

Task1:

Write a problem formulation for this activity including precise descriptions of the initial state, the actions available at each state, a goal test and a path cost function.

1. Breadth – First Search**NOTE for Breadth – First Search:**

A is Action

P is Preconditions

E is Effect

Initial State: Victoria

Goal: Leicester Square

Knowledge base

(UK Government, 2019)

1. Breadth – First Search		
Knowledge Base	Number of Action	Goal Test
	1.1	
Initial State: Victoria	A: walk (Victoria, Green Park)	
	P: NOT Green Park	
Green Park ←	E: Green Park →	
		Leicester Square? No
	1.2	
	A: walk (Victoria, St. James's Park)	
	P: NOT St. James's Park	
St. James's Park	E: St. James's Park	
		Leicester Square? No
	1.3	
	A: walk (Victoria, Pimlico)	
	P: NOT Pimlico	
Pimlico	E: Pimlico	
		Leicester Square? No
	1.4	
	A: walk (Victoria, Sloane Square)	
	P: NOT Sloane Square	
Sloane Square	E: Sloane Square	
		Leicester Square? No

	2	
	2.1	
	2.1.1	
	A: walk (Green Park , Hyde Park Corner)	
	P: NOT Hyde Park Corner	
Hyde Park Corner	E: Hyde Park Corner	
		Leicester Square? No
	2.1.2	
	A: walk (Green Park , Bond Street)	
	P: NOT Bond Street	
Bond Street	E: Bond Street	
		Leicester Square? No
	2.1.3	
	A: walk (Green Park , Oxford Circus)	
	P: NOT Oxford Circus	
Oxford Circus	Oxford Circus	
		Leicester Square? No
	2.1.4	
	A: walk (Green Park , Piccadilly Circus)	
	P: NOT Piccadilly Circus	
Piccadilly Circus	E: Piccadilly Circus	
		Leicester Square? No
	2.1.5	
	A: walk (Green Park , Westminster)	
	P: NOT Westminster	
Westminster	E: Westminster	
		Leicester Square? No
	2.2	
	2.2.1	
	A: walk (St. James's Park , Westminster)	
	P: NOT Westminster	
	E: Westminster	
		Leicester Square? No
	2.3	
	2.3.1.	
	A: walk (Pimlico, Vauxhall)	
	P: NOT Vauxhall	
Vauxhall	E: Vauxhall	

		Leicester Square? No
	2.4	
	2.4.1.	
	A: walk (Sloane Square, South Kensington)	
	P: NOT South Kensington	
South Kensington	E: South Kensington	
		Leicester Square? No
	3	
	3.1	
	A: walk (Hyde Park Corner, Knightsbridge)	
	P: NOT Knightsbridge	
Knightsbridge	E: Knightsbridge	
		Leicester Square? No
	3.2	
	3.2.1	
	A: walk (Bond Street, Marble Arch)	
	P: NOT Marble Arch	
Marble Arch	E: Marble Arch	
		Leicester Square? No
	3.2.2	
	A: walk (Bond Street, Baker Street)	
	P: NOT Baker Street	
Baker Street	E: Baker Street	
		Leicester Square? No
	3.2.3	
	A: walk (Bond Street, Oxford Circus)	
	P: NOT Oxford Circus	
	E: Oxford Circus	
		Leicester Square? No
	3.3	
	3.3.1	
	A: walk (Oxford Circus, Bond Street)	
	P: NOT Bond Street	
	E: Bond Street	
		Leicester Square? No
	3.3.2	
	A: walk (Oxford Circus, Regent's Park)	
	P: NOT Regent's Park	

Regent's Park	E: Regent's Park	
		Leicester Square? No
	3.3.3	
	A: walk (Oxford Circus, Warren Street)	
	P: NOT Warren Street	
Warren Street	E: Warren Street	
		Leicester Square? No
	3.3.4	
	A: walk (Oxford Circus, Tottenham Court Road)	
	P: NOT Tottenham Court Road	
Tottenham Court Road	E: Tottenham Court Road	
		Leicester Square? No
	3.3.5	
	A: walk (Oxford Circus, Piccadilly Circus)	
	P: NOT Piccadilly Circus	
	E: Piccadilly Circus	
		Leicester Square? No
	3.4	
	3.4.1	
	A: walk (Piccadilly Circus, Oxford Circus)	
	P: NOT Oxford Circus	
	E: Oxford Circus	
		Leicester Square? No
	3.4.2	
	A: walk (Piccadilly Circus, Leicester Square)	
	P: NOT Leicester Square	
Leicester Square	E: Leicester Square	
		Leicester Square? Yes

