EDAS (Evaluation based on Distance from Average Solution) is a Multi-Criteria Decision Making (MCDM) method used to rank alternatives based on their proximity to an average solution. Here's a step-by-step guide on using the EDAS method for ranking alternatives with TFNs (Triangular Fuzzy Numbers):

## Steps for EDAS with TFNs:

**Define the Decision Matrix**: Construct the matrix where rows represent alternatives and columns represent criteria. Each entry should be a TFN representing an alternative's performance on a criterion.

**Determine Positive and Negative Deviations**: Calculate the deviation of each alternative from the average solution for each criterion. Use TFNs to calculate the positive and negative deviations.

- **Positive Deviation (PD)**: $PD_{ij} = max\left(X_{ij} - A_j, 0\right)$
- **Negative Deviation (ND)**: $ND_{ij} = max\left(A_j - X_{ij}, 0\right)$

Where $X_{ij}$ is the performance of the alternative on a criterion, and $A_j$ is the average TFN for criterion $j$.

**Compute Weighted Sum of Positive and Negative Deviations**: For each alternative, calculate the weighted sum of positive deviations ($PDS_i$) and the weighted sum of negative deviations ($NDS_i$) across all criteria.

**Normalize Deviation Scores**: Normalize the weighted sum scores to scale between 0 and 1.

**Calculate the Appraisal Score**: The appraisal score for each alternative combines the normalized positive and negative deviation sums:

**Middle value**: $x$

**Upper bound**: $x + 5\% \times x$

For the extracted table:

| C2 | C3 | C4 | C5 |
|---|---|---|---|
| 10 | 22 | 9 | 60 |
| 0.33 | 9 | 3 | 70 |
| 8 | 13 | 8 | 70 |

| C2 | C3 | C4 | C5 |
|---|---|---|---|
| 15 | 28 | 5 | 90 |

We apply a 5% deviation to each value:

### TFN Matrix with 5% Deviation:

| C2 | C3 | C4 | C5 |
|---|---|---|---|
| (9.5, 10, 10.5) | (20.9, 22, 23.1) | (8.55, 9, 9.45) | (57, 60, 63) |
| (0.3135, 0.33, 0.3465) | (8.55, 9, 9.45) | (2.85, 3, 3.15) | (66.5, 70, 73.5) |
| (7.6, 8, 8.4) | (12.35, 13, 13.65) | (7.6, 8, 8.4) | (66.5, 70, 73.5) |
| (14.25, 15, 15.75) | (26.6, 28, 29.4) | (4.75, 5, 5.25) | (85.5, 90, 94.5) |

Each entry now consists of a TFN with a 5% deviation. Let me know if you need any further calculations or adjustments!

To rank the alternatives using the **EDAS method** with the TFN matrix, we will follow these steps:

## 1. **Determine the Average Solution (TFN-based Average)**:

We calculate the average TFN for each column, which is the average of the middle values of the TFNs across all rows.

## 2. **Calculate Positive and Negative Deviations**:

For each alternative, compute the positive deviation (PD) and negative deviation (ND) compared to the average solution.

- **Positive Deviation**: $PD_{ij} = max(X_{ij} - A_j, 0)$
- **Negative Deviation**: $ND_{ij} = max(A_j - X_{ij}, 0)$ Where $X_{ij}$ is the performance of an alternative in a criterion, and $A_j$ is the average for criterion $j$.

## 3. **Weighted Sum of PD and ND**:

Calculate the weighted sum of positive and negative deviations across all criteria for each alternative.

## 4. **Normalize PD and ND**:

Normalize the positive and negative deviation sums to get them in a comparable range between 0 and 1.

## 5. **Appraisal Score**:

Finally, calculate the appraisal score (AS) for each alternative and rank them.

Let me calculate the necessary values and show the ranks.

The appraisal scores and ranks of the alternatives based on the EDAS method are as follows:

### Appraisal Scores:

1. **Alternative 1**: 0.348
2. **Alternative 2**: 0.000
3. **Alternative 3**: 0.353
4. **Alternative 4**: 0.973

### Ranks:

1. **Alternative 4** (Rank 1)
2. **Alternative 3** (Rank 2)
3. **Alternative 1** (Rank 3)
4. **Alternative 2** (Rank 4)

Alternative 4 ranks the highest based on the EDAS method.

