LAPORAN TUGAS KECIL 3
IF2211 STRATEGI ALGORITMA
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Penentuan Lintasan Terpendek dengan Algoritma UCS dan A*

Disusun oleh:

Haidar Hamda	13521105
Bintang Dwi Marthen	13521144

PROGRAM STUDI
TEKNIK INFORMATIKA
SEKOLAH TEKNIK ELEKTRO
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1. DESKRIPSI PERSOALAN

Peta suatu daerah dapat direpresentasikan menggunakan graf dengan *node* melambangan suatu lokasi dengan *edge* merepresentasikan jalan antar dua lokasi. Dengan banyaknya permutasi jalur dari dua titik, mencari jalur terpendek merupakan suatu dambaan. Untuk mencari lintasan terpendek antara dua titik terdapat berbagai pilihan algoritma: Dijkstra, BFS, Floyd-Warshall, Bellman Ford, UCS, dan A*. Dalam tugas kecil ini, mahasiswa diminta untuk membuat algoritma UCS dan A* untuk mencari lintasan terpendek antara dua titik tertentu.

2. SOURCE CODE DALAM BAHASA GOLANG

2.1. Berkas graph.go

```
package lib

import (
	"container/list"
	"fmt"
	"strconv"
)

type Edge struct {
	dest   int
	weight float32
}

/*
Graph is a struct that represents a graph
Using an adjacency list
nodes are represented by integers to save the number of nodes
adj is the adjacency list
*/
type Graph struct {
	nodes int
	adj   []*list.List
	names []string
}

func GetName(g Graph) []string {
	return g.names
}

func AddEdge(g *Graph, src, dest int, weight float32) {
	g.adj[src].PushBack(&Edge{dest, weight})
}

func NewGraph(matrix [][]float32) *Graph {
	g    :=    &Graph{len(matrix),    make([]*list.List,    len(matrix)),
make([]string, len(matrix))}

	for i := 0; i < len(matrix); i++ {
		g.adj[i] = list.New()
		g.names[i] = strconv.Itoa(i)
	}

	for i := 0; i < len(matrix); i++ {
```

```
		for j := 0; j < len(matrix[i]); j++ {
			if matrix[i][j] != 0 {
				AddEdge(g, i, j, matrix[i][j])
			}
		}
	}

	return g
}

func NewGraphNamed(matrix [][]float32, names []string) *Graph {
	g := &Graph{len(matrix), make([]*list.List, len(matrix)), names}

	for i := 0; i < len(matrix); i++ {
		g.adj[i] = list.New()
	}

	for i := 0; i < len(matrix); i++ {
		for j := 0; j < len(matrix[i]); j++ {
			if matrix[i][j] != 0 {
				AddEdge(g, i, j, matrix[i][j])
			}
		}
	}

	return g
}

func PrintGraphInfos(g *Graph) {
	fmt.Println("Graph Infos:")
	fmt.Println("Number of nodes:", g.nodes)
	fmt.Println("Adjacency List:")
	for i := 0; i < g.nodes; i++ {
		fmt.Print(g.names[i], ": ")
		if g.adj[i].Len() == 0 {
			fmt.Println("No edge")
			continue
		}
		for e := g.adj[i].Front(); e != nil; e = e.Next() {
			fmt.Printf("%s(%f)  ",  g.names[e.Value.(*Edge).dest],
e.Value.(*Edge).weight)
		}
		fmt.Println()
	}
}
```

2.2. Berkas PrioQueue.go

```
package lib

import (
	"container/heap"
	"container/list"
)

//https://pkg.go.dev/container/heap
```

```
type Item struct {
	Value      int     // The Value of the item; arbitrary.
	Priority   float32 // The Priority of the item in the queue.
	PassedNode list.List
	// The Index is needed by update and is maintained by the
heap.Interface methods.
	Index int // The Index of the item in the heap.
}

// A PriorityQueue implements heap.Interface and holds Items.
type PriorityQueue []*Item

func (pq PriorityQueue) Len() int {
	return len(pq)
}

func (pq PriorityQueue) Less(i, j int) bool {
	return pq[i].Priority < pq[j].Priority
}

func (pq PriorityQueue) Swap(i, j int) {
	pq[i], pq[j] = pq[j], pq[i]
	pq[i].Index = i
	pq[j].Index = j
}

func (pq *PriorityQueue) Push(x any) {
	n := len(*pq)
	item := x.(*Item)
	item.Index = n
	*pq = append(*pq, item)
}

func (pq *PriorityQueue) Pop() any {
	old := *pq
	n := len(old)
	item := old[n-1]
	old[n-1] = nil  // avoid memory leak
	item.Index = -1 // for safety
	*pq = old[0 : n-1]
	return item
}

func (pq *PriorityQueue) Update(item *Item, Value int, Priority float32) {
	item.Value = Value
	item.Priority = Priority
	heap.Fix(pq, item.Index)
}
```

2.3. Berkas Utils.go

```
package lib

import (
	"bufio"
	"container/list"
	"errors"
```

```
	"fmt"
	"log"
	"math"
	"os"
	"strconv"
	"strings"
)

func itemInList(item Item, list list.List) bool {
	for e := list.Front(); e != nil; e = e.Next() {
		//println("lis", e.Value.(*Item).Value)
		if item.Value == e.Value.(*Item).Value {
			return true
		}
	}
	return false
}

func euclideanDistance(x1, y1, x2, y2 float32) float32 {
	return  float32(math.Sqrt(float64((x1-x2)*(x1-x2)  +  (y1-y2)*(y1-
y2))))
}

func ReadFiletoGraph(dir string) (*Graph, []float32, []float32, error) {
	f, err := os.Open(dir)
	if err != nil {
		//log.Fatal(err)
		return nil, nil, nil, err
	}
	defer f.Close()
	scanner := bufio.NewScanner(f)
	scanner.Scan()
	nodeCount, err := strconv.ParseInt(scanner.Text(), 10, 64)
	if err != nil {
		//log.Fatal(err)
		return nil, nil, nil, err
	}
	//println(parseInt)
	names := make([]string, int(nodeCount))
	xarr := make([]float32, int(nodeCount))
	yarr := make([]float32, int(nodeCount))
	if nodeCount < 8 {
		return nil, nil, nil, errors.New("invalid node count")
	}
	for i := int64(0); i < nodeCount; i++ {
		scanner.Scan()
		tmp := strings.Split(scanner.Text(), " ")
		if len(tmp) != 3 {
			return  nil,  nil,  nil,  errors.New("invalid  argument
number")
		}
		names[i] = tmp[0]
		x, err := strconv.ParseFloat(tmp[1], 64)
		if err != nil {
			//log.Fatal(err)
			return nil, nil, nil, err
```

```
			}
			xarr[i] = float32(x)
			y, err := strconv.ParseFloat(tmp[2], 64)
			if err != nil {
				//log.Fatal(err)
				return nil, nil, nil, err
			}
			yarr[i] = float32(y)
		}
		matrix := make([][]float32, nodeCount)
		for i := range matrix {
			matrix[i] = make([]float32, nodeCount)
		}
		for j := 0; j < int(nodeCount); j++ {
			scanner.Scan()
			tmp := strings.Split(scanner.Text(), " ")
			if len(matrix[j]) != len(tmp) {
				return nil, nil, nil, errors.New("out of bound")
			}
			for i := 0; i < len(tmp); i++ {
				parseF, err := strconv.ParseFloat(tmp[i], 64)
				if err != nil {
					//log.Fatal(err)
					return nil, nil, nil, err
				}
				if parseF < 0 {
					return  nil,  nil,  nil,  errors.New("negative
weight")
				}
				matrix[j][i] = float32(parseF)
			}
		}
		return NewGraphNamed(matrix, names), xarr, yarr, nil
}

func NameToIndex(g Graph, name string) int {
		for i := 0; i < len(g.names); i++ {
			if g.names[i] == name {
				return i
			}
		}
		return -1
}

func PathToName(g Graph, i Item) []string {
		path := make([]string, 0)
		for e := i.PassedNode.Front(); e != nil; e = e.Next() {
			path = append(path, g.names[e.Value.(int)])
		}
		return path
}

func FileNameParse() (Graph, []float32, []float32) {
		args := os.Args[1:]
		if len(args) != 1 {
			log.Fatal("invalid argument number")
```

```
	}
	g, x, y, err := ReadFiletoGraph(args[0])
	if err != nil {
		log.Fatal(err)
	}
	return *g, x, y
}

func RangedInput(min, max int) int {
	var input int
	for {
		fmt.Scanln(&input)
		if input >= min && input <= max {
			break
		}
		fmt.Println("invalid input")
	}
	return input
}

func PrintPath(g Graph, i Item) {
	if i.Priority == -1 {
		fmt.Println("No path found")
		return
	}
	fmt.Println("Path: ", PathToName(g, i))
	fmt.Println("Cost: ", i.Priority)
}
```

2.4. Berkas astar.go

```
package lib

import (
	"container/heap"
	"container/list"
)

func euclideanCalculator(x, y []float32, end int) []float32 {
	euclid := make([]float32, len(x))
	for i := 0; i < len(x); i++ {
		euclid[i] = euclideanDistance(x[i], y[i], x[end], y[end])
	}
	return euclid
}

func Astar(g Graph, x, y []float32, start, end int) *Item {
	// init variables
	euclid := euclideanCalculator(x, y, end)
	expandedWeight := euclid
	pq := make(PriorityQueue, 0)
	heap.Init(&pq)
	heap.Push(&pq, &Item{start, euclid[start], list.List{}, 0})
	visited := list.New()
	// start algorithm
	for pq.Len() > 0 {
		currentItem := heap.Pop(&pq).(*Item)
```

```
            currentNodeNumber := currentItem.Value
            currentNodeCost := currentItem.Priority
            currentPassed := list.New()
            currentPassed.PushBackList(&currentItem.PassedNode)
            currentPassed.PushBack(currentNodeNumber)

            // update expandedWeight
            for e := g.adj[currentNodeNumber].Front(); e != nil; e =
e.Next() {
                  if       expandedWeight[e.Value.(*Edge).dest]       >
currentNodeCost+e.Value.(*Edge).weight+euclid[e.Value.(*Edge).dest] {
                        expandedWeight[e.Value.(*Edge).dest]          =
currentNodeCost + e.Value.(*Edge).weight + euclid[e.Value.(*Edge).dest]
                  }
            }

            if currentNodeNumber == end {
                  var dist float32 = 0
                  for e := currentPassed.Front(); e != nil && e.Next()
!= nil; e = e.Next() {
                        for f := g.adj[e.Value.(int)].Front(); f != nil;
f = f.Next() {
                              if        f.Value.(*Edge).dest        ==
e.Next().Value.(int) {
                                    dist += f.Value.(*Edge).weight
                              }
                        }
                  }
                  return &Item{
                        Value:      currentNodeNumber,
                        Priority:   float32(dist),
                        PassedNode: *currentPassed,
                        Index:      0,
                  }
            } else {
                  if !itemInList(*currentItem, *visited) {
                        visited.PushBack(currentItem)
                        for e := g.adj[currentNodeNumber].Front(); e !=
nil; e = e.Next() {
                              tmp    :=    &Item{e.Value.(*Edge).dest,
currentNodeCost + e.Value.(*Edge).weight, *currentPassed, len(pq)}
                              heap.Push(&pq, tmp)
                              pq.Update(tmp,                tmp.Value,
currentNodeCost+e.Value.(*Edge).weight+expandedWeight[tmp.Value])
                        }
                  }
            }
      }
      return &Item{
            Value:      -1,
            Priority:   -1,
            PassedNode: list.List{},
            Index:      -1,
      }
}
```

2.5. Berkas UCS.go

```
package lib

import (
"container/heap"
"container/list"
)

func UCS(g Graph, startNode int, goalNode int) *Item {
nodeQueue := make(PriorityQueue, 0)
heap.Init(&nodeQueue)
heap.Push(&nodeQueue, &Item{startNode, 0, list.List{}, 0})
visited := list.New()
//fmt.Println("nq", nodeQueue.Len())
for nodeQueue.Len() > 0 {
	currentItem := heap.Pop(&nodeQueue).(*Item)
	currentNodeNumber := currentItem.Value
	currentNodeCost := currentItem.Priority
	currentPassed := list.New()
	currentPassed.PushBackList(&currentItem.PassedNode)
	currentPassed.PushBack(currentNodeNumber)
	//fmt.Println("currnod", currentNodeNumber, currentNodeCost)
	//for e := currentPassed.Front(); e != nil && e.Value != nil; e =
e.Next() {
	//	fmt.Println("v", e.Value)
	//}
	if currentNodeNumber == goalNode {
		return &Item{
			Value:	currentNodeNumber,
			Priority:	currentNodeCost,
			PassedNode: *currentPassed,
			Index:	0,
		}
	} else {
		if !itemInList(*currentItem, *visited) {
			visited.PushBack(currentItem)
			for e := g.adj[currentNodeNumber].Front(); e != nil;
e = e.Next() {
				//fmt.Println("1", e.Value.(*Edge).dest)
				tmp	:=	&Item{e.Value.(*Edge).dest,
currentNodeCost + e.Value.(*Edge).weight, *currentPassed, len(nodeQueue)}
				heap.Push(&nodeQueue, tmp)
				nodeQueue.Update(tmp,		tmp.Value,
currentNodeCost+e.Value.(*Edge).weight)
			}
		}
	}
}
return &Item{
	Value:	-1,
	Priority:	-1,
	PassedNode: list.List{},
	Index:	-1,
}
//PrintGraphInfos(g)
}
```

2.6. Berkas main.go

```
package main

import (
	"fmt"
	"main/lib"
)

func main() {
	g, x, y := lib.FileNameParse()
	lib.PrintGraphInfos(&g)
	fmt.Println("Do you want to use a* or ucs?")
	fmt.Println("1. A*")
	fmt.Println("2. UCS")
	algo := lib.RangedInput(1, 2)
	fmt.Println("Below are the names of the nodes:")
	for i := 0; i < len(lib.GetName(g)); i++ {
		fmt.Println(i, lib.GetName(g)[i])
	}
	fmt.Println("Please enter the start node:")
	start := lib.RangedInput(0, len(lib.GetName(g))-1)
	fmt.Println("Please enter the end node:")
	end := lib.RangedInput(0, len(lib.GetName(g))-1)
	var res *lib.Item
	if algo == 1 {
		res = lib.Astar(g, x, y, start, end)
	} else {
		res = lib.UCS(g, start, end)
	}
	lib.PrintPath(g, *res)
}
```

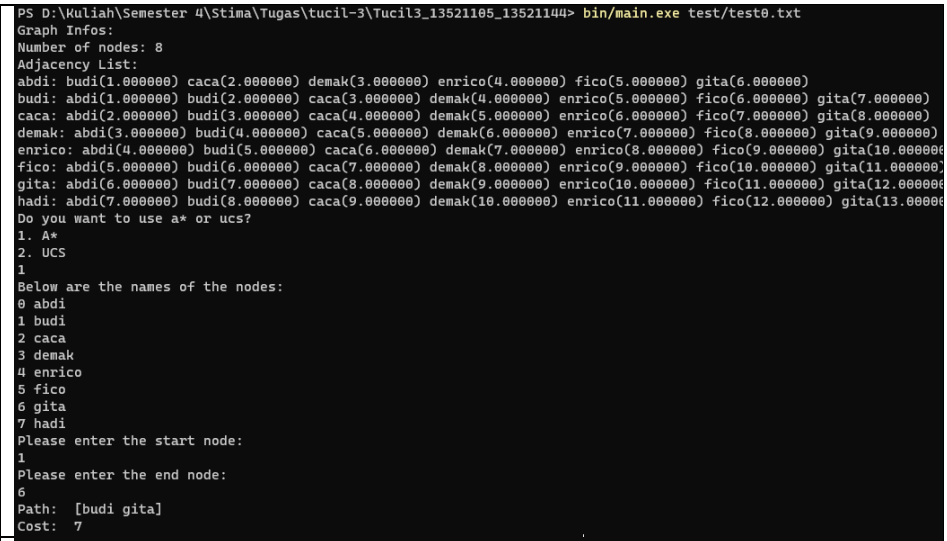
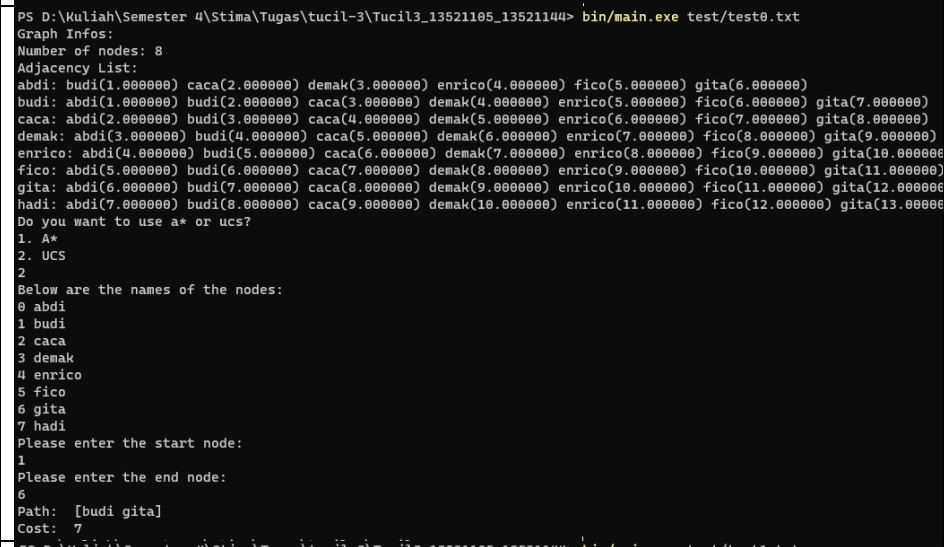
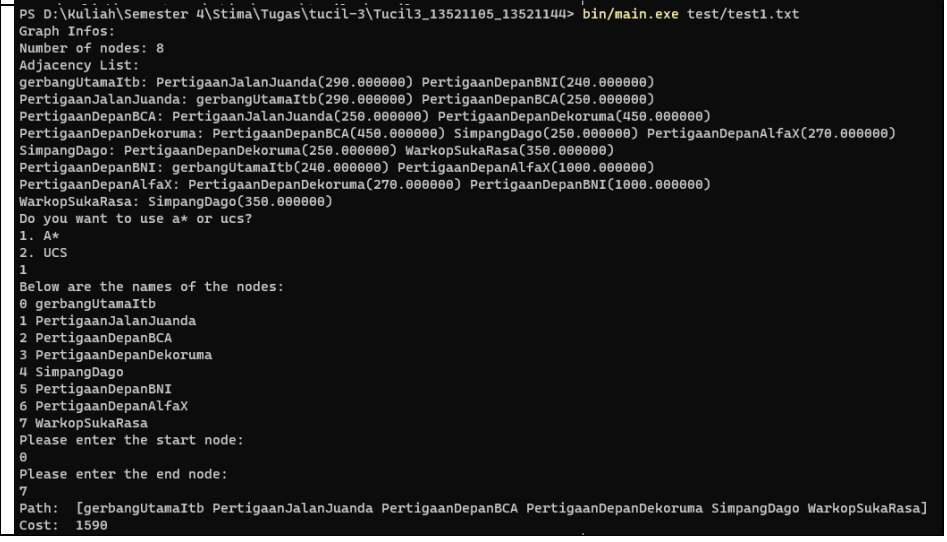
3. HASIL EKSEKUSI PROGRAM

Kasus	Tangkapan Layar
Tidak ada Berkas Masukan	`PS D:\Kuliah\Semester 4\Stima\Tugas\tucil-3\Tucil3_13521105_13521144> bin/main.exe` `2023/04/12 02:32:00 invalid argument number`
Berkas Masukan Tidak Ada	`PS D:\Kuliah\Semester 4\Stima\Tugas\tucil-3\Tucil3_13521105_13521144> bin/main.exe test/test6.tx` `2023/04/12 02:32:54 open test/test6.txt: The system cannot find the file specified.`
Berkas Masukan Tidak Valid	`PS D:\Kuliah\Semester 4\Stima\Tugas\tucil-3\Tucil3_13521105_13521144> bin/main.exe test/test5.t` `2023/04/12 02:32:33 invalid node count`

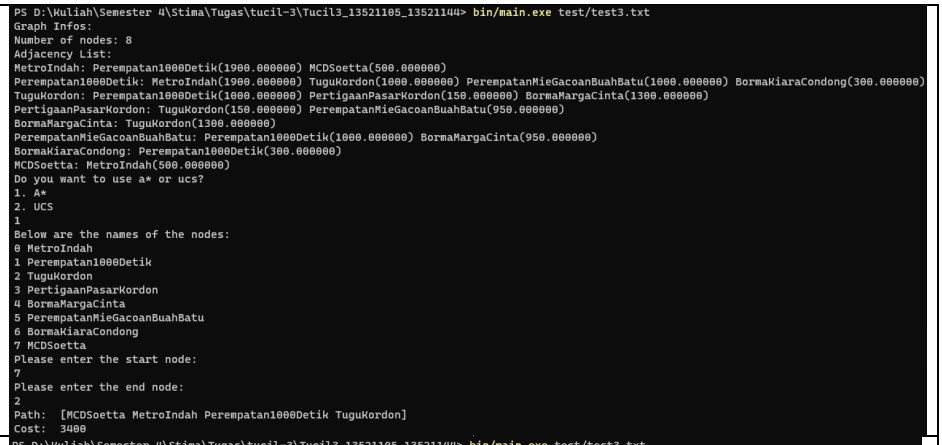
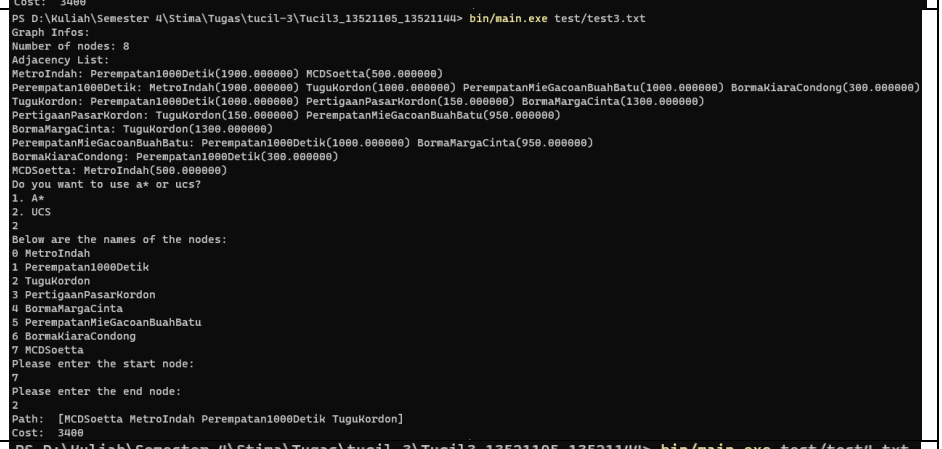
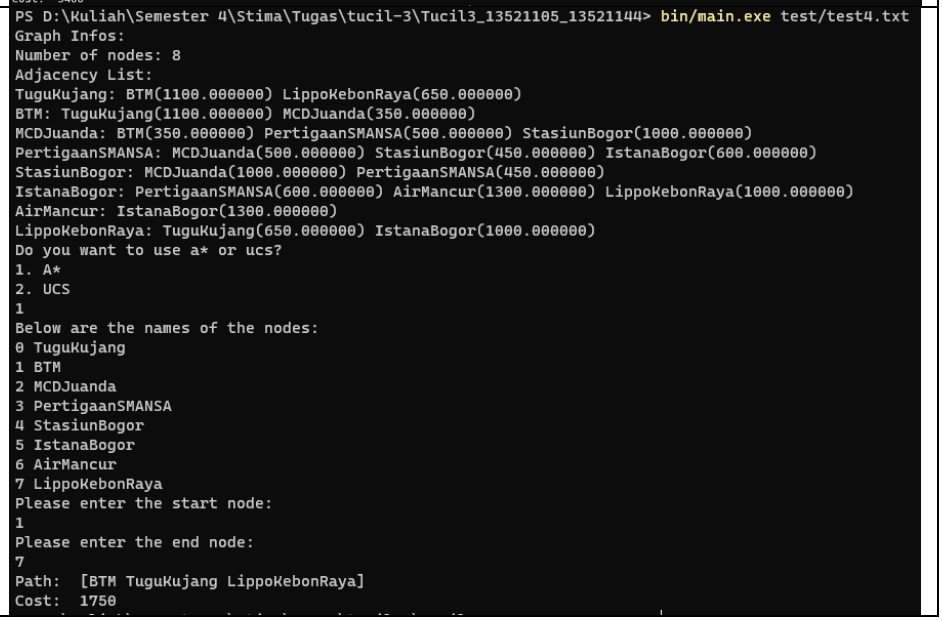
Berkas test.txt dari n0 ke n8 menggunakan algoritma UCS	`PS D:\Kuliah\Semester 4\Stima\Tugas\tucil-3\Tucil3_13521105_13521144> bin/main.exe test/test.`
	`Graph Infos:`
	`Number of nodes: 8`
	`Adjacency List:`
	`n1: n2(2.000000) n3(3.000000)`
	`n2: n1(2.000000) n4(4.000000)`
	`n3: n1(3.000000) n2(3.000000) n5(5.000000)`
	`n4: n2(4.000000) n3(5.000000) n5(6.000000)`
	`n5: n4(6.000000) n6(7.000000)`
	`n6: n5(7.000000) n7(8.000000)`
	`n7: n6(8.000000)`
	`n8: No edge`
	`Do you want to use a* or ucs?`
	`1. A*`
	`2. UCS`
	`2`
	`Below are the names of the nodes:`
	`0 n1`
	`1 n2`
	`2 n3`
	`3 n4`
	`4 n5`
	`5 n6`
	`6 n7`
	`7 n8`
	`Please enter the start node:`
	`0`
	`Please enter the end node:`
	`7`
	`No path found`

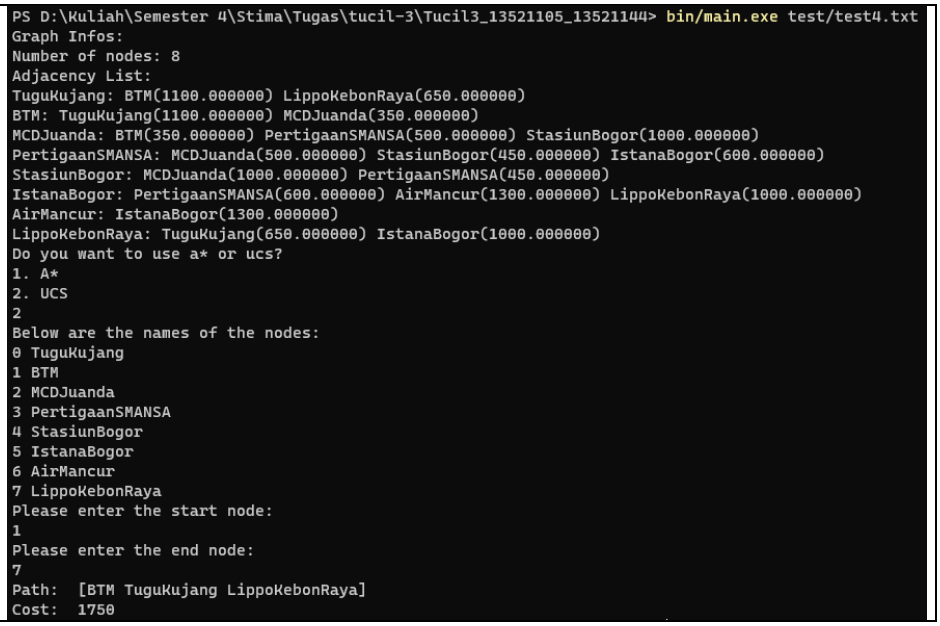
Berkas test.txt dari n0 ke n8 menggunakan algoritma A*	`PS D:\Kuliah\Semester 4\Stima\Tugas\tucil-3\Tucil3_13521105_13521144> bin/main.exe test/test.`
	`Graph Infos:`
	`Number of nodes: 8`
	`Adjacency List:`
	`n1: n2(2.000000) n3(3.000000)`
	`n2: n1(2.000000) n4(4.000000)`
	`n3: n1(3.000000) n2(3.000000) n5(5.000000)`
	`n4: n2(4.000000) n3(5.000000) n5(6.000000)`
	`n5: n4(6.000000) n6(7.000000)`
	`n6: n5(7.000000) n7(8.000000)`
	`n7: n6(8.000000)`
	`n8: No edge`
	`Do you want to use a* or ucs?`
	`1. A*`
	`2. UCS`
	`1`
	`Below are the names of the nodes:`
	`0 n1`
	`1 n2`
	`2 n3`
	`3 n4`
	`4 n5`
	`5 n6`
	`6 n7`
	`7 n8`
	`Please enter the start node:`
	`0`
	`Please enter the end node:`
	`7`
	`No path found`

Berkas test.txt dari n0 ke n7 menggunakan algoritma A*	PS D:\Kuliah\Semester 4\Stima\Tugas\tucil-3\Tucil3_13521105_13521144> bin/ Graph Infos: Number of nodes: 8 Adjacency List: n1: n2(2.000000) n3(3.000000) n2: n1(2.000000) n4(4.000000) n3: n1(3.000000) n2(3.000000) n5(5.000000) n4: n2(4.000000) n3(5.000000) n5(6.000000) n5: n4(6.000000) n6(7.000000) n6: n5(7.000000) n7(8.000000) n7: n6(8.000000) n8: No edge Do you want to use a* or ucs? 1. A* 2. UCS 1 Below are the names of the nodes: 0 n1 1 n2 2 n3 3 n4 4 n5 5 n6 6 n7 7 n8 Please enter the start node: 0 Please enter the end node: 6 Path: [n1 n3 n5 n6 n7] Cost: 23
Berkas test.txt dari n0 ke n7 menggunakan algoritma UCS	PS D:\Kuliah\Semester 4\Stima\Tugas\tucil-3\Tucil3_13521105_13521144> bin/ Graph Infos: Number of nodes: 8 Adjacency List: n1: n2(2.000000) n3(3.000000) n2: n1(2.000000) n4(4.000000) n3: n1(3.000000) n2(3.000000) n5(5.000000) n4: n2(4.000000) n3(5.000000) n5(6.000000) n5: n4(6.000000) n6(7.000000) n6: n5(7.000000) n7(8.000000) n7: n6(8.000000) n8: No edge Do you want to use a* or ucs? 1. A* 2. UCS 2 Below are the names of the nodes: 0 n1 1 n2 2 n3 3 n4 4 n5 5 n6 6 n7 7 n8 Please enter the start node: 0 Please enter the end node: 6 Path: [n1 n3 n5 n6 n7] Cost: 23

Berkas test0.txt dari budi ke gita menggunakan algoritma A*	
Berkas test0.txt dari budi ke gita menggunakan algoritma UCS	
Berkas test1.txt dari gerbangUtamaITB ke WarkopSukaRasa menggunakan algoritma A*	

Berkas test1.txt dari gerbangUtamaITB ke WarkopSukaRasa menggunakan algoritma UCS	PS D:\Kuliah\Semester 4\Stima\Tugas\tucil-3\Tucil3_13521105_13521144> bin/main.exe test/test1.txt Graph Infos: Number of nodes: 8 Adjacency List: gerbangUtamaItb: PertigaanJalanJuanda(290.000000) PertigaanDepanBNI(240.000000) PertigaanJalanJuanda: gerbangUtamaItb(290.000000) PertigaanDepanBCA(250.000000) PertigaanDepanBCA: PertigaanJalanJuanda(250.000000) PertigaanDepanDekoruma(450.000000) PertigaanDepanDekoruma: PertigaanDepanBCA(450.000000) SimpangDago(250.000000) PertigaanDepanAlfaX(270.000000) SimpangDago: PertigaanDepanDekoruma(250.000000) WarkopSukaRasa(350.000000) PertigaanDepanBNI: gerbangUtamaItb(240.000000) PertigaanDepanAlfaX(1000.000000) PertigaanDepanAlfaX: PertigaanDepanDekoruma(270.000000) PertigaanDepanBNI(1000.000000) WarkopSukaRasa: SimpangDago(350.000000) Do you want to use a* or ucs? 1. A* 2. UCS 2 Below are the names of the nodes: 0 gerbangUtamaItb 1 PertigaanJalanJuanda 2 PertigaanDepanBCA 3 PertigaanDepanDekoruma 4 SimpangDago 5 PertigaanDepanBNI 6 PertigaanDepanAlfaX 7 WarkopSukaRasa Please enter the start node: 0 Please enter the end node: 7 Path: [gerbangUtamaItb PertigaanJalanJuanda PertigaanDepanBCA PertigaanDepanDekoruma SimpangDago WarkopSukaRasa] Cost: 1590
Berkas test2.txt dari SimpangBraga ke Norsefiicden menggunakan algoritma A*	PS D:\Kuliah\Semester 4\Stima\Tugas\tucil-3\Tucil3_13521105_13521144> bin/main.exe test/test2.txt Graph Infos: Number of nodes: 8 Adjacency List: AlunAlun: PerigaanKAASukarno(180.000000) Norsefiicden(350.000000) MuseumKAA: PertigaanJlBragaKaa(71.000000) PerigaanKAASukarno(44.000000) PertigaanJlBragaKaa: MuseumKAA(71.000000) SimpangBraga(190.000000) SimpangBraga: PertigaanJlBragaKaa(190.000000) PertigaanDepanBTN(110.000000) PertigaanDepanBTN: SimpangBraga(110.000000) PerigaanKAASukarno(180.000000) PerigaanKAASukarno: AlunAlun(180.000000) MuseumKAA(44.000000) PertigaanDepanBTN(180.000000) Norsefiicden: AlunAlun(350.000000) StasiunTimur(650.000000) StasiunTimur: Norsefiicden(650.000000) Do you want to use a* or ucs? 1. A* 2. UCS 1 Below are the names of the nodes: 0 AlunAlun 1 MuseumKAA 2 PertigaanJlBragaKaa 3 SimpangBraga 4 PertigaanDepanBTN 5 PerigaanKAASukarno 6 Norsefiicden 7 StasiunTimur Please enter the start node: 3 Please enter the end node: 6 Path: [SimpangBraga PertigaanDepanBTN PerigaanKAASukarno AlunAlun Norsefiicden] Cost: 820
Berkas test2.txt dari SimpangBraga ke Norsefiicden menggunakan algoritma UCS	PS D:\Kuliah\Semester 4\Stima\Tugas\tucil-3\Tucil3_13521105_13521144> bin/main.exe test/test2.txt Graph Infos: Number of nodes: 8 Adjacency List: AlunAlun: PerigaanKAASukarno(180.000000) Norsefiicden(350.000000) MuseumKAA: PertigaanJlBragaKaa(71.000000) PerigaanKAASukarno(44.000000) PertigaanJlBragaKaa: MuseumKAA(71.000000) SimpangBraga(190.000000) SimpangBraga: PertigaanJlBragaKaa(190.000000) PertigaanDepanBTN(110.000000) PertigaanDepanBTN: SimpangBraga(110.000000) PerigaanKAASukarno(180.000000) PerigaanKAASukarno: AlunAlun(180.000000) MuseumKAA(44.000000) PertigaanDepanBTN(180.000000) Norsefiicden: AlunAlun(350.000000) StasiunTimur(650.000000) StasiunTimur: Norsefiicden(650.000000) Do you want to use a* or ucs? 1. A* 2. UCS 2 Below are the names of the nodes: 0 AlunAlun 1 MuseumKAA 2 PertigaanJlBragaKaa 3 SimpangBraga 4 PertigaanDepanBTN 5 PerigaanKAASukarno 6 Norsefiicden 7 StasiunTimur Please enter the start node: 3 Please enter the end node: 6 Path: [SimpangBraga PertigaanDepanBTN PerigaanKAASukarno AlunAlun Norsefiicden] Cost: 820

Berkas test3.txt dari MCDSoetta ke TuguKordon menggunakan algoritma A*	
Berkas test3.txt dari MCDSoetta ke TuguKordon menggunakan algoritma UCS	
Berkas test4.txt dari BTM ke LippoKebun Raya menggunakan algoritma A*	

Berkas test4.txt dari BTIM ke LippoKebun Raya menggunakan algoritma UCS	

4. KESIMPULAN DAN KOMENTAR

4.1. Kesimpulan

1. Algoritma A* dan UCS memberikan solusi yang optimal
2. Algoritma A* dan UCS dapat mendeteksi bila tidak ada jalur
3. Algoritma A* dan UCS adalah algoritma yang *complete*

4.2. Komentar

1. Tugas kecil menarik dengan bonus menggunakan API Google Maps
2. Bonus menggunakan API relatif menyulitkan bagi mahasiswa yang tidak memiliki akses ke kartu kredit

5. LAMPIRAN

5.1. Pranala *Repository GitHub*
https://github.com/Marthenn/Tucil3_13521105_13521144

5.2. Tabel Ketercapaian Program

Poin	Ya	Tidak
1. Program dapat menerima input graf	✓	
2. Program dapat menghitung lintasan terpendek dengan UCS	✓	
3. Program dapat menghitung lintasan terpendek dengan A*	✓	
4. Program dapat menampilkan lintasan terpendek serta jaraknya	✓	
5. Bonus: Program dapat menerima input peta		✓

dengan Google Map API dan menampilkan peta serta lintasan terpendek pada peta		