复旦大學

函数式程序设计导引| Haskell课程设计

博士的家·增强版

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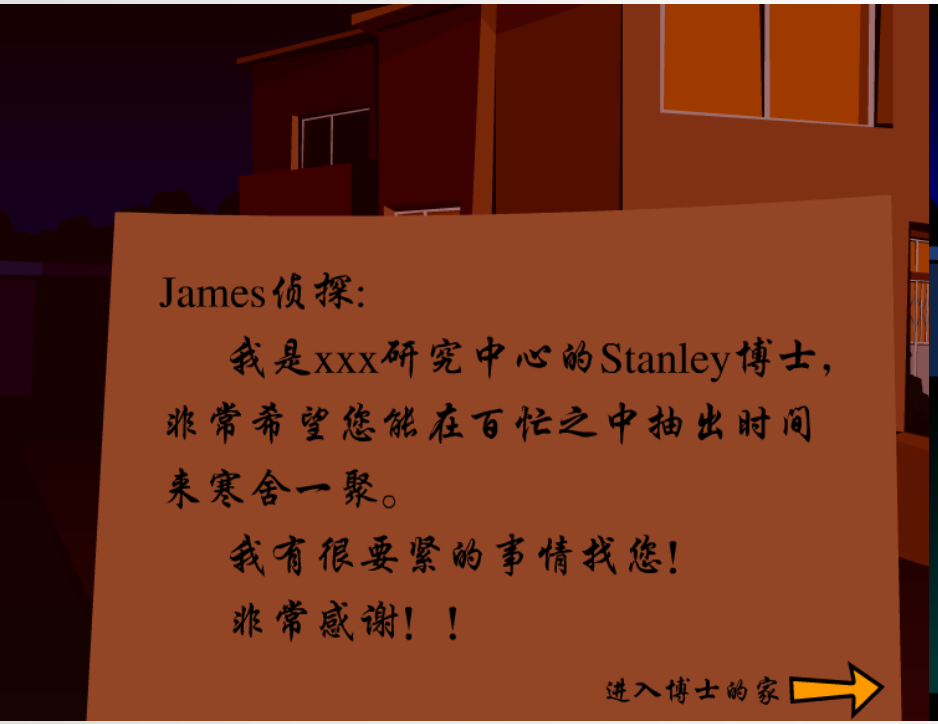
2018.12.28

