In [3]:
```
using JuMP
using Cbc
```

In [4]:
```
projects1 = [200 0 5 800
            -13.75 0.5 5 250
            125 1 4 700
            307 1 3 650
            -1.25 1 2 350
            393 0 2 800
            442.5 0 2 600
            265 0.5 1 400]
            #322 0.25 5 300
            #-100 1 1 400]

projects = [200    0.5  2 850
            -13.75 0    3 450
            125    1    4 700
            307    1    3 650
            -1.25  1    2 350
            393    0    2 800
            442.5  0    2 600
            265    0.5  1 400]

alternatives = ['A', 'B', 'C', 'D', 'E', 'F', 'G', 'H']#, 'I', 'J']

v1 = (projects[:, 1] .- minimum(projects[:, 1])) ./ (maximum(projects[:, 1]) - minim
v2 = (projects[:, 2] .- minimum(projects[:, 2])) ./ (maximum(projects[:, 2]) - minim
v3 = (projects[:, 3] .- minimum(projects[:, 3])) ./ (maximum(projects[:, 3]) - minim

weights = [0.25 0.25 0.5]
v = [v1 v2 v3] * transpose(weights);
```

In [6]:
```
function generate_model(vB)
    model = Model(Cbc.Optimizer)
    @variable(model, x[i in 1:size(projects, 1)], Bin)

    @objective(model, Max, sum(x.*(v.-vB)) + vB)
    @constraint(model, sum(x.*projects[:, 4]) <= 2500)

    return model
end
```

Out[6]:
```
generate_model (generic function with 1 method)
```

Sanity check for the consultancy company example with the

$$v^B = 0.258$$

In [7]:
```
model = generate_model(0.258)
set_silent(model)
optimize!(model)
x = value.(model[:x])
```

Out[7]:
```
8-element Vector{Float64}:
 0.0
 0.0
 1.0
 1.0
```

```
1.0
0.0
1.0
0.0
```

Print-based representation of the optimal portfolios when the baseline value is adjusted in increments of 0.01.

