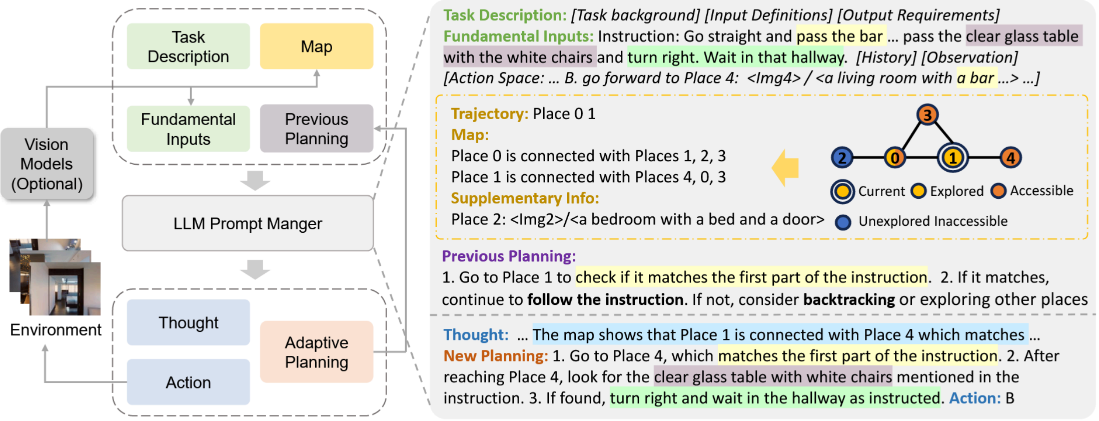
MapGPT



Task Description: *[Task background] [Input Definitions] [Output Requirements]*
Fundamental Inputs: Instruction: Go straight and pass the bar ... pass the clear glass table with the white chairs and turn right. Wait in that hallway. *[History] [Observation]*
[Action Space: ... B. go forward to Place 4: <Img4> / <a living room with a bar ...> ...]

Trajectory: Place 0 1
Map:
Place 0 is connected with Places 1, 2, 3
Place 1 is connected with Places 4, 0, 3
Supplementary Info:
Place 2: <Img2>/<a bedroom with a bed and a door>

Previous Planning:
1. Go to Place 1 to check if it matches the first part of the instruction. 2. If it matches, continue to **follow the instruction**. If not, consider **backtracking** or exploring other places

Thought: ... The map shows that Place 1 is connected with Place 4 which matches ...
New Planning: 1. Go to Place 4, which matches the first part of the instruction. 2. After reaching Place 4, look for the clear glass table with white chairs mentioned in the instruction. 3. If found, turn right and wait in the hallway as instructed. Action: B

(a) Prompt System

(b) Map-Guided Prompting with Adaptive Path Planning

Visual Observation:

只使用包含navigable point的图像，处理图像有两种办法，一种是和navgpt一样的two-stage system，既抽特征又送入bert生成描述，和navgpt一样，还有一种是one-stage system，直接把原始图片送到gpt里面。

这里只使用包含navigable point的图像就意味着，输给gpt的信息就只有包含navigable point的图像，其他无关图像直接丢弃不用。

action space：

stop+跳转到所有邻近的可观测到的navigable point

point category：

(1) explored nodes {enj }t j=0 (including starting node en0 and current node ent),

(2) accessible nodes {ant0, ant1, ...}, and

(3) unexplored inaccessible nodes {un0, un1, ...}.

