

# HW 14 Report Minh Nguyen

```
In [1]: # !pip install deepface
        # !pip install retina-face
        # !pip install tf_keras
```

```
In [ ]: import json
        from retinaface import RetinaFace
        from deepface import DeepFace

        from src.mappings import gallery_mapping, probe_mapping

        # Load the mappings to get the image filenames
        gallery_images = gallery_mapping.keys()
        probe_images = probe_mapping.keys()
```

```
In [ ]: # Compare 2 random images from the gallery and probe
        obj = DeepFace.verify(
            "gallery/Andrew_Garfield.jpg",
            "probe/Andrew_Garfield_4.jpg",
            model_name="ArcFace",
            detector_backend="retinaface",
        )
        print(obj["verified"])
        print(json.dumps(obj, indent=2))
```

```

True
{
  "verified": true,
  "distance": 0.5006100316699272,
  "threshold": 0.68,
  "model": "ArcFace",
  "detector_backend": "retinaface",
  "similarity_metric": "cosine",
  "facial_areas": {
    "img1": {
      "x": 303,
      "y": 85,
      "w": 175,
      "h": 247,
      "left_eye": [
        432,
        185
      ],
      "right_eye": [
        350,
        188
      ]
    },
    "img2": {
      "x": 1036,
      "y": 305,
      "w": 338,
      "h": 480,
      "left_eye": [
        1322,
        504
      ],
      "right_eye": [
        1168,
        496
      ]
    }
  },
  "time": 2.58
}

```

```

In [ ]: # Create a dictionary to store the similarities
# Structure: {probe_image: [(gallery_image, similarity_score), ...]}
similarities_dict = {probe_image: [] for probe_image in probe_images}

for probe_image in similarities_dict.keys():
    print(f"Processing probe image: {probe_image}")
    for gallery_image in gallery_images:
        # Verify the images using DeepFace
        result = DeepFace.verify(
            gallery_image,
            probe_image,
            model_name="ArcFace",
            detector_backend="retinaface",
        )

```

```
# Append the similarity score to the probe image's similarities list
similarities_dict[probe_image].append((gallery_image, result["distan
```

```
Processing probe image: probe/Andrew_Garfield_1.jpg
Processing probe image: probe/Andrew_Garfield_2.jpg
Processing probe image: probe/Andrew_Garfield_3.jpg
Processing probe image: probe/Andrew_Garfield_4.jpg
Processing probe image: probe/Andrew_Garfield_5.jpg
Processing probe image: probe/Robert_Downey_Jr_1.jpg
Processing probe image: probe/Robert_Downey_Jr_2.jpg
Processing probe image: probe/Robert_Downey_Jr_3.jpg
Processing probe image: probe/Robert_Downey_Jr_4.jpg
Processing probe image: probe/Robert_Downey_Jr_5.jpg
Processing probe image: probe/Ryan_Reynolds_1.jpg
Processing probe image: probe/Ryan_Reynolds_2.jpg
Processing probe image: probe/Ryan_Reynolds_3.jpg
Processing probe image: probe/Ryan_Reynolds_4.jpg
Processing probe image: probe/Ryan_Reynolds_5.jpg
Processing probe image: probe/Lionel_Messi_1.jpg
Processing probe image: probe/Lionel_Messi_2.jpg
Processing probe image: probe/Lionel_Messi_3.jpg
Processing probe image: probe/Lionel_Messi_4.jpg
Processing probe image: probe/Lionel_Messi_5.jpg
Processing probe image: probe/Gordon_Ramsay_1.jpg
Processing probe image: probe/Gordon_Ramsay_2.jpg
Processing probe image: probe/Gordon_Ramsay_3.jpg
Processing probe image: probe/Gordon_Ramsay_4.jpg
Processing probe image: probe/Gordon_Ramsay_5.jpg
```

```
In [16]: def display_similarities(similarities_dict, sorted=True):
        for probe_image, similarities in similarities_dict.items():
            # Sort the similarities by score
            if sorted:
                similarities.sort(key=lambda x: x[1])
            print(f"Similarities (sorted = {sorted}) for {probe_image}:")
            for gallery_image, score in similarities:
                print(f" Gallery image: {gallery_image}, Similarity score: {score}")
            print("----" * 10)
```

```
In [17]: # Print the similarities dictionary (without sorting)
display_similarities(similarities_dict, sorted=False)
```

