R_0 figure for SARS-CoV-2 Random Walk Epidemiological Model

Andrew Chu[1], Greg Huber[1], Aaron McGeever[1], Boris Veytsman[2], and David Yllanes[1]

[1]Chan Zuckerberg Biohub, 499 Illinois Street, San Francisco, CA 94158, USA
[2]Chan Zuckerberg Initiative, 601 Marshall St, Redwood City, CA 94063, USA

ABSTRACT

Here we generate figures for the random walkers paper.

Setting things up:

```
opts_chunk$set(
    dev='tikz',
    cache=T
)
#options(tikzDefaultEngine='luatex')
library(tidyverse)

## - Attaching packages --------------------------- tidyverse 1.3.0 -
## v ggplot2 3.3.2     v purrr   0.3.4
## v tibble  3.0.3     v dplyr   1.0.2
## v tidyr   1.1.2     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.5.0
## - Conflicts ------------------------------ tidyverse_conflicts() -
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()

library(ggthemes)
theme_set(theme_bw())
```

Reading the data:

```
data <- read_csv("../data/R0griddata.csv.gz")

## Parsed with column specification:
## cols(
##   p = col_double(),
##   tau = col_double(),
##   r0 = col_double()
## )

data

## # A tibble: 340 x 3
##        p   tau    r0
##    <dbl> <dbl> <dbl>
##  1   0.1     1 0.101
##  2   0.2     1 0.199
##  3   0.3     1 0.3
##  4   0.4     1 0.399
##  5   0.5     1 0.501
##  6   0.6     1 0.601
```

```
##  7   0.7     1 0.701
##  8   0.8     1 0.8
##  9   0.9     1 0.898
## 10   1       1 0.999
## # ... with 330 more rows
```

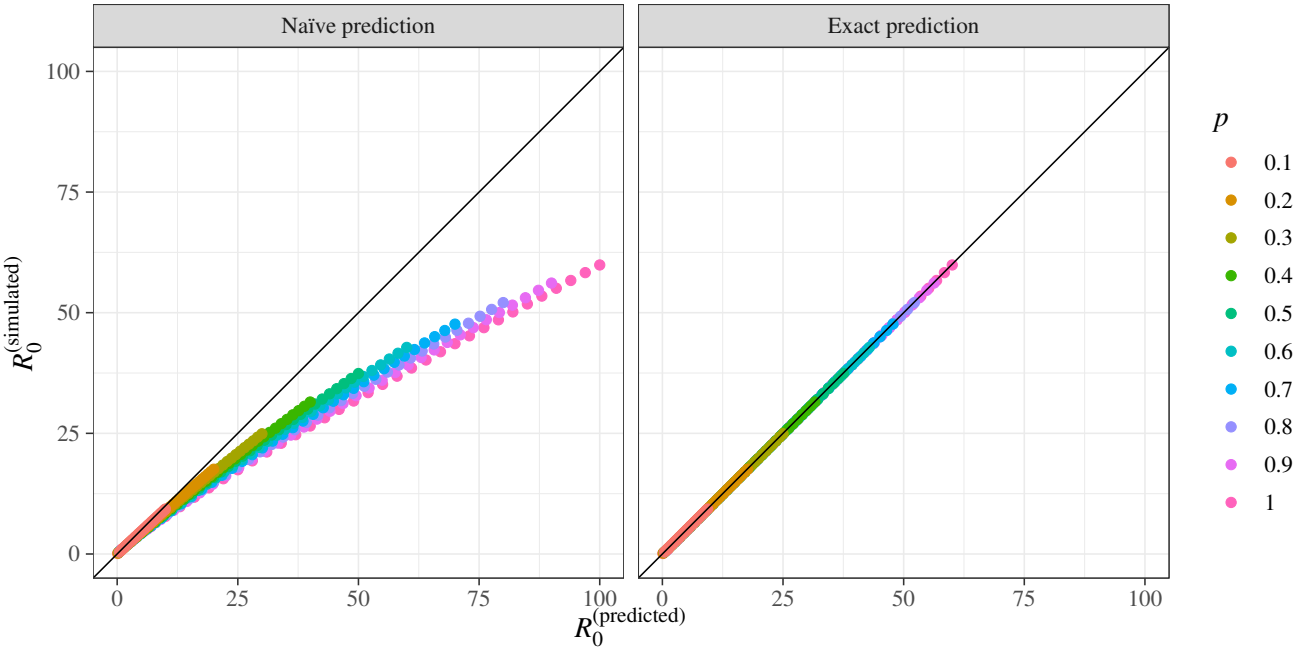
First, naïve prediction

```
data <- data %>% mutate(naive=p*tau)
```

Now, the theoretical prediction. Let us use zero adjustable parameters, taking c_2 from the structure factor and assuming $q_0 = 1$:

```
c2 <- 0.4575445
K <- 1/(4*pi*c2)
K

## [1] 0.1739229

tau0 <- 1/c2
tau0

## [1] 2.18558

data <- data %>% mutate(exact=p*tau/(1+K*p*log(tau/tau0))) %>%
    pivot_longer(cols=c('naive', 'exact'), names_to='type',
                 values_to='prediction') %>%
    mutate(type=factor(type, levels=c('naive', 'exact'),
                       labels=c('Na\\"ive prediction',
                       'Exact prediction')))
```

```
ggplot(data) + geom_point(aes(prediction,
    r0, color=as.factor(p))) +
    xlim(0,100) + ylim(0,100) +
    coord_fixed(ratio=1) +
    facet_wrap(~type, nrow=1) +
    geom_abline(intercept=0, slope=1) +
    xlab("$R_0^{\\text{(predicted)}}$") +
    ylab("$R_0^{\\text{(simulated)}}$") +
    labs(color="$p$")
```


Naïve prediction
Exact prediction
100
75
50
25
0
0
25
50
75
100
$R_0^{(simulated)}$
$R_0^{(predicted)}$
p
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1