Teaching Pack:
Teaching Prototypes for Decision Analysis

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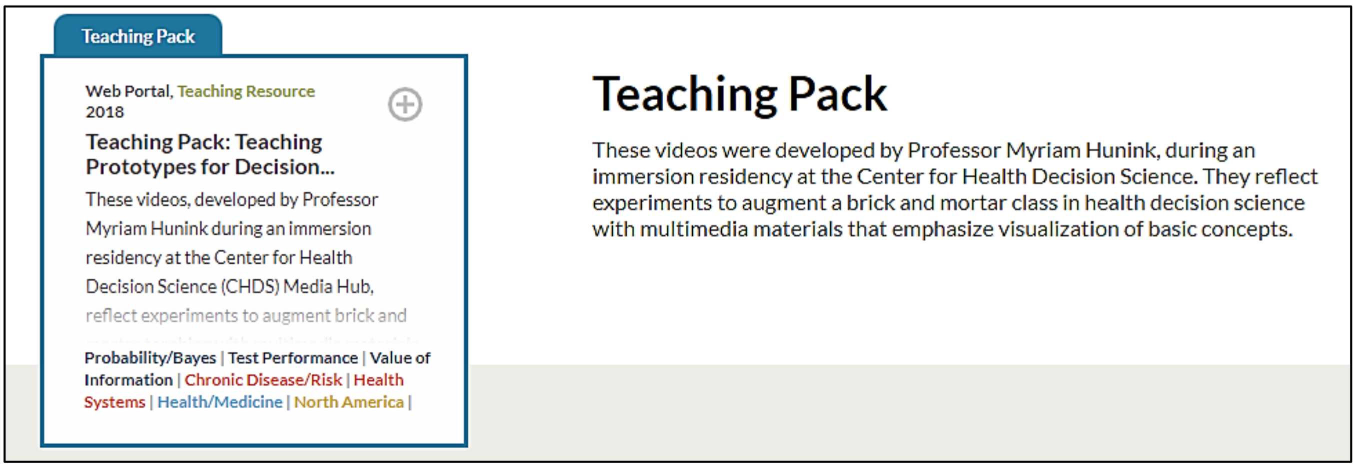
Overview



These videos, developed by Professor Myriam Hunink during an immersion residency at the Center for Health Decision Science (CHDS) Media Hub, reflect experiments to augment brick and mortar teaching with multimedia materials that emphasize visualization of basic concepts.

The first video introduces decision making under uncertainty, and illustrates the use of probability and odds to quantitatively express uncertainty. The second and third videos introduce probability revision visually and analytically, showing how an initial probability is influenced by new diagnostic information through the use of Bayes' theorem in two formats. In the fourth, fifth and sixth videos, Professor Hunink introduces the concepts of "thresholds" at which one would decide to treat, not treat, or obtain information, using graphical and analytical approaches. In the final video, she introduces ROC curves.

Learning Design Note

Hunink's residency was motivated by three factors. First, teaching techniques she used in the brick-and-mortar classroom did not always translate well to an online medium, such as video. Second, learners in her online classes were more heterogeneous in their quantitative backgrounds, with very different comfort levels using the formal language of mathematics (e.g., nomenclature and equations). Third, she was inspired by the video style created by the CHDS Media Hub that create more "connection" to learners and provide opportunities for active learner engagement in activities such as sketching, drawing, and using manipulatables.

Hunink worked with Media Hub leader Jake Waxman to experiment with new ways of visualizing mathematical concepts with the goal of providing novel articulations of content as alternative learning pathways for students. The media prototypes include (1) simulation of mathematical functions with a manipulatable graph using yarn tacked to a whiteboard with color-coded cue cards, (2) signposting with colors, shapes, and outlines, with attention to spatial and temporal contiguity, to manage cognitive load, and (3) arranging color-coded beans to express odds and probabilities.

More about Professor Hunink

Myriam Hunink, MD, PhD is a Professor of Clinical Epidemiology & Radiology and Director of the Netherlands Institute for Health Sciences, at Erasmus University Medical Center, Rotterdam, the Netherlands, and Adjunct Professor of Health Decision Sciences at Harvard T.H. Chan School of Public Health. Her vision is to optimize medical decisions by combining the best-available quantitative evidence on risks and benefits and integrating patient values, preferences, quality of life, and costs.