Similarities (sorted = False) for probe/Andrew\_Garfield\_1.jpg:  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.39319992147  
637706  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.8744728335  
782311  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8863652123180  
179  
Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.92358991812434  
31  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9706779553564  
077

Similarities (sorted = False) for probe/Andrew\_Garfield\_2.jpg:  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.24042729856  
676082  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.8761408799918  
965  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8936986178443  
599  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.0528848419  
596264  
Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.10164698331704  
52

Similarities (sorted = False) for probe/Andrew\_Garfield\_3.jpg:  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.81762457714  
24246  
Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.84720362638296  
64  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8881140014988  
497  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9871904882934  
271  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9968988604  
560459

Similarities (sorted = False) for probe/Andrew\_Garfield\_4.jpg:  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.50061003166  
99272  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.7893060597278  
551  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9434329709  
442818  
Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.96074248061846  
71  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9866648928979  
739

Similarities (sorted = False) for probe/Andrew\_Garfield\_5.jpg:  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.51184823429  
40326  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8922395165519  
528  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9766701600  
29526  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9976523441622

764

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.13284052450038  
83

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Similarities (sorted = False) for probe/Robert\_Downey\_Jr\_1.jpg:

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.5327794293  
313474

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8283363079398  
45

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.98268089296951  
77

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.99618832500  
84366

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.1081481213202  
407

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Similarities (sorted = False) for probe/Robert\_Downey\_Jr\_2.jpg:

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.4476615891  
0878284

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.9041880036517  
181

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.93646507004  
03954

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.95477640912040  
35

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9608237586306  
525

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Similarities (sorted = False) for probe/Robert\_Downey\_Jr\_3.jpg:

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.4869309789  
830327

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.85154030459  
36545

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9464509236945  
816

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.95880465421919  
88

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 1.0192072206183  
629

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Similarities (sorted = False) for probe/Robert\_Downey\_Jr\_4.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8778092785237  
376

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9227975724  
90835

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.95105942227  
91872

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9688892378693  
101

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.00290472734337  
5

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Similarities (sorted = False) for probe/Robert\_Downey\_Jr\_5.jpg:

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.5188614036  
574415

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.95047581547

82622

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.0034962592205305

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.0262054862434384

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 1.0529398837193846

Similarities (sorted = False) for probe/Ryan\_Reynolds\_1.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.2457490012238982

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.8898748618398434

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8921521348743086

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9714298356368658

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.977776664351927

Similarities (sorted = False) for probe/Ryan\_Reynolds\_2.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.40342378681941493

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.8065944023765104

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8501156774768839

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9557263602791625

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.0753154474460298

Similarities (sorted = False) for probe/Ryan\_Reynolds\_3.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.37480914537644716

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.872087684552568

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.9979138003105702

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.0161576752001544

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.0286593042060885

Similarities (sorted = False) for probe/Ryan\_Reynolds\_4.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.4615049578355035

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.7491269568458181

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8811364925488543

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9470339278425751

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9918449987034041

Similarities (sorted = False) for probe/Ryan\_Reynolds\_5.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.6272424240374  
075  
Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.72378358406743  
98  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.91511407474  
91071  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9323573089  
434873  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9867274172584  
591

Similarities (sorted = False) for probe/Lionel\_Messi\_1.jpg:

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.42131351070998  
213  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8218267577593  
388  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.8574651614909  
02  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.94762285363  
56309  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.0359681352  
699819

Similarities (sorted = False) for probe/Lionel\_Messi\_2.jpg:

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.36440370660000  
465  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8299562027271  
142  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.95644678468  
64811  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.0286599134578  
212  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.0932118318  
139332

Similarities (sorted = False) for probe/Lionel\_Messi\_3.jpg:

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.58015151906707  
56  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.7627863717251  
51  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9371128439838  
389  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9770182812  
900349  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 1.03025150285  
51682

Similarities (sorted = False) for probe/Lionel\_Messi\_4.jpg:

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.48728992792161  
363  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.7613027946791  
906  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.96150127906  
44711  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9749184797035

976

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.1114006505725436

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Similarities (sorted = False) for probe/Lionel\_Messi\_5.jpg:

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.5003155099749823

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8137303822390364

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8215791865340056

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.004640596094028

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.100088685168262

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Similarities (sorted = False) for probe/Gordon\_Ramsay\_1.jpg:

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.2520639455346124

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8783479741445681

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8879754491163478

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9576756009663171

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.1284164055219053

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Similarities (sorted = False) for probe/Gordon\_Ramsay\_2.jpg:

