1a)

$$P(Y|X) = \frac{P(YX)}{P(X)}; \text{definition of conditional probability}$$
$$= \frac{P(X|Y)P(Y)}{P(X)}; \text{chain rule}$$

1c)

$$P(Y|x_1, x_2, ..., x_{|w|}) = \frac{P(Y, x_1, x_2, ..., x_{|w|})}{P(x_1, x_2, ..., x_{|w|})}; \text{definition of multivariate conditional probability}$$
$$= \frac{P(x_1, x_2, ..., x_{|w|}|Y)P(Y)}{P(x_1, x_2, ..., x_{|w|})}; \text{chain rule}$$

1d)

$$P(Y) = \frac{|\{m|m \text{ is a movie on IMDB that was released in year } Y\}|}{|\{m|m \text{ is a movie on IMDB}\}|}$$
$$P(Y|x_i) = \frac{|\{r|r \text{ is a review where word } i \text{ appears } x_i \text{ times and } r\text{'s movie was released in year } Y\ \}|}{|\{r|r \text{ is an IMDB review where word } i \text{ appears } x_i \text{ times}\}|}$$
$$P(x_i|Y) = \frac{|\{r|r \text{ is a review where word } i \text{ appears } x_i \text{ times and } r\text{'s movie was released in year } Y\ \}|}{P(Y)}$$

1e)

$$P(Y|x_1, x_2, ..., x_{|w|}) = \frac{P(x_1, x_2, ..., x_{|w|}|Y)P(Y)}{P(x_1, x_2, ..., x_{|w|})}; \text{Bayes Rule}$$
$$= \frac{P(x_1|Y)(P(x_2, ..., x_{|w|}|Y, x_1)P(Y)}{P(x_1, x_2, ..., x_{|w|})}; \text{chain rule}$$
$$...$$
$$= \frac{P(Y)}{P(x_1, x_2, ..., x_{|w|})} \prod_{i=1}^{|w|} P(x_1, x_2, ..., x_i|Y, x_1, x_2, ..., x_{i-1})$$

1i)

$$P(Y|x_1, x_2, ..., x_{|w|}) = \frac{P(Y)}{P(x_1, x_2, ..., x_{|w|})} \prod_{i=1}^{|w|} P(x_1, x_2, ..., x_i|Y, x_1, x_2, ..., x_{i-1})$$
$$= \frac{P(Y)}{P(x_1, x_2, ..., x_{|w|})} \prod_{i=1}^{|w|} P(x_i|Y)$$