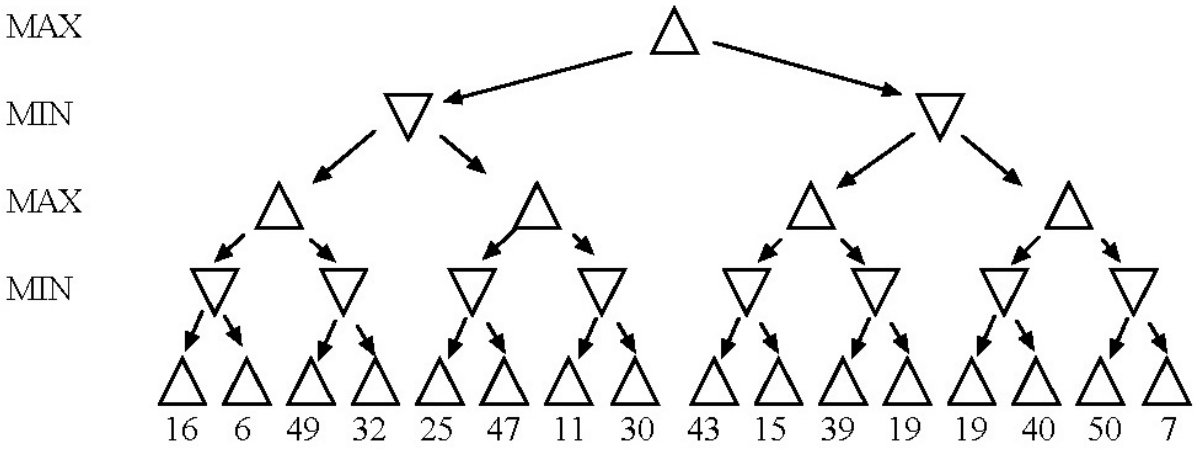
第五週建議作業

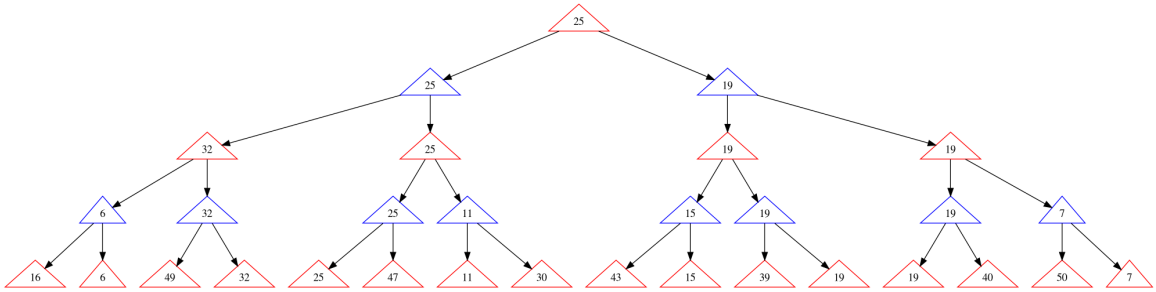
- 參考 AIMA 圖 5.2，採用 minimax 演算法，以下的 game tree 中，最上層的 MAX 該走左側選項或者右側選項，為什麼？
  - 

按照這棵 game tree，回溯計算評分結果為：**(紅為 MAX，藍為 MIN)**

In [1]:

```
digraph {
    a00[shape=triangle, label="25", color=red]

    b00[shape=triangle, label="25", color=blue]
    b01[shape=triangle, label="19", color=blue]

    a00->b00
    a00->b01

    a10[shape=triangle, label="32", color=red]
    a11[shape=triangle, label="25", color=red]
    a12[shape=triangle, label="19", color=red]
    a13[shape=triangle, label="19", color=red]

    b00->a10
    b00->a11
    b01->a12
    b01->a13

    b10[shape=triangle, label="6", color=blue]
    b11[shape=triangle, label="32", color=blue]
    b12[shape=triangle, label="25", color=blue]
    b13[shape=triangle, label="11", color=blue]
    b14[shape=triangle, label="15", color=blue]
    b15[shape=triangle, label="19", color=blue]
    b16[shape=triangle, label="19", color=blue]
    b17[shape=triangle, label="7", color=blue]

    a10->b10
    a10->b11
    a11->b12
    a11->b13
    a12->b14
    a12->b15
    a13->b16
    a13->b17

    a20[shape=triangle, label="16", color=red]
    a21[shape=triangle, label="6", color=red]
    a22[shape=triangle, label="49", color=red]
    a23[shape=triangle, label="32", color=red]
    a24[shape=triangle, label="25", color=red]
    a25[shape=triangle, label="47", color=red]
    a26[shape=triangle, label="11", color=red]
    a27[shape=triangle, label="30", color=red]
    a28[shape=triangle, label="43", color=red]
    a29[shape=triangle, label="15", color=red]
    a2A[shape=triangle, label="39", color=red]
    a2B[shape=triangle, label="19", color=red]
    a2C[shape=triangle, label="19", color=red]
    a2D[shape=triangle, label="40", color=red]
    a2E[shape=triangle, label="50", color=red]
    a2F[shape=triangle, label="7", color=red]

    b10->a20
    b10->a21
    b11->a22
    b11->a23
    b12->a24
```

```
    b12->a25
    b13->a26
    b13->a27
    b14->a28
    b14->a29
    b15->a2A
    b15->a2B
    b16->a2C
    b16->a2D
    b17->a2E
    b17->a2F
}
```