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.5576199034184046

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8364542373980852

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.9337196821983744

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.0350002276719785

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.09507407122247

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Similarities (sorted = False) for probe/Gordon\_Ramsay\_3.jpg:

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.3506785434672717

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8666591556596841

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8703256079551389

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9429317813568401

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.0883606162254824

-----  
Similarities (sorted = False) for probe/Gordon\_Ramsay\_4.jpg:

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.5658710482575604

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8591787399606805



Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.9335195370658713

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9778102924264626

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.0251526764717285

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Similarities (sorted = False) for probe/Gordon\_Ramsay\_5.jpg:

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.47454789483559756

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8365805526458697

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9659010562891873

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.9742863489032564

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.0564961802215185

In [ ]: `# Sort the similarities for each probe image  
display_similarities(similarities_dict, sorted=True)`

Similarities (sorted = True) for probe/Andrew\_Garfield\_1.jpg:  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.39319992147  
637706  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.8744728335  
782311  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8863652123180  
179  
Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.92358991812434  
31  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9706779553564  
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Similarities (sorted = True) for probe/Andrew\_Garfield\_2.jpg:  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.24042729856  
676082  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.8761408799918  
965  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8936986178443  
599  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.0528848419  
596264  
Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.10164698331704  
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Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.81762457714  
24246  
Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.84720362638296  
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551  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9434329709  
442818  
Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.96074248061846  
71  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9866648928979  
739

Similarities (sorted = True) for probe/Andrew\_Garfield\_5.jpg:  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.51184823429  
40326  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8922395165519  
528  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9766701600  
29526  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9976523441622

764

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.13284052450038  
83

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Similarities (sorted = True) for probe/Robert\_Downey\_Jr\_1.jpg:

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.5327794293  
313474

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8283363079398  
45

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.98268089296951  
77

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.99618832500  
84366

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.1081481213202  
407

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Similarities (sorted = True) for probe/Robert\_Downey\_Jr\_2.jpg:

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.4476615891  
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Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.9041880036517  
181

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.93646507004  
03954

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.95477640912040  
35

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9608237586306  
525

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Similarities (sorted = True) for probe/Robert\_Downey\_Jr\_3.jpg:

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.4869309789  
830327

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.85154030459  
36545

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9464509236945  
816

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.95880465421919  
88

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 1.0192072206183  
629

-----  
Similarities (sorted = True) for probe/Robert\_Downey\_Jr\_4.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8778092785237  
376

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9227975724  
90835

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.95105942227  
91872

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9688892378693  
101

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.00290472734337  
5

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Similarities (sorted = True) for probe/Robert\_Downey\_Jr\_5.jpg:

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.5188614036  
574415

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.95047581547

82622

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.0034962592205305

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.0262054862434384

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 1.0529398837193846

-----  
Similarities (sorted = True) for probe/Ryan\_Reynolds\_1.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.2457490012238982

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.8898748618398434

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8921521348743086

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9714298356368658

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.977776664351927

-----  
Similarities (sorted = True) for probe/Ryan\_Reynolds\_2.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.40342378681941493

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.8065944023765104

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8501156774768839

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9557263602791625

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.0753154474460298

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Similarities (sorted = True) for probe/Ryan\_Reynolds\_3.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.37480914537644716

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.872087684552568

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.9979138003105702

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.0161576752001544

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.0286593042060885

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Similarities (sorted = True) for probe/Ryan\_Reynolds\_4.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.4615049578355035

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.7491269568458181

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8811364925488543

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9470339278425751

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9918449987034041

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Similarities (sorted = True) for probe/Ryan\_Reynolds\_5.jpg:

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.6272424240374  
075  
Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.72378358406743  
98  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.91511407474  
91071  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9323573089  
434873  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9867274172584  
591

Similarities (sorted = True) for probe/Lionel\_Messi\_1.jpg:

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.42131351070998  
213  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8218267577593  
388  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.8574651614909  
02  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.94762285363  
56309  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.0359681352  
699819

Similarities (sorted = True) for probe/Lionel\_Messi\_2.jpg:

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.36440370660000  
465  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8299562027271  
142  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.95644678468  
64811  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.0286599134578  
212  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.0932118318  
139332

Similarities (sorted = True) for probe/Lionel\_Messi\_3.jpg:

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.58015151906707  
56  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.7627863717251  
51  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9371128439838  
389  
Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9770182812  
900349  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 1.03025150285  
51682