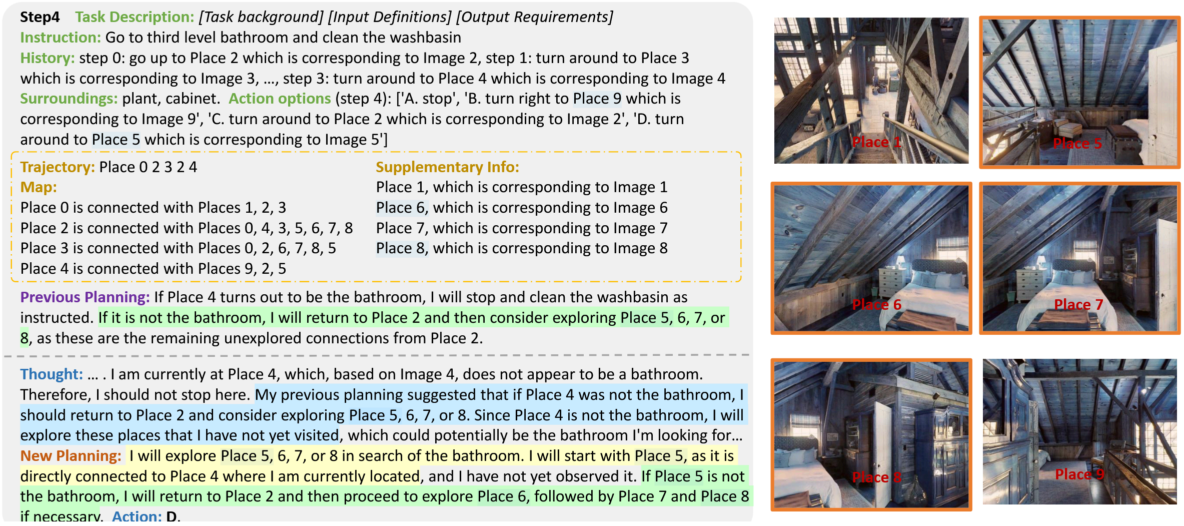
Map：

```
“Map:
Place {en0} is connected with Places {an00}, ...
Place {en1} is connected with Places {an01}, ...
...
Place {ent} is connected with Places {ant0}, ...”,
```

使用如上语言描述图

supplementary info:

记录目前不可到达且之前没探索过的地方的图像信息



Step4 Task Description: *[Task background] [Input Definitions] [Output Requirements]*
Instruction: Go to third level bathroom and clean the washbasin
History: step 0: go up to Place 2 which is corresponding to Image 2, step 1: turn around to Place 3 which is corresponding to Image 3, ..., step 3: turn around to Place 4 which is corresponding to Image 4
Surroundings: plant, cabinet. Action options (step 4): ['A. stop', 'B. turn right to Place 9 which is corresponding to Image 9', 'C. turn around to Place 2 which is corresponding to Image 2', 'D. turn around to Place 5 which is corresponding to Image 5']

Trajectory: Place 0 2 3 2 4
Map:
Place 0 is connected with Places 1, 2, 3
Place 2 is connected with Places 0, 4, 3, 5, 6, 7, 8
Place 3 is connected with Places 0, 2, 6, 7, 8, 5
Place 4 is connected with Places 9, 2, 5

Supplementary Info:
Place 1, which is corresponding to Image 1
Place 6, which is corresponding to Image 6
Place 7, which is corresponding to Image 7
Place 8, which is corresponding to Image 8

Previous Planning: If Place 4 turns out to be the bathroom, I will stop and clean the washbasin as instructed. If it is not the bathroom, I will return to Place 2 and then consider exploring Place 5, 6, 7, or 8, as these are the remaining unexplored connections from Place 2.

Thought: ... . I am currently at Place 4, which, based on Image 4, does not appear to be a bathroom. Therefore, I should not stop here. My previous planning suggested that if Place 4 was not the bathroom, I should return to Place 2 and consider exploring Place 5, 6, 7, or 8. Since Place 4 is not the bathroom, I will explore these places that I have not yet visited, which could potentially be the bathroom I'm looking for...
New Planning: I will explore Place 5, 6, 7, or 8 in search of the bathroom. I will start with Place 5, as it is directly connected to Place 4 where I am currently located, and I have not yet observed it. If Place 5 is not the bathroom, I will return to Place 2 and then proceed to explore Place 6, followed by Place 7 and Place 8 if necessary. Action: D.

Matterport Simulator：

```
        /**
         * Set a non-standard path to the viewpoint connectivity graphs. The provided directory must contain files
         * of the form "/<scanId>_connectivity.json". Default is "./connectivity" (the graphs provided
         * by this repo).
         */
        void setNavGraphPath(const std::string& path);
```

可以通过

```
sim.setNavGraphPath(connectivity_dir)
```

自定义连通图。

这里展示一个连通图文件

```
[

{
    // image_id应该是连通图上每个点的id
    "image_id":"10c252c90fa24ef3b698c6f54d984c5c",
    "pose":[-0.934268,-0.00147015,-0.35657,-5.48891,0.356526,-0.0200643,-0.93407,1.4484,-0.00578122,-0.999798,0.0192692,1.53509,0,0,0,1],
    "included":true,
    "visible":[false,false,true,false,false,false,false,false,true,false,false,false,true,false,true,true,false,true,true,false,false,false,false,true,false,false,false,false,false,true,true,true,false,false,false,false,true,false,false,false,false,false,false,false,false,false,true,false],
    "unobstructed":
[false,false,false,false,false,false,false,false,false,false,false,false,true,false,false,false,false,true,false,false,false,false,true,false,false,false,false,false,false,false,false,false,false,false,false,false,false,false,false,false,false,false,false,false,false,false],
    "height":1.5357383388956596
},

...

]
```

```
        /**
         * Set a non-standard path to the <a href="https://niessner.github.io/Matterport/">Matterport3D dataset</a>.
         * The provided directory must contain subdirectories of the form:
         * "<scanId>/matterport_skybox_images/". Default is "./data/v1/scans/".
         */
        void setDatasetPath(const std::string& path);
```