## Step 1: **Calculate the Average Solution (TFN-based Average)**

We first calculate the **average of the middle values** (second element of each TFN) for each criterion across all alternatives.

*TFN Matrix (Middle Values):*

| C2 | C3 | C4 | C5 |
|---|---|---|---|
| 10 | 22 | 9 | 60 |
| 0.33 | 9 | 3 | 70 |
| 8 | 13 | 8 | 70 |
| 15 | 28 | 5 | 90 |

*Step-by-step calculation of the average middle values:*

- **For C2**:
  $\frac{10+0.33+8+15}{4}=\frac{33.33}{4}=8.3325$
- **For C3**:
  $\frac{22+9+13+28}{4}=\frac{72}{4}=18$
- **For C4**:
  $\frac{9+3+8+5}{4}=\frac{25}{4}=6.25$
- **For C5**:
  $\frac{60+70+70+90}{4}=\frac{290}{4}=72.5$

*The average solution (middle values) for each criterion:*

- **C2**: 8.3325
- **C3**: 18
- **C4**: 6.25
- **C5**: 72.5

This completes Step 1 of the EDAS method, where we found the average middle values for each criterion.

## Step 2: **Calculate Positive and Negative Deviations**

Now that we have the average middle values for each criterion (from Step 1), we calculate the **Positive Deviation (PD)** and **Negative Deviation (ND)** for each alternative.

*Average Middle Values (from Step 1):*

| C2 | C3 | C4 | C5 |
|---|---|---|---|
| 8.33 | 18 | 6.25 | 72.5 |

*Middle Values (from the TFN matrix):*

| C2 | C3 | C4 | C5 |
|---|---|---|---|
| 10 | 22 | 9 | 60 |
| 0.33 | 9 | 3 | 70 |
| 8 | 13 | 8 | 70 |
| 15 | 28 | 5 | 90 |

## Positive and Negative Deviations

**Positive Deviation (PD):**
$PD_{ij} = max(X_{ij} - A_j, 0)$

**Negative Deviation (ND):**
$ND_{ij} = max(A_j - X_{ij}, 0)$

Where $X_{ij}$ is the middle value for alternative $i$ and criterion $j$, and $A_j$ is the average solution for criterion $j$.

*For **Alternative 1** (Middle values: 10, 22, 9, 60):*

- **C2**:
  $PD = max(10 - 8.33, 0) = 1.67$
  $ND = max(8.33 - 10, 0) = 0$

- **C3**:
  $PD = max(22 - 18, 0) = 4$
  $ND = max(18 - 22, 0) = 0$

- **C4**:
  $PD = max(9 - 6.25, 0) = 2.75$
  $ND = max(6.25 - 9, 0) = 0$

- **C5**:
  $PD = max(60 - 72.5, 0) = 0$
  $ND = max(72.5 - 60, 0) = 12.5$

So, for Alternative 1:

- **Positive Deviations (PD)**: $(1.67, 4, 2.75, 0)$
- **Negative Deviations (ND)**: $(0, 0, 0, 12.5)$

*For **Alternative 2** (Middle values: 0.33, 9, 3, 70):*

- **C2**:
  $PD = max(0.33 - 8.33, 0) = 0$
  $ND = max(8.33 - 0.33, 0) = 8$

- **C3**:
  $PD = max(9 - 18, 0) = 0$
  $ND = max(18 - 9, 0) = 9$

- **C4**:
  $PD = max(3 - 6.25, 0) = 0$
  $ND = max(6.25 - 3, 0) = 3.25$

- **C5**:
  $PD = max(70 - 72.5, 0) = 0$
  $ND = max(72.5 - 70, 0) = 2.5$

So, for Alternative 2:

- **Positive Deviations (PD)**: $(0, 0, 0, 0)$
- **Negative Deviations (ND)**: $(8, 9, 3.25, 2.5)$

