Natural Language Recipe Description

1. Pour the butter into the frying-pan and heat to melt.
2. Add the egg and cook until the egg is cooked.

Cooking Function Sequence Conversion from Recipe with Large Language Model

Express a cooking recipe as a sequence of functions that can be defined as below using the variables ingredient, vessel, tool, and state.
pour(ingredient, vessel)
mix(ingredient, ingredient, mixture, vessel, tool)
turn-on-stove(vessel)
set-stove(state, vessel)
turn-off-stove(vessel)
stir(ingredient, state, tool)
heat(ingredient, state)
cook(ingredient, state)
boil(ingredient, state)
stir-fry(ingredient, state, tool)

For example,

[Recipe]
Mix the eggs and milk well to make the egg mixture.
Melt the butter in a frying pan.
Pour the egg mixture into the frying pan and leave it there without touching it until the surrounding mixture hardens. When the egg mixture hardens, fry the eggs quickly with a wooden spoon until they are tender.
[Function Sequence]
mix(egg, milk, egg-mixture, bowl, whisk)
pour(butter, frying-pan)
heat(butter, melt)
pour(egg-mixture, frying-pan)
heat(egg-mixture, surroundings-hardened)
stir-fry(egg-mixture, whole-mixture-tender, wooden-spatula)

[Recipe]
Pour the salad oil into the frying pan and heat it for 30 seconds.
After 30 seconds, add an egg and cook until the egg is cooked.
[Function Sequence]
pour(salad-oil, frying-pan)
heat(salad-oil, thirty-seconds)
pour(egg, frying-pan)
cook(egg, cooked-egg)

[Recipe]
Boil water in a pot and turn the heat down to low.
Stir with a spoon to form a whirlpool.
Gently drop the eggs into the pot and boil for 3 minutes.
[Function Sequence]
boil(water, boiled-water)
set-stove(low, pot)
stir(water, vortexed-water, spoon)
pour(egg, pot)
boil(egg, three-minutes)

Then, convert the following recipe.

[Recipe]
Pour the butter into the frying-pan and heat to melt.
Add the egg and cook until the egg is cooked.
[Function Sequence]
pour(butter, frying-pan)
heat(butter, melt)
pour(egg, frying-pan)
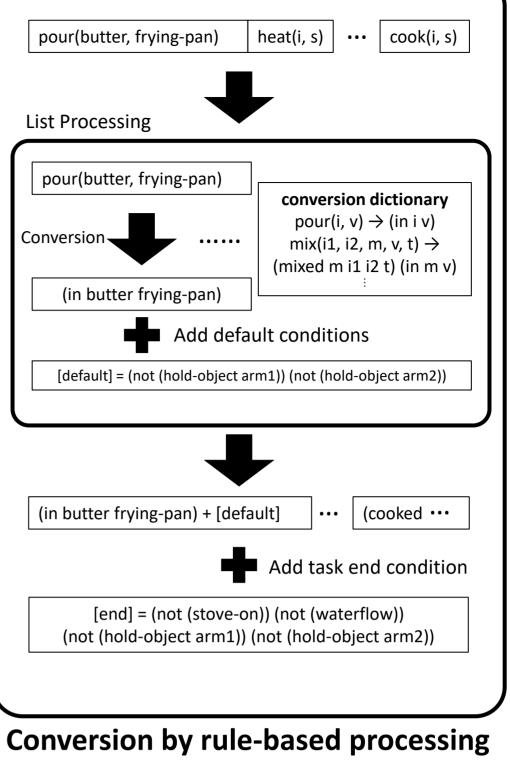**cook(egg, cooked-egg)**
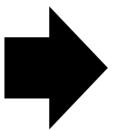
* Blue bolded part is inferred by LLM

Cooking Function Sequence

1. pour(butter, frying-pan)
2. heat(butter, melt)
3. pour(egg, frying-pan)
4. cook(egg, cooked-egg)

Executable Cooking Action Procedure Planning with PDDL

Conversion by rule-based processing

pour(butter, frying-pan) | heat(i, s) | ⋯ | cook(i, s)

List Processing

pour(butter, frying-pan)

Conversion ⋯⋯

conversion dictionary
pour(i, v) → (in i v)
mix(i1, i2, m, v, t) → (mixed m i1 i2 t) (in m v)
⋮

(in butter frying-pan)

➕ Add default conditions

[default] = (not (hold-object arm1)) (not (hold-object arm2))

(in butter frying-pan) + [default] ⋯ (cooked ⋯

➕ Add task end condition

[end] = (not (stove-on)) (not (waterflow)) (not (hold-object arm1)) (not (hold-object arm2))
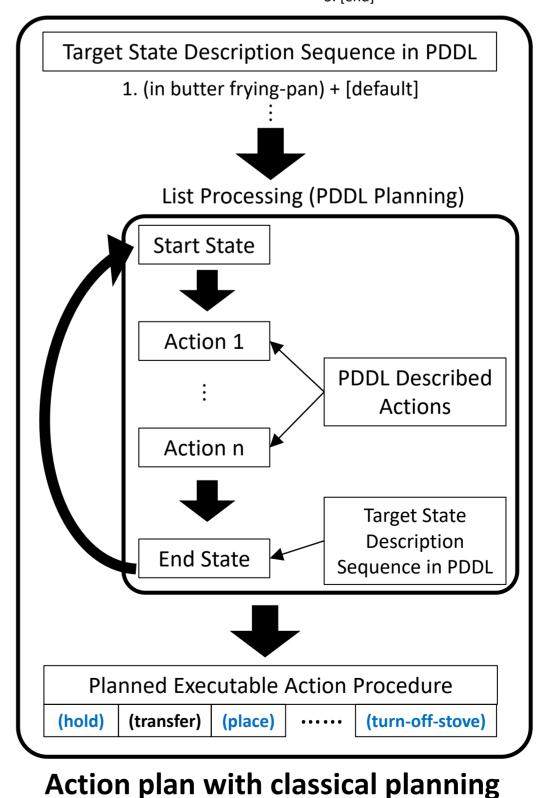
Target State Description Sequence
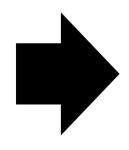
1. (in butter frying-pan) + [default]
2. (heated butter melt) + [default]
3. (in egg frying-pan) + [default]
4. (cooked egg cooked-egg) + [default]
5. [end]

Action plan with classical planning

Target State Description Sequence in PDDL
1. (in butter frying-pan) + [default]
⋮

List Processing (PDDL Planning)

Start State
⬇
Action 1 → PDDL Described Actions
⋮
Action n
⬇
End State → Target State Description Sequence in PDDL

Planned Executable Action Procedure
(hold) (transfer) (place) ⋯⋯ (turn-off-stove)

Planned Executable Action Procedure

(hold small-bowl arm2 stove)
(transfer butter small-bowl frying-pan arm2 stove)
(place small-bowl arm2 stove)
(turn-on-stove frying-pan arm1)
(heat butter frying-pan melt)
(hold bowl arm2 stove)
(transfer egg bowl frying-pan arm2 stove)
(place bowl arm2 stove)
(cook egg cooked-egg)
(turn-off-stove middle frying-pan arm1)

* Blue letters are supplemented by planning