Model V0.2 Equations

Note: ZZ is a prefix for model constants to facilitate the translation pipeline into R

The reason is to use a global space for the ode function, rather than passing all constants to the ode function directly. This allows for more flexibility in manipulating the environment sim_env.

(001) Actual Pulse Flag = PULSE TRAIN (ZZPulse Start Time , ZZPulse Duration , Pulse Repeat , ZZPulse End)
Units: Dmnl

(002) Additional ICU Places Required = max (0, Total Severe in NonICU Hospital - Total Severe in ICU)
Units: People

(003) AR1 = Awaiting Results 01 / ZZAverage Wait for Results
Units: People/Day

(004) ASI1 = Asymptomatic Infected 01 / (Net Infectious Period for Infection Compartments / 2)
Units: People/Day

(005) ASI2 = Asymptomatic Infected 02 / (Net Infectious Period for Infection Compartments / 2)
Units: People/Day

(006) Asymptomatic Infected 01 = INTEG(IP02a - ASI1 , 0)
Units: People
Model Equation (4) - Compartment 1

(007) Asymptomatic Infected 02 = INTEG(ASI1 - ASI2 , 0)
Units: People
Model Equation (4) - Compartment 2

(008) Asymptomatic Infectious Period = ZZIncubation Period C - ZZLatent Period L

Units: Day

(009) Awaiting Results 01 = INTEG(IP02c - AR1 , 0)
Units: People
Model Equation (6)

(010) Awaiting Results 02 = INTEG(AR1 - EntHos - EntRem , 0)
Units: People
Model Equation (7)

(011) Beta = Beta Intermediate * Physical Distancing Smoothed Value * Beta Pulse Reduction Factor

Units: 1/Day
Transmission parameter = R0/Total Infectious Period

(012) Beta From R0 = ZZR0 Input / (Numerator Term 1 + Numerator Term 2 + Numerator Term 3

)
Units: **undefined**

(013) Beta Intermediate = IF THEN ELSE (ZZR0 Fixed Flag = 1, Beta From R0
, ZZBeta Calibrated)
Units: **undefined**

(014) Beta Pulse Reduction Factor = 1 - Step (0.2, ZZSwitch Time)
Units: Dmnl
An assumption that there is limited social distancing during the
reopen phase

(015) C01 Total Infected Presymptomatic = Infected Presymptomatic 01 + Infected Presymptomatic 02

Units: People
Total Presymptomatic Infected (Subclinical infectious)

(016) C02 Total Asymptomatic Infected = Asymptomatic Infected 01 + Asymptomatic Infected 02

Units: People

(017) C03 Total Symptomatic Immediate Isolation Infectious = Symptomatic Immediate Isolation 01
+ Symptomatic Immediate Isolation 02
Units: People

(018) C04 Total Awaiting Results Infectious = Awaiting Results 01
Units: People

(019) C05 Total Isolated After Test Infected = Awaiting Results 02
Units: People

(020) C06 Total Not Quarantining Infected = Not Quarantine Infectious 01 +
Not Quarantine Infectious 02
Units: People

(021) CEICUE = Error Delta / ZZAT
Units: People/(Day*Day)

(022) Checksum Cumulative Flows = Cumulative Immediate Isolation + Cumulative Infectious Asymptomatic
+ Cumulative Not Quarantined + Cumulative Tests Positive
Units: People

(023) CheckSum Population = Susceptible + Total Exposed + Total Infectious
+ Total Removed + Total in Hospital
Units: People

(024) CPDSV = PDSVG / ZZPDAT
Units: Dmnl/Day

(025) Cumulative Immediate Isolation = INTEG(ICII , 0)
Units: People

(026) Cumulative Infectious Asymptomatic = INTEG(ICIA , 0)
Units: People

(027) Cumulative Model Infected = INTEG(ICI , 0)
Units: People
Keep track of the total number infected (cumulative)