*For **Alternative 3** (Middle values: 8, 13, 8, 70):*

- **C2**:
  $PD = max(8 - 8.33, 0) = 0$
  $ND = max(8.33 - 8, 0) = 0.33$

- **C3**:
  $PD = max(13 - 18, 0) = 0$
  $ND = max(18 - 13, 0) = 5$

- **C4**:
  $PD = max(8 - 6.25, 0) = 1.75$
  $ND = max(6.25 - 8, 0) = 0$

- **C5**:
  $PD = max(70 - 72.5, 0) = 0$
  $ND = max(72.5 - 70, 0) = 2.5$

So, for Alternative 3:

- **Positive Deviations (PD)**: $(0, 0, 1.75, 0)$
- **Negative Deviations (ND)**: $(0.33, 5, 0, 2.5)$

*For **Alternative 4** (Middle values: 15, 28, 5, 90):*

- **C2**:
  $PD = max(15 - 8.33, 0) = 6.67$
  $ND = max(8.33 - 15, 0) = 0$

- **C3**:
  $PD = max(28 - 18, 0) = 10$
  $ND = max(18 - 28, 0) = 0$

- **C4**:
  $PD = max(5 - 6.25, 0) = 0$
  $ND = max(6.25 - 5, 0) = 1.25$

- **C5**:
  $PD = max(90 - 72.5, 0) = 17.5$
  $ND = max(72.5 - 90, 0) = 0$

So, for Alternative 4:

- **Positive Deviations (PD)**: $(6.67, 10, 0, 17.5)$
- **Negative Deviations (ND)**: $(0, 0, 1.25, 0)$

### Summary of PDs and NDs:

| Alternative | Positive Deviations (PD) | Negative Deviations (ND) |
|---|---|---|
| 1 | (1.67, 4, 2.75, 0) | (0, 0, 0, 12.5) |
| 2 | (0, 0, 0, 0) | (8, 9, 3.25, 2.5) |
| 3 | (0, 0, 1.75, 0) | (0.33, 5, 0, 2.5) |
| 4 | (6.67, 10, 0, 17.5) | (0, 0, 1.25, 0) |

This completes Step 2, where we've computed the positive and negative deviations for each alternative.

Here are the tables summarizing **Steps 3, 4, 5, and 6** for the EDAS method.

## Step 3: Weighted Sum of Positive and Negative Deviations (Assuming Equal Weights)

| Alternative | Sum of PD | Sum of ND |
|---|---|---|
| 1 | 8.42 | 12.5 |
| 2 | 0 | 22.75 |
| 3 | 1.75 | 7.83 |
| 4 | 34.17 | 1.25 |

## Step 4: Normalize PD and ND

Normalized PD and ND are calculated by dividing each value by the maximum PD and ND.

- **Maximum PD** = 34.17

- **Maximum ND** = 22.75

| Alternative | Normalized PD | Normalized ND |
|---|---|---|
| 1 | 0.246 | 0.549 |
| 2 | 0 | 1 |
| 3 | 0.051 | 0.344 |
| 4 | 1 | 0.055 |

## Step 5: Appraisal Score

Appraisal score is calculated as:

$$AS = 0.5 \times \text{Normalized PD} + 0.5 \times (1 - \text{Normalized ND})$$

| Alternative | Appraisal Score |
|---|---|
| 1 | 0.348 |
| 2 | 0.000 |
| 3 | 0.353 |
| 4 | 0.973 |

## Step 6: Ranking

The alternatives are ranked in descending order of their appraisal scores.

| Alternative | Rank |
|---|---|
| 4 | 1 |
| 3 | 2 |
| 1 | 3 |
| 2 | 4 |

This completes the remaining steps of the EDAS method, leading to the final ranking of the alternatives.

ASi=0.5×PDSimax(PDS)+0.5×(1-NDSimax(NDS))AS_i = 0.5 \times \frac{PDS_i}{\max(PDS)} + 0.5 \times \left(1 - \frac{NDS_i}{\max(NDS)}\right)

**Rank the Alternatives**: Rank the alternatives based on their appraisal scores, with higher scores indicating better alternatives.

### Key Points with TFNs:

- TFNs allow modeling uncertainty in the ratings. You can apply fuzzy arithmetic to calculate deviations and aggregation steps.
- Use defuzzification techniques if necessary to handle the fuzzy nature of deviations when comparing scores.

This process helps in making informed decisions under uncertainty, taking into account both positive and negative deviations relative to an average solution.