$\int,\ dx,\ \ =,\ \ +C,\ x,\ x^2,\ x^3,\ x^4,\ 2x,\ 3x^2,\ 4x^3,\ \frac{x^2}{2}$ or $\frac{1}{2}x^2,\ \frac{x^3}{3}$ or $\frac{1}{3}x^3,\ \frac{x^4}{4}$ or $\frac{1}{4}x^4,\ \frac{x^5}{5}$ or $\frac{1}{5}x^5,\ \frac{t^2}{2}$ or $\frac{1}{2}t^2,\ \frac{t^3}{3}$ or $\frac{1}{3}t^3,\ \frac{t^4}{4}$ or $\frac{1}{4}t^4,.$
$\frac{t^5}{5}$ or $\frac{1}{5}t^5$

Among these symbols, $\int,\ dx,\ =$ always appear in the first, third and fourth places in mathematical expressions, and are not essential for making prediction.

Warning: The symbols in the test sets are not necessary of the same size. The size of the first five symbols ranges from 61×64 to 67×64. The size of the last symbol ranges from 49×64 to 79×64. It is reasonable to assume that there are some gaps between two adjacent symbols. But some samples of a single symbol may also have gaps between the left part and the right part.

Training set

The training set is a list of length 8,000. Each item in the list is a numpy array of shape 64×64 which is a grey-scale image of hand-written symbol of one of the following
$x,\ x^2,\ x^3,\ x^4,\ 2x,\ 3x^2,\ 4x^3,\ \frac{x^2}{2}$ or $\frac{1}{2}x^2,\ \frac{x^3}{3}$ or $\frac{1}{3}x^3,\ \frac{x^4}{4}$ or $\frac{1}{4}x^4,\ \frac{x^5}{5}$ or $\frac{1}{5}x^5,\ \ +C,\ \frac{t^2}{2}$ or $\frac{1}{2}t^2,\ \frac{t^3}{3}$ or $\frac{1}{3}t^3,\ \frac{t^4}{4}$ or $\frac{1}{4}t^4,\ \frac{t^5}{5}$ or $\frac{1}{5}t^5.$

These hand-written symbols are collected from different set of people, These symbols are labeled as $0, 1, \ldots, 15$ respectively.

Evaluation

Mean Absolute Error (MAE)

This is computed by comparing the score labels you upload to the correct score labels for the test set.

Specifically, we compute the average absolute difference between the "true labels" and your uploaded solution.

This is computed as:

$$MAE = \frac{\sum_{i=1}^{n} |y_i - y_i^p|}{n}$$