Ex. 1 (Lec. 18, problem 5, see also Nov. 16 notes)

\[ \text{Dijkstra} \rightarrow \]

a) Which of A's links can have the highest cost?
* Not "AD", because "ADF" is optimal path, hence \( |AD| + |DF| \leq |AF| \) \( \Rightarrow |AD| < |AF| \)
* "AB" possible:

\[ \text{Constructing an example: set arbitrary weights for the optimal routing tree links, other links should have weights > distance on the "ORT"} \]

b) Which A's links can have lowest costs?
* Not "AF" (see (a))
* "AB" possible:

\[ \text{Constructing an example, set arbitrary weights for the optimal routing tree, then set "sufficiently large" weights elsewhere} \]
Ex. 1 (continued)

Dijkstra QC

puts "CB", "CD", "CE" onto the optimal routing tree

C Which other links are guaranteed to be on the optimal routing tree QC?

* "AD" is guaranteed:
  since "ADC" is the only optimal path A -> C,
  "CPA" is the only optimal path C -> A
* Since "ORT" is a tree containing "CB", "CD", "CE", "AD": "BD", "DE", "AB" are not on it

* Example

shows that "AF" and "EF" are not necessarily on the tree

* Example

shows that "DF" is not necessarily on the tree

Which links are guaranteed not to be on the "ORTQC"?

* "BD", "DE", "AB" by the "tree" and "optimality" args.
* Not "DF" and not "EF", by the examples above
* "AF", because "ADF" being optimal means |AD| + |DF| < |AF|, hence |AF| > |DF|, hence |DA| + |AF| > |DF|
Ex. 2

Packet size = 1 KB
Transmission rate = 100 KB/sec
Propagation time = 10 ms (roundtrip)
ACK size ≈ 0

**Minimal RTT** = ?

Transmission time = \( \frac{\text{packet size}}{\text{transmit rate}} = \frac{1}{100} \text{ sec} = 10 \text{ ms} \)

Min. RTT = Transmit time + Prop. time = 20 ms.

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Ex. 3

**RTT Smoothing Algorithm:**

\[ S_n = S_{n-1} + 0.1 (R_n - S_{n-1}) \]

\( R_n \) oscillates around 2 ms "sinusoidally" with amplitude 2 ms and period 4 samples

What will be the behavior of \( S_n \)?

**H(e^{j\omega})** = \( \frac{0.1}{1 - 0.9 e^{-j\omega}} \)

Sinusoids with period = 4: \( \omega = \frac{\pi}{2} \) (= \( \frac{2\pi}{4} \))

\[ |H(e^{j\frac{\pi}{2}})| = \left| \frac{0.1}{1 - 0.9 j} \right| = \frac{0.1}{\sqrt{1.81}} \approx 0.074 \]

\[ |H(e^{j0})| = \left| \frac{0.1}{1 - 0.9 \cdot 1} \right| = 1 \]

\( S_n \) will oscillate around 2 ms with period 4 samples and amplitude \( \approx 0.074 \cdot 2 \approx 0.15 \)