Artículo científico de planificadores del estado del arte.

Balsells Orellana, Jorge A.

4 de enero de 2021

Resumen

Este documento contiene los resultados de análisis de algunos planificadores existentes en IPC del año 2018. IPC es una competencia internacional anual del estado de arte de planificadores, en la cual se motiva a desarrolladores a publicar sobre sus investigaciones en esta rama de la inteligencia artificial. Se han instalado y probado los primeros lugares en cada rama, y se han seleccionado 3 al azar para analizarlos de la misma manera y comparar sus resultados plasmados en conclusiones.

1. Introducción

La planificación en Inteligencia Artificial es una forma automática de programación a través de una secuencia de acciones que parten desde un estado inicial, hacia un estado final. En este caso se aplica al estado del arte, lo que significa que es una investigación técnica y científica en el campo de inteligencia artificial. Los planificadores no solo dan la solución a un problema, sino los pasos a seguir dentro del problema, por este motivo son tan importantes dado que se da a conocer el proceso con pasos ordenados y no solo el resultado obtenido.

Otro aspecto muy importante de la planificación automática son las técnicas existentes para planificación y la fuerte semejanza entre los procesos de planificación y los procesos de programación comparando el concepto de un plan y el desarrollo de un algoritmo.

2. Estado del arte

Es una categoría deductiva que nace con la pretensión de generar un balance en la investigación de algunas regiones, y tiene como fin una estrategia metodológica para análisis crítico en cualquier área de trabajo o estudio. Requiere un análisis hermenéutico del objeto de estudio sin ningún tipo de problema ante la crítica, para poder superar o igualar estudios existentes por procesos diferentes a lo ya existente. (Guevara Patiño, 2016)

En otras palabras, se puede decir que es una investigacion documental que sirve para compartir el conocimiento que se ha generado sobre un estudio específico. Esto hace posible una mejor comprensión crítica sobre un tema con fin de generar nuevos conocimientos y nuevas comprensiones. Permite desarrollar nuevas teorías a partir de análisis crítico, revisión e interpretación de los datos y documentos existentes. En este caso, la inteligencia artificial se ha centrado en razonamiento sobre la planificación de enfrentar problemas y resolverlos, y el estado del arte aplica en los algoritmos utilizados para ello. (Guzmán Luna, 2003)

3. Planificadores evaluados

En la selección de los planificadores automáticos de este documento, están basados en determinar cuáles tienen experimentos en su repositorio. Los planificadores seleccionados han sido de la competicion internacional de planificacion de 2018. Esta competición evalúa el estado del arte de planificadores cada año, siendo asi un medio que promueve el desarrollo de estos.

3.1. Fast Downward Stone Soup

Este planificador requiere un set de algoritmos de planificación que usa 144 algoritmos con configuraciones fast downward. De igual manera necesita instancias de entrenamiento, específicamente 2115 instancias.

```
6 portfolio := ...
    reduce(portfolio, results)
7 return portfolio
```

La evaluación de resultados del algoritmo tiene 2 parámetros, *Granularity* y *Timeout* medidos en segundos. Ruta Satisfactoria(*Satisficing Track*) (R. G. Seipp Jendrik, 2018)

Los resultados obtenidos de este algoritmo fueron todos los mensajes generados durante la ejecución, en un documento de texto de **1605673** líneas descritas, donde las ultimas 5 líneas son las siguientes.

```
1 1605669 3
2 1605670 11 1
3 1605671 22 1
4 1605672 39 1
5 1605673 end_CG
```

y luego de aproximadamente 30 minutos, en terminal ha quedado el siguiente mensaje:

```
remaining time: -0.72
config 16: relative time 30, ...
    remaining 210
Error: Unexpected exit codes: ...
[-11]
Command '['run-portfolio', ...
    '/planner/driver/ ...
    portfolios/seq_sat_fdss_2018 ...
    .py']' returned non-zero ...
exit status -11
```

3.2. LAPKT BFWS Preference

Se utilizan algoritmos basados en *búsque-da ancha* que obtienen la noción de un estado, suponiendo que el estado es el conjunto de proposiciones. La búsqueda de mejor

ancho primero proporciona una alternativa a IW(k) serializados completos, lo que implica que se pierde la naturaleza polinomial - temporal de IW(k). Ruta Satisfactoria(Satisficing Track) (Francés Guillem, 2018)

Los resultados obtenidos son los siguientes:

```
(take_grain worker2 worker1 ...
   worker2 round1 grain)
(plow_field worker1 noworker ...
   worker2 round1)
(ag_finish_round_backhome ...
   round1 worker2)
(ag__finish_round_renew ...
   round1 noworker)
(aq_advance_round_normal ...
   round1 round2 act_sheep)
(take_grain worker2 worker1
   worker2 round2 carrot)
(take_food worker1 noworker ...
   worker2 round2 num2 num3)
(ag_finish_round_backhome ...
   round2 worker2)
(ag__finish_round_renew ...
   round2 noworker)
(ag__advance_round_normal ...
   round2 round3 act_sow)
(take_food worker2 worker1 ...
   worker2 round3 num3 num4)
(sow worker1 noworker worker2 ...
   round3 grain)
(ag_finish_round_backhome ...
   round3 worker2)
(ag__finish_round_renew ...
   round3 noworker)
(aq_advance_round_normal ...
   round3 round4 act_fences)
(take_food worker2 worker1 ...
   worker2 round4 num4 num5)
(collect_resource worker1 ...
   noworker worker2 round4 ...
   act_clay clay)
(ag__finish_round_backhome ...
   round4 worker2)
```

```
(ag__finish_round_renew ...
    round4 noworker)
(ag_harvest_collect_end ...
    round4 stage1)
(ag_harvest_feed round4 ...
    stage1 worker2 num5 num5 num0)
 (ag_harvest_breed_end round4 ...
    stage1)
(ag__finish_stage stage1 ...
    stage2 round4 round5 act_boar)
(take_food worker2 worker1 ...
    worker2 round5 num0 num1)
(collect_resource worker1 ...
    noworker worker2 round5 ...
    act_stone stone)
 (aq_finish_round_backhome ...
    round5 worker2)
(ag__finish_round_renew ...
    round5 noworker)
(ag__advance_round_normal ...
    round5 round6 act_improve)
(improve_home worker2 worker1 ...
    worker2 round6 fireplace)
(collect_cook_animal boar ...
    act_sheep worker1 noworker ...
    worker2 round6 num1 num3)
(ag__finish_round_backhome ...
    round6 worker2)
(ag__finish_round_renew ...
    round6 noworker)
(ag_advance_round_normal ...
    round6 round7 act_cattle)
(collect_cook_animal boar ...
    act_sheep worker2 worker1 ...
    worker2 round7 num3 num5)
(collect_cook_animal boar ...
    act_cattle worker1 ...
    noworker worker2 round7
    num5 num7)
(ag__finish_round_backhome ...
    round7 worker2)
 (ag__finish_round_renew ...
    round7 noworker)
(ag_harvest_collect_end ...
    round7 stage2)
(ag_harvest_feed round7 ...
    stage2 worker2 num7 num5 num2)
(ag_harvest_breed_end round7 ...
    stage2)
```

```
(ag__finish_stage stage2 ...
      stage3 round7 round8 ...
      act_carrot)
   (collect_cook_animal boar ...
      act_sheep worker2 worker1
      worker2 round8 num2 num4)
  (sow worker1 noworker worker2
      round8 carrot)
   (ag__finish_round_backhome
      round8 worker2)
   (ag__finish_round_renew
      round8 noworker)
   (ag_advance_round_normal
46
      round8 round9 void)
   (take_food worker2 worker1 .
      worker2 round9 num4 num5)
  (collect_cook_animal boar ...
      act_sheep worker1 noworker
      worker2 round9 num5 num7)
  (ag__finish_round_backhome ...
      round9 worker2)
   (ag__finish_round_renew
      round9 noworker)
   (ag_harvest_collect_end ...
      round9 stage3)
   (ag_harvest_feed round9 ...
      stage3 worker2 num7 num5 num2)
  (ag_harvest_breed_end round9 ...
      stage3)
```

3.3. Complementary 2

Este planificador es una implementación de las heurísticas (CPC). Es una descripción general de alto nivel del CPC de búsqueda realizada en un espacio de colección de patrones. Recibe una tarea de planificación con una base heurística, límites de tiempo y memoria. Este devuelve un conjunto de colecciones de patrones en base a una función heurística canónica. Ruta óptima (Optimal Track) (Franco Santiago, 2018)

Los resultados obtenidos son los siguientes:

```
(collect_resource worker2 ...
   worker1 worker2 round1 ...
   act_reed reed)
(collect_resource worker1 ...
   noworker worker2 round1 ...
   act_wood wood)
(ag_finish_round_backhome ...
   round1 worker2)
(ag_finish_round_renew ...
   round1 noworker)
(ag__advance_round_normal
   round1 round2 act_sheep)
(build_room worker2 worker1
   worker2 worker3 round2 room3)
(family_growth worker1 ...
   noworker worker2 worker3
   round2 clay room3)
(ag_finish_round_backhome_withchild ...
   round2 worker2 worker3)
(ag__finish_round_renew ...
   round2 noworker)
(ag__advance_round_normal
   round2 round3 act_sow)
(collect_resource worker3
   worker2 worker3 round3 ...
   act_clay clay)
(collect_resource worker2 ...
   worker1 worker3 round3 ...
   act_reed reed)
(plow_field worker1 noworker ...
   worker3 round3)
(ag__finish_round_backhome ...
   round3 worker3)
(ag__finish_round_renew
   round3 noworker)
(aq_advance_round_normal ...
   round3 round4 act_fences)
(take_food worker3 worker2 ...
   worker3 round4 num2 num3)
(take_grain worker2 worker1 ...
   worker3 round4 carrot)
(sow worker1 noworker worker3 ...
   round4 carrot)
(ag_finish_round_backhome ...
   round4 worker3)
(ag__finish_round_renew
```

round4 noworker)

(ag_harvest_collecting_veg ...

## (ag_finish_round_backhome round4 stage1) ## (ag_harvest_feed round4 stage1 worker3 num6 num6 num0) ## (ag_harvest_feed round4 stage1) ## (ag_finish_stage stage1 stage2) ## (ag_finish_stage stage1 stage2 round4 round5 act_boar) ## (collect_resource worker3 worker4 round5 round5 act_wood wood) ## (family_growth worker1 worker3 worker4 round5 round5 round5 clay room4) ## (ag_finish_stage stage2 stage2 worker4 num8 num8 num0) ## (ag_harvest_feed round7 stage2 worker4 num8 num0 num0 num0 num0) ## (ag_harvest_feed round7 stage2 worker4 num8 num0 num0 num0 num0 num0 num0 num0 num0		round4 stage1 carrot num3		worker4 round7 num7 num8)
28 (ag_harvest_feed round4 stagel worker3 num6 num6 num0) 29 (ag_harvest_breed_end round4 stagel) 20 (ag_finish.stage stagel stage2 round4 round5 act_boar) 20 (collect_resource worker3 worker4 worker3 round5 worker3 worker4 round5 room4) 20 (family_growth worker1 noworker worker3 worker4 round5 round5 box rower4 round5 round5 box rower4 round5 clay room4) 30 (ag_finish.round.backhome.withchil round5 noworker) 31 (ag_finish.round.renew round5 rownd6 act_improve) 32 (collect_resource worker4 worker3 worker4 round5 worker3 worker4 round6 act_stone stone) 34 (improve.home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker4 worker4 round6 num0 num2) 36 (take.food worker1 noworker worker4 round6 num6 num0 num2) 37 (ag_finish.round.renew round6 round6 num6 num0 num2) 38 (ag_finish.round.packhome round8 worker4 worker4 round6 num0 num2) 39 (ag_finish.round.packhome round6 round7 num3) 37 (ag_finish.round.packhome round8 worker4 worker4 round6 num0 num2) 39 (ag_advance.round normal round6 roworker) 39 (ag_finish.round.packhome round6 roworker3 worker4 worker4 round9 num7 num8) 40 (build_fences boar worker4 worker4 round9 num7 num8) 41 (collect_cook_animal boar act_sheep worker4 worker4 round9 num7 num8) 42 (collect_cook_animal boar act_sheep worker4 worker4 round9 num7 num8) 43 (ag_finish.round.packhome round8 orwer4 worker4 round8 num1 num7) 43 (collect_cook_animal boar round8 noworker1 worker4 round9 num7 num8) 44 (ag_finish.round.packhome round8 noworker2 worker4 round9 num7 num8) 45 (ag_finish.round.packhome round8 noworker1 worker4 round9 num7 num8) 46 (ag_finish.round.packhome round8 noworker1 worker4 round9 num7 num8) 47 (ag_finish.round.packhome			44	(agfinish_round_backhome
round4 stagel) 24 (ag_harvest_feed round4 stagel worker3 num6 num0) 25 (ag_harvest_breed_end round4 stagel) 26 (ag_finish.stage stagel stage2 round4 round5 act_boar) 27 (collect_resource worker3 worker2 worker1 round5 act_wood wood) 28 (build_room worker2 worker1 worker3 worker4 round5 room4) 29 (family_growth worker1 noworker worker3 worker4 round5 clay room4) 20 (ag_finish.round_backhome_withchil round5 worker3 worker4 round5 round5 noworker) 21 (ag_finish.round_backhome_withchil round5 worker3 worker4 worker4 round6 act_improve) 25 (collect_resource worker4 worker4 worker4 round6 act_stone stone) 26 (collect_cook_animal boar act_stepe worker2 worker1 worker4 round6 num2) 27 (ag_finish.round_backhome round8 worker4 worker4 round6 num2) 28 (collect_cook_animal boar act_stepe worker2 worker1 worker4 round6 num0 num2) 29 (collect_cook_animal boar act_stepe worker4 worker4 round6 num0 num2) 20 (collect_cook_animal boar act_stepe worker4 worker4 round6 num0 num2) 20 (collect_cook_animal boar act_stepe worker4 worker4 worker4 worker4 round6 num0 num2) 20 (collect_cook_animal boar act_stepe worker4 worker4 round7 act_cattle) 21 (collect_cook_animal boar act_boar worker4 worker4 worker4 round7 num3 num5) 22 (collect_cook_animal boar act_boar worker4 worker1 worker4 round9 num7 num8) 23 (ag_finish.round_backhome round9 round9 num7 num8) 24 (collect_cook_animal boar act_boar worker4 worker4 round9 num7 num8) 25 (collect_cook_animal boar round9 round9 num7 num8) 26 (collect_cook_animal boar round9 round9 num7 num8) 27 (collect_cook_animal boar round9 noworker1 worker4 round9 num7 num8) 28 (collect_cook_animal boar round9 noworker2 worker4 round9 num7 num8) 29 (collect_cook_animal b	23	(ag_harvest_collect_end		-
24 (ag_harvest_feed round4 stage1 worker3 num6 num6 num0) 25 (ag_harvest_breed_end round4 stage2) 26 (ag_finish_stage stage1 stage2 round4 round5 act_boar) 27 (collect_resource worker3 worker3 worker4 round5 act_wood wood) 28 (build_room worker2 worker1 worker3 worker4 round5 room4) 29 (family_growth worker1 noworker worker3 worker4 round5 clay room4) 30 (ag_finish_round_backhome_withchild round5 noworker worker3 worker4 round5 round6 noworker) 31 (ag_finish_round_renew round5 round6 act_improve) 32 (collect_resource worker4 worker3 worker4 round6 act_stone stone) 34 (improve_home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 num0 num2) 36 (ag_finish_round_renew round6 worker4) 37 (ag_finish_round_backhome round8 round9 void) 38 (ag_finish_round_renew round8 round9 void) 39 (ag_finish_round_backhome round8 round9 void) 30 (alg_finish_round_renew round8 round9 void) 31 (collect_cook_animal boar act_sheep worker2 worker4 worker4 round6 num0 num2) 36 (ag_finish_round_renew round8 round9 void) 37 (ag_finish_round_renew round8 round9 void) 38 (ag_finish_round_renew round9 num5 num7) 39 (ag_advance_round_normal worker4 round6 num0 num2) 30 (alg_finish_round_renew worker4 round6 num0 num2) 31 (alg_finish_round_renew worker4 round6 num0 num2) 32 (alg_finish_round_renew worker4 round9 num5 num7) 39 (alg_finish_round_renew worker4 round9 num5 num7) 30 (alg_finish_round_renew round9 nowrker1 worker4 round9 num5 num7) 30 (alg_finish_round_renew round9 num6 num0 round9 num6 num0 round9 num6 num6 r		round4 stage1)	45	(agfinish_round_renew
stagel worker3 num6 num0 46 (ag_harvest_collect_end stagel) 26 (ag_finish_stage stagel stage2 round4 round5 act_boar) 27 (collect_resource worker3 worker2 worker3 round5 act_wood wood) 28 (build_room worker2 worker1 worker3 worker4 round5 room4) 29 (family_growth worker1 round5 clay room4) 30 (ag_finish_round_backhome_withchild round5 worker3 worker4) 31 (ag_finish_round_renew round5 round6 act_improve) 32 (collect_resource worker4 worker3 worker4 round6 act_sheep worker3 worker4 worker3 worker4 round6 act_sheep worker3 worker4 worker4 round6 fireplace) 36 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round6 fireplace) 38 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round6 num0 num2) 39 (ag_finish_round_backhome round6 worker4)	24	-		
round7 stage2) (ag_harvest_breed_end round4 stage1) (ag_finish.stage stage1 stage2 round4 round5 act_boar) (ag_finish.stage stage1 stage2 worker4 num8 num0) (ag_worker3 worker3 cound5 act_wood wood) (build.room worker2 worker1 worker3 worker4 round5 room4) (ag_finish_round.room4) (ag_finish_round.backhome.withchild round5 noworker) (ag_finish_round.ronew round5 noworker) (ag_advance_round_normal round5 round6 act_improve) (act_stone stone) (collect_resource worker4 worker4 round6 num0 num2) (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 num0 num2) (take_food worker1) (take_food worker1 noworker worker4 round6 num0 num2) (take_food worker1 noworker worker4 round9 num5 num7) (tollect_cook_animal boar act_sheep worker2 worker4 round9 num7 num8) (collect_cook_animal boar act_sheep worker2 worker4 round9 num7 num8) (tollect_cook_animal boar act_sheep worker2 round8 num4 num5) (cag_finish_round_renew round8 num4 num5) (ag_finish_round_renew round8		. 9	46	(ag_harvest_collect_end
stagel ound4 round5 act.boar) 27 (collect.resource worker3	25			. 3
stage2 round4 round5 act_boar) 27 (collect_resource worker3			47	
stage2 round4 round5 act_boar) 27 (collect_resource worker3 worker2 worker3 round5 act_wood wood) 28 (build_room worker4 round5 room4) 29 (family_growth worker1 noworker worker3 worker4 round5 clay room4) 30 (agfinish_round_backhome_withchil round5 worker3 worker4) 31 (agfinish_round_normal round5 noworker) 32 (agadvance_round_normal round5 round6 act_improve) 33 (collect_resource worker4 worker3 worker4 round6 act_sheep worker2 worker1 worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 fireplace) 36 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 fireplace) 37 (agfinish_round_backhome round6 worker1 noworker worker4 round6 num2 num3) 38 (agfinish_round_backhome round6 worker1) 39 (agadvance_round_normal round6 worker4) 39 (agadvance_round_normal round6 worker4) 30 (agfinish_round_backhome round6 worker4) 31 (agfinish_round_backhome worker4 round8 num2 num3) 37 (agfinish_round_backhome round9 worker4 round9 act_sheep worker2 worker2 worker4 round9 num7 num8) 40 (build_fences boar worker4 worker4 round8 num2 num2) 50 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round9 noworker worker4 round9 num7 num8) 50 (collect_cook_animal boar act_sheep worker2 worker4 round8 num4 num5) 51 (collect_cook_animal boar act_sheep worker2 worker4 round8 num4 num5) 52 (collect_cook_animal boar act_sheep worker2 worker4 round8 num4 num5) 58 (agfinish_round_normal round8 worker1) 59 (agadvance_round_normal worker4 round9 noworker worker4 round9 noworker worker4 round9 num7 num8) 60 (build_fences boar worker2 worker4 round8 num4 num5) 61 (agfinish_round_normal worker4 round9 noworker worker4 round9 noworker	26			
stage2 (ag_finish.stage stage2 act_carrot)			48	
worker2 worker3 round5 act.wood wood) 28 (build.room worker2 worker1 worker3 worker4 round5 room4) 29 (family_growth worker1 round5 clay room4) 30 (ag_finish.round.backhome.withchild round5 noworker) 31 (ag_finish.round.normal round5 noworker) 32 (ag_advance_round.normal round5 round6 act_improve) 33 (collect_resource worker4 worker3 worker4 round6 act_stone stone) 34 (improve.home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 num0 num2) 36 (take.food worker1 noworker worker4 round6 noworker round6 worker4) 38 (ag_finish.round.backhome round6 worker4) 39 (ag_advance_round.normal round6 worker4) 39 (ag_finish.round.backhome round6 worker4 round7 worker4 round9 num5 num7) 40 (build.fences boar worker4 worker4 round8 num0 num2) 55 (ag_finish.round.backhome round8 worker4 round9 num5 num7) 56 (ag_finish.round.normal worker4 round9 num5 num7) 57 (collect_cook_animal boar act_boar worker4 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round9 num7 num8) 64 (build.fences boar worker4 worker4 round8 num0 num2) 55 (ag_finish.round.backhome round8 noworker worker4 round8 num2 num4) 65 (ag_finish.round.backhome round8 noworker1 worker4 round8 num0 num2) 65 (ag_finish.round.backhome round8 noworker1 worker4 round8 num0 num5) 65 (ag_finish.round.backhome round8 noworker1 worker4 round9 num5 num7) 66 (ag_finish.round.backhome round9 worker4 worker4 round9 num7 num8) 67 (collect_cook_animal boar act_boar worker3 worker2 worker4 round9 num7 num8) 68 (ag_finish.round.backhome round9 worker4 worker3 worker4 worker4 round9 num7 num8) 69 (ag_finish.round.backhome round8 noworker (ag_finish.round.backhome round8 noworker) 60 (build.fences boar worker4 worker3 worker4 worker4 round9 num7 num8) 61 (ag_finish.round.backhome round8 noworker (ag_finish.round.	27			. 3
act.wood wood) 28 (build.room worker2 worker1		worker2 worker3 round5	49	
28 (build_room worker2 worker1 worker3 worker4 round5 room4) 29 (family_growth worker3 worker4 round5 clay room4) 30 (agfinish.round_backhome_withchil round5 moworker) 31 (agfinish.round_renew round5 noworker) 32 (agadvance_round_normal round5 round6 act.improve) 33 (collect_resource worker4 worker3 worker4 round6 act.stone stone) 34 (improve_home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar act.sheep worker2 worker1 worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num0 num2) 37 (agfinish.round_backhome round6 worker1 noworker worker4 round6 num0 num2) 38 (agfinish.round_backhome round6 worker1 oworker worker4 round6 num0 num2) 39 (agadvance_round_normal round6 worker4) 39 (agfinish.round_backhome round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker2 worker4 round9 num5 num7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round8 num0 num2) 50 (take_food worker1 noworker vorder4 round9 num5 num7) 50 (collect_cook_animal boar act_sheep worker4 round9 act_sheep worker4 round9 num7 num8) 61 (agfinish_round_renew vorder4 round9 num7 num8) 62 (agfinish_round_backhome vorder4 round9 num7 num8) 63 (collect_cook_animal boar act_sheep worker2 worker4 round8 num0 num2) 53 (take_food worker1 worker3 worker4 worker3 worker4 worker4 round8 num4 num5) 54 (agfinish_round_renew round8 round9 void) 55 (collect_cook_animal boar act_sheep worker2 worker4 round9 num7 num8) 66 (agfinish_round_renew round9 noworker worker4 round9 num7 num8) 67 (collect_cook_animal boar act_sheep worker4 worker4 round9 num7 num8) 68 (agfinish_round_renew		act_wood wood)		
worker3 worker4 round5 room4) 29 (family_growth worker1	28	(build_room worker2 worker1		
worker3 worker4 round8) so (ag_finish_round_backhome_withchild round5 worker3 worker4) so (ag_finish_round_renew round5 noworker) so (ag_advance_round_normal round5 round6 act_improve) so (collect_resource worker4 worker4 round8 num2 num4) so (collect_cook_animal boar act_sheep worker2 worker1 worker4 round8 num2 num4) so (ag_advance_round_normal round5 noworker3 worker4 worker4 round8 num2 num4) so (collect_cook_animal boar act_sheep worker2 worker1 worker4 round8 num2 num4) so (collect_cook_animal boar act_sheep worker3 worker4 worker4 round6 fireplace) so (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 num2 num3) so (ag_finish_round_backhome round6 worker4) so (collect_cook_animal boar act_sheep worker3 worker2 worker4 round9 num5 num7) so (collect_resource worker2 worker4 round9 num7 num8) so (collect_cook_animal boar act_sheep worker3 worker4 worker3 worker4 worker4 round9 num7 num8) so (collect_cook_animal boar act_sheep worker4 worker4 round9 num7 num8) so (ag_finish_round_backhome round6 worker1 noworker worker4 round9 num7 num8) so (ag_finish_round_backhome round9 worker4 worker4 round9 num7 num8) so (ag_finish_round_backhome round9 noworker2 worker4 round9 num7 num8) so (ag_finish_round_backhome round9 noworker4 worker4 round9 num7 num8) so (ag_finish_round_backhome round9 noworker4 worker4 round9 num7 num8) so (ag_finish_round_backhome round9 noworker4 worker4 round9		worker3 worker4 round5 room4)	50	
noworker worker3 worker4 round5 clay room4) 30 (agfinish_round_backhome_withchild round5 worker3 worker4) 31 (agfinish_round_renew round5 noworker) 32 (agadvance_round_normal round5 round6 act.improve) 33 (collect_resource worker4 worker3 worker4 round6 act_stone stone) 34 (improve_home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num0 num2) 37 (agfinish_round_backhome round6 worker4 noworker worker4 round6 num2 num3) 38 (agfinish_round_backhome round6 worker4) 39 (agadvance_round_normal round6 worker4) 39 (agadvance_round_normal round6 roworker) 30 (agfinish_round_backhome round6 worker4) 31 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round9 num5 num7) 30 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round9 num5 num7) 30 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round8 num0 num2) 31 (take_food worker1 noworker worker4 round8 num2 num4) 32 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round8 num2 num4) 32 (take_food worker1 noworker worker4 round8 num2 num5) 4 (agfinish_round_backhome round8 noworker) 4 (agfinish_round_normal worker3 worker4 worker4 round9 num7 num5) 4 (collect_cook_animal boar act_sheep worker2 worker4 round9 num7 num8) 40 (build_fences boar worker4 worker4 round9 num7 num8) 40 (build_fences boar worker4 worker4 round9 num7 num8) 40 (collect_cook_animal boar act_sheep worker2 worker4 round9 num7 num8) 41 (collect_cook_animal boar act_sheep worker2 worker4 round9 num7 num8) 42 (agfinish_round_lecthome round9 noworker) 43 (agfinish_round_lecthome round9 noworker1 44 (agfinish_round_lecthome round9 noworker1 45 (agfinish_round_lecthome roun	29	•		worker3 worker4 round8)
30 (ag_finishround_backhome_withchild worker4 round8 num0 num2) round5 worker3 worker4) 31 (ag_finish_round_renew round5 noworker) 32 (ag_advance_round_normal round5 round6 act_improve) 33 (collect_resource worker4 worker3 worker4 round6 act_stone stone) 34 (improve_home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker4 worker4 round6 fireplace) 36 (take_food worker1 noworker worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num0 num2) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_renew round6 moworker) 39 (agadvance_round_normal round6 worker4) 39 (agadvance_round_normal round6 worker4) 30 (agfinish_round_backhome round6 worker4) 31 (collect_cook_animal boar act_boar worker4 round7 num3 num5) 31 (collect_cook_animal boar act_boar worker3 worker2 worker4 round8 num2 num4) 32 (take_food worker1 noworker round8 noworker round8 noworker round8 round9 void) 35 (build_fences boar worker4 worker4 round9 num5 num7) 36 (collect_cook_animal boar act_sheep worker2 worker worker4 round8 num2 num4) 36 (agfinish_round_normal round8 noworker round8 noworker worker4 round9 void) 37 (build_fences boar worker4 worker3 worker4 round9 act_sheep worker3 worker2 worker4 round8 num4 num5) 33 (agfinish_round_normal round8 noworker vound8 noworke			51	
30 (agfinish_round_backhome_withchild round5 worker3 worker4) 31 (agfinish_round_renew round5 noworker) 32 (agadvance_round_normal round5 round6 act_improve) 33 (collect_resource worker4 worker4 round8 num2 num4) 34 (improve_home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar worker4 round6 fireplace) 36 (take_food worker1 noworker worker4 round6 fireplace) 37 (agfinish_round_backhome round8 noworker) 38 (agfinish_round_backhome worker4 round6 num0 num2) 39 (take_food worker1 noworker worker4 round6 num0 num2) 30 (take_food worker1 noworker worker4 round9 num3) 31 (agfinish_round_backhome round6 worker4) 32 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round9 num7 num8) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round8 num2 num4) 52 (collect_cook_animal boar act_sheep worker2 noworker1 worker4 round8 num2 num4) 53 (take_food worker1 noworker round8 noworker round8 noworker4) 54 (agfinish_round_backhome round8 noworker4) 55 (agfinish_round_normal round8 round9 vorker4 worker4 round9 num5 num7) 56 (collect_cook_animal boar worker4 round9 num5 num7) 57 (collect_resource worker2 worker4 round9 num7 num8) 58 (collect_cook_animal boar worker4 round9 num7 num7) 59 (collect_cook_animal boar act_clay clay) 60 (take_food worker1 noworker round9 worker4) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_backhome round9 noworker) 63 (agfinish_round_normal round9 worker4) 64 (agfinish_round_normal round9 worker4) 65 (agfinish_round_normal round8 noworker) 65 (agfinish_round_normal round8 noworker) 66 (agfinish_round_normal round8 noworker) 67 (build_fences boar worker4 worker4 round9 num7 num8) 69 (collect_resource worker2 worker4 round9 num7 num8) 60 (take_food worker1		round5 clay room4)		act_cattle worker3 worker2
round5 worker3 worker4) 31 (agfinish_round_renew round5 noworker) 32 (agadvance_round_normal round5 round6 act_improve) 33 (collect_resource worker4 worker3 worker4 round6 act_stone stone) 34 (improve_home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num2 num3) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round9 num7 num8) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker3 worker4 worker4 round9 num7 num8) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round9 num7 num8) 44 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round9 num7 num8) 45 (agfinish_round_normal round8 noworker) 46 (agadvance_round_normal worker3 worker4 worker4 round9 num7 num7) 47 (collect_resource worker2 worker4 round9 num7 num8) 48 (agfinish_round_normal round9 noworker worker4 round9 num7 num8) 49 (collect_cook_animal boar act_sheep worker2 worker4 round9 num7 num8) 40 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round9 num7 num8) 41 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round9 num7 num8) 41 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round9 num7 num8) 42 (collect_resource worker2 worker4 round9 num7 num8) 43 (agfinish_round_backhome round9 noworker worker4 round9 num7 num8) 44 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round9 num7 num8) 45 (agfinish_round_ba	30	<u>=</u>	ld.	worker4 round8 num0 num2)
round5 noworker) 32 (ag_advance_round_normal round5 round6 act_improve) 33 (collect_resource worker4 worker3 worker4 round6 act_stone stone) 34 (improve_home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num0 num2) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_backhome round6 noworker) 39 (agadvance_round_normal round6 noworker) 30 (agfinish_round_backhome round6 worker4) 31 (agfinish_round_backhome round6 worker4) 32 (agfinish_round_backhome round6 worker1 noworker worker4 roundn_normal round8 noworker) 36 (collect_cook_animal boar worker4 round9 num5 num7) 37 (agfinish_round_renew round6 worker4) 38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 worker4) 40 (build_fences boar worker4 worker4 round9 num7 num8) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round8 num4 num5) 42 (callect_resource worker1 worker4 round8 num4 num5) 43 (take_food worker1 noworker round8 noworker) 45 (agfinish_round_renew round8 noworker) 45 (agfinish_round_renew round8 noworker) 45 (agfinish_round_renew round8 noworker) 45 (agfinish_round_renew round8 noworker) 46 (agfinish_round_normal worker4 round9 num7 num7) 47 (collect_cook_animal boar act_beep worker4 worker4 round8 num4 num5) 48 (agfinish_round_backhome round8 noworker) 49 (build_fences boar worker2 worker4 round9 num7 num8) 40 (build_fences boar worker4 worker4 round9 num7 num8) 40 (agfinish_round_backhome round9 noworker. round9 noworker) 40 (agfinish_round_renew round9 noworker. round9 noworker) 40 (agfinish_round_renew round9 noworker. round9 stage3)		. 9		•
round5 noworker) 32 (ag_advance_round_normal round5 round6 act_improve) 33 (collect_resource worker4 worker3 worker4 round6 act_stone stone) 34 (improve_home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num0 num2) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker3 worker2 worker4 round7 num5 num7) 43 (take_food worker1 noworker round8 noworker) 54 (agfinish_round_renew round8 noworker) 55 (agfinish_round_renew round8 noworker) 66 (agfinish_round_renew worker4 round9 num7 num8) 67 (build_fences boar worker4 worker4 round9 num7 num8) 68 (collect_cook_animal boar round6 worker1 noworker worker4 round8 num4 num5) 59 (agfinish_round_backhome round8 noworker) 69 (agfinish_round_renew worker3 worker4 worker4 round9 num7 num7) 59 (collect_cook_animal boar worker4 round9 num7 num8) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_renew round8 noworker) 62 (cal_ect_cook_animal boar worker4 round-renew round8 noworker) 63 (agfinish_round_renew worker3 worker4 worker4 round9 num7 num9 64 (collect_cook_animal boar worker4 round9 num7 num8 65 (agfinish_round_renew round8 noworker) 66 (agfinish_round_renew worker4 round9 num7 num9 67 (build_fences boar worker2 worker4 round9 num7 68 (collect_cook_animal boar worker4 round9 num7 69 (take_food worker1 noworker worker4 round9 num7 60 (take_food worker1) 61 (agfinish_round_renew round9 noworker) 62 (agfinish_round_renew	31	(agfinish_round_renew		act_sheep worker2 worker1
round5 round6 act.improve) 33 (collect_resource worker4 worker3 worker4 round6 act_stone stone) 34 (improve_home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num2 num3) 37 (agfinish_round_renew round6 worker4) 38 (agfinish_round_renew round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round9 num7 num8) 44 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round9 num7 num8) 45 (agfinish_round_renew round8 noworker) 56 (agdavance_round_normal round8 round9 void) 57 (build_fences boar worker4 worker3 worker4 round9) 58 (collect_cook_animal boar worker4 round9 num7) 59 (collect_resource worker2 worker4 round9 num7 num8) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_renew round8 noworker) 62 (agda_ninsh_round_renew worker3 worker4 worker3 worker2 worker4 round9 num7 63 (agfinish_round_renew round8 round9 void) 64 (build_fences boar worker4 worker3 worker2 worker4 round9 65 (collect_cook_animal boar worker4 round9 num7 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_renew round8 noworker) 62 (agdavance_round_normal worker4 round9 63 (collect_cook_animal boar worker4 round9 num7 64 (agfinish_round_renew round8 round9 void) 65 (collect_cook_animal boar worker4 round9 num7 66 (agfinish_round_renew round9 noworker1 67 (agfinish_round_renew round9 noworker2 67		round5 noworker)		-
33 (collect_resource worker4 worker3 worker4 round6 act_stone stone) 34 (improve_home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num2 num3) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_backhome round6 noworker) 39 (agadvance_round_normal round8 round9 void) 50 (build_fences boar worker4 worker3 worker4 round9) 51 (collect_cook_animal boar round8 round9 void) 52 (collect_cook_animal boar worker3 worker4 round9 num5 num7) 53 (collect_cook_animal boar round8 round9 void) 54 (agfinish_round_renew round8 round9 void) 55 (build_fences boar worker4 worker3 worker4 round9 num5 num7) 56 (collect_cook_animal boar act_sheep worker3 worker2 worker4 round9 num5 num7) 57 (collect_cook_animal boar act_sheep worker4 worker4 round9 num7 num8) 68 (agfinish_round_backhome round8 round9 void) 59 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round9 num7 num8) 69 (take_food worker1 noworker worker4 round9 num7 num8) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 num7 num8) 62 (agdavance_round_normal round8 round9 void) 63 (collect_cook_animal boar act_sheep worker3 worker2 worker4 round9 num7 num8) 63 (collect_cook_animal boar act_clay clay) 64 (agfinish_round_renew round9 num7 num8) 65 (collect_cook_animal boar act_sheep worker4 worker4 round9 num7 num8) 65 (collect_cook_animal boar round9 num7 num8) 66 (take_food worker1 noworker round9 num7 num8) 67 (collect_cook_animal boar round9 noworker) 68 (agfinish_round_backhome round9 num7 num8) 69 (agfinish_round_renew round9 noworker) 60 (take_food	32	(ag_advance_round_normal	53	(take_food worker1 noworker
33 (collect_resource worker4 worker3 worker4 round6 act_stone stone) 34 (improve.home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num2 num3) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_backhome round6 moworker) 39 (agadvance_round_normal round8 round9 void) 50 (build_fences boar worker4 round9) 51 (collect_cook_animal boar worker4 round9 num5 num7) 52 (collect_cook_animal boar worker4 round9 num7 num8) 63 (agfinish_round_backhome worker4 round9 num7 num8) 64 (agfinish_round_backhome round9 worker1 noworker worker4 round9 num7 num8) 65 (agadvance_round_normal act_sheep worker2 worker3 worker4 worker4 round9 num7 num8) 66 (agfinish_round_backhome round9 worker4 worker4 round9 num7 num8) 67 (agfinish_round_backhome round8 noworker4 round8 noworker4 vound9 num6 round9 void) 68 (collect_cook_animal boar act_sheep worker4 worker4 round9 num7 num8) 69 (take_food worker1 noworker worker4 round9 num7 num8) 60 (take_food worker1 noworker worker4 round9 num7 num8) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 noworker) 62 (agdavance_round_normal round8 noworker4 worker3 worker4 worker3 worker4 round9 63 (collect_cook_animal boar act_sheep worker3 worker4 worker4 round9 num7 num8) 63 (agfinish_round_backhome round9 num7 num8) 64 (agfinish_round_renew round9 num7 num8) 65 (agfinish_round_renew round9 num7 num8) 66 (agfinish_round_renew round9 num7 num8) 67 (agfinish_round_renew round9 num7 num8) 68 (agfinish_round_renew round9 num7 num8)		round5 round6 act_improve)		worker4 round8 num4 num5)
act.stone stone) 34 (improve_home worker3 worker2	33	-	54	(ag_finish_round_backhome
34 (improve_home worker3 worker2 worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num2 num3) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) Tound6 noworker) 56 (agadvance_round_normal round8 noworker) 56 (agadvance_round_normal round8 round9 void) 57 (build_fences boar worker4 worker4 round9 num7 num7) 58 (collect_cook_animal boar worker4 round9 num7 num7) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 noworker) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)		worker3 worker4 round6		round8 worker4)
worker4 round6 fireplace) 35 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num2 num3) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round9) 58 (collect_cook_animal boar worker4 round9 num5 num7) 59 (collect_resource worker2 worker1 worker1 noworker worker4 round9 num7 num8) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)		act_stone stone)	55	(ag_finish_round_renew
round8 round9 void) sct_sheep worker2 worker1 worker4 round6 num0 num2) (take_food worker1 noworker worker4 round6 num2 num3) (agfinish_round_backhome round6 worker4) (agfinish_round_renew round6 noworker) (agadvance_round_normal round6 round7 act_cattle) (build_fences boar worker4 worker3 worker4 round9) (collect_resource worker2 worker1 worker4 round9 worker1 worker4 round9 worker4 round9 num7 num8) (take_food worker1 noworker worker1 worker4 round9 act_clay clay) (take_food worker1 noworker worker4 round9 num7 num8) (take_food worker1 noworker worker4 round9 num7 num8) (agfinish_round_backhome round9 worker4) (agfinish_round_renew round9 noworker) (agharvest_collect_end round9 stage3)	34	(improve_home worker3 worker2		round8 noworker)
act_sheep worker2 worker1 worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num2 num3) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) 57 (build_fences boar worker4 worker3 worker2 worker4 round9 num5 num7) 59 (collect_resource worker2 worker4 round9 worker1 worker4 noworker worker4 round9 num7 num8) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)		worker4 round6 fireplace)	56	(agadvance_round_normal
worker4 round6 num0 num2) 36 (take_food worker1 noworker worker4 round6 num2 num3) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round9 num7 num8) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) worker3 worker4 round9 num5 num7) 58 (collect_cook_animal boar worker4 round9 num5 num7) 59 (collect_resource worker2 worker1 worker4 round9 num7 num8) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)	35	<pre>(collect_cook_animal boar</pre>		round8 round9 void)
36 (take_food worker1 noworker worker4 round6 num2 num3) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)		act_sheep worker2 worker1	57	(build_fences boar worker4
worker4 round6 num2 num3) 37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) act_sheep worker3 worker2 worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)		worker4 round6 num0 num2)		worker3 worker4 round9)
<pre>37 (agfinish_round_backhome round6 worker4) 38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round9 num5 num7) 59 (collect_resource worker2 worker1 worker4 round9 act_clay clay) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)</pre>	36	(take_food worker1 noworker	58	(collect_cook_animal boar
round6 worker4) 38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) 59 (collect_resource worker2 worker1 worker4 round9 act_clay clay) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)		worker4 round6 num2 num3)		act_sheep worker3 worker2
<pre>38 (agfinish_round_renew round6 noworker) 39 (agadvance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7)</pre> <pre> worker1 worker4 round9 act_clay clay) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)</pre>	37	(ag_finish_round_backhome		worker4 round9 num5 num7)
round6 noworker) 39 (ag_advance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) act_clay clay) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)		round6 worker4)	59	(collect_resource worker2
39 (ag_advance_round_normal round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) 60 (take_food worker1 noworker worker4 round9 num7 num8) 61 (ag_finish_round_backhome round9 worker4) 62 (ag_finish_round_renew round9 noworker) 63 (ag_harvest_collect_end round9 stage3)	38	(ag_finish_round_renew		worker1 worker4 round9
round6 round7 act_cattle) 40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) worker4 round9 num7 num8) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)		round6 noworker)		act_clay clay)
40 (build_fences boar worker4 worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) 61 (agfinish_round_backhome round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)	39	(ag_advance_round_normal	60	•
worker3 worker4 round7) 41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) round9 worker4) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)		round6 round7 act_cattle)		worker4 round9 num7 num8)
41 (collect_cook_animal boar act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) 62 (agfinish_round_renew round9 noworker) 63 (agharvest_collect_end round9 stage3)	40	(build_fences boar worker4	61	(ag_finish_round_backhome
act_boar worker3 worker2 worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) round9 noworker) round9 noworker) round9 stage3)		worker3 worker4 round7)		round9 worker4)
worker4 round7 num3 num5) 42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) 63 (agharvest_collect_end round9 stage3)	41	(collect_cook_animal boar	62	(ag_finish_round_renew
42 (collect_cook_animal boar act_sheep worker2 worker1 worker4 round7 num5 num7) round9 stage3)				round9 noworker)
act_sheep worker2 worker1 worker4 round7 num5 num7)		worker4 round7 num3 num5)	63	(ag_harvest_collect_end
worker4 round7 num5 num7)	42	(round9 stage3)
		±		
43 (take_food worker1 noworker		·		
	43	(take_food worker1 noworker		

3.4. Symple

Planificación simbólica basada en **EVMDDs** Edge-Valued Multi-Valued Decision Diagrams. Este fué el primer planificador que ejecuté, sin embargo no fué satisfactoria la ejecución, ya que la demora generada era superior al límite que tienen en IPC para poder ejecutar un algoritmo, y no fué funcional en mi sistema el paquete, ya que generaba errores de sintaxis. Sin embargo, se decidió dejar este problema en el documento ya que si fue instalado, pero se optó por considerar un planificador más. Ruta óptima (Optimal Track) (Speck David, 2018).

3.5. Scorpion

Planificador abstracto de optimizacion secuencial de rutas implementado en sistemas rapidos de planificacion descendente con Fast Downward. Fast downward es un planificador clasico de dominio independiente, en el cual el mismo autor de Scorpion tiene contribuciones. Ruta óptima (Optimal Track) (J. Seipp, 2018).

Este planificador genera errores en la ejecución, por lo cual la única salida retornada son los mensajes generados a través de la ejecución del script. Los cuales en total son 276117. Siendo los últimos 5 los siguientes:

```
1 276113 3
2 276114 11 1
3 276115 21 1
4 276116 39 1
5 276117 end_CG
```

4. Instalación de planificadores

Los planificadores se utilizan de la misma manera, motivo por el cual solamente se describen las instrucciones de instalación generalizadas para los planificadores.

Para utilizar los planificadores, necesitamos Singularity, que es una tecnología para crear contenedores virtuales con contenido y hacer mas eficiente la virtualización. Singularity utiliza un propio formato de contenedores, pero permite la importación de contenedores de otras plataformas como Docker. Para instalar Singularity, necesitamos instalar Go, que es un lenguaje de programación concurrente y compilado que busca ser una opción con el rendimiento de C y la dinámica de Python.

Singularity se ha instalado en Ubuntu 20.04, teniendo en cuenta las dependencias previas a la instalación.

Luego de instalar las dependencias, se procede a instalar GO y a crear su variable de entorno respectiva.

```
1 export VERSION=1.13.5 ...
OS=linux ARCH=amd64 && \
2 wget ...
```

```
https://dl.google.com/ ...
        qo/qo$VERSION ...
        .$OS-$ARCH.tar.qz && \
    sudo tar -C /usr/local ...
        -xzvf qo$VERSION ...
        .$OS-$ARCH.tar.gz && \
        go$VERSION.$OS-$ARCH.tar.gz
echo 'export ...
   GOPATH=$\{HOME\}/go'>> \neg...
   /.bashrc && \
    echo 'export ...
        PATH=/usr/local/go/bin ...
        :${PATH} ...
        :${GOPATH}/bin' >> ¬...
        /.bashrc && \
    source ¬/.bashrc
```

Teniendo lo anterior listo, se procede a revisar la versión de descarga y a descargar singularity como usuario root, y por último realizamos los cambios necesarios para poder trabajar con singularity con un usuario sin privilegios de administrador.

```
git clone ...
      https://github.com/sylabs ...
      /singularity.git && \
      cd singularity && \
      git checkout v3.5.2
3
  ./mconfig && \
      make -C ./builddir && \
      sudo make -C ./builddir
7
          install
   ./mconfig ...
      --prefix=/opt/singularity
10
  ./mconfig --without-setuid ...
      --prefix=/home/jbalsells ...
      /singularity && \
      make -C ./builddir && \
12
      make -C ./builddir install
```

En el repositorio de IPC 2018

https://ipc2018-classical.bitbucket.io/ están las instrucciones para poder correr los scripts en la competencia. Estos mismos nos sirven para correr localmente los mismos scripts y hacer las pruebas requeridas.

Lo primero es clonar el repositorio en el Branch donde ubiquemos el archivo Singularity que haga referencia a crear un contenedor, ya que si clonamos el archivo Singularity que se encuentra en el máster del repositorio, en algunos casos tiene internamente un documento HTML que no es legible para Singularity.

```
1 git clone -b <br/>branch. ej: ...
    ipc-2018-seq-sat> <url. repo>
2 cd Singularity
3 sudo singularity build ...
    planner.img Singularity
```

Podemos clonar el repositorio de los dominios y problemas con el mismo comando git clone hacia el branch máster en la dirección https://bitbucket.org/ipc2018-classical/domains/src/master/, y buscar que problema y que dominio queremos aplicar al planificador. En este caso, todos los planificadores se ejecutaron con el problema 1(OPT o SAT dependiendo el caso del planificador) y el dominio correspondiente al directorio agrícola.

Luego de elegir el dominio y problema, creamos un directorio llamado rundir en el mismo directorio donde generamos el *build* del planificador para fines prácticos, el cual contendrá el dominio y el problema a planificar.

```
1 mkdir rundir
2018 2 cp path/to/domain.pddl rundir
```

Terminando esto, ejecutamos los comandos que obtendrán la ruta en la que estamos trabajando, el dominio, el problema, el archivo de salida generado al finalizar la ejecución y los límites para poder ingresarlos de una manera mas fácil a la ejecución del planificador con singularity. El Costbound solamente se aplica a planificadores costbounded track.

```
1 RUNDIR="$(pwd)/rundir"
2 DOMAIN="$RUNDIR/domain.pddl"
3 PROBLEM="$RUNDIR/problem.pddl"
4 PLANFILE="$RUNDIR/sas_plan"
5 COSTBOUND=42
6 ulimit -t 1800
7 ulimit -v 8388608
8 singularity run -C -H $RUNDIR ...
planner.img $DOMAIN ...
$PROBLEM $PLANFILE $COSTBOUND
```

Luego de esto, esperamos a que se ejecute el proceso y analizamos los resultados.

5. Conclusión

Los planificadores al igual que cualquier desarrollo, se basa en diferentes algoritmos que pueden llevar a los mismos resultados, siendo estos en algunos casos más óptimos que otros en calidad de respuesta, tiempo requerido para la ejecución o recursos consumidos. En este caso se han probado algorimos de las mismas ramas *Optimal Tracks* y *Satisficing Tracks* para poder tener algunas comparativas de los diferentes algoritmos al realizar la misma acción. Por tomar un ejemplo, en el caso de *Scorpion* el algoritmo se completó en aproximadamente 30 minutos, mientras que *Complementary2*,

realizando la misma tarea con los mismos datos, se completó en un tiempo aproximado de 5 minutos. Esto demuestra que la optimización de algoritmos en base a funciones asintóticas es muy importante cuando se trabaja con múltiples procesos o con múltiples datos, en donde los problemas cada vez se vuelven mas complejos.

Referencias

Francés Guillem, L. N. R. M., Geffner Hector. (2018). Best first width search. complete, simulated and polynomial variants. University of Basel, ICREA U Pompeu Fabra, University of Melbourne.

Franco Santiago, B. M., Levi H. S. Lelis. (2018). The complementary 2 planner in the ipc. School of Computing Engineering, University of Huddersfield, UK.

Guevara Patiño, R. (2016). El estado del arte en la investigación. Universidad Pedagógica Nacional, Bogotá, Colombia.

Guzmán Luna, J. A. (2003). Técnicas de planificación para la generación automática de programas de control. Universidad Nacional de Medellín, Colombia.

Seipp, J. (2018). Scorpion planning. University of Basel, Switzerland.

Seipp, R. G., Jendrik. (2018). Fast downward stone soup. University of Basel, Switzerland.

Speck David, M. R., Geiber Florian. (2018). Symbolic planning based on evmdds. University of Freiburg, Germany.