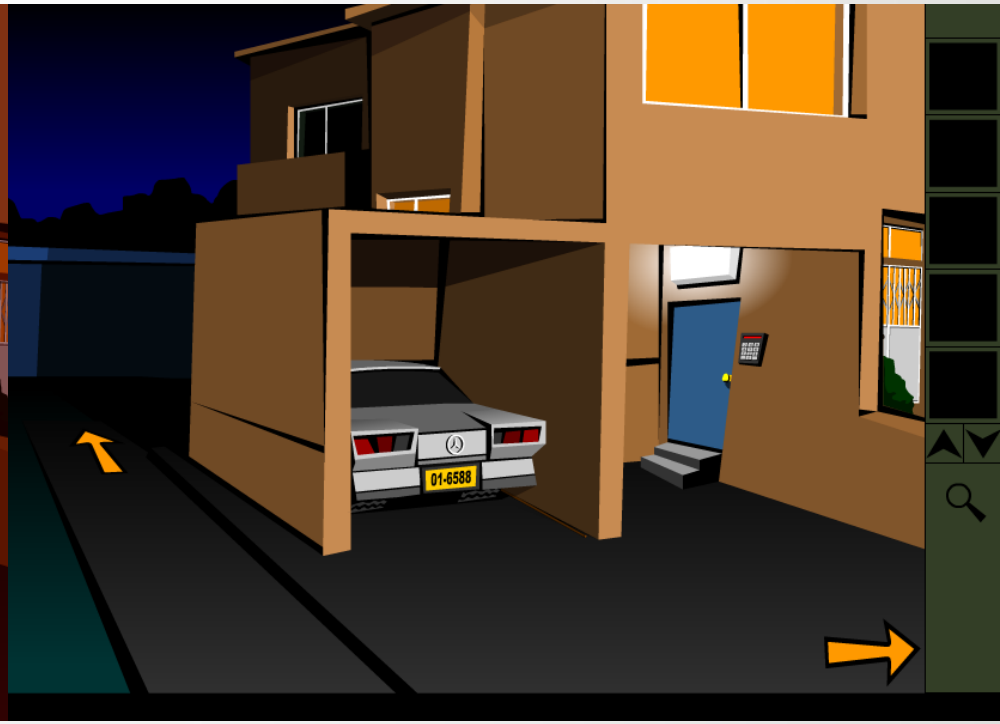
目录 Contents

C目录 ontents

Stanley 博士的家

李鹏（James Li） 2005年





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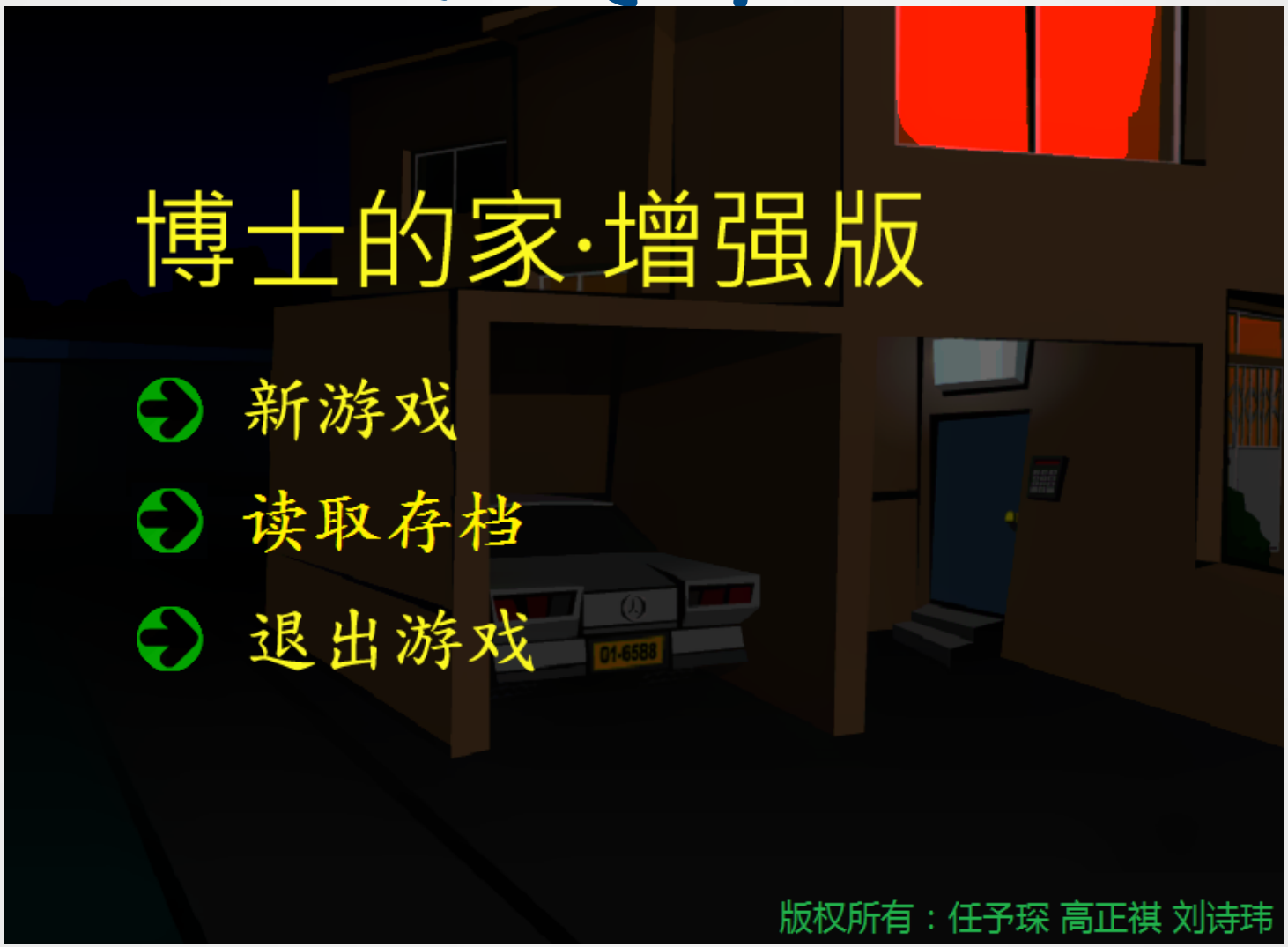
游戏开始



游戏场景

物品栏

选中物品

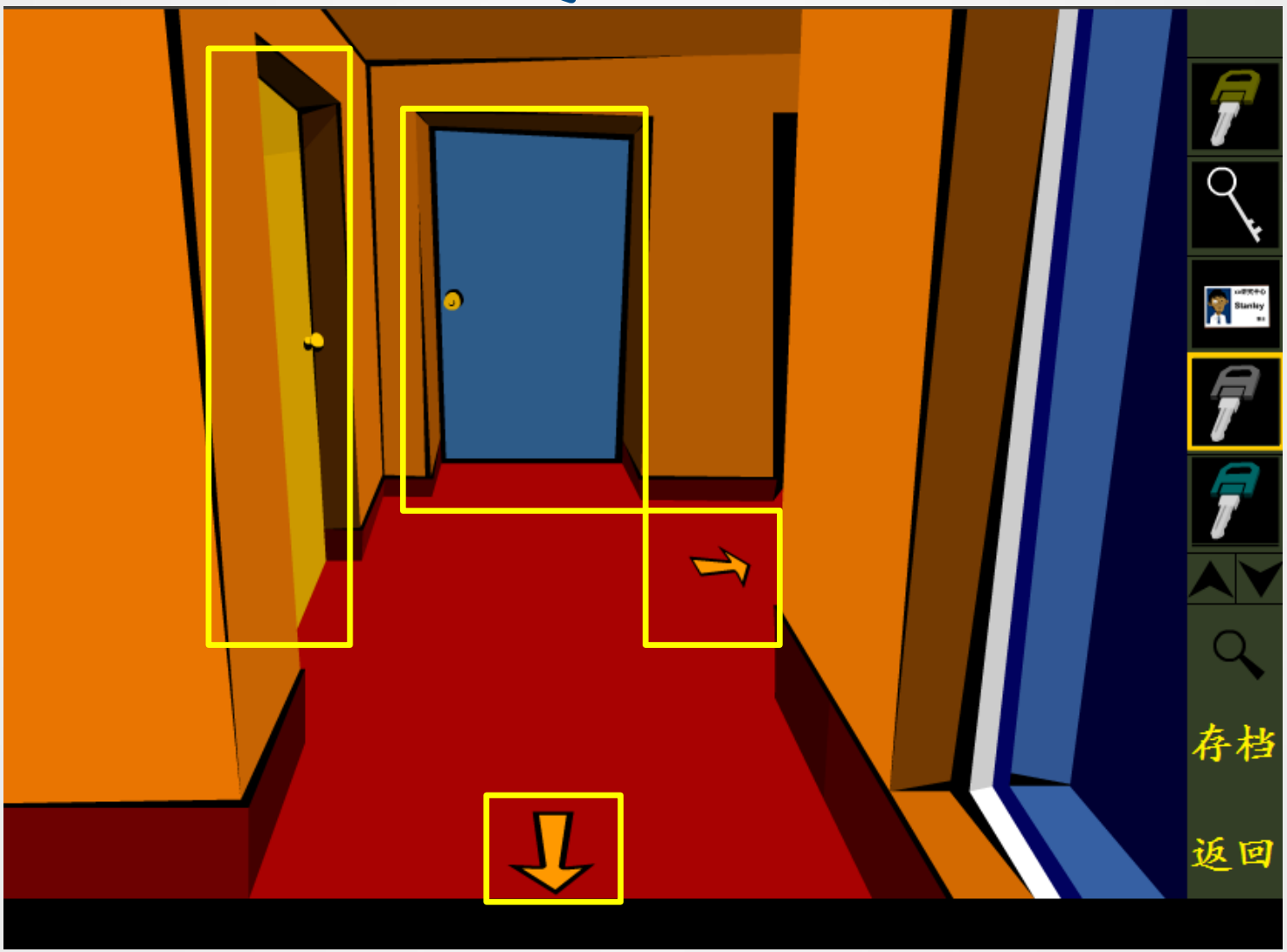
翻页

查看放大物品

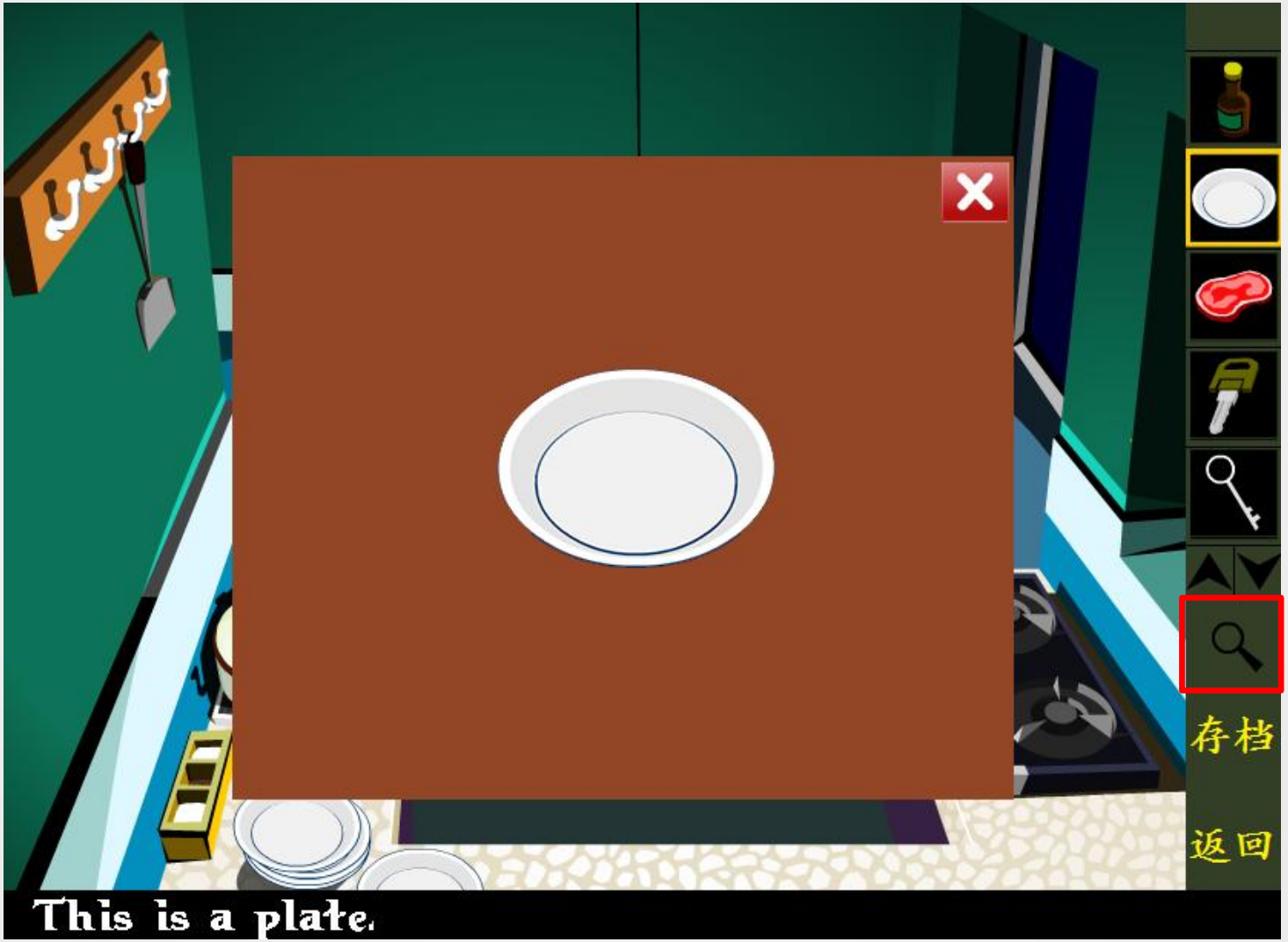
存档

返回

场景切换

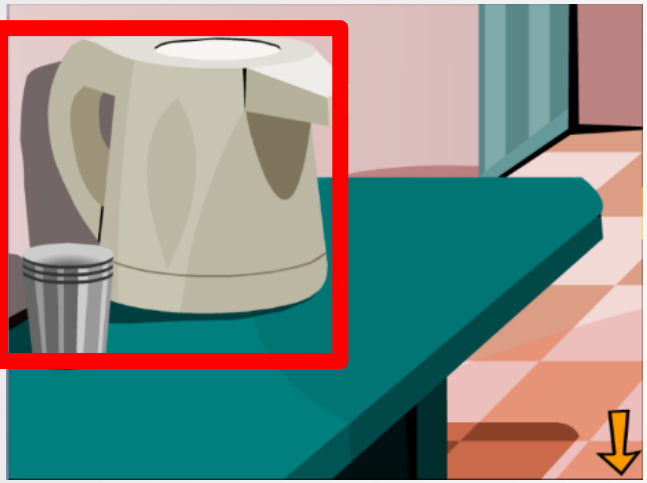
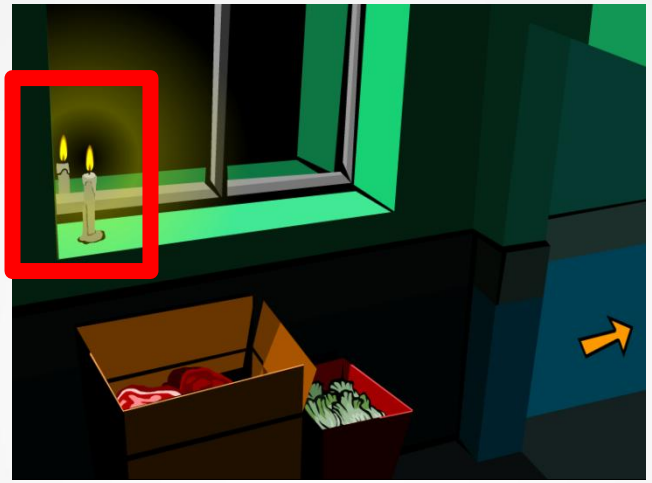
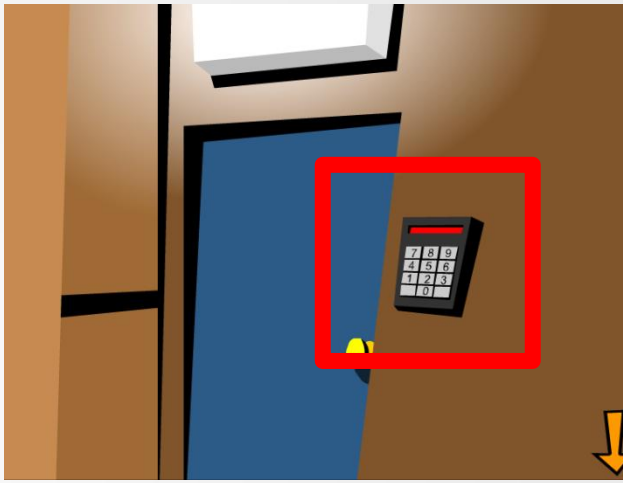
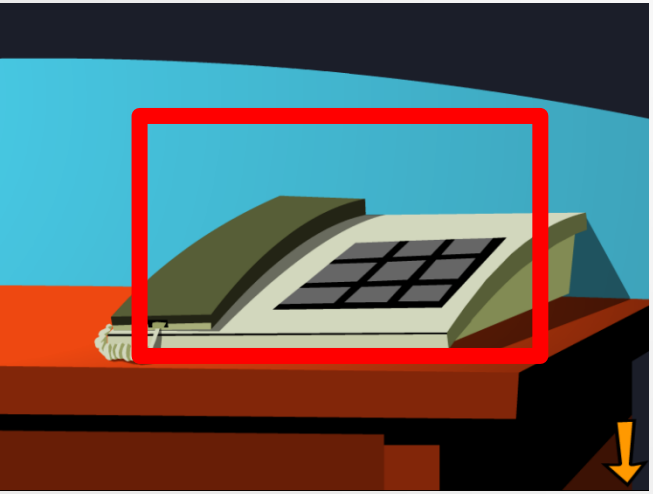
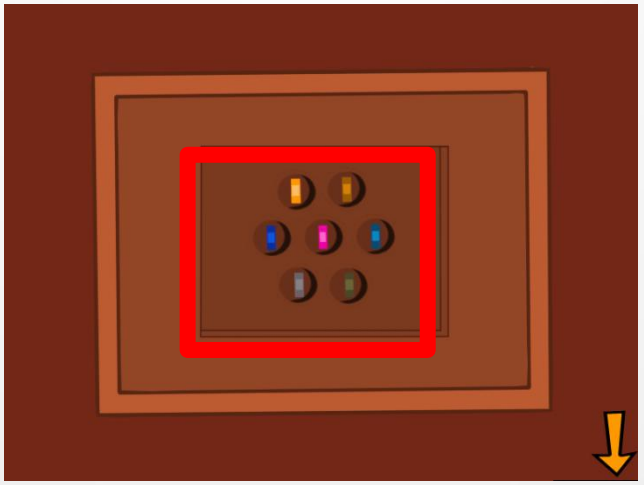


查看物品



组合物品

触发事件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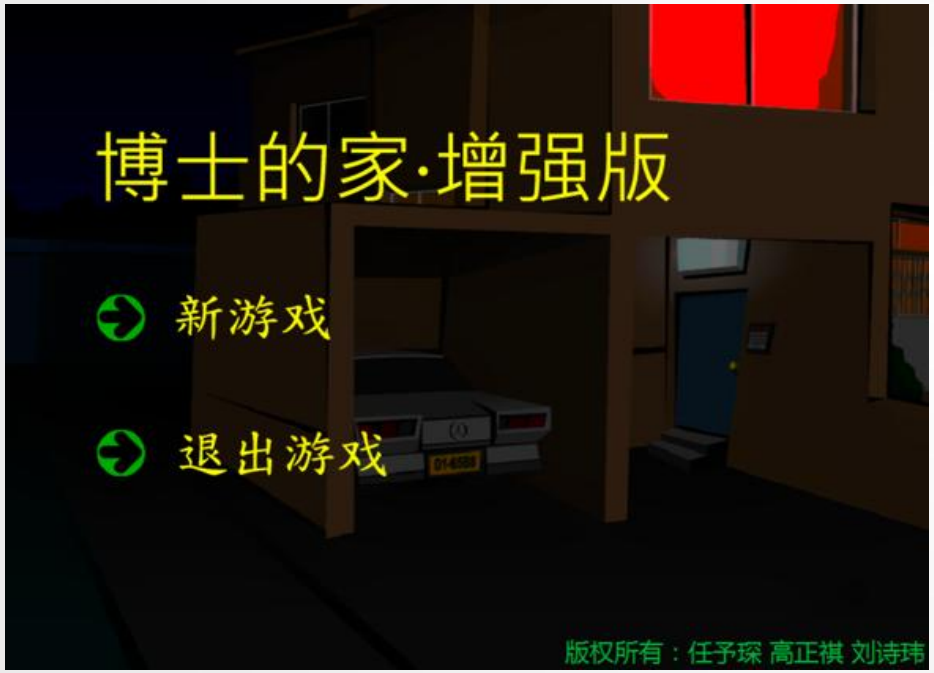
SDL2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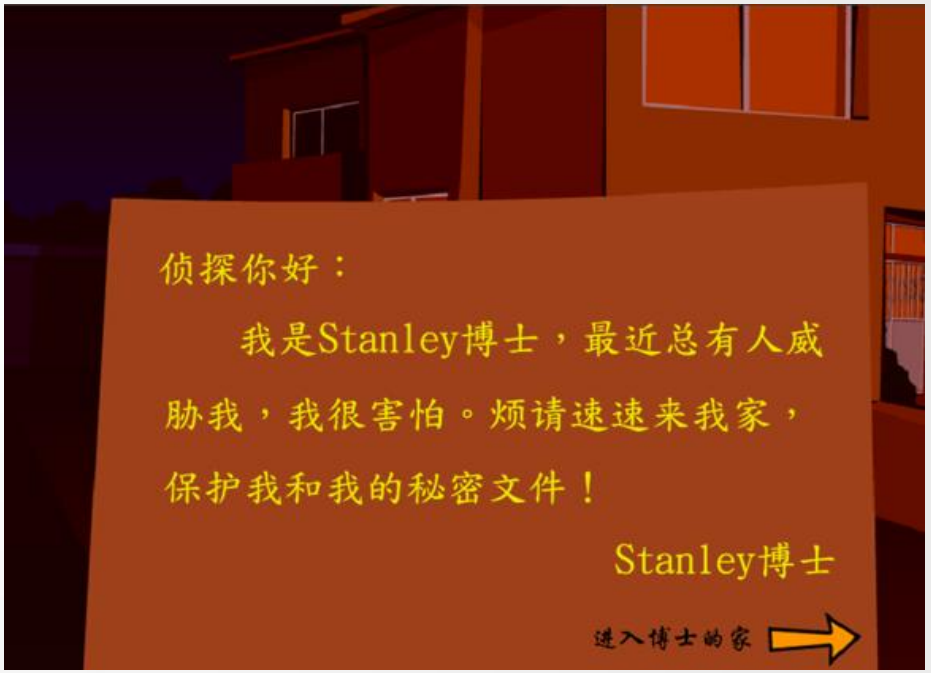
侦探你好：
我是Stanley博士，最近总有人威胁我，我很害怕。烦请速速来我家，保护我和我的秘密文件！
Stanley博士
进入博士的家

SDL2

```
main = do
  SDL.initialize [SDL.InitVideo]
  window <- SDL.createWindow "SDL Tutorial" SDL.defaultWindow { SDL.windowInitialSize = V2 screenWidth screenHeight }
  SDL.showWindow window
  screenSurface <- SDL.getWindowSurface window

  xOut <- getDataFileName "figs/first.bmp" >>= SDL.loadBMP
  xOut2 <- getDataFileName "figs/second.bmp" >>= SDL.loadBMP
  SDL.surfaceBlit xOut Nothing screenSurface Nothing
  let
    loop mouse buttons = do
      --events  <- SDL.pollEvents
      events <- map SDL.eventPayload <$> ((<$>) (\a -> a:[]) SDL.waitEvent)
      mousePos <- SDL.getAbsoluteMouseLocation

      let current_state = getAny $ foldMap (\case
                SDL.MouseButtonEvent e -> Any $ SDL.mouseButtonEventMotion e == SDL.Pressed
                otherwise -> Any False) events

      let quit = SDL.QuitEvent `elem` events
      let mouse' = Mouse {posM = mousePos, state = current_state}
      let res = map (handleEvent mouse') buttons
      if (head res) == True
         then SDL.surfaceBlit xOut2 Nothing screenSurface Nothing
         else return $  Just (SDL.Rectangle (P (V2 0 0)) (V2 0 0))
      SDL.updateWindowSurface window
      unless (quit || (last res)) (loop mouse' buttons)

  loop (Mouse {posM = (P (V2 0 0)), state = False}) [button1,button2]

  SDL.freeSurface xOut
  SDL.destroyWindow window
```

SDL2

```haskell
import Paths_sdl2 (getDataFileName)
screenWidth, screenHeight :: CInt
(screenWidth, screenHeight) = (640, 480)
main :: IO ()
main = do
  SDL.initialize [SDL.InitVideo]
  window <- SDL.createWindow "SDL Tutorial" SDL.defaultWindow { SDL.windowInitialSize = V2 screenWidth screenHeight }
  SDL.showWindow window
  screenSurface <- SDL.getWindowSurface window

  helloWorld <- getDataFileName "examples/lazyfoo/hello_world.bmp" >>= SDL.loadBMP
```

```haskell
getDataFileName :: FilePath -> IO FilePath
getDataFileName = return
```

音乐播放

背景音乐支持库

- SDL2_MIXER

  SDL2_MIXER是SDL2在音频支持上的扩展

音效与背景音乐

- SDL2_MIXER将音频分为音效和背景音乐

  音效(sound)：可以同时播放多个音效

  音乐(music)：只能有一个背景音乐播放

背景音乐播放流程

```
SDL.initialize [SDL.InitAudio]                                  → 初始SDL_MIXER
Mix.openAudio 44100 Mix.AUDIO_S16LSB 2 4096                     → 打开播放设备
Mix.allocateChannels 16                                         → 设置混音通道(mix channel)数
music <- withCString "./bgm.mp3" $ \cstr -> Mix.loadMUS cstr    → 加载音频文件
temp <- Mix.playMusic music (-1)                                → 播放音频
assert $ temp /= -1                                             → 是否正常播放
threadDelay 100000                                              → 等待音频播放完成
```

- 关键函数

  openAudio

  allocateChannels

  threadDelay

音乐播放

音效播放流程

```
SDL.initialize [SDL.InitAudio]
Mix.openAudio 44100 Mix.AUDIO_S16LSB 2 4096
Mix.allocateChannels 16
sound <- withCString "./bgm.wav" $ \cstr -> Mix.loadWav cstr
channel <- Mix.playChannel (-1) sound 0
assert $ channel /= -1
threadDelay 100000
```

初始SDL_MIXER

打开播放设备

设置混音通道(mix channel)数

加载音频文件

播放音频

是否正常播放

等待音频播放完成

- 关键函数
  - loadWav
  - playChannel

文本显示

文本显示支持库

- SDL2_TTF

  SDL2不支持文本显示

文本显示流程

```
white :: SDL.Font.Color
white = SDL.V4 255 255 255 0

Font.initialize
font <- Font.load "films.Hellbound.ttf" 30
text <- Font.solid font red "There is the dog"
Font.free font
SDL.surfaceBlit text Nothing screenSurface (Just (P (V2 20 575)))
```

字体颜色

初始TTF

加载字库，设置字号

加载文本

释放字库

文本显示

- 通过SDL2_MIXER，文本作为图片显示

Haskell调用其他语言函数

- FFI (Foreign Function Interface)

  通过FFI，Haskell可以调用其他语言的函数，也可以被其他语言调用

- FFI 使用流程

  文件首行添加 {-# LANGUAGE ForeignFunctionInterface #-}

  将其他语言函数原型转换为Haskell中相对应的原型

```
foreign import ccall "SDL_mixer.h Mix_LoadMUS" loadMus' :: CString -> IO (Ptr Music)
```

- 数据类型转换

  外部语言的数据类型，Haskell往往不支持

模块	类型
Foreign.C.Types	CInt，CDouble，CUChar...
Foreign.C.String	CString
Foreign.C.Ptr	指针

Haskell调用其他语言函数

- Haskell可以调用外部语言的原因

  在机械码层面上实现语言的转换

- 实现自己的SDL2_TTF库

  根据FFI，实现了SDL2_TTF库基本函数

```
foreign import ccall "TTF_SizeText" sizeText' :: Ptr Font -> CString -> Ptr CInt -> Ptr CInt -> IO CInt
foreign import ccall "TTF_SizeUTF8" sizeUTF8' :: Ptr Font -> CString -> Ptr CInt -> Ptr CInt -> IO CInt
foreign import ccall "TTF_SizeUNICODE" sizeUNICODE' :: Ptr Font -> Ptr CUShort -> Ptr CInt -> Ptr CInt -> IO CInt

init :: MonadIO m => m CInt
init = liftIO init'
{-# INLINE init #-}

quit :: MonadIO m => m ()
quit = liftIO quit'
{-# INLINE quit #-}

wasinit :: MonadIO m => m CInt
wasinit = liftIO wasinit'
{-# INLINE wasinit #-}

load :: MonadIO m => CString -> CInt -> m (Ptr Font)
load v1 v2 = liftIO $ load' v1 v2
{-# INLINE load #-}
```

游戏素材获取与整理

- 游戏界面各元素排列组合可能极多
- 获取游戏素材是一项工作量巨大又无趣的工作

批处理脚本

函数名	函数功能
screenshot	鼠标控制截图区域并保存图片；打印图片左上角坐标并保存
batch_rename	某些图片漏截后，重新修改文件夹下所有图片名称，保证截取顺序不变
batch_resize	统一手动截取的图片大小

- 利用OpenCV批处理图片减少工作量
- 仍需要大量手动工作截取原始游戏画面，初始化各数据结构

游戏演示


Doctor's House - Enhanced Version
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新游戏
读取存档
退出游戏
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目录 Contents

main :: IO ()

（1）开启音乐

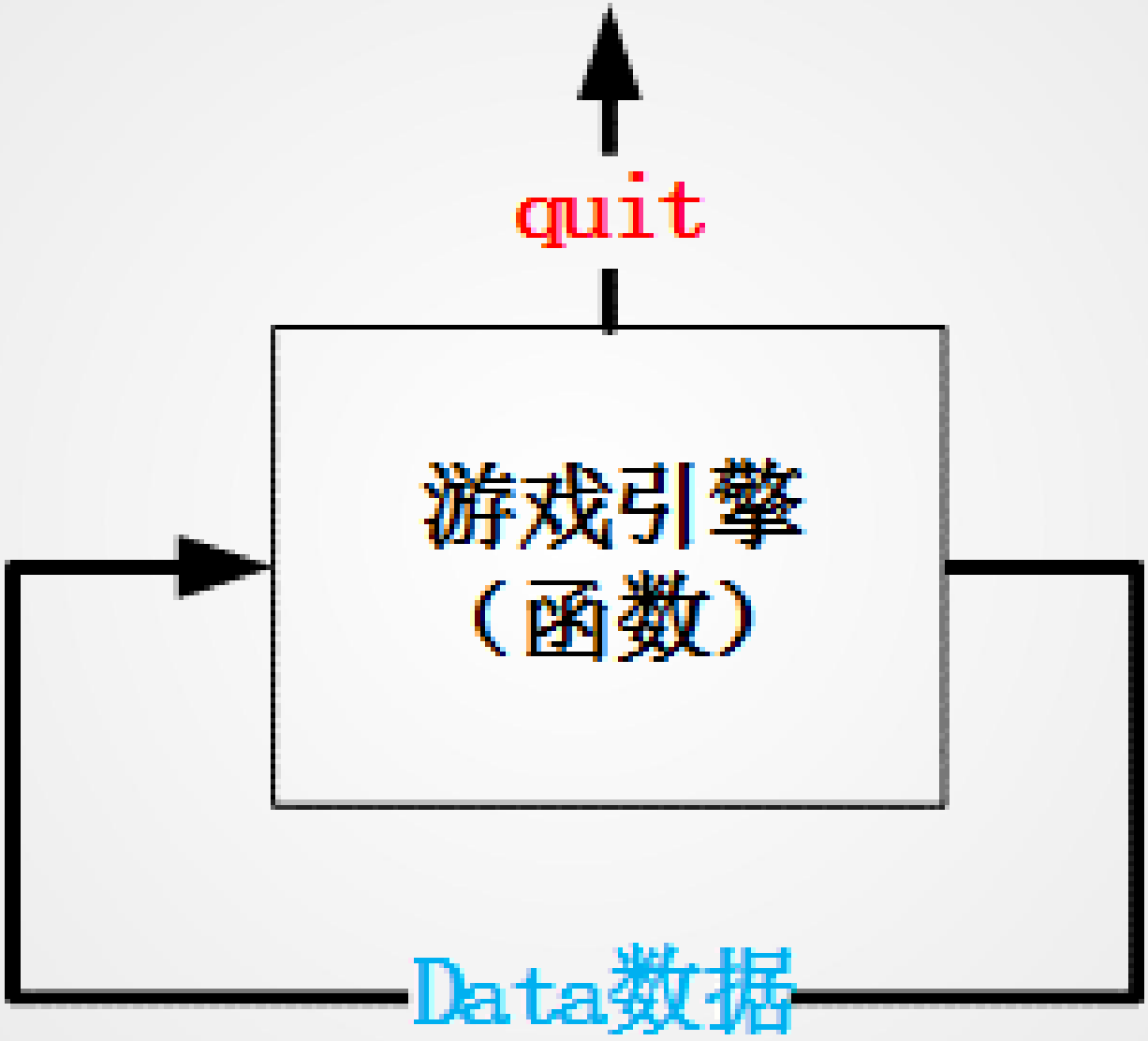
（2）设置文本字体

（3）创建窗口

（4）绘制游戏开始界面

（5）进入游戏引擎

（6）关闭窗口


quit
游戏引擎
（函数）
Data数据

```
data Interface = Interface {  dialogue           :: Int
                            , possessed_items    :: [Int]
                            , selected_item      :: Int
                            , showed_first_item  :: Int
                            , main_scene         :: Int
                            , current_scene      :: Int
                           }
```

当前场景、物品、对话……

```
data Scene = Scene {  background :: Int
                   , triggers   :: [Int]
                   }
```

背景图、触发域列表

动态游戏资源 · 触发域 Trigger

```
data Trigger = Trigger {  picture :: Int
                       , trigger_vertex :: (Point V2 CInt)
                       , trigger_size :: V2 CInt
                       , trigger_type :: Triggertype
                       , needed_item :: Int
                       , backup_item :: Int
                       , trigger_data :: Int
                       , relation_trigger :: Int
                       , relation_trigger_new_scene :: Int
                       , relation_trigger_new_picture :: Int
                       , triggerself_new_picture :: Int
                       , fail_dialogue :: Int
                       , new_dialogue :: Int
                       , new_scene :: Int
                       , add_item :: Int
                       , delete_item :: Int
                       , selected_item_delete :: Bool
                       , change_main_scene :: Bool
                       , relation_scene :: Int
                       , relation_scene_trigger_delete :: Int
                       , relation_scene_trigger_add :: Int
                       , triggerself_delete :: Bool
                       }  deriving (Eq)
```

游戏资源 · 物品、密码锁、钥匙插盘……

```
data Item = Item {  item_picture :: Int
                  , item_scene :: Int
                  , trigger_picture :: Int
                  }
```

```
data Password_Lock = Password_Lock { correct_password :: [Int]
                                   , input_password   :: [Int]
                                   }
```

```
data Advanced_Password_Lock = Advanced_Password_Lock { ad_correct_password :: [Int]
                                                     , ad_hidden_password  :: [Int]
                                                     , ad_input_password   :: [Int]
                                                     }
```

```
data Keys_Lock = Keys_Lock { correct_keys :: [Int]
                           , current_keys :: [Int]
                           }
```

绘制游戏界面：draw_interface

```
let
  draw_interface interface all_scenes all_triggers = do
```

（1）边栏底图

（2）物品选框，物品

（3）对话提示

（4）主场景及触发域

（5）当前场景及触发域

游戏引擎：loop_run

```
let
  loop_run interface all_scenes all_triggers house_password_lock bronze_password_lock file_password_lock rainbow_lock = do
    event <- map SDL.eventPayload <$> ((<$>) (\a -> a:[]) SDL.waitEvent)  --get [one event]
    mousePos <- SDL.getAbsoluteMouseLocation  --get mouse position

    let whether_click = getAny $ foldMap (\case
            SDL.MouseButtonEvent e -> Any $ SDL.mouseButtonEventMotion e == SDL.Pressed
            otherwise -> Any False) event
    let quit = SDL.QuitEvent `elem` event

    if whether_click
      then  --deal with click event
        if (within_ra_pos mousePos ra_magnifier) && (selected_item interface >= 0)  --click magnifier
        then do let new_interface = event_magnifier interface
                draw_interface new_interface all_scenes all_triggers
                unless (quit) (loop_run new_interface all_scenes all_triggers house_password_lock bronze_password_lock fil
        else if (within_ra_pos mousePos ra_turn_page_up) && (showed_first_item interface > 0)  --click turn page up
             then do let new_interface = event_turnpageup interface
                     draw_interface new_interface all_scenes all_triggers
                     unless (quit) (loop_run new_interface all_scenes all_triggers house_password_lock bronze_password_loc
        else if (within_ra_pos mousePos ra_record) && (not (elem (main_scene interface) [87, 88, 89, 90]))
             then do r1 <- record_interface interface
                     r3 <- record_all_triggers all_triggers
                     r4 <- record_all_locks house_password_lock bronze_password_lock file_password_lock rainbow_lock
```

触发域、物品栏、读/存档、返回、退出

尝试触发域：try_triggers

```
try_triggers :: (Point V2 CInt) -> Interface -> [
try_triggers mousePos interface all_scenes all_tr
  | (my_trigger == []) && (fail_trigger == []) =
  | fail_trigger /= [] = (False, (update_dialogue
  | otherwise = trigger_event my_trigger_index in
```

（1）非触发域

（2）触发失败

（3）触发成功

触发事件/更新资源：trigger_event

```
trigger_event :: Int -> Interface -> [Scene] -> [Trigger] -> Password_Lock -> Password_Lock ->
trigger_event my_tri_index interface all_scenes all_triggers house_password_lock bronze_passwo
  | (trigger_type my_tri == HOUSE_PASSWORD_BUTTON) && (judge_open house_password_lock) = (Fals
  | ((trigger_type my_tri) == HOUSE_PASSWORD_BUTTON) && (not (judge_open house_password_lock))
  | (trigger_type my_tri) == BRONZE_PASSWORD_BUTTON = (False, bronze_new_interface, all_scenes
  | (trigger_type my_tri) == ADVANCED_PASSWORD_BUTTON = (False, advanced_new_interface, all_sc
  | (trigger_type my_tri) == KEY_HOLE = (False, rainbow_new_interface, all_scenes, rainbow_new
  | (trigger_type my_tri) == MENU = (False, init_interface, init_scenes, init_triggers, house_
  | (trigger_type my_tri) == END_GAME = (True, interface, all_scenes, all_triggers, house_pass
  | otherwise = (False, ordinary_new_interface, ordinary_new_all_scenes, ordinary_new_all_trig
      where my_tri = all_triggers !! my_tri_index
```

密码锁按钮、钥匙孔、返回、退出、普通

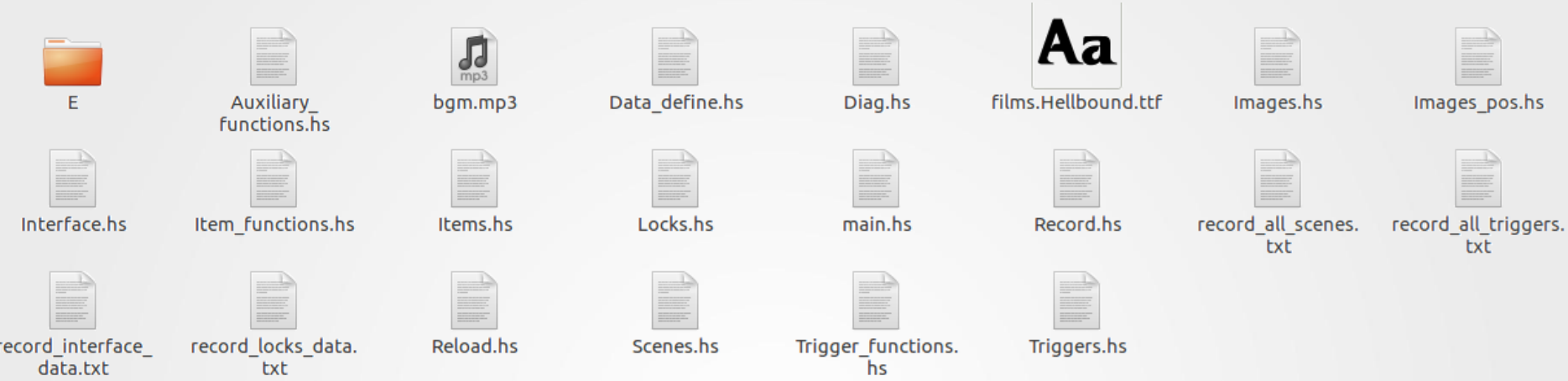
点击物品栏：event_

```haskell
event_magnifier :: Interface -> Interface
event_magnifier interface = if elem (main_scene interface) [87, 88, 89, 90]
                            then interface
                            else interface { dialogue = ((possessed_items ir
                                                        , current_scene = item_scene $ al


--click turn_page_up
event_turnpageup :: Interface -> Interface
event_turnpageup interface = interface { showed_first_item = (showed_first_i


--click turn_page_down
event_turnpagedown :: Interface -> Interface
event_turnpagedown interface = interface { showed_first_item = (showed_first


--click item_1
event_item1 :: Interface -> Interface
event_item1 interface = interface { selected_item = (showed_first_item inter
```

存/读档：_record/reload_

```
record_all_scenes :: [Scene] -> IO (Bool)
record_all_scenes all_scenes = do handle <- openFile "record_all_scenes.txt" WriteMode
                                  h_is_open <- hIsOpen handle
                                  if h_is_open
                                  then do loop_record_all_scenes handle all_scenes
                                          hClose handle
                                          return (True)
                                  else return (False)

loop_record_all_scenes :: Handle -> [Scene] -> IO ()
loop_record_all_scenes handle all_scenes = do if length all_scenes > 0
                                              then do let cur_scene = head all_scenes
                                                      hPutStrLn handle (show (background cur_scene))
                                                      hPutStrLn handle (show (triggers cur_scene))
                                                      loop_record_all_scenes handle (tail all_scenes)
                                              else return ()
reload_interface :: Interface -> IO Interface
reload_interface interface = do handle <- openFile "record_interface_data.txt" ReadMode
                                h_is_open <- hIsOpen handle
                                if h_is_open
                                then do content_dialogue <- hGetLine handle
                                        content_possessed_items <- hGetLine handle
                                        content_selected_item <- hGetLine handle
                                        content_showed_first_item <- hGetLine handle
                                        content_main_scene <- hGetLine handle
                                        hClose handle
                                        return Interface { dialogue = str2int content_dialogue
                                                         , possessed_items = str2intlist content_possessed_items
                                                         , selected_item = str2int content_selected_item
                                                         , showed_first_item = str2int content_showed_first_item
                                                         , main_scene = str2int content_main_scene
                                                         , current_scene = str2int content_main_scene }
                                else return interface
```

整理、编译、链接


E
Auxiliary_ functions.hs
bgm.mp3
Data_define.hs
Diag.hs
films.Hellbound.ttf
Images.hs
Images_pos.hs
Interface.hs
Item_functions.hs
Items.hs
Locks.hs
main.hs
Record.hs
record_all_scenes. txt
record_all_triggers. txt
record_interface_ data.txt
record_locks_data. txt
Reload.hs
Scenes.hs
Trigger_functions. hs
Triggers.hs


E
bgm.mp3
films.Hellbound.ttf
main
record_all_scenes. txt
record_locks_data. txt
record_all_triggers. txt
record_interface_ data.txt

目录 Contents

成果

（1）具有图形用户界面、动态文本、背景音乐、原创Haskell代码的解密游戏，以及配套的用户手册。

（2）丰富有趣的游戏功能：多类型的触发事件、组合物品、密码锁、钥匙插盘、读/存档……

展望

（1）可读性更高、更便捷的游戏资源编辑器

（2）动画、多份存档等高级功能

（3）全新的游戏场景和剧情

Haskell特色代码 · 举例

```haskell
cur_triggers = [all_triggers !! index | index <- (triggers cur_scene)]

cur_triggers_images = filter (>= 0) (map picture cur_triggers)

change_list_x ls n new = (take n ls) ++ (new : (drop (n+1) ls))

filt_core_str = map (\ch -> if ch == ',' then ' ' else ch) core_str
```

```haskell
char2int ch
  |ch == '1' = 1
  |ch == '2' = 2
  |ch == '3' = 3
  |ch == '4' = 4
  |ch == '5' = 5
  |ch == '6' = 6
  |ch == '7' = 7
  |ch == '8' = 8
  |ch == '9' = 9
  |otherwise = 0
```

11月初 ~ 12月底，每周讨论

任予琛：游戏逻辑代码……

高正祺：SDL2图形库……

刘诗玮：音乐文字库……

详见《报告》中的日程表

参考资料（库）

[1] sdl2[OL]. *http://hackage.haskell.org/package/sdl2*.

[2] Haskell SDL2 Examples[OL]. *https://github.com/palf/haskell-sdl2-examples*.

[3] sdl2-ttf[OL]. *https://github.com/haskell-game/sdl2-ttf*.

[4] sdl2-mix[OL]. *https://github.com/tempname11/sdl2-mixer*.

復旦大學

Thanks!

任予琛 高正祺 刘诗玮

2018.12.28