In [22]:

```
for vB = -1:0.01:1
    model = generate_model(vB)
    set_silent(model)
    optimize!(model)
    x = value.(model[:x])

    print("$(vB): $(alternatives[x .== 1]) \n")
end
```

```
-1.0: ['B', 'C', 'E', 'G', 'H']
-0.99: ['B', 'C', 'E', 'G', 'H']
-0.98: ['B', 'C', 'E', 'G', 'H']
-0.97: ['B', 'C', 'E', 'G', 'H']
-0.96: ['B', 'C', 'E', 'G', 'H']
-0.95: ['B', 'C', 'E', 'G', 'H']
-0.94: ['B', 'C', 'E', 'G', 'H']
-0.93: ['B', 'C', 'E', 'G', 'H']
-0.92: ['B', 'C', 'E', 'G', 'H']
-0.91: ['B', 'C', 'E', 'G', 'H']
-0.9: ['B', 'C', 'E', 'G', 'H']
-0.89: ['B', 'C', 'E', 'G', 'H']
-0.88: ['B', 'C', 'E', 'G', 'H']
-0.87: ['B', 'C', 'E', 'G', 'H']
-0.86: ['B', 'C', 'E', 'G', 'H']
-0.85: ['B', 'C', 'E', 'G', 'H']
-0.84: ['B', 'C', 'E', 'G', 'H']
-0.83: ['B', 'C', 'E', 'G', 'H']
-0.82: ['B', 'C', 'E', 'G', 'H']
-0.81: ['B', 'C', 'E', 'G', 'H']
-0.8: ['B', 'C', 'E', 'G', 'H']
-0.79: ['B', 'C', 'E', 'G', 'H']
-0.78: ['B', 'C', 'E', 'G', 'H']
-0.77: ['B', 'C', 'E', 'G', 'H']
-0.76: ['B', 'C', 'E', 'G', 'H']
-0.75: ['B', 'C', 'E', 'G', 'H']
-0.74: ['B', 'C', 'E', 'G', 'H']
-0.73: ['B', 'C', 'E', 'G', 'H']
-0.72: ['B', 'C', 'E', 'G', 'H']
-0.71: ['B', 'C', 'E', 'G', 'H']
-0.7: ['B', 'C', 'E', 'G', 'H']
-0.69: ['B', 'C', 'E', 'G', 'H']
-0.68: ['B', 'C', 'E', 'G', 'H']
-0.67: ['B', 'C', 'E', 'G', 'H']
-0.66: ['B', 'C', 'E', 'G', 'H']
-0.65: ['B', 'C', 'E', 'G', 'H']
-0.64: ['B', 'C', 'E', 'G', 'H']
-0.63: ['B', 'C', 'E', 'G', 'H']
-0.62: ['B', 'C', 'E', 'G', 'H']
-0.61: ['B', 'C', 'E', 'G', 'H']
-0.6: ['B', 'C', 'E', 'G', 'H']
-0.59: ['B', 'C', 'E', 'G', 'H']
-0.58: ['B', 'C', 'E', 'G', 'H']
-0.57: ['B', 'C', 'E', 'G', 'H']
-0.56: ['B', 'C', 'E', 'G', 'H']
-0.55: ['B', 'C', 'E', 'G', 'H']
-0.54: ['B', 'C', 'E', 'G', 'H']
-0.53: ['B', 'C', 'E', 'G', 'H']
-0.52: ['B', 'C', 'E', 'G', 'H']
-0.51: ['B', 'C', 'E', 'G', 'H']
```

```
-0.5: ['B', 'C', 'E', 'G', 'H']
-0.49: ['B', 'C', 'E', 'G', 'H']
-0.48: ['B', 'C', 'E', 'G', 'H']
-0.47: ['B', 'C', 'E', 'G', 'H']
-0.46: ['B', 'C', 'E', 'G', 'H']
-0.45: ['B', 'C', 'E', 'G', 'H']
-0.44: ['B', 'C', 'E', 'G', 'H']
-0.43: ['B', 'C', 'E', 'G', 'H']
-0.42: ['B', 'C', 'E', 'G', 'H']
-0.41: ['B', 'C', 'E', 'G', 'H']
-0.4: ['B', 'C', 'E', 'G', 'H']
-0.39: ['B', 'C', 'E', 'G', 'H']
-0.38: ['B', 'C', 'E', 'G', 'H']
-0.37: ['B', 'C', 'E', 'G', 'H']
-0.36: ['B', 'C', 'E', 'G', 'H']
-0.35: ['B', 'C', 'E', 'G', 'H']
-0.34: ['B', 'C', 'E', 'G', 'H']
-0.33: ['B', 'C', 'E', 'G', 'H']
-0.32: ['B', 'C', 'E', 'G', 'H']
-0.31: ['B', 'C', 'E', 'G', 'H']
-0.3: ['B', 'C', 'E', 'G', 'H']
-0.29: ['B', 'C', 'E', 'G', 'H']
-0.28: ['B', 'C', 'E', 'G', 'H']
-0.27: ['B', 'C', 'E', 'G', 'H']
-0.26: ['B', 'C', 'E', 'G', 'H']
-0.25: ['B', 'C', 'E', 'G', 'H']
-0.24: ['B', 'C', 'E', 'G', 'H']
-0.23: ['B', 'C', 'E', 'G', 'H']
-0.22: ['B', 'C', 'E', 'G', 'H']
-0.21: ['B', 'C', 'E', 'G', 'H']
-0.2: ['B', 'C', 'E', 'G', 'H']
-0.19: ['B', 'C', 'E', 'G', 'H']
-0.18: ['B', 'C', 'E', 'G', 'H']
-0.17: ['B', 'C', 'E', 'G', 'H']
