

## Lesson 17. Attributes and User-Defined Distributions in ProModel

### 1 Last time

- Haircut times are exactly 10 minutes
  - Select Build → Processing, change the operation of “Customer” at “Dan” to “WAIT 10”
- Fantastic Dan’s shop has 2 hair stylists – assuming they are identical
  - Select Build → Locations, change the capacity of “Dan” to 2
- Idealized queue:
  - In Build → Entities, change the speed of “Customer” to “INFINITE”
  - In Build → Locations, double-click on the queue in the Layout window and change the queue length to 0

### 2 Today...

- Let’s look at the following modification of Fantastic Dan’s problem

**Problem 1.** Customers visit the neighborhood hair stylist Fantastic Dan for haircuts. The customer interarrival time is exponentially distributed with mean 9 minutes. 60% of the customers want a regular haircut, and 40% want a deluxe haircut. Regular haircuts take Fantastic Dan anywhere from 7 to 15 minutes, uniformly distributed. The time for a deluxe haircut is distributed according to the following probability distribution:

Deluxe haircut time (min)	16	20	24
Probability	0.20	0.50	0.30

How many customers spend more than 30 minutes at Fantastic Dan’s?

- The ProModel file for today’s lesson contains the model we constructed for the original Fantastic Dan problem (changed to have idealized queue settings)
- In addition, there is a global variable “Wait more than 30 mins” defined (without icon)
- How can we modify the model to take into account these changes?

### 3 Attributes

- An **attribute** is a variable attached to a location or an entity
  - e.g. the type of haircut for each customer that arrives
- Define an attribute for the haircut type each customer wants
  - Select Build → Attributes

- Create a new attribute with ID “haircut type”; set Type to Integer, Classification to Entity
- We will let haircut type = 0 for regular, 1 for deluxe; use the Notes field to document this
- Define an attribute for the arrival time of each customer (to determine if the customer spends more than 30 minutes at the shop)
  - Create a new attribute with ID “arrival time”; set Type to Real, Classification to Entity

#### 4 User defined distributions

- ProModel has the “standard” probability distributions built-in
- What about entering our own? (e.g. haircut type desired, deluxe haircut times)
- Define the probability distribution for haircut type
  - Select Build → More Elements → User Distributions
  - Create a new distribution with ID “haircut type dist”; set Type to Discrete, Cumulative to No, and click Table...
  - Enter the probability distribution (60% ↔ 0, 40% ↔ 1)
    - ◊ Note that you need to enter percentages, not probabilities
- Do the same for deluxe haircut time; call it “deluxe haircut time dist”

#### 5 Changing an attribute’s value

- When a customer arrives, we need to: (i) determine its haircut type and (ii) record its arrival time
  - Select Build → Arrivals
  - Modify the logic of the “Customer” arriving at “Queue” as follows:
 

```
haircut_type = haircut_type_dist()
arrival_time = CLOCK(MIN)
```
- When a customer is served, we need to: (i) process it for the right amount of time, and (ii) record whether it was at the shop for more than 30 minutes

- Select Build → Processing
- Modify the operation of the “Customer” at “Dan” as follows:

```
IF haircut_type = 0 THEN {
  WAIT U(11,4,2)
} ELSE {
  WAIT deluxe_haircut_time_dist(3)
}
IF CLOCK(MIN) - arrival_time > 30 THEN {
  INC Wait_more_than_30_mins
}
```