Matterport3D图像数据并没有包含在其中，需要单独下载。

simulator api:[peteanderson80/Matterport3DSimulator: AI Research Platform for Reinforcement Learning from Real Panoramic Images.](https://github.com/peteanderson80/Matterport3DSimulator)

By default, only camera viewpoints that are within the agent's current field of view are considered navigable, unless restricted navigation is turned off (i.e., the agent can't move backwards, for example).

```
[
  {
    "scanId" : "2t7WUuJeko7"  // Which building the agent is in
    "step" : 5,               // Number of frames since the last newEpisode() call
    "rgb" : <image>,          // 8 bit image (in BGR channel order), access with np.array(rgb, copy=False)
    "depth" : <image>,        // 16 bit single-channel image containing the pixel's distance in the z-direction from the camera center
                              // (not the euclidean distance from the camera center), 0.25 mm per value (divide by 4000 to get meters).
                              // A zero value denotes 'no reading'. Access with np.array(depth, copy=False)
    "location" : {            // The agent's current 3D location
        "viewpointId" : "1e6b606b44df4a6086c0f97e826d4d15",  // Viewpoint identifier
        "ix" : 5,                                            // Viewpoint index, used by simulator
        "x" : 3.59775996208,                                 // 3D position in world coordinates
        "y" : -0.837355971336,
        "z" : 1.68884003162,
        "rel_heading" : 0,                                   // Robot relative coords to this location
        "rel_elevation" : 0,
        "rel_distance" : 0
    }
    "heading" : 3.141592,     // Agent's current camera heading in radians
    "elevation" : 0,          // Agent's current camera elevation in radians
    "viewIndex" : 0,          // Index of the agent's current viewing angle [0-35] (only valid with discretized viewing angles)
                              // [0-11] is looking down, [12-23] is looking at horizon, is [24-35] looking up
    "navigableLocations": [   // List of viewpoints you can move to. Index 0 is always the current viewpoint, i.e. don't move.
        {                     // The remaining valid viewpoints are sorted by their angular distance from the image centre.
            "viewpointId" : "1e6b606b44df4a6086c0f97e826d4d15",  // Viewpoint identifier
            "ix" : 5,                                            // Viewpoint index, used by simulator
            "x" : 3.59775996208,                                 // 3D position in world coordinates
            "y" : -0.837355971336,
            "z" : 1.68884003162,
            "rel_heading" : 0,                                   // Robot relative coords to this location
            "rel_elevation" : 0,
            "rel_distance" : 0
        },
        {
            "viewpointId" : "1e3a672fa1d24d668866455162e5b58a",  // Viewpoint identifier
            "ix" : 14,                                           // Viewpoint index, used by simulator
            "x" : 4.03619003296,                                 // 3D position in world coordinates
            "y" : 1.11550998688,
            "z" : 1.65892004967,
            "rel_heading" : 0.220844170027,                      // Robot relative coords to this location
            "rel_elevation" : -0.0149478448723,
            "rel_distance" : 2.00169944763
        },
        {...}
    ]
  }
]
```

code analysis：

首先，实例化一个R2RNavBatch对象，存放在val_env中。

```
val_envs = {}
split = args.split = MapGPT_72_scenes_processed
val_envs[split] = val_env
```

MapGPT_72_scenes_processed.json保存了每条轨迹数据，而且是预处理过的数据

```
[

{"distance": 11.66, "scan": "VLzqgDo317F", "path_id": 6250, "path": ["af3af33b0120469c9a00daa0d0b36799", "5be145994f974347850a48cecd04cdcd", "79aedad1206b4eea9c4b639ea2182eb7", "1c91ed40af2246f2b126dd0f661970df", "385019f5d018430fa233d483b253076c", "fd263d778b534f798d0e1ae48886e5f3"], "heading": 3.751, "instr_id": "6250_2", "instruction": "walk forward then turn right at the stairs then go down the stairs."},

{"distance": 6.64, "scan": "sT4fr6TAbpF", "path_id": 3414, "path": ["9d001c6bc0f64a699fd36a6b9a61266a", "8138835f78064c28b6c9c35a89eda7d6", "37a978a1cc0e4464a714fb676f65b7fb", "859a7c9c12c847d9a6860bd6d6bd635a", "c3c5e202b9a04a63ae33742fe9095936", "c06aae190b804b759496db0b88fe4820"], "heading": 4.714, "instr_id": "3414_1", "instruction": "Head straight until you pass the wall with holes in it the turn left and wait by the glass table with the white chairs."},

...

]
```

这些数据被保存在R2RNavBatch.data中

R2RNavBatch.env保存EnvBatch的实例对象，而在EnvBatch中

EnvBatch.sims 以列表形式储存了批量大小个MatterSim.Simulator()

并且设置了vfov=60，以及

```
if scan_data_dir:
    sim.setDatasetPath(scan_data_dir)
sim.setNavGraphPath(connectivity_dir)
sim.setRenderingEnabled(False)
sim.setDiscretizedViewingAngles(True)   # Set increment/decrement to 30 degree. (otherwise by radians)
```

但是scan_data_dir为空

```
  args.scan_data_dir = os.path.join(ROOTDIR, 'Matterport3D', 'v1_unzip_scans')
```

R2RNavBatch.gt_trajs定义如下

```
self.gt_trajs = self._get_r2r_gt_trajs(self.data) # for evaluation

    def _get_r2r_gt_trajs(self, data):
        gt_trajs = {
            x['instr_id']: (x['scan'], x['path']) \
                for x in data if len(x['path']) > 1
        }
        return gt_trajs
```

R2RNavBatch.ix = 0，保存目前数据评估到哪里了

R2RNavBatch.graphs={scanid:G}存放图的信息

R2RNavBatch.sim又新建了一个配置相同的sim

R2RNavBatch.buffered_state_dict = {}

接下来实例化GPTNavAgent对象，储存在agent中

GPTNavAgent.env=R2RNavBatch

GPTNavAgent.prompt_manager = OneStagePromptManager(self.args)

GPTNavAgent.logs = defaultdict(list)

接下来进入主函数agent.test(args=args)

agent.results = {}

进入rollout

进入R2RNavBatch的reset

R2RNavBatch.batch保存一个批量大小的数据

self.sims[i].newEpisode([scanId], [viewpointId], [heading], [0])初始化episode

最后R2RNavBatch._get_obs()返回observations

在R2RNavBatch._get_obs()中，首先要调用self.make_candidate(state.scanId, state.location.viewpointId, state.viewIndex)获得周围点的信息

进入make_candidate中

```
for ix in range(36):
    if ix == 0:
        self.sim.newEpisode([scanId], [viewpointId], [0], [math.radians(-30)])
    elif ix % 12 == 0:
        self.sim.makeAction([0], [1.0], [1.0])
    else:
        self.sim.makeAction([0], [1.0], [0])
```

使用另外一个单独获取周围点的sim，对周围扫36次，获取周围点的各种信息，包括周围点的图像。

将周围点信息保存在R2RNavBatch.buffered_state_dict[long_id]中，下次访问相同点时就可直接使用。

返回周围点信息列表，make_candidate结束。

_get_obs返回所有观察结果，不包括自己当前视角下的图像信息。

R2RNavBatch的reset 结束

继续rollout

```
        # Record the navigation path
        traj = [{
            'instr_id': ob['instr_id'],
            'path': [[ob['viewpoint']]],
            'details': {},
            'a_t': {},
        } for ob in obs]
```

下面开始构造prompt

```
            cand_inputs = self.prompt_manager.make_action_prompt(obs,
previous_angle)
            if self.args.response_format == 'str':
                nav_input =
self.prompt_manager.make_r2r_prompts(cand_inputs=cand_inputs, obs=obs, t=t)
            elif self.args.response_format == 'json':
                nav_input =
self.prompt_manager.make_r2r_json_prompts(cand_inputs=cand_inputs, obs=obs, t=t)
            else:
                raise NotImplemented
```

到这里都实现批量，后面只将第一个批量取出送入llm预测动作

用正则式取出动作，执行动作

最后更新history

```
self.prompt_manager.make_history(a_t, nav_input, t)
```

总结

1. in MapGPT/GPT/one_stage_prompt_manager.py at main · chen-judge/MapGPT line67

```
direction = self.get_action_concept(cc['absolute_heading'] - previous_angle[i]
['heading'],cc['absolute_elevation'] - 0)
```

   解答：因为所有的elevation都为0

2. 用别人视角里包含路径点的一张图概括路径点的特征，是否有些片面。个人感觉可以在后续采到同一路径点不同视角下的图像时，也可以保留之前图片，一起作为该路径点的特征。
3. ce中路径点会改变，如何构造一个和离散相似的map：参考ETPNav
4.

```
--img_root /path/to/images
img_path = os.path.join(self.args.img_root, scanId, viewpointId, str(ix) +
'.jpg')
```

--img_root用来存放图像RGB_Observations.zip

issue解答：

Please follow this and --img_root should be the path to your images:
"The observation images need to be collected in advance from the simulator. You can use your own saved images or use the RGB_Observations.zip we have processed."

疑问

```
if scan_data_dir:
    sim.setDatasetPath(scan_data_dir)
args.scan_data_dir = os.path.join(ROOTDIR, 'Matterport3D', 'v1_unzip_scans')
```

但是scan_data_dir为空，还是说里面应该放RGB_Observations.zip？

```
        /**
         * Set a non-standard path to the <a
href="https://niessner.github.io/Matterport/">Matterport3D dataset</a>.
         * The provided directory must contain subdirectories of the form:
         * "<scanId>/matterport_skybox_images/". Default is "./data/v1/scans/".
         */
        void setDatasetPath(const std::string& path);
```

移植改动：

1. 将ce数据集以类似MapGPT_72_scenes_processed.json的形式传入
2. 如何将habitat simulator输出的图像送到gpt中
3. ~~sim.setNavGraphPath(connectivity_dir)中的连通图~~
4. 得到ce中的shortest_distances

研究connectivity_dir下的连通图的作用

```
class R2RNavBatch(object):
    def __init__()
        self._load_nav_graphs()

    def _load_nav_graphs(self):
        """
        load graph from self.scan,
        Store the graph {scan_id: graph} in self.graphs
        Store the shortest path {scan_id: {view_id_x: {view_id_y: [path]} } } in self.paths
        Store the distances in self.distances. (Structure see above)
        Load connectivity graph for each scan, useful for reasoning about shortest paths
        :return: None
        """
        print('Loading navigation graphs for %d scans' % len(self.scans))
        self.graphs = load_nav_graphs(self.connectivity_dir, self.scans)

        #事实上，self.shortest_paths根本没有用在其他地方
        self.shortest_paths = {}
        for scan, G in self.graphs.items():  # compute all shortest paths
            self.shortest_paths[scan] = dict(nx.all_pairs_dijkstra_path(G))


        self.shortest_distances = {}
        for scan, G in self.graphs.items():  # compute all shortest paths
            self.shortest_distances[scan] = dict(nx.all_pairs_dijkstra_path_length(G))
```

```
def load_nav_graphs(connectivity_dir, scans):
    ''' Load connectivity graph for each scan '''

    def distance(pose1, pose2):
        ''' Euclidean distance between two graph poses '''
        return ((pose1['pose'][3]-pose2['pose'][3])**2\
          + (pose1['pose'][7]-pose2['pose'][7])**2\
          + (pose1['pose'][11]-pose2['pose'][11])**2)**0.5

    graphs = {}
    for scan in scans:
        with open(os.path.join(connectivity_dir, '%s_connectivity.json' % scan)) as f:
            G = nx.Graph()
            positions = {}
            data = json.load(f)
            for i,item in enumerate(data):
                if item['included']:
                    for j,conn in enumerate(item['unobstructed']):
                        if conn and data[j]['included']:
                            positions[item['image_id']] = np.array([item['pose'][3],
                                    item['pose'][7], item['pose'][11]]);
                            assert data[j]['unobstructed'][i], 'Graph should be undirected'
                            G.add_edge(item['image_id'],data[j]['image_id'],weight=distance(item,data[j]))
            nx.set_node_attributes(G, values=positions, name='position')
            graphs[scan] = G
    return graphs
```

事实上，只有R2RNavBatch.shortest_distances在后续的过程中被用到，它被加入到了_get_obs函数的返回结果中。

```
            # RL reward. The negative distance between the state and the final
state
            # There are multiple gt end viewpoints on REVERIE.
            if ob['instr_id'] in self.gt_trajs:
                ob['distance'] = self.shortest_distances[ob['scan']]
[ob['viewpoint']][item['path'][-1]]
            else:
                ob['distance'] = 0
```

pyshortest_distances可以作为RL的评估指标，以及在evaluation阶段中使用。

ce中可以得到shortest_distances吗?