

PROGPROMPT: Generating Situated Robot Task Plans using Large Language Models Ishika Singh, Valts Blukis, Arsalan Mousavian, Ankit Goyal, Danfei Xu, Jonathan Tremblay, Dieter Fox, Jesse Thomason, Animesh Garg



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PROMPT for Planning **Generated Plan PROMPT for State Feedback** ef microwave_salmon(): **Classical Task Planning** Example assertion check(s) LLM [GPT-3] Import action primitives Method: # 0: walk to kitchen You see: "fridge is CLOSED, rom actions import walk <obj>. walk('kitchen' grab <obj>, switchon <obj>, lightswitch is ON, cereal, Action AP # 1: find microwave Demo in open <obj>, standup, find bookshelf, box INSIDE bookshelf × Requires myriad domain knowledge lan Step cereal ON wallshelf, paper <obj>, putin <obj> <obj>, ... find('microwave') # 2: open microwave INSIDE bookshelf.... X Large search space, hard to scale Available objects list Virtual You have: "book" assert('close' to 'microwave' X Domain specific else: find('microwave') objects=[clothesshirt, sink, assert('close' to 'mug') pie, apple, fridge, garbagecan, assert('microwave' of microwave salmon(): 'closed is × Requires concrete goal specification False Home tv, dishwashingliquid, bed, else: close('microwave' # 5: put salmon in microwave assert('book' in 'hands') bookshelf, salmon, stove, plate, tate open('microwave') True coffeepot, kitchentable, assert('microwave' is 'opened → else open('microwave')) assert('cereal' on 'bookshelf' wineglass, paper, microwave. # 5: put salmon in microwave False putin('salmon', 'microl toothbrush, toothpaste, assert('salmon' in 'hands') . . . **Planning with LLMs** bathroomcabinet, kitchen, lime, else: **find**('salmon') painkillers, barsoap, ...] **Current Semantic State** else: grab('salmon') You see: "microwave is OPEN and Example task(s) assert('close' to 'microwave Env [VH] else: **find**('microwave') OFF, microwave ON Prompt def throw away lime(): LLM [GPT-3] kitchencounter.' assert('microwave' is 'opened # 0: find lime ask: make coffee You have: "salmon. find('lime') else: open('microwave') vlan. putin('salmon', 'microwave') Go to kitchen assert('microwave' is 'opened' # 5: close garbagecan find mua assert('close' to 'garbagecan') close('microwave') grab mug else: find('garbagecan') **Full Execution** find coffee machine **Generated Plan** switchon('microwave') assert('garbagecan' is 'opened' put mug in coffee machine # 8: wait for salmon to be done cooking 1-2 minutes else: open('garbagecan') walk(kitchen) find(salmon) grab(salmon putin(salmon. turn on coffee machine Find the salmon close('garbagecan') # 9: turn off microwave 7 switch off coffee machine Place the salmon on the plate *** # 6: Done switchoff('microwave') grab mug Put the plate in the micrwave find table Set the timer for the desured open('microwave') Next task prompt 10. put mug on the table amout of time 11. Done grab('salmon') Wait for the timer to go off ef microwave salmon(): 12: put salmon on plate switchon switchoff lgrab(salmon Remove the plate from the assert('salmon' in 'hands' Fask: microwave salmon (microwave) (microwave) (microwave) (microwave (microwave microwave assert('close' to 'plate') else: find('plate') Enjoy your delicious salmon LLM [GPT-3] putin('salmon', 'plate') close('microwave') X I I M is not situated in the scene Plan steps using unavailable actions and objects Prompt X Text-to-robot action mapping may from actions import grab_and_putin <obj><obj>, grab_and_puton <obj><obj>, switchon <obj>, Generated Plan Results grab_and_puton('al-Robot Arm puton('banana', 'plate' VirtualHome Simulator switchoff <obj>, open <obj>, ... not be trivial LLM situated in the def microwave_salmon() (# 0: walk to kitcher def throw away banana(): ★ Combinatorial admissible:action^{bj>} walk objects = ['banana', 'garbage can',...] scene 1: put banana in garbage can # 1: find microw find('microwave' pen <obj>, standup, find obj>, putin <obj> <obj>, - Prompt Format and Parameters space grab and putin('banana', 'garbagecan' Format COMMENTS FEEDBACK LLM Ba Available objects list (1:[0,n]) text-robot assert 'close' t<mark>o</mark> find ('microwave Actions CODEX biects=[clothesshirt' sink. put_fork_and_spoon_on_the_box(): action mapping ie apple fridge garbagecan ert('microwav 2 PROGPROMPT DAVINCI objects = ['fork', 'spoon', 'knife',] owave') 3 PROGPROMPT GPT3 **KEY TAKEAWAY** 4 PROGPROMPT GPT3 Plans restricted to put fork on plate and spoon in box(almon in5 har BBOGPROMPT ind('s 6 PROGPROMPT GPT3 available actions and GPT3 f sort fruits on plate and bottles in box(): TO 7 MICLONE PROMPT 0.00±0.00 0.36±0.00 0.42±0.02 GPT3 Ŧ 'banana', 'bottle', 'box', 'table', 'drill', 'strawberry'] We present a Example task(s)mmatic objects 'nlate' 0.00±0.00 0.45±0.03 0.21±0.03 Baseline from HUANG ET AL. [2] GPT3 find('m 8 LLM [GPT-3] prompt structure that enables blan pen('microwave') mon', 'microwave') True Use LLM's real' on 'bookshelf # 3: put bottle in box grab_and_putin('bottle', 'box') GCR on plate VH Scene SR Exec generation functional across situated grab and nuton('banana' 'plate') commonsense to 2: put strawberry on plate 0.65 ± 0.05 emantic State ENV-0 0.34 ± 0.08 0.84 ± 0.01 grab and puton('s compose action robot capabilities. environments. 0.81 0.0 0 microwave is OPEN and ENV-1 $0.56 {\pm} 0.08$ 0.85 ± 0.02 Env [VII] Task Description Distractors SR Plan SR GCR to handle combinatorial ENV-2 0.56 ± 0.05 0.85 ± 0.03 0.72±0.09 ter. and tasks. salmon 1/1Next task prompt) action space (microwave' is 'opened') 1/1 0.48 ± 0.13 $0.85 {\pm} 0.02$ Average Dut the 1/1 1/1 Generalizes to new to 'plate' else: find('plate') LLM [GPT-3] 2/2 tasks, scenes, and 2/2 proaprompt.github.io robots sort the fruits on the plate 2/3 3/3 and the bottles in the box