2. Depth – Limited Search

NOTE for Breadth – First Search:

LIMIT: 3 steps

A: Action

P: Preconditions

E: Effect

Initial State: Victoria

Goal: Leicester Square

Knowledge base

(UK Government, 2019)

2. Depth – Limited Search		
Knowledge Base	Number	Goal Test
	1 From Victoria	
	1.1	
Initial State: Victoria	A: walk (Green Park, Oxford Circus, Warren Street)	
Green Park	P: NOT Green Park, NOT Oxford Circus, NOT Warren Street	
Oxford Circus	E: Warren Street	
Warren Street		Leicester Square? No
	1.2	
	A: walk (St. James's Park, Westminster, Embankment)	
St. James's Park	P: NOT St. James's Park, NOT Westminster, NOT Embankment	
Westminster	E: Embankment	
Embankment		Leicester Square? No
	1.3	
	A: walk (Pimlico, Vauxhall, Stockwell)	
Pimlico	P: NOT Pimlico, NOT Vauxhall, NOT Stockwell	
Vauxhall	E: Stockwell	
Stockwell		Leicester Square? No
	1.4	
	A: walk (Sloane Square, South Kensington, Gloucester Road)	
Sloane Square	P: NOT Sloane Square, NOT South Kensington, NOT Gloucester Road	
South Kensington	E: Gloucester Road	
Gloucester Road		Leicester Square? No

	1.1 From Warren Street	
	1.1.1	
	A: walk (Euston, Mornington Crescent, Camden Town)	
Euston	P: NOT Euston, NOT Mornington Crescent, NOT Camden Town	
Mornington Crescent	E: Camden Town	
Camden Town		Leicester Square? No
	1.1.2	
	A: walk (King's Cross St. Pancras, Caledonian Road & Barnsbury, Highbury & Islington)	
King's Cross St. Pancras	P: NOT King's Cross St. Pancras, NOT Caledonian Road & Barnsbury, NOT Highbury & Islington	
Caledonian Road & Barnsbury	E: Highbury & Islington	
Highbury & Islington		Leicester Square? No
	1.1.3	
	A: walk (Goodge Street, Tottenham Court Road, Leicester Square)	
Goodge Street	P: NOT Goodge Street, NOT Tottenham Court Road, NOT Leicester Square	
Tottenham Court Road	E: Leicester Square	
Leicester Square		Leicester Square? Yes

3. Uniform-Cost Search

NOTE for Breadth – First Search:

A: Action

P: Preconditions

E: Effect

Initial State: Victoria

Goal: Leicester Square

Path cost

Knowledge base

(UK Government, 2019)

2. Uniform-Cost Search			
Knowledge Base	Number	Path Cost	
Initial State: Victoria	1		
St. James's Park	A1: walk (Victoria, St. James's Park)	11	
Pimlico	A2: walk (Victoria, Pimlico)	12	
Sloane Square	A3: walk (Victoria, Sloane Square)	13	
Green Park	A4: walk (Victoria, Green Park)	19	
	P: NOT St. James's Park , NOT Pimlico, NOT Sloane Square, NOT Green Park		
Westminster	E: St. James's Park		St. James's Park + Westminster = 11 + 11 = 22
	2		
	A1: walk Pimlico	12	
	A2: walk Sloane Square	13	
	A3: walk Green Park	19	
	A4: walk St. James's Park + Westminster	22	
	P: NOT Pimlico, NOT Sloane Square, NOT Green Park		
Vauxhall	E: Pimlico		Pimlico + Vauxhall = 12 + 18 = 30
	3		
	A1: walk Sloane Square	13	
	A2: walk Green Park	19	
	A3: walk St. James's Park + Westminster	22	
	A4: walk Pimlico + Vauxhall	30	