Filming and editing credits: Jake Waxman

Selected Resources – At a Glance

Video. Probabilities and Odds: Teaching Prototype
Probabilities and Odds: Teaching Prototype. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607945/2dd655433c55433c

Video. Bayes with Beans: Teaching Prototype
Bayes with Beans: Teaching Prototype. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607953/d0592a55a8

Video. Bayes Theorem with Odds and LR's: Teaching Prototype
Bayes Theorem with Odds and LR's. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607957/fac8283e7c

Video. To Treat or Not to Treat: Teaching Prototype
To Treat or Not to Treat: Teaching Prototype. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607959/3e58983b3e

Video. To Test or Not to Test I: The Value of Perfect Information
To Test or Not to Test I: The Value of Perfect Information. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607962

Video. To Test or Not to Test II: The Value of Imperfect Information
To Test or Not to Test II: The Value of Imperfect Information. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607966/d1a2ac43c6

Video. ROC Curves: Teaching Prototype
ROC Curves: Teaching Prototype. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607964/040d28bbbf

Annotated Bibliography

Video. Probabilities and Odds: Teaching Prototype
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https://vimeo.com/236607945/2dd655433c55433c
CHDS repository link: http://repository.chds.hsph.harvard.edu/repository/2576
In this video, Professor Myriam Hunink emphasizes the importance of uncertainty in the context of decision making in clinical medicine and health policy. Using the example of a 55-year-old woman with exertional chest pain, she poses the question, what is the chance, or probability, that she has underlying coronary artery disease, and how does that relate to our decision making process?

Access the video. Probabilities and Odds: Teaching Prototype (~6 min)

Students learn that odds and probability are two different ways to describe the chance of an event occurring, and visualize the relationship between probability and odds. The quantitative language and underlying theory of probability will allow us to formally incorporate uncertainty in our decision making processes where the benefits and risks of different alternatives are identified, measured and valued.

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Video. Bayes with Beans: Teaching Prototype
Bayes with Beans: Teaching Prototype. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607953/d0592a55a8
CHDS repository link: http://repository.chds.hsph.harvard.edu/repository/2577
In this video, Professor Myriam Hunink introduces the concept of "diagnostic Bayesian thinking" through a simple example and a visual representation using beans! Students consider how an initial probability or belief is influenced by new diagnostic information through the use of Bayes' theorem.

Access the video. Bayes with Beans: Teaching Prototype (~14 min)

Using the example of a tick bite after a walk through the woods, she asks you to imagine sitting in a doctor's office with 99 other patients just like yourself, all worried about tick bites and the possibility of Lyme disease. What will the physician do? Treat everybody with antibiotics? Perform a diagnostic test? Wait and monitor without testing or treating?

Students learn how to combine information about the prior probability with diagnostic information that is not perfect, to calculate two "post-test" probabilities of disease – the probability of disease given a positive test and the probability of disease given a negative test. Professor Hunink differentiates conditional probabilities that are test characteristics (e.g., the probability of a positive test given disease positive or sensitivity) from conditional probabilities that provide information helpful for clinical decision making or post-test probabilities (e.g., probability of disease given a positive test, and probability of disease given a negative test).

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Video. Bayes Theorem with Odds and LR's: Teaching Prototype
Bayes Theorem with Odds and LR's. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607957/fac8283e7c
CHDS repository link: http://repository.chds.hsph.harvard.edu/repository/2578
In this video, Professor Myriam Hunink walks through an analytic approach to probability revision using the Odds-LR form of Bayes. Students consider how an initial probability or belief is influenced by new diagnostic information through the use of Bayes' theorem.

Access the video. Bayes Theorem with Odds and LR's: Teaching Prototype (~9 min)

Using the example of 100 patients with a tick bite and suspected Lyme disease, Professor Hunink visually maps out the prior odds of disease and reviews the use of likelihood ratios to describe test performance. In this case, assuming a dichotomous test, we are concerned about two likelihood ratios - the likelihood ratio for a positive test (LR+) and the likelihood ratio for a negative test (LR-). She derives the equation, posterior odds = prior odds x LR, otherwise known as the "Odds-LR form of Bayes". The video concludes with reflection on the influence of the likelihood ratio positive and negative on the posterior or post-test odds of disease.

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Video. To Treat or Not to Treat: Teaching Prototype
To Treat or Not to Treat: Teaching Prototype. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607959/3e58983b3e
CHDS repository link: http://repository.chds.hsph.harvard.edu/repository/2579
In this video, Professor Myriam Hunink begins with "To treat or not to treat, that is the question..." Students are reminded of the influential factors in clinical decision making, such as the prior probability of disease, the benefits of treatment, and the harms of treatment.

Access the video. To Treat or Not to Treat: Teaching Prototype (~12 min)

Professor Hunink introduces the concept of thresholds. In this particular case, the threshold of interest is defined as the "probability of disease" above which you would treat and below which you would not treat. Students derive an explicit equation to calculate this threshold. That equation can be used to calculate the threshold probability above which action (e.g., treat) is indicated and below which inaction (e.g., do not treat) is best.

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Video. To Test or Not to Test I: The Value of Perfect Information
To Test or Not to Test I: The Value of Perfect Information. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607962
CHDS repository link: http://repository.chds.hsph.harvard.edu/repository/2580
In this video, Professor Myriam Hunink asks students to think beyond a decision to treat or not to treat, and to consider a third alternative or option - to test and get more information. In this case, the test information is assumed to be perfect. Students are reminded of the influential factors in clinical decision making, such as the prior probability of disease, the benefits of treatment, and the harms of treatment.

Access the video. To Test or Not to Test I: The Value of Perfect Information (~15 min)

Students are prompted to consider a hypothetical patient with exertional chest pain that presents to a clinical practice. As the clinician decides whether to test or not test, they incorporate what they learn from the history and physical exam with what they know about the underlying probability of disease in similar patients, and weigh the potential benefits and risks of doing a diagnostic test.

The diagnostic test you are asked to consider is perfect but it will pose a small but real risk. Professor Hunink uses a white board mounted on a bulletin board with colored strings to geometrically display and derive the no treat-test threshold and the test-treat threshold for a test that provides perfect information.

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Video. To Test or Not to Test II: The Value of Imperfect Information
To Test or Not to Test II: The Value of Imperfect Information. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607966/d1a2ac43c6
CHDS repository link: http://repository.chds.hsph.harvard.edu/repository/2581
In this video, Professor Myriam Hunink asks students to think beyond a decision to treat or not to treat, and to consider a third alternative or option - to test and get more information. In this case, the test information is assumed to be imperfect.

Access the video. To Test or Not to Test II: The Value of Imperfect Information (~20 min)

Professor Hunink shares the story of a colleague who was at the recommended age for colon cancer screening with a colonoscopy. As a radiologist, he preferred a CT virtual colonoscopy to avoid the endoscopic procedure. Although no abnormal findings were detected in the colon, other abnormalities were revealed in other organs. What should the clinician responsible do? In essence, there are three alternatives - take action, do not take action, and get more information.

Leveraging this example, Professor Hunink graphically illustrates thresholds for a test that delivers imperfect information. Students are reminded of the influential factors in clinical decision making, such as the prior probability of disease, the benefits of treatment, and the harms of treatment - and in this context, they now also consider test characteristics and the consequences of the false positives compared with the true negatives (i.e., potential harms), and the consequences of false negatives compared with the true positives (i.e., foregone benefits of treatment).

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Video. ROC Curves: Teaching Prototype
ROC Curves: Teaching Prototype. Teaching Pack: Teaching Prototypes for Decision Analysis. Center for Health Decision Science, Harvard T.H. Chan School of Public Health 2018.
https://vimeo.com/236607964/040d28bbbf
CHDS repository link: http://repository.chds.hsph.harvard.edu/repository/2582
In this video, ROC curves, Professor Myriam Hunink introduces students to tests with continuous or categorical results. In contrast to a test with dichotomous results (e.g., positive versus negative), she poses a scenario in which a test has multiple possible results.

Access the video. ROC Curves: Teaching Prototype (~20 min)

Professor Hunink asks students to consider a CT coronary artery calcium for the diagnosis of cardiovascular disease. She explains that a high score is more abnormal than a low score - but provides data from a study group of patients with results separated into three categories. Using the data from this study group, students learn how to calculate a likelihood ratio for a specific "test result" when there are multiple results.

An ROC curve is defined and plotted, and the conceptual basis for a "lenient" and "strict" zone of the ROC curve explained. Professor Hunink walks through the implications of a 'cutoff point' for a test with continuous results, or in this case, the implications of calling a particular test category result, "positive" or "negative", for which "positive" would indicate "treat" and "negative" would indicate "do not treat". Students acquire an introduction to the factors that influence an optimal positivity criterion of the test variable - recognizing these include the prior probability of disease, the test performance, and the harm to benefit ratio of treatment.

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