(028) Cumulative Not Quarantined = INTEG(ICNQ , 0)
Units: People

(029) Cumulative Test Incidence = INTEG(ICTI , 0)
Units: People
Model Equation (10)

(030) Cumulative Tests Positive = INTEG(ICTP , 0)
Units: People

(031) E01 = Exposed 01 / (ZZLatent Period L / 2)
Units: People/Day
Exit rate from Exposed 01

(032) E02 = Exposed 02 / (ZZLatent Period L / 2)
Units: People/Day
Exit rate from Exposed 02

(033) EntHos = ZZProportion Hospitalised * Total Exiting AR02
Units: People/Day

(034) EntRem = (1 - ZZProportion Hospitalised) * Total Exiting AR02
Units: People/Day

(035) Error Delta = ICU02 - Expected ICU Exits
Units: People/Day

(036) EXH01a = ZZFraction in Risk Group * ZZFraction In Hospital Severe * Total Exiting Hospital 01

Units: People/Day

(037) EXH01b = (1 - ZZFraction In Hospital Severe) * Total Exiting Hospital 01

Units: People/Day

(038) EXH02 = In Hospital 02 / (ZZAverage HLOS / 3)
Units: People/Day

(039) EXH03 = In Hospital 03 / (ZZAverage HLOS / 3)
Units: People/Day

(040) Expected ICU Exits = INTEG(CEICUE , 0)
Units: People/Day

(041) Exposed 01 = INTEG(IR - E01 , 0)
Units: People
Model Equation (2) First Compartment

(042) Exposed 02 = INTEG(E01 - E02 , 0)
Units: People
Model Equation (2) Second Compartment

(043) FINAL TIME = 200
Units: Day
The final time for the simulation.

(044) ICI = IR
Units: People/Day

(045) ICIA = IP02a
Units: People/Day

(046) ICII = IP02b
Units: People/Day

(047) ICNQ = IP02d
Units: People/Day

(048) ICTI = AR1
Units: People/Day

(049) ICTP = IP02c
Units: People/Day

(050) ICU Available Space = ICU Daily Freed Up Space + ZZICU Available Capacity - Total Severe in ICU
Units: People

(051) ICU Daily Freed Up Space = Expected ICU Exits / ZZLag Time
Units: People

(052) ICU01 = Severe Cases ICU 01 / (ZZICU Residency Time / 2)
Units: People/Day

(053) ICU02 = Severe Cases ICU 02 / (ZZICU Residency Time / 2)
Units: People/Day

(054) IHS01 = min (ICU Available Space , Total Exiting Hospital Severe)
Units: People/Day

(055) IHS02 = Total Exiting Hospital Severe - min (ICU Available Space , Total Exiting Hospital Severe)
Units: People/Day

(056) In Hospital 01 = INTEG(EntHos - EXH01a - EXH01b , 0)
Units: People

(057) In Hospital 02 = INTEG(EXH01b - EXH02 , 0)
Units: People

(058) In Hospital 03 = INTEG(EXH02 - EXH03 , 0)
Units: People

(059) In Hospital Severe = INTEG(EXH01a - IHS01 - IHS02 , 0)
Units: People

(060) Infected Presymptomatic 01 = INTEG(E02 - IP01 , ZZNumber Seeds)
Units: People
Model Equation (3) - Compartment 1

(061) Infected Presymptomatic 02 = INTEG(IP01 - IP02a - IP02b - IP02c - IP02d
, 0)
Units: People
Model Equation (3) - Compartment 2

(062) INITIAL TIME = 1
Units: Day
The initial time for the simulation.