	P: NOT Sloane Square, NOT Green Park, NOT St. James's Park + Westminster		
South Kensington	E: Sloane Square		Sloane Square + South Kensington = 13 + 17 = 30
	4		
	A1: walk Green Park	19	
	A2: walk St. James's Park + Westminster	22	
	A3: walk Pimlico + Vauxhall	30	
	A4: Sloane Square + South Kensington	30	
	P: NOT Green Park, NOT St. James's Park + Westminster, NOT Pimlico + Vauxhall		
Hyde Park Corner	E: Green Park		Green Park + Hyde Park Corner = 19 + 12 = 31
Bond Street			Green Park + Bond Street = 19 + 14 = 33
Oxford Circus			Green Park + Oxford Circus = 19 + 15 = 34
Piccadilly Circus			Green Park + Piccadilly Circus = 19 + 8 = 27
			Green Park + Westminster = 19 + 21 = 40
	5		
	A1: walk St. James's Park + Westminster	22	
	A2: walk Green Park + Piccadilly Circus	27	
	A3: walk Pimlico + Vauxhall	30	
	A4: walk Sloane Square + South Kensington	30	
	P: NOT St. James's Park + Westminster, NOT Green Park + Piccadilly Circus, NOT Pimlico + Vauxhall		
Embankment	E: St. James's Park + Westminster		(St. James's Park + Westminster) + Embankment = 22 + 10 = 32
	6		
	A1: walk Green Park + Piccadilly Circus	27	
	A2: walk Pimlico + Vauxhall	30	
	A3: walk Sloane Square + South Kensington	30	
	A4: walk St. James's Park + Westminster + Embankment	32	
	P: NOT Green Park + Piccadilly Circus, NOT Pimlico + Vauxhall, NOT Sloane Square + South Kensington		

Leicester Square	E: Green Park + Piccadilly Circus		(Green Park + Piccadilly Circus) + Oxford Circus = 27 + 12 = 39
			<u>(Green Park + Piccadilly Circus) + Leicester Square</u> <u>= 27 + 6 = 33</u>

Task2: Show how the quickest route will be calculated by each of the following search strategies:

Note: The Sunburst Chart was chosen to be presented here (and in the following questions) instead of Search Trees – in order to save a space and provide a better design view. Every step was explained in the table above.

i. Breadth-first search.