Similarities (sorted = True) for probe/Lionel\_Messi\_4.jpg:

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.48728992792161  
363  
Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.7613027946791  
906  
Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.96150127906  
44711  
Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.9749184797035

976

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.1114006505725436

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Similarities (sorted = True) for probe/Lionel\_Messi\_5.jpg:

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 0.5003155099749823

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8137303822390364

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8215791865340056

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 1.004640596094028

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.100088685168262

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Similarities (sorted = True) for probe/Gordon\_Ramsay\_1.jpg:

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.2520639455346124

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8783479741445681

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8879754491163478

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9576756009663171

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.1284164055219053

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Similarities (sorted = True) for probe/Gordon\_Ramsay\_2.jpg:

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.5576199034184046

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8364542373980852

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.9337196821983744

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 1.0350002276719785

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.09507407122247

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Similarities (sorted = True) for probe/Gordon\_Ramsay\_3.jpg:

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.3506785434672717

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8666591556596841

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8703256079551389

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9429317813568401

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.0883606162254824

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Similarities (sorted = True) for probe/Gordon\_Ramsay\_4.jpg:

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.5658710482575604

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.8591787399606805

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.9335195370658713

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9778102924264626

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.0251526764717285

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Similarities (sorted = True) for probe/Gordon\_Ramsay\_5.jpg:

Gallery image: gallery/Gordon\_Ramsay.jpg, Similarity score: 0.47454789483559756

Gallery image: gallery/Ryan\_Reynolds.jpg, Similarity score: 0.8365805526458697

Gallery image: gallery/Robert\_Downey\_Jr.jpg, Similarity score: 0.9659010562891873

Gallery image: gallery/Andrew\_Garfield.jpg, Similarity score: 0.9742863489032564

Gallery image: gallery/Lionel\_Messi.jpg, Similarity score: 1.0564961802215185  
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```
In [31]: import numpy as np
import matplotlib.pyplot as plt

# Compute the rank of the correct match for each probe image
ranks = []
for probe_img, gallery_list in similarities_dict.items():
    # Sort the gallery images by similarity score (highest similarity first)
    sorted_gallery = sorted(gallery_list, key=lambda x: x[1])

    # Get the probe identity using the mapping
    probe_identity = probe_mapping[probe_img]

    correct_rank = None
    for rank, (gallery_img, score) in enumerate(sorted_gallery, start=1):
        # print(f"Rank {rank}: Comparing {probe_img} with {gallery_img} (score: {score})")
        # Check if the identity matches using the mapping
        if gallery_mapping[gallery_img] == probe_identity:
            # print(f"Correct match found for {probe_img} at rank {rank}: {score}")
            correct_rank = rank
            break
    if correct_rank is not None:
        ranks.append(correct_rank)
    else:
        # If no match is found, append infinity to indicate no correct match
        ranks.append(np.inf)

# Calculate the CMC curve:
# For each rank k, compute the fraction of probes with a correct match at or below rank k
max_rank = len(gallery_mapping)
cmc = np.zeros(max_rank)
num_probes = len(ranks)
for k in range(1, max_rank + 1):
    cmc[k - 1] = np.sum(np.array(ranks) <= k) / num_probes

