Python Programming

2D-1D Mappings

Mostafa S. Ibrahim
Teaching, Training and Coaching since more than a decade!

Artificial Intelligence & Computer Vision Researcher
PhD from Simon Fraser University - Canada
Bachelor / Msc from Cairo University - Egypt
Ex-(Software Engineer / ICPC World Finalist)

2D and 1D Flatten Relationships

- Let's say we have this 3x4 matrix
- We can flatten to
  - **flst = [8, 16, 9, 52,** 3, 15, 27, 6, **14, 25, 2, 10]**
- We want to learn the indices relations
  - lst[0][3] = 52 ⇒ is same as ⇒ flst[3]
  - lst[1][0] = 3 ⇒ is same as ⇒ flst[4]
  - lst[1][2] = 27 ⇒ is same as ⇒ flst[6]
- For an NxM grid:
  - Given index (i, j), convert to its corresponding 1D flat index? E.g. (1, 0) ⇒ 4
  - Given index i in 1D flat index, convert to its corresponding 2D (i, j)? 4 ⇒ (1, 0)

```
3   lst = [
4       [8, 16, 9, 52],
5       [3, 15, 27, 6],
6       [14, 25, 2, 10]
7   ]
```

Find the equations

```python
def from2d_to_1d(cols, i, j):...


def from1d_to_2d(cols, idx):...


def list_relations(rows = 3, cols = 5):
    idx = 0
    for r in range(rows):
        for c in range(cols):
            print(f'({r}, {c}) ==> {idx}')

            assert (r, c) == from1d_to_2d(cols, idx)
            assert idx == from2d_to_1d(cols, r, c)

            idx += 1


list_relations(3, 5)
```

```
(0, 0) ==> 0
(0, 1) ==> 1
(0, 2) ==> 2
(0, 3) ==> 3
(0, 4) ==> 4
(1, 0) ==> 5
(1, 1) ==> 6
(1, 2) ==> 7
(1, 3) ==> 8
(1, 4) ==> 9
(2, 0) ==> 10
(2, 1) ==> 11
(2, 2) ==> 12
(2, 3) ==> 13
(2, 4) ==> 14
```

3 Equations

```
3   lst = [
4       [8, 16, 9, 52],
5       [3, 15, 27, 6],
6       [14, 25, 2, 10]
7   ]
```

- **flst = [8, 16, 9, 52,** 3, 15, 27, 6, **14, 25, 2, 10]**
- To convert from (i, j) in matrix to 1D array
  - i * COLS + j
  - (1, 2) ⇒ 1 * 4 + 2 = 6
- To convert from index in 1D array to (i, j) in matrix
  - i = idx//COLS j = idx%COLS
  - Idx = 6 ⇒ (6//4, 6%4) ⇒ (1, 2)
  - Why? Idx = i * COLS + j
    - Idx // COLS = (i * COLS + j)//COLS = i + 0, as j < COLS
    - Idx % COLS = (i * COLS + j)%COLS = 0 + j, as j < COLS and (i*COLS)%COLS = 0

"Acquire knowledge and impart it to the people."

"Seek knowledge from the Cradle to the Grave."