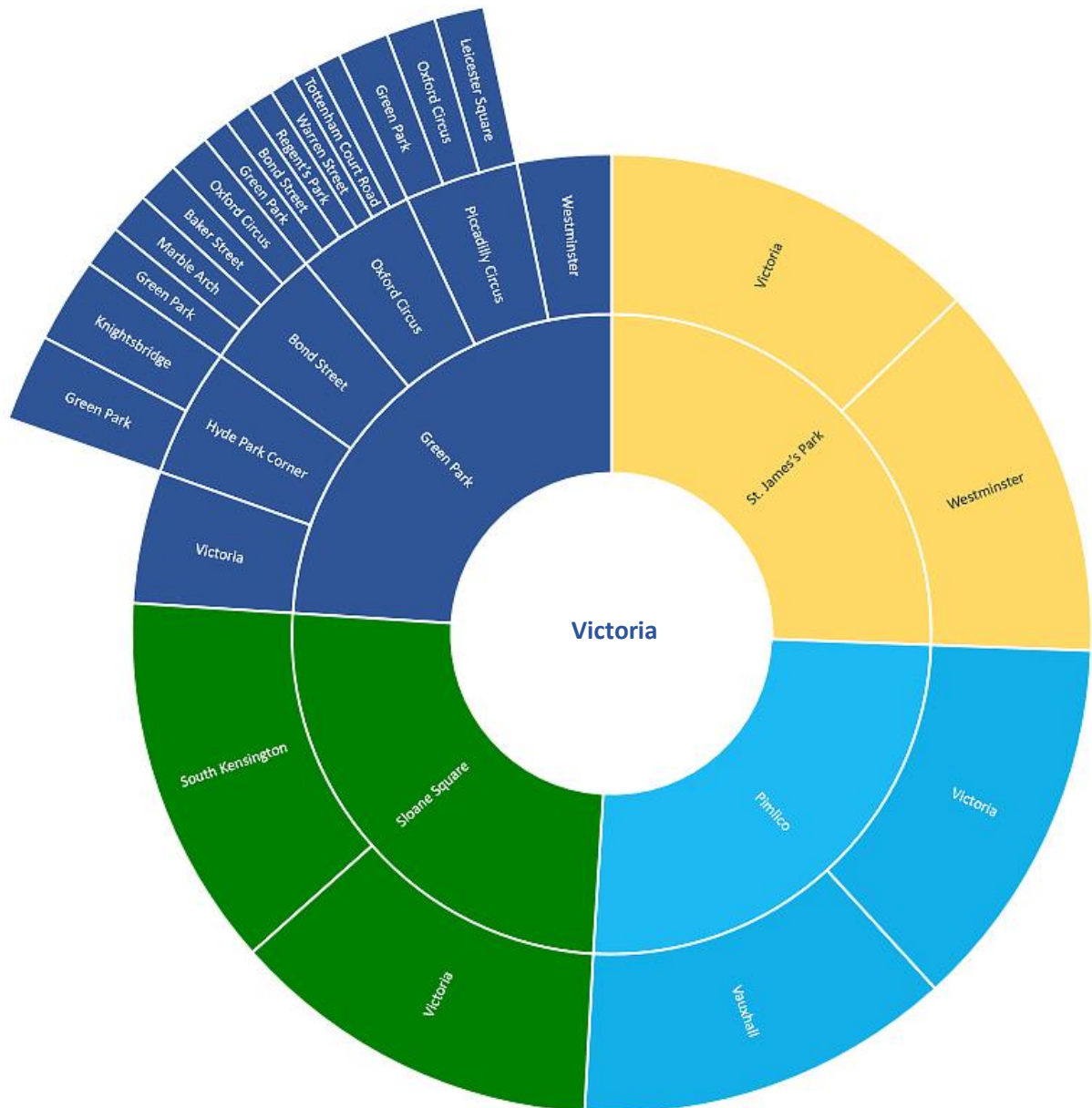


Figure 1 Sunburst Chart for Breadth-first search.

ITERATION	From	To
ITERATION 1		
STEP 1	Victoria	Green Park
STEP 2	Victoria	St. James's Park
STEP 3	Victoria	Pimlico
STEP 4	Victoria	Sloane Square
ITERATION 2		
STEP 1.1	Green Park	Victoria (X)
STEP 1.2	Green Park	Hyde Park Corner
STEP 1.3	Green Park	Bond Street
STEP 1.4	Green Park	Oxford Circus
STEP 1.5	Green Park	Piccadilly Circus
STEP 1.6	Green Park	Westminster
STEP 2.1	St. James's Park	Victoria (X)
STEP 2.2	St. James's Park	Westminster
STEP 3.1	Pimlico	Victoria (X)
STEP 3.2	Pimlico	Vauxhall
STEP 4.1	Sloane Square	Victoria (X)
STEP 4.2	Sloane Square	South Kensington
ITERATION 3		
STEP 1.2.1	Hyde Park Corner	Green Park (X)
STEP 1.2.2	Hyde Park Corner	Knightsbridge
STEP 1.3.1	Bond Street	Green Park (X)
STEP 1.3.2	Bond Street	Marble Arch
STEP 1.3.3	Bond Street	Baker Street
STEP 1.3.4	Bond Street	Oxford Circus
STEP 1.4.1	Oxford Circus	Green Park (X)
STEP 1.4.2	Oxford Circus	Bond Street
STEP 1.4.3	Oxford Circus	Regent's Park
STEP 1.4.4	Oxford Circus	Warren Street
STEP 1.4.5	Oxford Circus	Tottenham Court Road
STEP 1.4.6	Oxford Circus	Piccadilly Circus
STEP 1.5.1	Piccadilly Circus	Green Park (X)
STEP 1.5.2	Piccadilly Circus	Oxford Circus
<u>STEP 1.5.3</u>	<u>Piccadilly Circus</u>	<u>Leicester Square</u>

Figure 2 Explanation Table for Breadth-first search.

ii. Depth-limited search, to a depth limit determined by you (give reasons for your decision).

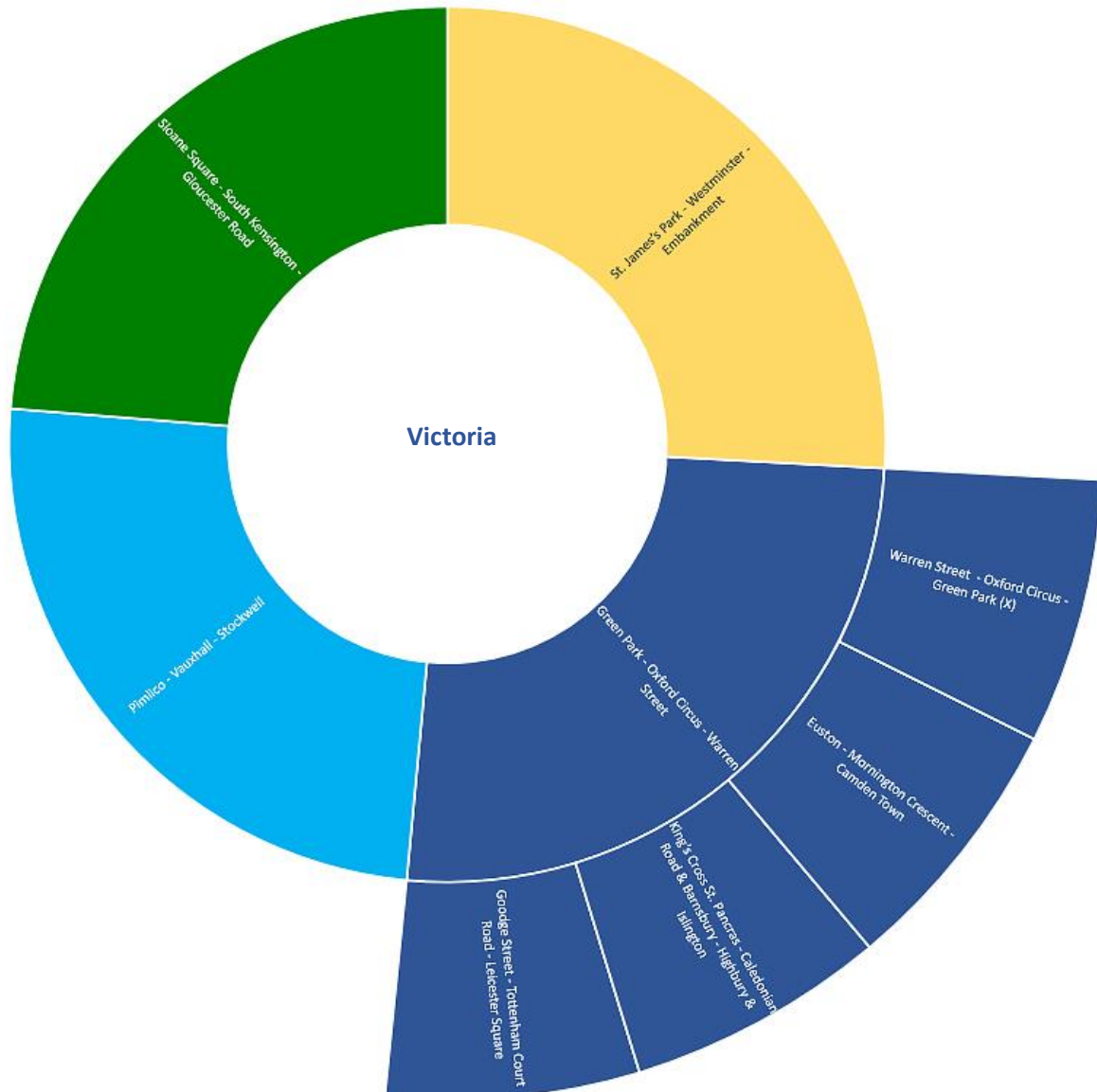


Figure 3 Sunburst Chart for Breadth-limited search.

ITERATION 1	From	To
STEP 1	Victoria	Green Park - Oxford Circus - Warren Street
STEP 2	Victoria	St. James's Park - Westminster - Embankment
STEP 3	Victoria	Pimlico - Vauxhall - Stockwell
STEP 4	Victoria	Sloane Square - South Kensington - Gloucester Road
ITERATION 2		
STEP 1.1	Green Park - Oxford Circus - Warren Street	Warren Street - Oxford Circus - Green Park (X)
STEP 1.2	Green Park - Oxford Circus - Warren Street	Euston - Mornington Crescent - Camden Town
STEP 1.3	Green Park - Oxford Circus - Warren Street	King's Cross St. Pancras - Caledonian Road & Barnsbury - Highbury & Islington
<u>STEP 1.4</u>	<u>Green Park - Oxford Circus - Warren Street</u>	<u>Goodge Street - Tottenham Court Road - Leicester Square</u>

Figure 4 Explanation Table for Breadth-limited search

iii. Uniform-cost search.

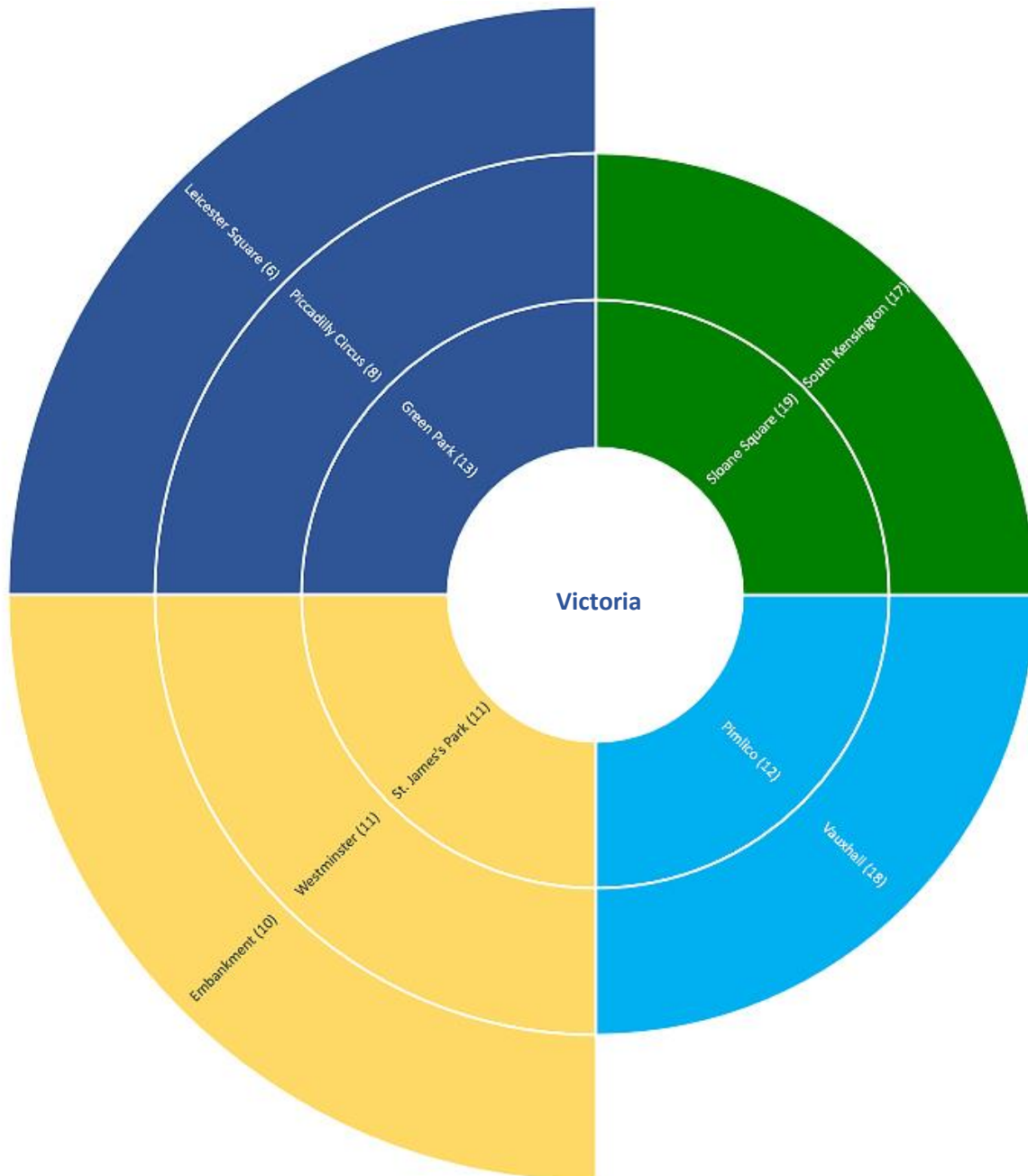


Figure 5 Sunburst Chart for Uniform-cost search.

ITERATION	From	To	Cost	Calculation
ITERATION 1				
STEP 1	Victoria	St. James's Park	11	
	Victoria	Pimlico	12	
	Victoria	Sloane Square	13	
	Victoria	Green Park	19	
STEP 2				St. James's Park + Westminster = 11 + 11 = 22
ITERATION 2				
STEP 3		Pimlico	12	
		Sloane Square	13	
		Green Park	19	
		St. James's Park + Westminster	22	
STEP 4				Pimlico + Vauxhall = 12 + 18 = 30
ITERATION 3				
STEP 5		Sloane Square	13	
		Green Park	19	
		St. James's Park + Westminster	22	
		Pimlico + Vauxhall	30	
STEP 6				Sloane Square + South Kensington = 13 + 17 = 30
ITERATION 4				
STEP 7		Green Park	19	
		St. James's Park + Westminster	22	
		Pimlico + Vauxhall	30	
		Sloane Square + South Kensington	30	
STEP 8				Green Park + Hyde Park Corner = 19 + 12 = 31
				Green Park + Bond Street = 19 + 14 = 33
				Green Park + Oxford Circus = 19 + 15 = 34
				Green Park + Piccadilly Circus