print("Cumulative Matching Characteristic (CMC): ", list(cmc))
```

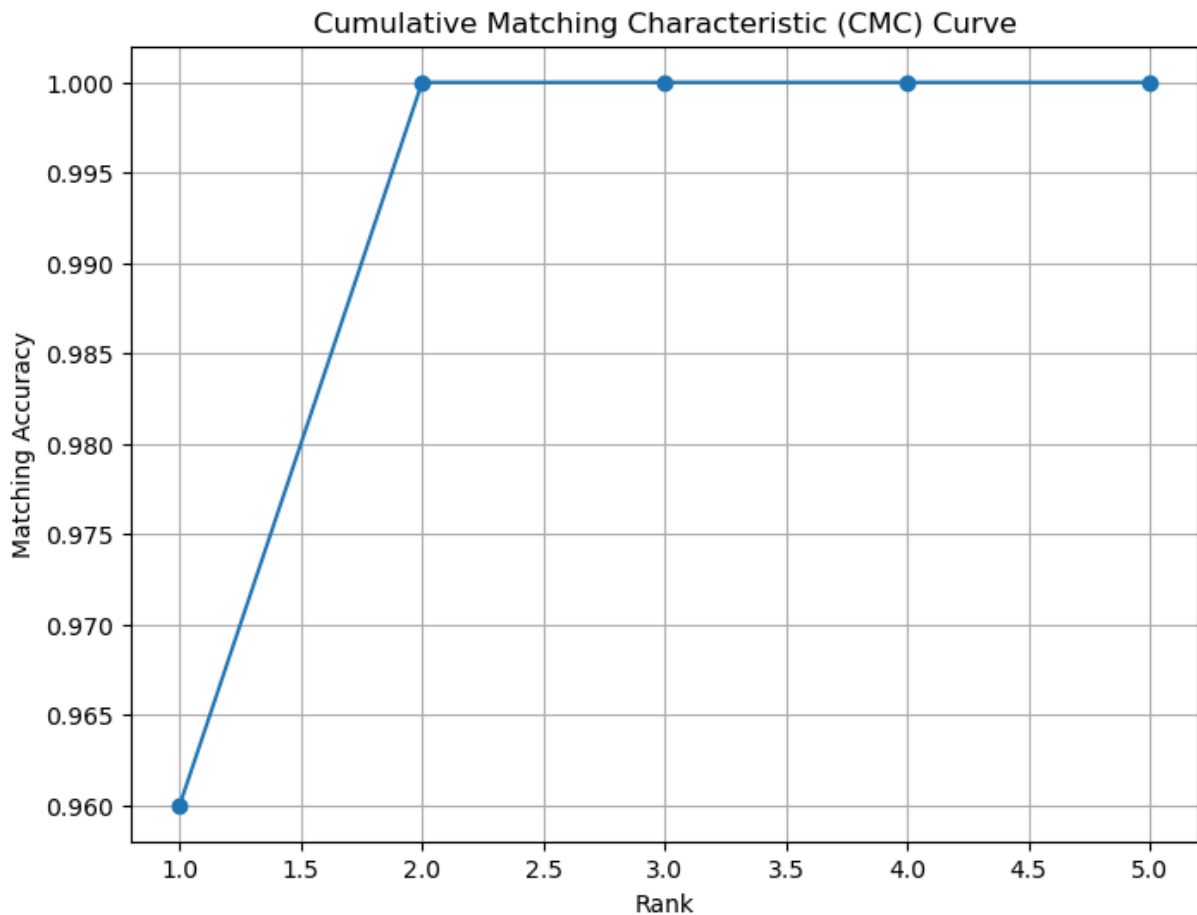
```

# Rank-1 Accuracy is the first value of the CMC curve
rank1_accuracy = cmc[0]
print("Rank-1 Accuracy:", rank1_accuracy)

# Plot the CMC curve
plt.figure(figsize=(8, 6))
plt.plot(range(1, max_rank + 1), cmc, marker="o")
plt.xlabel("Rank")
plt.ylabel("Matching Accuracy")
plt.title("Cumulative Matching Characteristic (CMC) Curve")
plt.grid(True)
plt.show()

```

Cumulative Matching Characteristic (CMC): [0.96, 1.0, 1.0, 1.0, 1.0]  
Rank-1 Accuracy: 0.96



## Comments:

1. What are the different steps of processing facial images that the verify function of the RetinaFace API takes to process and compare facial images?
  - A. The `verify` function first converts facial images to vectors.
  - B. Then it calculates the cosine similarity between the those vectors.



- C. Vectors of images of the same person should exhibit higher similarity (or lower distance) than vectors of images of different persons.
  - D. (Optional) If a threshold is given, the function will use that for comparison. If the distance is less than the threshold, the images are considered to be of the same person.
2. If you trained the ArcFace model from scratch, what type of tasks would you be able to perform within a face recognition pipeline?
- A. Face detection: Identify and locate faces in an image.
  - B. Face alignment: Align the detected faces to a standard shape.
  - C. Face embedding: Convert the aligned faces into a feature vector that can be used for face recognition.
  - D. Face verification: Compare the similarity between two face embeddings to determine if they are of the same person.
3. Can it perform face detection or alignment?
- Yes, it can perform both face detection and alignment.
4. Are these tasks performed automatically in the code you used for this homework?
- Yes, the code automatically performs face detection and alignment as part of the face recognition pipeline. DeepFace use RetinaFace for face detection and alignment, and ArcFace for face embedding generation. The `verify` function handles the entire process, from detecting faces to comparing embeddings.