**DegreeD Algorithm in details**

For each `row` in `user\_data`:

Initialize `num\_clicks = 0`, `num\_skips = 0`, `prev\_user\_embedding = None`.

Set `doc\_embeddings\_up\_to\_t1 = []` and `total\_divergence = 0`.

Extract `user\_id`, `actions`, and `doc\_ids` from `row`.

For `t1` from 0 to `len(actions) - 2`:

Let `action = actions[t1]`, `doc\_id\_t1 = doc\_ids[t1]`, `doc\_id\_t2 = doc\_ids[t1 + 1]`.

If `action == 'click'`:

If `num\_clicks == 0`:

- Set `Dt1 = doc\_embeddings[doc\_id\_t1]` (default to zero embedding if not found).

- Set `Ut1 = title\_embeddings[doc\_id\_t1]` (default to zero embedding if not found).

- Increment `num\_clicks`.

Else:

- Append `doc\_embeddings[doc\_id\_t1]` to `doc\_embeddings\_up\_to\_t1`.

Else If `action == 'skip'`:

Append `doc\_embeddings[doc\_id\_t1]` to `doc\_embeddings\_up\_to\_t1`.

Else If `action == 'gen\_summ'`:

Append `doc\_embeddings[doc\_id\_t1]` to `doc\_embeddings\_up\_to\_t1`.

Compute `Dt2` as the mean of `doc\_embeddings\_up\_to\_t1` if not empty; otherwise, use `doc\_embeddings[doc\_id\_t1]`.

Set `Ut2 = user\_embeddings[doc\_id\_t2]` (default to zero embedding if not found).

Calculate document similarity:

`doc\_divergence = (min(sigma(Dt1, Dt2), sigma(Ut2, Ut1)) + 1e-7) /

(max(sigma(Dt1, Dt2), sigma(Ut2, Ut1)) + 1e-7)`.

Calculate penalty for theme deviation:

`penalty = sigma(Dt1, Ut1) / (sigma(Dt2, Ut2) + 1e-7)`.

Penalized divergence:

`penalized\_deps = doc\_divergence \* penalty`.

Divergence for this step:

`document\_divergence = penalized\_deps \* sigma(Ut2, Ut1)`.

Update `total\_divergence += document\_divergence`.

Reset `doc\_embeddings\_up\_to\_t1 = []`.

Update `Dt1 = Dt2`, `Ut1 = Ut2`.

Normalize divergence for this trajectory:

If `len(actions) > 1`:

`row\_divergence = total\_divergence / (len(actions) - 1)`.

Add `row\_divergence` to `overall\_divergence`.

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#### \*\*Final Calculation\*\*:

Normalize the total divergence across all users:

```plaintext

degree\_d = 0.51 \* overall\_divergence / total\_users