				$= 19 + 8 = 27$
				Green Park + Westminster $= 19 + 21 = 40$
ITERATION 5				
STEP 9		St. James's Park + Westminster	22	
		Green Park + Piccadilly Circus	27	
		Pimlico + Vauxhall	30	
		Sloane Square + South Kensington	30	
STEP 10				(St. James's Park + Westminster) + Embankment $= 22 + 10 = 32$
ITERATION 6				
STEP 11		Green Park + Piccadilly Circus	27	
		Pimlico + Vauxhall	30	
		Sloane Square + South Kensington	30	
		St. James's Park + Westminster + Embankment	32	
STEP 12				(Green Park + Piccadilly Circus) + Oxford Circus $= 27 + 12 = 39$
				<u>(Green Park + Piccadilly Circus) + Leicester Square</u> <u>$= 27 + 6 = 33$</u>

Figure 6 Explanation Table for Uniform-cost search

Task3: Find the fastest walking time from each relevant station to Leicester Square using <https://walkit.com/>. (Walkit, 2019)

From	To	Walking Time (min)
Victoria	Green Park	15
Victoria	St. James's Park	8
Victoria	Pimlico	9
Victoria	Sloane Square	12
Green Park	Hyde Park Corner	17
Green Park	Bond Street	10
Green Park	Oxford Circus	11
Green Park	Piccadilly Circus	6
Green Park	Westminster	16
St. James's Park	Westminster	9
Pimlico	Vauxhall	9
Sloane Square	South Kensington	14
Hyde Park Corner	Knightsbridge	7
Bond Street	Marble Arch	6
Bond Street	Baker Street	11
Bond Street	Oxford Circus	4
Oxford Circus	Bond Street	4
Oxford Circus	Regent's Park	16
Oxford Circus	Warren Street	12
Oxford Circus	Tottenham Court Road	12
Oxford Circus	Piccadilly Circus	7
Piccadilly Circus	Oxford Circus	7
Piccadilly Circus	<u>Leicester Square</u>	<u>4</u>

Figure 7 Table of the fastest walking time

(UK Government, 2019)

References

UK Government, 2019. <http://content.tfl.gov.uk/walking-tube-map.pdf>. [Online]
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