(063) IP01 = Infected Presymptomatic 01 / (Asymptomatic Infectious Period
/ 2)
Units: People/Day
Exit rate from Infected Presymptomatic 01

(064) IP02 Outflow Total Exiting Checksum = IP02a + IP02b + IP02c + IP02d
Units: People/Day

(065) IP02a = Total Exiting IP02 * ZZProportion Asymptomatic f
Units: People/Day

(066) IP02b = Total Exiting IP02 * (1 - ZZProportion Asymptomatic f) * ZZProportion Quarantined q

Units: People/Day

(067) IP02c = Total Exiting IP02 * (1 - ZZProportion Asymptomatic f) * ZZProportion Tested t

Units: People/Day

(068) IP02d = Total Exiting IP02 * (1 - ZZProportion Asymptomatic f) * (
1 - ZZProportion Tested t - ZZProportion Quarantined q)
Units: People/Day

(069) IR = Lambda * Susceptible
Units: People/Day
Infection rate (indicence) in the population

(070) Lambda = ((Beta * C01 Total Infected Presymptomatic) + (Beta * ZZBeta Multiplier h
* ZZBeta Multiplier k * C02 Total Asymptomatic Infected) +
(Beta * ZZBeta Multiplier i * C03 Total Symptomatic Immediate Isolation Infectious
) + (Beta * C04 Total Awaiting Results Infectious) + (Beta
* ZZBeta Multiplier j * C05 Total Isolated After Test Infected)
+ (Beta * C06 Total Not Quarantining Infected)) / ZZTotal Population

Units: 1/Day
Force of infection, with contributions from all of the infected

compartments.

(071) Net Infectious Period for Infection Compartments = ZZTotal Infectious Period D + ZZLatent Period L - ZZIncubation Period C
Units: Day

(072) Not Quarantine Infectious 01 = INTEG(IP02d - NQI1 , 0)
Units: People
Model Equation (8) - Compartment 1

(073) Not Quarantine Infectious 02 = INTEG(NQI1 - NQI2 , 0)
Units: People
Model Equation (8) - Compartment 2

(074) NQI1 = Not Quarantine Infectious 01 / (Net Infectious Period for Infection Compartments / 2)
Units: People/Day

(075) NQI2 = Not Quarantine Infectious 02 / (Net Infectious Period for Infection Compartments / 2)
Units: People/Day

(076) Numerator Term 1 = (ZZIncubation Period C - ZZLatent Period L) * (- ZZProportion Asymptomatic f * ZZBeta Multiplier h + (ZZProportion Asymptomatic f - 1) * (ZZBeta Multiplier i - 1) * ZZProportion Quarantined q + ZZProportion Asymptomatic f)
Units: Dmnl

(077) Numerator Term 2 = (ZZProportion Asymptomatic f - 1) * (ZZBeta Multiplier j - 1) * ZZProportion Tested t * (ZZIncubation Period C - ZZLatent Period L + ZZAverage Wait for Results)
Units: **undefined**

(078) Numerator Term 3 = ZZTotal Infectious Period D * (ZZProportion Asymptomatic f * (ZZBeta Multiplier h - ZZBeta Multiplier i * ZZProportion Quarantined q - ZZBeta Multiplier j * ZZProportion Tested t + ZZProportion Quarantined q + ZZProportion Tested t - 1) + (ZZBeta Multiplier i - 1) * ZZProportion Quarantined q + (ZZBeta Multiplier j - 1) * ZZProportion Tested t + 1)
Units: **undefined**

(079) PDSVG = Physical Distancing Fractional Reduction Amount - Physical Distancing Smoothed Value

Units: Dmnl

(080) Physical Distancing Fractional Reduction Amount = IF THEN ELSE (Pulse Policy = 1 :OR: ZZDistancing Flag = 1, 1 - ZZPercentage Reduction of Physical Distancing , 1)
Units: Dmnl
If any policy is active, physical distancing occurs

(081) Physical Distancing Smoothed Value = INTEG(CPDSV , 1)
Units: Dmnl

(082) Population Attack Rate = Total Removed / ZZTotal Population
Units: Dmnl

(083) Pulse Policy = ZZPulse Strategy Flag * Actual Pulse Flag
Units: Dmnl
The overall policy

(084) Pulse Repeat = ZZPulse Duration + ZZPulse Off Duration
Units: Day
The lag time between pulse peaks

(085) R0 = (Numerator Term 1 + Numerator Term 2 + Numerator Term 3) * Beta

Units: **undefined**

(086) Removed Asymptomatic = INTEG(ASI2 , 0)
Units: People
Model Equation (9) - First Term

(087) Removed Awaiting Results = INTEG(EntRem , 0)
Units: People
Model Equation (9) - Third Term

(088) Removed Hospital = INTEG(EXH03 , 0)
Units: People

(089) Removed Not Quarantine = INTEG(NQI2 , 0)
Units: People
Model Equation (9) - Fourth Term

(090) Removed Severe Cases Hospital = INTEG(SCH02 , 0)
Units: People

(091) Removed Severe Cases ICU = INTEG(ICU02 , 0)
Units: People

(092) Removed Symptomatic Immediate Isolation = INTEG(SII02 , 0)
Units: People
Model Equation (9) - Second Term

(093) Reported Incidence = AR1
Units: People/Day

(094) SAVEPER = TIME STEP
Units: Day
The frequency with which output is stored.

(095) SCH01 = Severe Cases Hospital 01 / (ZZAverage HLOS / 2)
Units: People/Day

(096) SCH02 = Severe Cases Hospital 02 / (ZZAverage HLOS / 2)
Units: People/Day

(097) Severe Cases Hospital 01 = INTEG(IHS02 - SCH01 , 0)
Units: People

(098) Severe Cases Hospital 02 = INTEG(SCH01 - SCH02 , 0)
Units: People

(099) Severe Cases ICU 01 = INTEG(IHS01 - ICU01 , 0)
Units: People

(100) Severe Cases ICU 02 = INTEG(ICU01 - ICU02 , 0)
Units: People

(101) SII01 = Symptomatic Immediate Isolation 01 / (Net Infectious Period for Infection Compartments / 2)
Units: People/Day

(102) SII02 = Symptomatic Immediate Isolation 02 / (Net Infectious Period for Infection Compartments / 2)
Units: People/Day

(103) Susceptible = INTEG(- IR , ZZTotal Population - ZZNumber Seeds)
Units: People
Model Equation (1)

(104) Symptomatic Immediate Isolation 01 = INTEG(IP02b - SII01 , 0)
Units: People
Model Equation (5) - Compartment 1

(105) Symptomatic Immediate Isolation 02 = INTEG(SII01 - SII02 , 0)
Units: People
Model Equation (5) - Compartment 2

(106) Test = 0 + Step (1, 20)
Units: **undefined**

(107) TIME STEP = 0.125
Units: Day
The time step for the simulation.

(108) Total Exiting AR02 = Awaiting Results 02 / (max (1, Net Infectious Period for Infection Compartments - ZZAverage Wait for Results))
Units: People/Day

(109) Total Exiting Hospital 01 = In Hospital 01 / (ZZAverage HLOS / 3)
Units: People/Day

(110) Total Exiting Hospital Severe = In Hospital Severe / ZZRTime Severe
Units: People/Day

(111) Total Exiting IP02 = Infected Presymptomatic 02 / (Asymptomatic Infectious Period / 2)
Units: People/Day
Total exit rate from Infected Presymptomatic 02

(112) Total Exposed = Exposed 01 + Exposed 02
Units: People

(113) Total Hospitalised = In Hospital 01 + In Hospital 02 + In Hospital 03

Units: People

(114) Total in Hospital = Total in Hospital Non Severe + Total Severe in NonICU Hospital + Total Severe in ICU + In Hospital Severe
Units: People

(115) Total in Hospital Non Severe = In Hospital 01 + In Hospital 02 + In Hospital 03

Units: People

(116) Total Infectious = C01 Total Infected Presymptomatic + C02 Total Asymptomatic Infected + C03 Total Symptomatic Immediate Isolation Infectious + C04 Total Awaiting Results Infectious + C05 Total Isolated After Test Infected + C06 Total Not Quarantining Infected

Units: People

(117) Total Removed = Removed Asymptomatic + Removed Awaiting Results + Removed Hospital + Removed Not Quarantine + Removed Severe Cases Hospital + Removed Severe Cases ICU + Removed Symptomatic Immediate Isolation
Units: People

(118) Total Severe in Hospital = Total Severe in ICU + Total Severe in NonICU Hospital

Units: People

(119) Total Severe in ICU = Severe Cases ICU 01 + Severe Cases ICU 02
Units: People

(120) Total Severe in NonICU Hospital = Severe Cases Hospital 01 + Severe Cases Hospital 02

Units: People

(121) ZZAT = 1
Units: Day

(122) ZZAverage HLOS = 15
Units: Day

(123) ZZAverage Wait for Results = 3.16
Units: Day

(124) ZZBeta Calibrated = 0.91
Units: 1/Day
Beta value calibrated to Irish data

(125) ZZBeta Multiplier h = 0.11
Units: Dmnl
Multiplicative factor for reduction in infectiousness of asymptomatic infected compartment

(126) ZZBeta Multiplier i = 0.07
Units: Dmnl
Multiplier on isolation compartment

(127) ZZBeta Multiplier j = 0.0612326
Units: Dmnl

(128) ZZBeta Multiplier k = 1
Units: Dmnl

(129) ZZDistancing Flag = (0 + Step (1, ZZDistancing Start Time) - Step (1, ZZSwitch Time)) * ZZDistancing Switch
Units: Dmnl
Whether or not physical distancing is being implemented

(130) ZZDistancing Start Time = 20
Units: Day
Start time for physical distancing

(131) ZZDistancing Switch = 1
Units: Dmnl
A switch that activates physical distancing

(132) ZZFraction In Hospital Severe = 0
Units: Dmnl

(133) ZZFraction in Risk Group = 0
Units: Dmnl

(134) ZZICU Available Capacity = 250
Units: People

(135) ZZICU Residency Time = 10
Units: Day

(136) ZZIncubation Period C = 5.79
Units: Day
Duration of time at incubation stage

(137) ZZLag Time = 1
Units: 1/Day

(138) ZZLatent Period L = 3.58
Units: Day
Duration of time in incubation stage

(139) ZZNumber Seeds = 1
Units: People
Number of seeds initially importing the virus

(140) ZZPDAT = 4
Units: Day

(141) ZZPercentage Reduction of Physical Distancing = 0.6
Units: Dmnl

(142) ZZProportion Asymptomatic f = 0.25
Units: Dmnl
Proportion of infected who show symptoms

(143) ZZProportion Hospitalised = 0
Units: Dmnl

(144) ZZProportion Quarantined q = 0.21
Units: Dmnl
Proportion quarantined

(145) ZZProportion Tested t = 0.55
Units: Dmnl

(146) ZZPulse Duration = 21
Units: Day
The duration of the pulsed social distancing

(147) ZZPulse End = 300
Units: Day

(148) ZZPulse Off Duration = 10
Units: **undefined**
The duration when the policy is off (i.e. social distancing is relaxed)

(149) ZZPulse Start Time = ZZSwitch Time + ZZPulse Off Duration
Units: Day
The start time for the pulse strategy

(150) ZZPulse Strategy Flag = (0 + Step (1, ZZSwitch Time + ZZPulse Off Duration)) * ZZPulse Switch
Units: Dmnl
Whether or not the pulse startegy is enabled. It will start after the physical distancing has ended (following an initial lag)

(151) ZZPulse Switch = 0
Units: Dmnl

A switch to activate the pulse policy

(152) ZZR0 Fixed Flag = 0
Units: **undefined**

(153) ZZR0 Input = 2.8
Units: **undefined**

(154) ZZRTime Severe = 1
Units: Day

(155) ZZSwitch Time = 200
Units: Day
The time that continuous physical distancing ends

(156) ZZTotal Infectious Period D = 5.46
Units: Day
Duration of infectiousness

(157) ZZTotal Population = 4.99997e+06
Units: People
Total Population at outset of epidemic