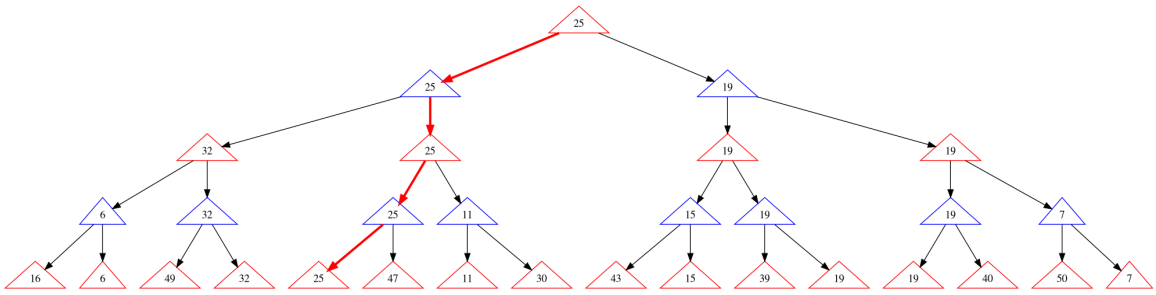


並得整個的決策路線如下：

In [2]:

```
digraph {
    a00[shape=triangle, label="25", color=red]

    b00[shape=triangle, label="25", color=blue]
    b01[shape=triangle, label="19", color=blue]

    a00->b00[color=red, penwidth=3.0]
    a00->b01

    a10[shape=triangle, label="32", color=red]
    a11[shape=triangle, label="25", color=red]
    a12[shape=triangle, label="19", color=red]
    a13[shape=triangle, label="19", color=red]

    b00->a10
    b00->a11[color=red, penwidth=3.0]
    b01->a12
    b01->a13

    b10[shape=triangle, label="6", color=blue]
    b11[shape=triangle, label="32", color=blue]
    b12[shape=triangle, label="25", color=blue]
    b13[shape=triangle, label="11", color=blue]
    b14[shape=triangle, label="15", color=blue]
    b15[shape=triangle, label="19", color=blue]
    b16[shape=triangle, label="19", color=blue]
    b17[shape=triangle, label="7", color=blue]

    a10->b10
    a10->b11
    a11->b12[color=red, penwidth=3.0]
    a11->b13
    a12->b14
    a12->b15
    a13->b16
    a13->b17

    a20[shape=triangle, label="16", color=red]
    a21[shape=triangle, label="6", color=red]
    a22[shape=triangle, label="49", color=red]
    a23[shape=triangle, label="32", color=red]
    a24[shape=triangle, label="25", color=red]
    a25[shape=triangle, label="47", color=red]
    a26[shape=triangle, label="11", color=red]
    a27[shape=triangle, label="30", color=red]
    a28[shape=triangle, label="43", color=red]
    a29[shape=triangle, label="15", color=red]
    a2A[shape=triangle, label="39", color=red]
    a2B[shape=triangle, label="19", color=red]
    a2C[shape=triangle, label="19", color=red]
    a2D[shape=triangle, label="40", color=red]
    a2E[shape=triangle, label="50", color=red]
    a2F[shape=triangle, label="7", color=red]

    b10->a20
    b10->a21
    b11->a22
    b11->a23
    b12->a24[color=red, penwidth=3.0]
```

```
    b12->a25
    b13->a26
    b13->a27
    b14->a28
    b14->a29
    b15->a2A
    b15->a2B
    b16->a2C
    b16->a2D
    b17->a2E
    b17->a2F
}
```



因此，最上層的應該是走左邊那條路。因為回溯到第二層的分數時，左邊的 25 > 右邊的 19，而第一步棋，應當選擇 MAX 來走。

- 參考 Neapolitan.GA.pdf Table 9.4，搭配 order.crossover.pdf 的說明，決定下列以 GA 處理 TSP 問題時，所產生的子代基因序列。以紅色直線代表一號切點，藍色直線代表二號切點。
  - 問題一
    - 1 2 | 3 4 5 6 | 7 8 9
    - 1 3 | 5 7 9 2 | 4 6 8

In [6]:

```
splitList :: Int -> Int -> [Int] -> ([Int], [Int], [Int])
splitList c1 c2 lst
  | c1 < c2 = split c1 c2 lst
  | otherwise = split c2 c1 lst
  where split left right lst = let (l1, lo) = splitAt left lst
                                   (l2, l3) = splitAt (right - left) lo
                               in (l1, l2, l3)

filterList :: [Int] -> [Int] -> [Int]
filterList fix [] = []
filterList fix (x:xs)
  | x `elem` fix = filterList fix xs
  | otherwise = x:filterList fix xs


neapolitanGaMid :: Int -> Int -> [Int] -> [Int] -> ([Int], [Int])
neapolitanGaMid c1 c2 l1 l2 =
  let (l1Left, l1Mid, l1Right) = splitList c1 c2 l1
      (l2Left, l2Mid, l2Right) = splitList c1 c2 l2

      filteredL1 = filterList l2Mid (l1Mid ++ l1Right ++ l1Left)
      filteredL2 = filterList l1Mid (l2Mid ++ l2Right ++ l2Left)

      (filteredL1Left, filteredL1Right) = splitAt c1 filteredL1
      (filteredL2Left, filteredL2Right) = splitAt c1 filteredL2

  in (filteredL2Left ++ l1Mid ++ filteredL2Right,
      filteredL1Left ++ l2Mid ++ filteredL1Right)


neapolitanGaSide :: Int -> Int -> [Int] -> [Int] -> ([Int], [Int])
neapolitanGaSide c1 c2 l1 l2 =
  let (l1Left, l1Mid, l1Right) = splitList c1 c2 l1
      (l2Left, l2Mid, l2Right) = splitList c1 c2 l2

      filteredL1 = filterList (l2Left ++ l2Right) (l1Right ++ l1Left ++ l1Mid)
      filteredL2 = filterList (l1Left ++ l1Right) (l2Right ++ l2Left ++ l2Mid)

  in (l1Left ++ filteredL2 ++ l1Right, l2Left ++ filteredL1 ++ l2Right)

neapolitanGa :: Int -> Int -> [Int] -> [Int] -> ([Int], [Int])
neapolitanGa c1 c2 l1 l2
  | c1 < c2 = neapolitanGaMid c1 c2 l1 l2
  | c1 > c2 = neapolitanGaSide c1 c2 l1 l2
```

In [7]:

```
-- 第一小題

l1 = [1, 2, 3, 4, 5, 6, 7, 8, 9]
l2 = [1, 3, 5, 7, 9, 2, 4, 6, 8]

neapolitanGa 2 6 l1 l2
```

```
([7,9,3,4,5,6,2,8,1],[3,4,5,7,9,2,6,8,1])
```

由上述執行結果可知，本次的 GA 演算執行完後，結果是：

- 7 9 3 4 5 6 2 8 1
- 3 4 5 7 9 2 6 8 1

- (續上題)
  - 問題二 (更正版題目，原本的題目誤植了兩個5)
    - 1 2 | 3 4 5 6 7 | 8 9
    - 1 3 | 5 7 9 2 4 | 6 8

In [8]:

```
-- 第二小題

l1 = [1, 2, 3, 4, 5, 6, 7, 8, 9]
l2 = [1, 3, 5, 7, 9, 2, 4, 6, 8]

neapolitanGa 7 2 l1 l2
```

```
([1,2,6,3,5,7,4,8,9],[1,3,9,2,4,5,7,6,8])
```

由上述執行結果可知，本次的 GA 演算執行完後，結果是：

- 1 2 6 3 5 7 4 8 9
- 1 3 9 2 4 5 7 6 8

- 延用上課時所建立的 simulated.annealing.xlsx 檔案，驗證 simulated annealing 演算法，從比較好的節點走向比較差的節點的機率有如下的特點
  - 在 T 固定的時候，隨著 ΔE 的變小而變小
  - 在 ΔE 固定的時候，隨著 T 的變小而變小

In [4]:

```
simAnneal :: Float -> Float -> Float
simAnneal t dE = exp $ dE / t
```

In [5]:

```
t = 16
dEs = [-0.3, -0.8, -10]

probTs = map (simAnneal t) dEs
probTs
```

```
[0.9814247,0.95122945,0.53526145]
```

In [6]:

```
tt = 8
probTTs = map (simAnneal tt) dEs
probTTs
```

```
[0.96319443,0.9048374,0.2865048]
```

由上述程式結果可看出以下趨勢：

ΔE/T	16	8
-0.3	0.9814247	0.96319443
-0.8	0.95122945	0.9048374
-10	0.53526145	0.2865048

而按 Probility 計算公式：

$$\exp^{\Delta E/T}$$

可得：

- 當 T (時間溫度函式) 固定時，ΔE 越小，則降溫機率越小
- 當 ΔE 固定時，T 越小，機率理應越大，但因 ΔE < 0，因此導致降溫機率反而越小

In [ ]: