SGN WORKSHOP 2024,
Group Project & Presentation
IMSc, Chennai

Chennai Darshan?

OPTIMISING A TRAVEL ITINERARY AROUND CHENNAI

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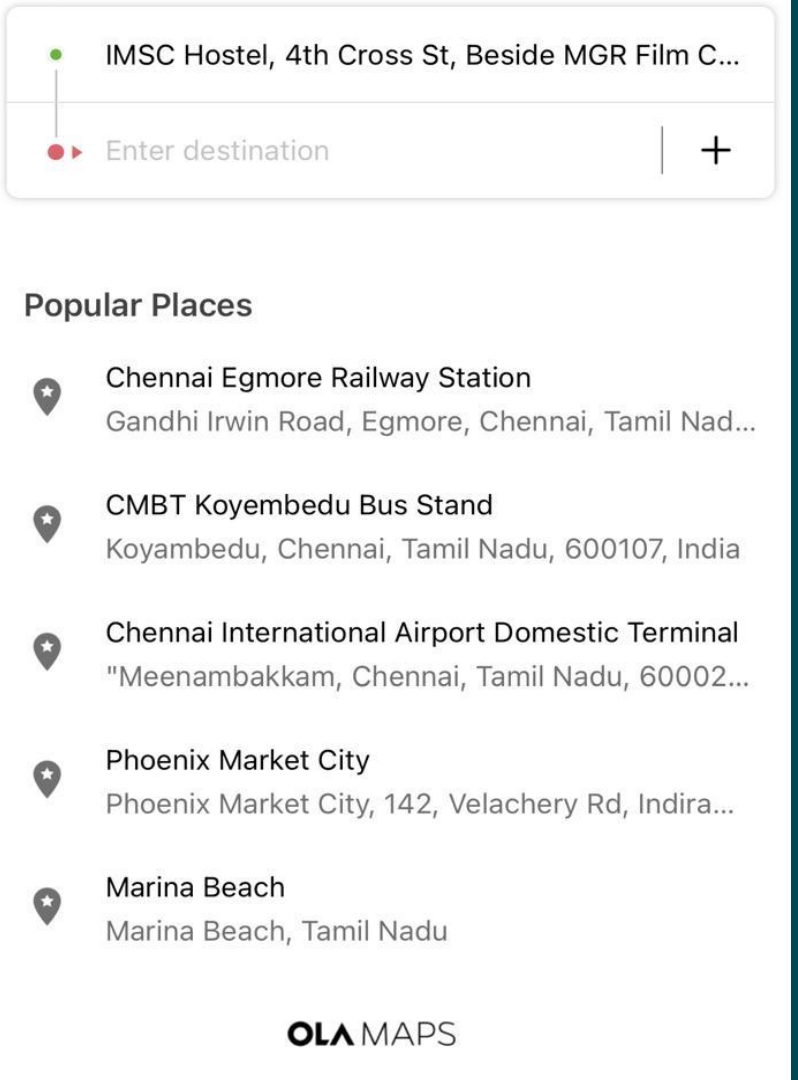
Problem Statement

“How to make an optimal travel plan based on maximising happiness for a group of three?”

Constraints:

- Limited Time
- Individual Preferences
- Categorised places

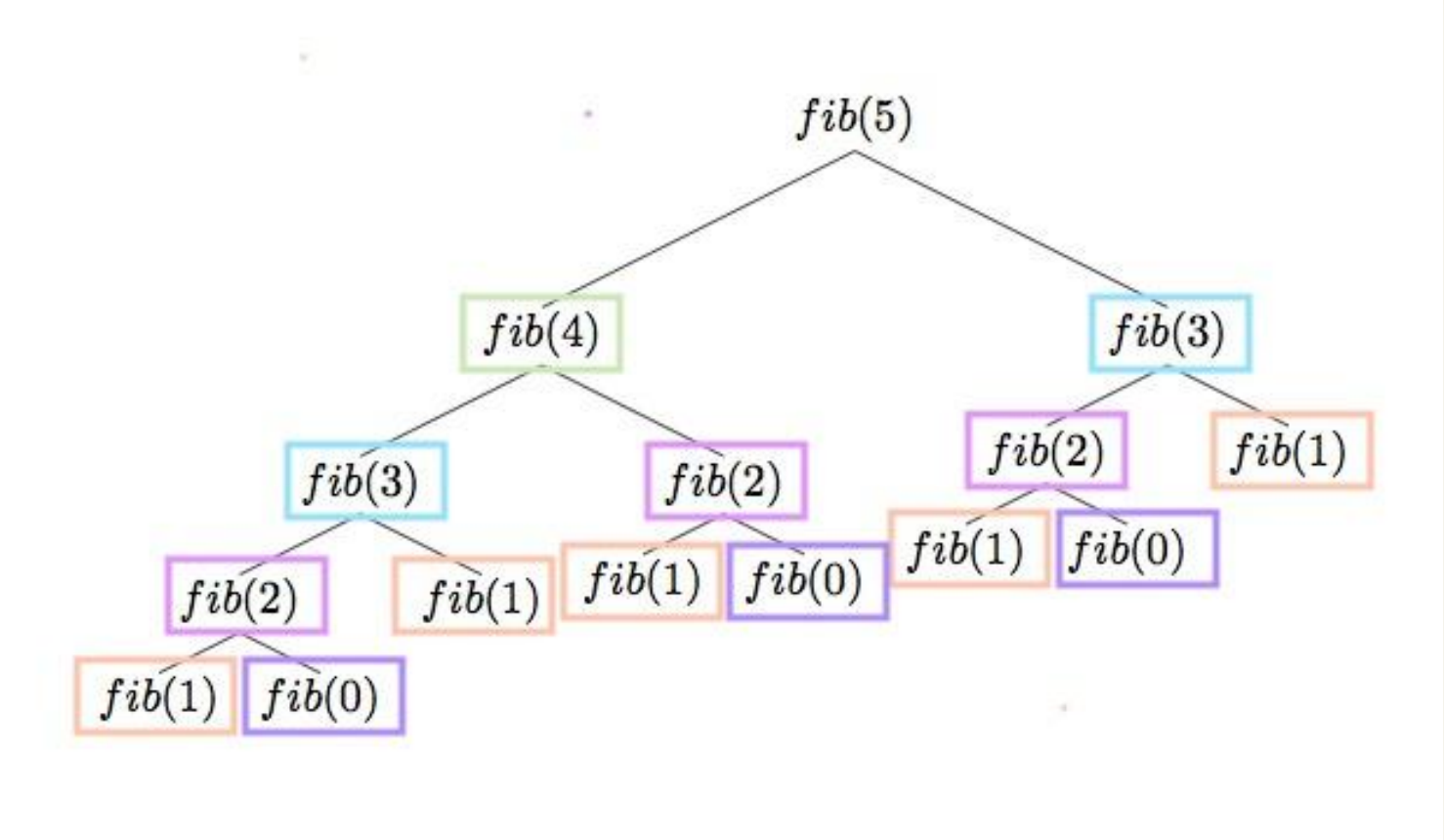


Data Collection

Brute-forcing our *way* through

From ↓ / To→	IMSc	Elliot's Beach	Marina Beach	The Fisherman's Wharf	The Fat Boy	San Thome Church	Government Museum	Kalaignar Centenary Park	Arignar Anna Zoological Park	Phoenix Mall	T. Nagar	Mylapore	Guindy Natio
IMSc	0	11	17	15	10	14	18	14	40	14	16	18	11
Elliot's Beach	11	0	14	15	1	13	22	20	42	18	18	16	14
Marina Beach	17	14	0	23	15	6	10	8	47	22	12	6	18
The Fisherman's Wharf	15	15	23	0	20	20	25	22	40	18	30	30	20
The Fat Boy	10	1	15	20	0	12	20	15	35	18	22	18	10
San Thome Church	14	13	6	20	12	0	13	9	45	20	14	7	14
Government Museum	18	22	10	25	20	13	0	6	44	22	12	12	16
Kalaignar Centenary Park	14	20	8	22	15	9	6	0	41	18	8	6	12
Arignar Anna Zoological Park	40	42	47	35	40	45	44	41	0	35	40	45	40
Phoenix Mall	14	18	22	18	18	20	22	18	35	0	18	20	10
T. Nagar	16	18	12	30	22	14	12	8	40	18	0	12	14
Mylapore	18	16	6	30	18	7	12	6	45	20	12	0	18
Guindy National Park	11	14	18	20	10	14	16	12	40	10	14	18	0
Pallavaram Mountain	30	35	40	35	30	35	35	30	30	30	30	35	28
Valluvar Kottam	41	20	14	30	20	16	14	10	40	20	4	12	14
Dakshina Chitra	18	35	40	24	35	40	45	45	30	40	45	45	35
Koyambedu Flower market	28	35	26	40	30	28	20	20	35	28	18	24	26
Chennai Snake Park	10	14	18	20	10	14	16	12	40	10	14	18	1
Thambi Vilas	30	30	22	40	30	24	16	18	40	30	16	22	26

Dynamic Programming


fib(5)
fib(4)
fib(3)
fib(3)
fib(2)
fib(2)
fib(1)
fib(2)
fib(1)
fib(1)
fib(0)
fib(1)
fib(0)
fib(1)
fib(0)

State Definition

We use a mask state to represent which nodes have been visited. If the i-th bit of mask is 1, then node i is included in the visited set.

Define:

$$\text{DP}[\text{mask},\ i,\ c] \ = \ \Big(H_{\text{mask},\,i,\,c},\ M_{\text{mask},\,i,\,c}\Big),$$

where

- i is the last visited node.
- c is the category of the last visited node (i.e., $c = \text{type}[i]$).
- $H_{\text{mask},\,i,\,c}$ is the *maximum total happiness* achievable by visiting the subset of nodes in mask, ending at node i of category c.
- $M_{\text{mask},\,i,\,c}$ is the *minimum total time* to achieve that maximum happiness $H_{\text{mask},\,i,\,c}$.

In practice, we store these as tuples and perform comparisons by:

- First comparing happiness (higher is better),
- then, if happiness is equal, comparing time (lower is better).

A Cost Function Approach

$$E(\sigma) = -\sum_{k=1}^{K-1} \Big(h[\sigma_{k+1}] \times p(\sigma_k, \sigma_{k+1}) \Big) \; + \; \lambda \max\big(0, \, [\mathrm{Time}(\sigma)] - T\big)$$

$$p(\sigma_k, \sigma_{k+1}) = \begin{cases} 0.5, & \text{if they are the same non-zero category,} \\ 1, & \text{otherwise,} \end{cases}$$

$$\mathrm{Time}(\sigma) = \sum_{k=1}^{K-1} t[\sigma_k, \sigma_{k+1}] \; + \; (K-1)\,\mathrm{stay\_time}.$$

Case I:
Our Actual Preferences
(In the pursuit of happyness)

```
happiness = {
    0: 0,  # IMSc (0,0,0)
    1: 18,  # Elliot's Beach (8,3,7)
    2: 19,  # Marina Beach (5,9,5)
    3: 25,  # The Fisherman's Wharf (8,7,10)
    4: 11,  # The Fat Boy (4,3,4)
    5: 19,  # San Thome Church (Cultural) (7,10,2)
    6: 20,  # Government Museum (Cultural) (10,4,6)
    7: 25,  # Kalaignar Centenary Park (Nature) (7,9,9)
    8: 13,  # Arignar Anna Zoological Park (Nature) (5,3,5)
    9: 16,  # Phoenix Mall (Shopping) (6,8,2)
    10: 24,  # T. Nagar (Shopping) (8,8,8)
    11: 13,  # Mylapore (Cultural) (5,2,6)
    12: 14,  # Guindy National Park (Nature) (7,1,6)
    13: 19,  # Pallavaram Mountain (Nature)(8,4,7)
    14: 27,  # Dakshina Chitra (Cultural) (9,9,9)
    15: 13,  # Chennai Snake Park (Nature) (7,2,4)
    16: 15,  # Valluvar Kottam (Cultural) (8,2,5)
    17: 16,  # Koyambedu Flower Market (Cultural) (8,3,5)
    18: 17   # Thambi Vilas (Food) (7,2,8)
}
```

Case II: Equal Scores

```
happiness = {
    0: 0,   # IMSc
    1: 5,  # Elliot's Beach
    2: 5,  # Marina Beach
    3: 5,  # The Fisherman's Wharf
    4: 5,  # The Fat Boy
    5: 5,  # San Thome Church
    6: 5,  # Government Museum
    7: 5,  # Kalaignar Centenary Park
    8: 5,  # Arignar Anna Zoological Park
    9: 5,  # Phoenix Mall
    10: 5, # T. Nagar
    11: 5, # Mylapore
    12: 5, # Guindy National Park
    13: 5, # Pallavaram Mountain
    14: 5, # Dakshina Chitra
    15: 5, # Chennai Snake Park
    16: 5, # Valluvar Kottam
    17: 5, # Koyambedu Flower Market
    18: 5  # Thambi Vilas
```

Case III: An Outlier

```
happiness = {
    0: 0,   # IMSc
    1: 5,  # Elliot's Beach
    2: 5,  # Marina Beach
    3: 5,  # The Fisherman's Wharf
    4: 5,  # The Fat Boy
    5: 5,  # San Thome Church
    6: 5,  # Government Museum
    7: 5,  # Kalaignar Centenary Park
    8: 6,  # Arignar Anna Zoological Park
    9: 5,  # Phoenix Mall
    10: 5, # T. Nagar
    11: 5, # Mylapore
    12: 5, # Guindy National Park
    13: 5, # Pallavaram Mountain
    14: 5, # Dakshina Chitra
    15: 5, # Chennai Snake Park
    16: 5, # Valluvar Kottam
    17: 5, # Koyambedu Flower Market
    18: 5  # Thambi Vilas
}
```

Case IV:
Same as III but Different

Case V: Random Assignment

Other Ways ?

- Neural Networks ! ?
  We tried initially to solve this problem via a Hopfield Neural Network, As it turns out Creating a proper Energy Function for this is cumbersome and the results we got were not at all satisfactory.
- Animal Cognition :
  Humans and other living beings do these kinds of Optimizations all the time .
  Ex: Us choosing travel plans, Bees Forage & Ants adopt to Obstacles.
  So modelling optimization based on this kind of behaviour could be one such method.
  MacGregor, James N.; Chu, Yun (2011),
  , *Journal of Problem Solving*, **3** (2), :

Scope

- Can be applied to any city.
- Constrain parameters can be changed as per what we want to optimise.
- More constraints can be added.
- Modes of transport can be diversified.

Limitations

- Single mode of transport.
- The model is very simplistic in terms of constraints currently.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Thank You!

Links

All Plots and the code are in HTML File Here