-0.16: ['B', 'C', 'E', 'G', 'H']
-0.15: ['B', 'C', 'E', 'G', 'H']
-0.14: ['C', 'D', 'E', 'G']
-0.13: ['C', 'D', 'E', 'G']
-0.12: ['C', 'D', 'E', 'G']
-0.11: ['C', 'D', 'E', 'G']
-0.1: ['C', 'D', 'E', 'G']
-0.09: ['C', 'D', 'E', 'G']
-0.08: ['C', 'D', 'E', 'G']
-0.07: ['C', 'D', 'E', 'G']
-0.06: ['C', 'D', 'E', 'G']
-0.05: ['C', 'D', 'E', 'G']
-0.04: ['C', 'D', 'E', 'G']
-0.03: ['C', 'D', 'E', 'G']
-0.02: ['C', 'D', 'E', 'G']
-0.01: ['C', 'D', 'E', 'G']
0.0: ['C', 'D', 'E', 'G']
0.01: ['C', 'D', 'E', 'G']
0.02: ['C', 'D', 'E', 'G']
0.03: ['C', 'D', 'E', 'G']
0.04: ['C', 'D', 'E', 'G']
0.05: ['C', 'D', 'E', 'G']
0.06: ['C', 'D', 'E', 'G']
0.07: ['C', 'D', 'E', 'G']
0.08: ['C', 'D', 'E', 'G']
0.09: ['C', 'D', 'E', 'G']
0.1: ['C', 'D', 'E', 'G']
0.11: ['C', 'D', 'E', 'G']
0.12: ['C', 'D', 'E', 'G']
0.13: ['C', 'D', 'E', 'G']
0.14: ['C', 'D', 'E', 'G']
0.15: ['C', 'D', 'E', 'G']
0.16: ['C', 'D', 'E', 'G']
0.17: ['C', 'D', 'E', 'G']
0.18: ['C', 'D', 'E', 'G']
```

```
0.19: ['C', 'D', 'E', 'G']
0.2: ['C', 'D', 'E', 'G']
0.21: ['C', 'D', 'E', 'G']
0.22: ['C', 'D', 'E', 'G']
0.23: ['C', 'D', 'E', 'G']
0.24: ['C', 'D', 'E', 'G']
0.25: ['C', 'D', 'E', 'G']
0.26: ['C', 'D', 'E', 'G']
0.27: ['C', 'D', 'E', 'G']
0.28: ['C', 'D', 'E', 'G']
0.29: ['C', 'D', 'E', 'G']
0.3: ['C', 'D', 'E', 'G']
0.31: ['C', 'D', 'E', 'G']
0.32: ['C', 'D', 'E', 'G']
0.33: ['C', 'D', 'E', 'G']
0.34: ['C', 'D', 'E', 'G']
0.35: ['C', 'D', 'E', 'G']
0.36: ['C', 'D', 'E', 'G']
0.37: ['C', 'D', 'E', 'G']
0.38: ['C', 'D', 'E', 'G']
0.39: ['C', 'D', 'E', 'G']
0.4: ['C', 'D', 'E', 'G']
0.41: ['C', 'D', 'E', 'G']
0.42: ['C', 'D', 'E']
0.43: ['C', 'D']
0.44: ['C', 'D']
0.45: ['C', 'D']
0.46: ['C', 'D']
0.47: ['C', 'D']
0.48: ['C', 'D']
0.49: ['C', 'D']
0.5: ['C', 'D']
0.51: ['C', 'D']
0.52: ['C', 'D']
0.53: ['C', 'D']
0.54: ['C', 'D']
0.55: ['C', 'D']
0.56: ['C', 'D']
0.57: ['C', 'D']
0.58: ['C', 'D']
0.59: ['C', 'D']
0.6: ['C', 'D']
0.61: ['C', 'D']
0.62: ['C', 'D']
0.63: ['C', 'D']
0.64: ['C', 'D']
0.65: ['C', 'D']
0.66: ['C', 'D']
0.67: ['C', 'D']
0.68: ['C', 'D']
0.69: ['C', 'D']
0.7: ['C', 'D']
0.71: ['C', 'D']
0.72: ['C', 'D']
0.73: ['C', 'D']
0.74: ['C', 'D']
0.75: ['C', 'D']
0.76: ['C']
0.77: ['C']
0.78: ['C']
0.79: ['C']
0.8: ['C']
0.81: ['C']
0.82: ['C']
0.83: Char[]
0.84: Char[]
0.85: Char[]
0.86: Char[]
0.87: Char[]
```

```
0.88: Char[]
0.89: Char[]
0.9: Char[]
0.91: Char[]
0.92: Char[]
0.93: Char[]
0.94: Char[]
0.95: Char[]
0.96: Char[]
0.97: Char[]
0.98: Char[]
0.99: Char[]
1.0: Char[]
```

Examples of shortly commenting the results:

- The project C is included throughout the interval, until $v^B = 0.83$ after which the optimal portfolio is empty
- Changes in alternative A result in it not being included in any of the optimal portfolios
- B is now included in the portfolio only when the baseline is negative
- The change in scaling has changed the range of the alternative values, as the portfolio becomes empty with a larger baseline
-

In [ ]: