Fundamentals of Traffic Operations and Control
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Exercise solutions
Adaptive Signal Control

For each vehicle, the travel time from "arrival" to the detectors:

$$\frac{L\ -L_d}{v_{free}} = \frac{110\ -20}{15} s = 6\ s$$

The arrival time to detectors can be obtained as

ARRIVALS (A)	ARRIVALS (B)
7.5	
11.2	
13.6	
	14.5
15.6	
	17.3
17.8	
	21.5
	28.0
29.0	
	31.2
	33.4
38.7	
	38.8
40.4	
	40.6
	43.3

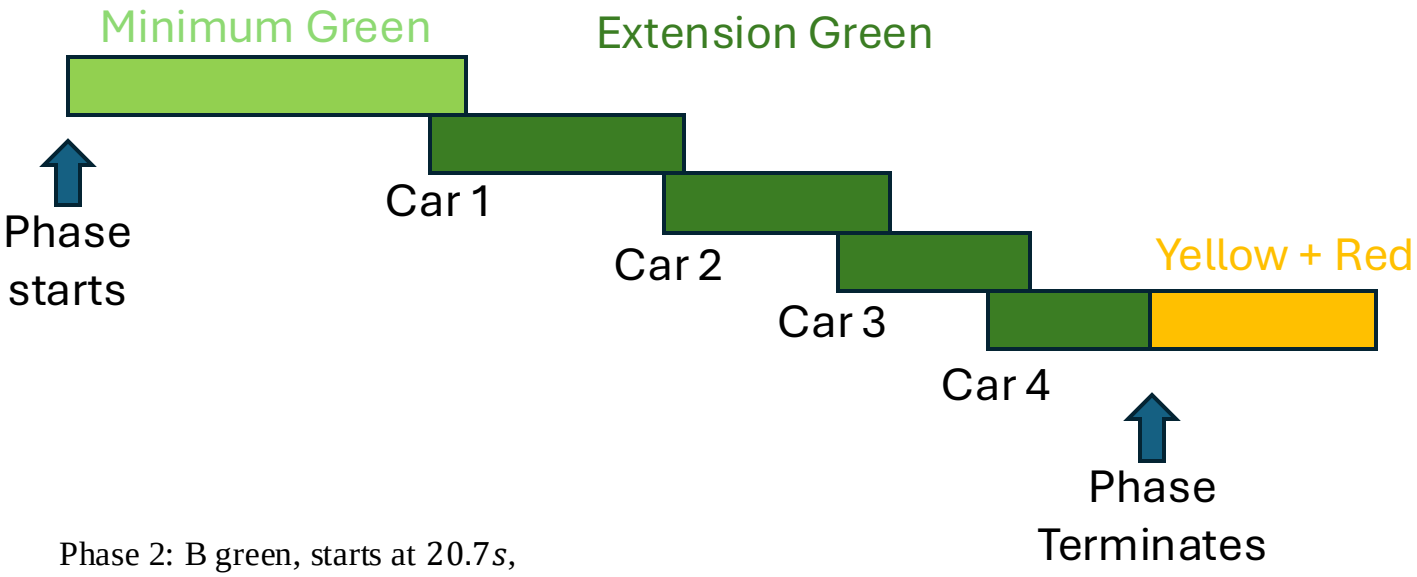
The minimum green time $= \frac{L_d}{L_v} \cdot the\ minimum\ headway = \frac{20}{5} \cdot 2\ s = 8\ s$

The extension policy can be expressed as

$$t_{gap}(T) = \begin{cases} 4, & 0 \le T < 8, \\ -0.25T + 6, & 8 \le T < 16, \\ 2, & T \ge 16. \end{cases}$$

Phase 1: A green
Car 1: $7.5 + t_{gap}(7.5) = 7.5 + 4 = 11.5,$
Car 2: $11.2 + t_{gap}(11.2) = 11.2 - 0.25 \cdot (11.2\ - 0) + 6 = 14.4$
Car 3: $13.6 + t_{gap}(13.6) = 13.6\ - 0.25 \cdot (13.6\ - 0) + 6 = 16.2$
Car 4: $15.6 + t_{gap}(15.6) = 15.6 - 0.25 \cdot (15.6\ - 0) + 6 = 17.7 < 17.8$ (when Car 5 arrives)
Start gap out, green time for Phase 1: $G_A^1 = 17.7\ s$
After "yellow + red" $=\ 17.7s\ +\ 3\ s = 20.7s$

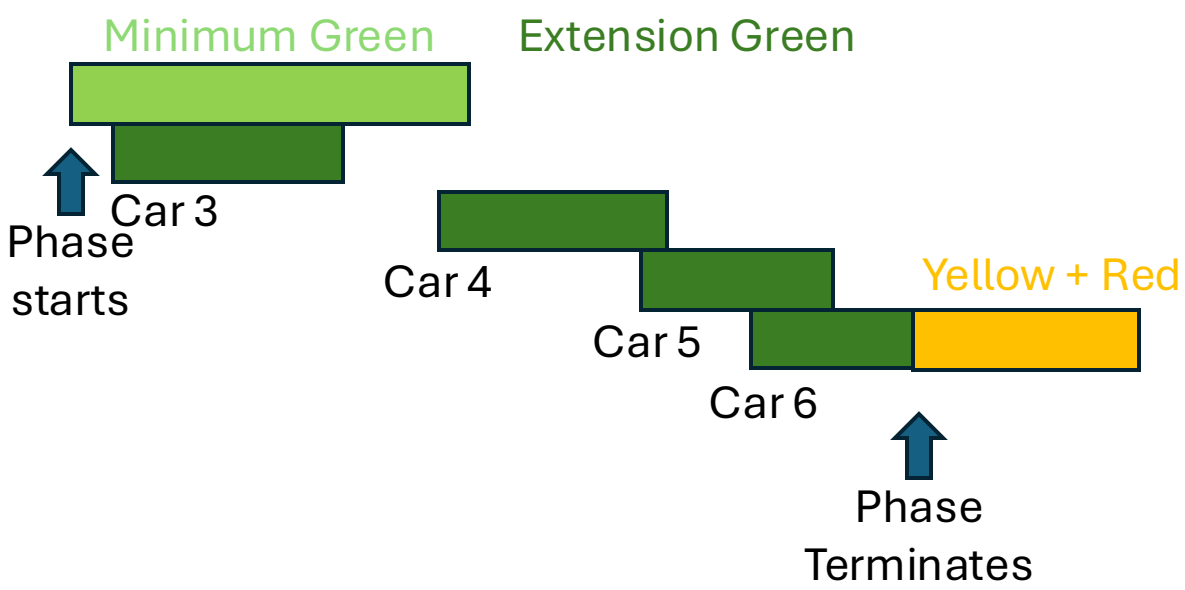
Phase 1 Diagram:



Phase 2: B green, starts at $20.7s$,
minimum green is $20.7 + 8\ s = 28.7s$
Maximum green is $20.7 + 25s = 45.7s$

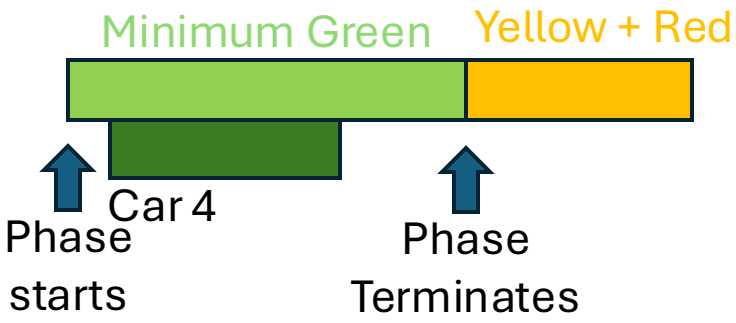
Car 1: 14.5, in the queue,
Car 2: 17.3, in the queue,
Car 1 and Car 2 are in the queue, they need $2 + \ 2 = 4\ s$ to clear.
Car 3: $21.5 + t_{gap}(21.5\ - 20.7) = 21.5 + 4 = 25.5s$
Car 4: $28.0\ s < 28.7s$
$28.0 + t_{gap}(28.0\ - 20.7) = 28.0 + 4 = 32.0s$
Car 5: $31.2\ s < 32.0s$
$31.2 + t_{gap}(31.2\ - 20.7) = 34.575\ s$
Car 6: $33.4\ s < 34.575\ s$
$33.4 + t_{gap}(33.4\ - 20.7) = 36.225s < 38.8$ s (when Car 7 arrives)
Start gap out, green time for Phase 2: $G_B^2 = 36.225\ - 20.7s = 15.525s$.
After "yellow + red" $= 36.225s\ +\ 3\ s = 39.225\ s$.

Phase 2 Diagram:



Phase 3: A green, starts at 39.225s
minimum green is $39.225 + 8\,s = 47.225\,s$
maximum green is $39.225 + 25\,s = 64.225\,s$
Car 1: 17.8, in the queue,
Car 2: 29.0, in the queue,
Car 3: 38.7, in the queue.
3 cars are in the queue, they need $2 + 2 + 2\,\text{s} = 6\,\text{s}$ to clear.
Car 4: $40.4 + t_{gap}(40.4 - 39.225) = 44.4\,s$
Green time for Phase 3: $G_A^3 = 8\,s$
After "yellow + red" = $47.225 + 3\,s = 50.225\,s$.

Phase 3 Diagram:



Phase 4: B green, starts at $50.225\,s$
minimum green is $50.225\,s + 8\,s = 58.225\,s$
maximum green is $50.225\,s + 25\,s = 75.225\,s$
Car 1: 38.8, in the queue,
Car 2: 40.6, in the queue,
Car 3: 43.3, in the queue.
3 cars are in the queue, they need $2 + 2 + 2\,\text{s} = 6\,\text{s}$ to clear.
Green time for Phase 4: $G_B^4 = 8\,s$
After "yellow + red" = $58.225 + 3\,s = 61.225\,s$.

Phase 4 Diagram: