

Grey Box Modeling

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```
library(ctsmr)
library(tidynamics)

files <- dir(
  "~/GitHub/tidynamics/vignettes/funcs/ctsm",
  full.names = TRUE
)
for (i in 1:length(files)) {
  source(files[i])
}
```

1, Get Data

```
ti <-
  read_csv(
    "~/GitHub/tidynamics/data/mpc.csv",
    skip = 1,
    col_names = c("timedate", "Y1", "Y2", "Ta", "Gv", "Ph1", "Ph2")
  ) %>%
  mutate(timedate = asP(.$timedate)) %>%
  mutate(t = asHours(.$timedate - .$timedate[1]))

ti %>%
  print()
#> # A tibble: 540 x 8
#>   timedate           Y1    Y2    Ta    Gv    Ph1    Ph2    t
#>   <dtm>          <dbl> <dbl> <dbl>  <dbl> <dbl> <dbl> <dbl>
#> 1 1983-10-10 15:20:00 24.5 27.4 11.8 0.007    1.5    1.5 0
#> 2 1983-10-10 15:30:00 24.6 27.4 11.9 0.0053    1.5    1.5 0.167
#> 3 1983-10-10 15:40:00 24.7 27.3 12.1 0.0049    1.5    0    0.333
#> 4 1983-10-10 15:50:00 24.8 27.2 12.3 0.0051    1.5    0    0.5
#> 5 1983-10-10 16:00:00 24.7 27.0 12.6 0.0011    1.5    1.5 0.667
#> 6 1983-10-10 16:10:00 24.6 26.9 12.7 0.001    1.5    0    0.833
#> 7 1983-10-10 16:20:00 24.8 26.8 12.7 0.0007    1.5    0    1
#> 8 1983-10-10 16:30:00 24.8 26.7 12.7 0.0001    1.5    0    1.17
#> 9 1983-10-10 16:40:00 24.9 26.9 12.7 0          1.5    1.5 1.33
#> 10 1983-10-10 16:50:00 24.9 27.2 12.7 0.000600    1.5    1.5 1.5
#> # ... with 530 more rows
```

2, Model using CTSM

```
ti_est <- tibble(
  name = c(
    "T1a0", "T1m0", "C1a", "C1m", "R1a",
    "R1m", "A1w", "p1", "p1a", "p1m", "e11"
  ),
  init = c(25, 25, 6, 12, 10, 1, 1, 0.5, 1, 1, -1),
  lb = c(0, 0, 1E-5, 1, 1, 1E-10, 1E-10, 0, -30, -30, -50),
  up = c(35, 35, 20, 50, 80, 10, 10, 1, 10, 10, 10)
)

li_mod <- list()

li_mod[[1]] <- tidynamics::set_mod_ctsm(
  c_expr_sys = c(
    d(T1a) ~ (
      1 / (C1a * R1m) * (T1m - T1a) + 1 / (C1a * R1a) * (Ta - T1a) +
      1 / C1a * Ph1 + p1 * A1w / C1a * Gv
    ) * d(t) + exp(p1a) / C1a * d(w1a),
    d(T1m) ~ (
      1 / (C1m * R1m) * (T1a - T1m) + (1 - p1) * A1w / C1m * Gv
    ) * d(t) + exp(p1m) / C1m * d(w1m)
  ),
  expr_obs = Y1 ~ T1a,
  expr_var = Y1 ~ exp(e11),
  c_input = c("Ta", "Ph1", "Gv"),
  ti_est = ti_est
)
```

3, Estimate the Model

4, Get State Space Model

```
li_mat_ss <-
  fit1 %>%
  tidynamics::trans_ctsm_ss()

li_mat_ss %>%
  print()
#> $a
#>           [,1]      [,2]
#> [1,] -4.7239320  4.6707253
#> [2,]  0.5298541 -0.5298541
#>
#> $b
#>           [,1]      [,2]      [,3]
```

```

#> [1,] 0.05320661 1.142277 2.6931338
#> [2,] 0.00000000 0.000000 0.3071376
#>
#> $c
#>      [,1] [,2]
#> [1,]    1    0
#>
#> $d
#>      [,1] [,2] [,3]
#> [1,]    0    0    0

```

```

li_mat_ss_d <-
  li_mat_ss %>%
  tidynamics::trans_mat_ss(ti_data = ti)

li_mat_ss_d %>%
  print()
#> $a
#>      [,1]      [,2]
#> [1,] 0.47520528 0.5185888
#> [2,] 0.05882948 0.9408721
#>
#> $b
#>      [,1]      [,2]      [,3]
#> [1,] 0.0062059616 0.133233952 0.32931116
#> [2,] 0.0002984526 0.006407391 0.06456796
#>
#> $c
#>      [,1] [,2]
#> [1,]    1    0
#>
#> $d
#>      [,1] [,2] [,3]
#> [1,]    0    0    0

```